01.00.00 Physico-mathematical sciences

01.00.00 Физико-математические науки

UDC 004

Cloud Computing and Some Scenarios for its Application in Universities

[1] Cigdem Selcukcan Erol
[2] Elif Kartal Karatas
[3] Zeki Ozen
[4] Sevinc Gulsecen

[1-4] Istanbul University, Turkey
Department of Informatics, Beyazit, 34452, Istanbul
[1] PhD (Biology), Assistant Professor
E-mail: cigdems@istanbul.edu.tr
[2] Msc (Informatics), Research Assistant
E-mail: elifk@istanbul.edu.tr
[3] Msc (Informatics), Research Assistant
E-mail: zekiozen@istanbul.edu.tr
[4] PhD (Business Administration), Professor
E-mail: gulsecen@istanbul.edu.tr

ABSTRACT. Cloud computing is a new technology and a new trend. In recent years most of organisations start to choose their cloud models. The educational institutions, especially universities, cannot ignore the huge amount of benefits that cloud computing may bring them. In this paper, we are explaining in details the concept of cloud computing, its models and usage areas, its working principle, its advantages and disadvantages. We specifically focus on its importance for universities by giving examples for its implementation in e-Learning.

Keywords: Cloud Computing; IT Services; Cloud Computing in Universities; e-Learning.

1. INTRODUCTION

Cloud computing, which is one of the new generation information technologies, becomes more popular day by day in most countries. Recently, organizations try to answer questions such as "What is cloud computing?", "What are the pros and cons of cloud computing?", "Is implementing cloud computing appropriate for our organization?". According to a study by McKinsey (the global management consulting firm), there are 22 possible separate definitions of cloud computing (Sultan, 2010).

Cloud computing refers to both the applications delivered as services over the Internet and the hardware and systems software in the data centers that provide those services (Armbrust et. al, 2009). Moreover cloud computing is based on delivering Internet-based information and technology services in real time. This is the most important feature of a cloud system (Kuyucu, 2011). According to Ercan (2010) cloud computing is a kind of computing which is highly scalable and use virtualized resources that can be shared by the users; they do not need any background knowledge of the services.

The term "cloud" was probably inspired by IT text books' illustrations which depicted remote environments (e.g., the Internet) as cloud images in order to conceal the complexity that lies behind them (Sultan, 2010).

The emergence of the phenomenon commonly known as cloud computing represents a fundamental change in the way IT services are invented, developed, deployed, scaled, updated, maintained and paid for (Marston, 2011). Clouds, or clusters of distributed computers, provide on-demand resources and services over a network, usually the Internet, with the scale and reliability of a data center (Grossman, 2009). More sophisticated clouds also provide useful datasets (e.g., genomic or census data), management capabilities, programming environments (e.g., Net in Microsoft Azure), web service platforms (e.g., Google App Engine) or access to particular applications (Rosenthal et al., 2010). As higher education faces budget restrictions and sustainability challenges, one approach to relieve these pressures is cloud computing (Sasikala and Prema, 2010).

In this paper, by extensive review of literature, we are explaining the concept of cloud computing in details, its models and usage areas, its working principle, its advantages and disadvantages. We specifically focus on its importance for universities by giving examples for its implementation in e-Learning.

2. DEFINITION AND MODELS OF CLOUD COMPUTING

The U.S. National Institute of Standards and Technology (NIST) defines cloud computing 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 (Mell and Grance, 2011). This model promotes availability and is composed of five essential characteristics: On-demand self-service, broad network access, resource pooling, rapid elasticity and measured service. Cloud computing has three service models: Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS). Additionally it has four deployment models: Private cloud, community cloud, public cloud and hybrid cloud.

According to literature (Mell and Grance, 2011; Kuyucu, 2011; Sultan, 2010), we can summarize the essential characteristics, service models and deployment models as below:

- *Essential Characteristics*

On-Demand Self-Service: A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service's provider.

Broad Network Access: Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g.,mobile phones, laptops, and PDAs).

Resource Pooling: The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the consumer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, network bandwidth, and virtual machines.

Rapid Elasticity: Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out, and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.

Measured Service: Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

- *Service Models*

Software as a Service (SaaS): The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as a web browser (e.g., web-based email).

Platform as a Service (PaaS): The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider.

Infrastructure as a Service (IaaS): The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications.

- *Deployment Models*

Private Cloud: The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise.

Community Cloud: The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise.

Public Cloud: The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.

Hybrid Cloud: The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

3. THE ESSENTIALS of Cloud Computing

The central idea of cloud computing is that data centers are scattered around the whole world having world of computers and you run your programs, stores data, use services at somewhere out there but you don't know where and also don't care where (Jangra and Bala, 2011).

3.1 Where it is usedand How It Works?

As it is seen in Figure 1, compared to other sectors,cloud computing is being used more in the areas of finance and business (Gartner, 2009; Ercan, 2010).

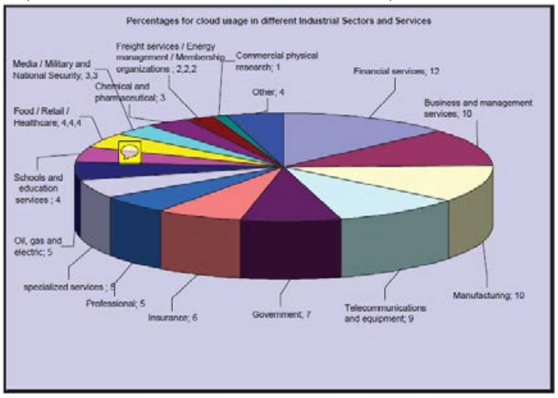

Figure 1: The Percentages of Cloud Computing Usage (Gartner, 2009; Ercan, 2010)

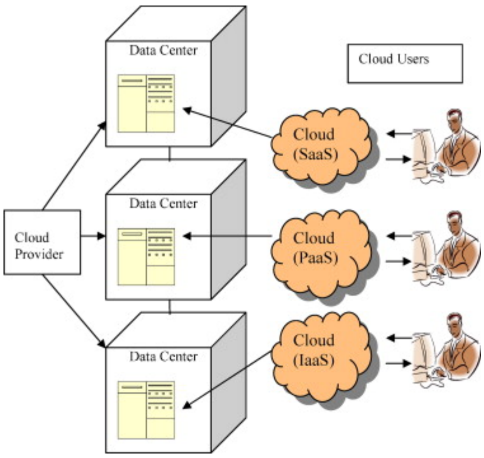

Figure 2: A simple representation of information communication via cloud computing (Sultan, 2011).

Figure 2 gives a simplified pictorial impression of how cloud computing works. A cloud provider maintains a number of data centers (possibly scattered in different parts of the world and inter-connected) stocked with servers that provide the three types of cloud services listed above. Cloud users access and interact with those services through the cloud (i.e., the Internet). Typically, users do not have to worry about the location of their data. In some cases, however, they could be presented with an option to choose the preferred locations of data centers. This would be useful for organizations that are legally required to maintain their clients' personal data in certain geographical locations (Sultan, 2011).

Instead of installing a suite of software for each computer, you'd only have to load one application. That application would allow workers to log into a web-based service which hosts all the programs the user would need for his or her job. Hardware and software demands on the user's side decrease. The only thing the user's computer needs to be able to run is the cloud computing system's interface software, which can be as simple as a web browser, and the cloud's network takes care of the rest (Strickland, 2008).

Jangra and Bala (2011) states that according to the architecture point of view, it's better to divide the cloud computing system into two sections: front end and back end. While client devices (like PC, mobile phone, laptops) and interfaces (web browsers) through which consumers are connected to cloud providers for consuming the various services, are included in front end, various clouds are grouped together to act as whole cloud computing system where cloud itself act as back end which compromise various servers, data storage systems, computer machines. According to same researchers there are four major actors which plays an important role to perform various activities and functions in cloud computing:

(i) Cloud consumer: A cloud consumer may request the services, weather it is SaaS, PaaS or IaaS, from cloud brokers or directly from cloud providers.

(ii) Cloud service provider: An organization or entity that is responsible for delivering the services to cloud consumer or services consumer. For providing the services, each cloud provider deploys the cloud system according to one of the four deployment models mentioned before.

(iii) Cloud auditor: A cloud auditor can evaluate the independent assessment of cloud services in terms of privacy impact, performance and security control.

(iv) Cloud broker: Manages the delivery of cloud services to consumer because the integration of cloud services can be too complex to manage for a cloud consumer. Cloud broker can enhance a given service by improving their capabilities and also integrate the multiple services into one or more services to provide some new services.

3.3. Advantages of Cloud Computing

The most important advantages of cloud computing are reduced cost,increased storage, flexibility, support and data/application accessibility:

• *Reduced Cost*

Cloud computing is a system that you can pay as per usage; the infrastructure is not purchased and you do not need to purchase additional hardware as your space requirements grow thus lowering maintenance. Initial expense (capital expense) and recurring expenses are much lower than traditional computing (URL1, URL2). Furthermore, you don't have to maintain infrastructure for applications. This saves your labor costs, as well as electricity costs (URL3).

• *Increased Storage*

Cloud computing architectures have proven to be very scalable for example, cloud-based storage services can easily manage a petabyte of data, whereas managing this much data with a traditional database is problematic (Grossman, 2009).

• *Flexibility*

Instead of making costly investments in new hardware when they need additional capacity, organizations have the ability to increase and decrease cloud resources used as the demand changes. In order to take a full advantage of this capability, organizations need to have full visibility into how their existing resources are being used in both internal and external environments (URL1).

With enterprises having to adapt, even more rapidly, to changing business conditions, speed to deliver is critical (URL2).

• *Support*

Your server will have offsite backup in case something goes wrong. If you need, you can get the support of your service providers (URL4).

• *Data/Application Accessibility*

Also, you can access the applications anywhere you go with cloud computing (URL3).

3.4. Disadvantages of Cloud Computing

Of course cloud computing has some disadvantages. Some of them are listed below:

- *Data Protection*

Data security is a crucial element and its meaning is mostly everything for every enterprise. They fear form losing data and the data confidentiality of consumers (URL2). If you prefer cloud computing, your data will not be directly in your hands (URL3).

Your data will be at the mercy of a third-party company (URL4), you are dependent on them to keep the application up and your data intact (URL3). You do not have control over the remote servers, their software, or their security (URL4). In the existing models, firewalls across data centers (owned by enterprises) protect this sensitive information. In the cloud model, service providers are responsible for maintaining data security (URL2). For this reason it's important to choose the appropriate company for cloud computing.

- *Internet Dependency*

Cloud computing services rely fully on the availability, speed, quality and performance of internet as it works as carrier in between consumer and service provider (Jangra and Bala, 2011).

- *Data Recovery and Availability*

All business applications have service level agreements that are stringently followed. Operational teams play a key role in management of service level agreements and runtime governance of applications. In production environments, operational teams support; appropriate clustering and fail over, data replication, system monitoring (transactions monitoring, logs monitoring and others), maintenance (runtime governance), disaster recovery, capacity and performance management. If any of the above mentioned services is under-served by a cloud provider, the damage and impact could be severe (URL2).

- *Management Capabilities*

Despite there being multiple cloud providers, the management of platform and infrastructure is still in its infancy. Features like "Auto-scaling" for example, are a crucial requirement for many enterprises. There is huge potential to improve on the scalability and load balancing features provided today (URL2).

- *Regulatory and Compliance Restrictions*

In some of the European countries, government regulations do not allow customer's personal information and other sensitive information to be physically located outside the state or country. In order to meet such requirements, cloud providers need to setup a data center or a storage site exclusively within the country to comply with regulations. Having such an infrastructure may not always be feasible and is a big challenge for cloud providers (URL2).

Cloud computing issue's sum up three topics (Sanli, 2011); security and privacy (segregation and protection, vulnerability, identity, physical and personal, data leak, availability, application security, incidence responds, privacy), compliance (continuity and disaster recovery, logs and audit trial, specific requirements) and legal and contractal issues (liability, intellectual property, end of service support, auditing agreement).

3.5 How To Obtain Cloud Computing?

When an organization, either enterprise or academic institution, decides to use cloud computing, it can obtain the cloud computing in two different ways:

1. Using open source resources for cloud computing
2. Buying cloud computing services through vendors

Some examples of open source resources for cloud computing are OpenNebula (URL5), Eucalyptus (URL6), Nimbus (URL7), CloudStack (URL8), OpenStack (URL9), AppScale (URL10), Typhoon AE (URL11), Apache Hadoop (URL12), OpenCirrus (URL13).

Companies like Google, Dell, HP, Oracle, Amazon, Salesforce.com, and even Microsoft are providing applications (Krasne, 2008). Organizations can buy cloud computing services through vendors such as Amazon Elastic Compute Cloud (URL14), Windows Azure and SQL Azure (URL15), GigaSpaces Cloudify (URL16). Gartner believes that 80 percent of Fortune 1000 companies will be using some form of cloud computing services by 2012 (Krasne, 2008).

4. IMPLEMENTING CLOUD COMPUTING IN UNIVERSITIES

As it was mentioned in previous sections, as other organizations do, universities also try to follow this new technology trend. Academic researchers have expressed a need for access to massively scaled computing infrastructures that allow them to complete projects and research activities that have been difficult or impossible previously due to the amount of data involved (Sasikala and Prema, 2010). Moreover today's cloud computing providers are offering higher education the opportunity to substitute a presence in "the cloud" for universities' existing data centers, servers, and applications, replacing these machines' traditional "physical" presence on campus (Sasikala and Prema, 2010).

4.1 Cloud Computing in Some Universities

The cloud computing application can be of great help when a large university is considered, for instance (Praveena and Betsy, 2009). For example; Oxford University (England), Berkeley University (U.S.A.) and North Carolina State University (U.S.A.), are the major examples (URL17, URL18, URL19).

Today cloud computing replaces IT services of universities such as software, hardware and development environments (Sultan, 2010) (Figure 3-4).

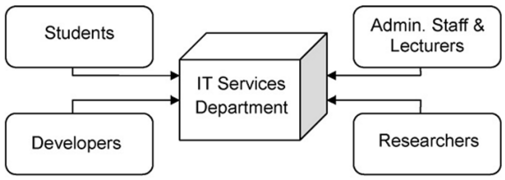

Figure 3: Simplified structure of the main users of IT services in a typical university (Sultan, 2010).

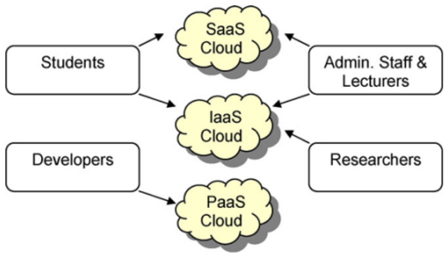

Figure 4: Simplified structure of the main users of IT services in a typical university now using the services of cloud computing (Sultan, 2010).

The University of California (UC) at Berkeley, found cloud computing to be attractive to be used in one of the courses which was focused exclusively on developing and deploying SaaS applications. By a donation from Amazon Web Services (AWS), UC was able to move its course from locally owned infrastructure to the cloud (Sultan, 2010).

In some cases, a large university might become a provider of cloud services. More often, individual campuses will obtain services from the cloud. The trend toward greater use of mobile devices also supports cloud computing because it provides access to applications, storage, and other resources to users from nearly any device (Sasikala and Prema 2010).

4.2 Cloud Computing Scenarios in Use

Sasikala and Prema (2010) offer Massive Centralized Cloud Computing (MCCC) scenario for educational institutions (Figure 5). By MCCC model students get access to the resources anytime, anywhere regardless of the user platform. Uniform applications and services are offered to all students with their own choice of applications. Campus gets support for on campus and distance learning, longer life cycle, lower economies, more effective license administration, greater flexibility and Open Source benefits (Sasikala and Prema, 2010).

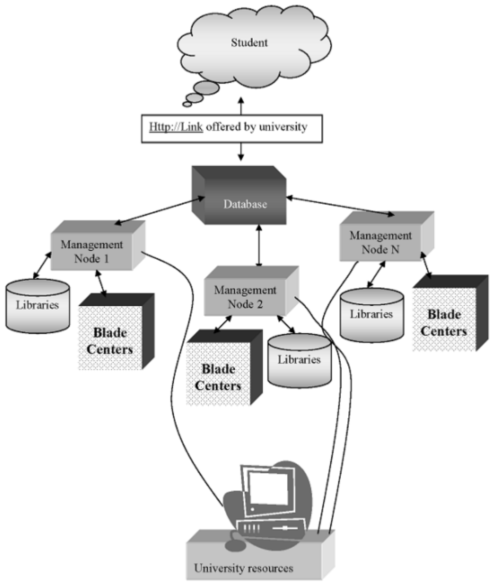

Figure 5: Massive Centralized Cloud Computing scenario (Sasikala and Prema, 2010)

When we divide human resources in university into four classes, e.g. administrative staff, researchers and lecturers, IT staff and students, the issues effected each class when cloud computing is applied, can be expressed in Table 1.

	Administrative Staff	Researchers and Lecturers	IT Staff	Students
Easy Access to Associated Data Pools	√	√	-	√
Easy Access to Content (scientific and social subjects, opinions, textbooks, etc.)	√	√	-	√
Easy Access to Applications (e-mail services, software, database, etc.)	√	√	√	√
Reducing Expenses (software, hardware)	√	-	-	-
Extended Data Storage	√	√	√	√
New Educational Challenges	-	√	-	√
Extended Data Security	√	√	√	√

Table 1: The Effects of Cloud Computing In Universities

University researchers can benefit from associated data pools usually installed between different universities and supported by cloud computing. For example, the protein research (a very expensive undertaking) done at the Medical College of Wisconsin Biotechnology and Bioengineering Center in Milwaukee, thanks to renting processing time on Google's powerful cloud-based servers, is more accessible to scientists worldwide (Sultan, 2010).

Cloud content (scientific and social subjects, art, opinions, textbooks, encyclopedias, etc.) is controlled by the service providers and available to users whenever they request it. Students and administrative staff have the opportunity to quickly and economically access various application platforms and resources through the web pages on-demand. This automatically reduces the cost of organizational expenses and offers more powerful functional capabilities (Ercan, 2010).

With cloud computing, the operation of services moves "above the campus," and an institution saves the upfront costs of building technology systems and instead pays only for the services that are used (Sasikala and Prema, 2010).

There are, in essence, three converging forces that are creating a perfect storm scenario for why university CIOs are now looking to cloud computing as a way forward (Tallon et al., 2010):

1. Universities are facing severe spending cutbacks. Both tuition-driven and state funded schools are hardest hit. CIOs are being asked to do more with less and, if possible, to pursue green initiatives.

2. Students are IT-savvy and expect their campuses to be leading adopters of new innovations. They are already familiar with cloud-based applications such as Google Docs and Gmail and expect to see similar applications in the classroom. New forms of pedagogy are also pushing the cloud as a way to meet students' needs. Students want less lecturing by professors and more interaction with their classmates outside of a traditional physical classroom. A cloud could help to meet this need.

3. Researchers are facing strict data protection covenants from federal granting agencies. This could induce researchers to put their data into a secure private cloud rather than managing it themselves.

4.3 Scenarios for Cloud Computing in e-Learning

Cloud computing offers very advantageous services for e-learning systems. Especially cloud IaaS promising infrastructure for e-learning projects and gradually use in e-learning projects (Casquero et al., 2008; Marenzi et al., 2008; Al-Zoube, 2009; Al-Zoube et. al., 2010). This is why Blackboard and Moodle, the biggest players in the field of e-learning software, have now versions of the base applications that are cloud oriented (Pocatilu et al., 2010).

4.3.1. What Cloud Computing Provides in E-Learning?

E-learning systems can benefit from cloud computing in following ways (Pocatilu et al., 2010):

- Use an e-learning solution on the provider's infrastructure (infrastructure benefit),
- Use and develop an e-learning solution based on the provider's development interface (platform benefit),
- Use the e-learning solution given by the provider (service benefit).

A very big concern is related to the data security because both the software and the data are located on remote servers that can crash or disappear without any additional warnings. Even if it seems not very reasonable, the cloud computing provides the listed below major security benefits for individuals and companies that are using/developing e-learning solutions (Pocatilu et al., 2010):

- Improved improbability; it is almost impossible for any interested person (thief) to determine where is located the machine that stores some needed data (tests, exam questions, results) or to find out which is the physical component he needs to steal in order to get a digital asset;
- Virtualization; makes possible the rapid replacement of a compromised cloud located server without major costs or damages. It is very easy to create a clone of a virtual machine so the cloud downtime is expected to be reduced substantially;
- Centralized data storage; loosing a cloud client is no longer a major incident while the main part of the applications and data is stored into the cloud so a new client can be connected very fastly. Imagine what is happening today if a laptop that stores the examination questions is stolen;
- Monitoring of data access becomes easier in view of the fact that only one place should be supervised, not thousands of computers belonging to a university, for example. Also, the security changes can be easily tested and implemented since the cloud represents a unique entry point for all the clients.
- The teaching methods are convenient and flexible. According to their actual conditions, the two sides can choose different times and different locations to complete the curriculum design and self-study by using a variety of teaching resources and the editing tools on the platform of cloud computing model, so many knowledge can be acquired (Guoli and Wanjun, 2010).

Chandran and Kempegowda (2010) stated that the current e-learning platforms require high initial cost on the infrastructure and software applications. If the e-learning services are used for a relative short time (several weeks, a quarter, a semester), the savings are very important (Pocatilu et al., 2010).

A metrics system has been developed in order to measure the efficiency of cloud computing based e-learning solutions. Also, the Pareto Principle is still a strong mechanism constantly used in quality control of projects from various areas, including the IT field. The Academy of Economic

Studies from Bucharest uses an e-learning solution based on Moodle and it has its own data center that can be in the future a platform for cloud computing (Pocatilu et al., 2010).

4.3.2. E-Learning and Cloud Computing: Some Applications

Casquero et al. (2008) presented a framework based on iGoogle and gadgets over Google Apps infrastructure for the development of a network of corporative Personal Learning Environment (PLE). They discussed the integration of institutional and external services in order to give support, in a personal way, to the daily activity of each faculty member, and to take advantage of the framework as a test-bed for the research, implementation and testing of social services for educational purposes (Al-Zoube, 2009).

Marenzi et al. (2008) investigated how social software can be used in formal learning or work environments, and how to develop and integrate models and tools into an open source infrastructure for the creation, storage and exchange of learning objects, suitable knowledge resources as well as learning experiences. They presented the “LearnWeb 2.0” infrastructure to support lifelong learning and enhance learning experience. This infrastructure brings together information stored on institutional servers, centralized repositories, locally on learner desktops and online community-sharing systems like Flickr and YouTube (Al-Zoube, 2009).

Dong et al. (2009) presented an e-learning ecosystem based on cloud computing infrastructure. Cloud computing infrastructure and related mechanisms allow stability, equilibrium, efficient resource use, and sustainability of an e-learning ecosystem.

Al-Zoube (2009) built a virtual and personal learning environment which combines a wide range of services to create an interactive tool for education based on services available in the cloud. The environment and the design proposed can also be used as a platform for exploring and sharing new ideas as well as for designing, modifying and monitoring educational or course contents. Their design under the same environment also allows integration of different pedagogical approaches to both learning and teaching (Al- Zoube et al., 2010).

5. CONCLUSIONS

This paper summarizes information on what cloud computing is and does it suitable for universities or not. Today many researchers agree on the reality that deploying cloud computing services changes the way organizations and institutions go about managing their computing resources: they are more flexible in using available capacity in the way that is most cost effective.

Cloud computing issue sums up three topics; security and privacy, compliance and legal and contractal issues. On the other hand, as Sultan (2010) stated, the potential of cloud computing for improving efficiency, cost and convenience for the educational sector is being recognized by a number of US educational (and official) establishments recently.

Before starting to conduct a cost analysis for cloud computing in a university, administration of university should "hear" from academic representatives (deans, heads of laboratories, directors of research centers etc.) about whether and how academic researchers can hope to do work on the cloud. In other words, the university administrators should decide to use cloud computing by answering following questions: "Is cloud computing appropriate for our university?" or "Which of the cloud computing services are necessary for our university?"

Since universities have lots of sets of data (related with students, staff, procedures, equipment, research etc.) every unit or department can obtain the needed data from associated data pool installed as a cloud between different universities or between a university and a private or government institution.

Most of universities use products that require license fee (e.g. Microsoft Office, MS SQL Server, SPSS, Adobe Connect, etc.). If a problem occurs about the licenses, the technical staff of every university has to spend time to cope with this problem. But with cloud computing solution, everybody can access services that they want anytime from anywhere. Furthermore, if a university takes the services from the third party company, they will acquire the support team for university’s needs.

As it was expressed in previous sections, we believe that the development of e-learning solution in a university cannot ignore the cloud computing trends, because as Pocatilu et al. (2010) stated using cloud computing for e-learning solutions influences the way the e-learning software projects are managed.

On the other hand, some strategically operations (such as entering exam results, salary operations, etc.) at universities can be effected from the cloud computing services negatively. So, universities have to have a B plan against any unexpected situation. Especially when the cloud provider is an international body, the regulations of international law system must be followed.

Another important issue is the agreement signed between university and the cloud provider by means of including statements related with data security and any possible trouble situation. Business concern is important for IT staff while for researchers, their own data security is important issue. So, the cloud computing transition process, must take into account the human factor.

For educational institutions, together with all advantages of cloud computing, of course there are some limitations among which the only two real limitations are Internet access and vision and willingness of university administration.

6. Acknowledgements

We would like to thank Mrs. Oya Şanlı for sharing her knowledge and opinions with us.

REFERENCES:

1. Al-Zoube, M., 2009. E-Learning on the Cloud, International Arab Journal of e-Technology, 1 (2): 58-64.

2. Al-Zoube, M., El-Seoud, S. A.,Wyne, M. F., 2010. Cloud Computing Based E-Learning System, International Journal of Distance Education Technologies (IJDET), 8 (2): 58-71 (Abstract).

3. Armbrust, M., Fox, A., Griffith, R., Joseph, A. D., Katz, R. H., Konwinski, A., Lee, G., Petterson, D.A., Rabkin, A., Stoica,I., Zaharia, M., 2009. Above the Clouds: A Berkeley View of Cloud Computing, http://www.eecs.berkeley.edu/Pubs/TechRpts/2009/EECS-2009-28.html, [Access Date: 05.07.2011].

4. Casquero, O., Portillo, J., Ramón Ovelar, R., Romo, J., Benito, M., 2008. iGoogle and gadgets as a platform for integrating institutional and external services, MUPPLE'08, 37-41. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.143.708andrep=rep1andtype=pdf, [Access Date: 08.07.2011].

5. Chandran, D., Kempegowda, S., 2010. Hybrid E-learning platform based on cloud architecture model: A proposal, 2010 International Conference on Signal and Image Processing (ICSIP), 534-537,

6. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5697535&isnumber=5697428, [Access Date: 20.07.2011].

7. Dong, B., Zheng, Q., Yang, J., Li, H., &Qiao, M., 2009. An E-learning Ecosystem Based on Cloud Computing Infrastructure. 2009 Ninth IEEE International Conference on Advanced Learning Technologies, 2009 (2009): 125-127. IEEE. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5194182, [Access Date: 09.07.2011].

8. Ercan, T., 2010. Effective use of cloud computing in educational institutions, Procedia - Social and Behavioral Sciences, 2 (2): 938-942, doi: 16/j.sbspro.2010.03.130.

9. Gartner, 2009, Cloud Computing Inquiries at Gartner, http://blogs.gartner.com/thomas_bittman/2009/10/29/cloud-computing-inquiries-at-gartner/, [Access Date: 12.07.2011], in Ercan, T., 2010. Effective use of cloud computing in educational institutions, Procedia - Social and Behavioral Sciences, 2 (2): 938-942,.

10. Grossman, R. L., 2009. The Case for cloud computing, IT Professional, 11(2): 23-27, doi:10.1109/MITP.2009.40, http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber= 4804045 &isnumber=4804034, [Access Date: 05.07.2011].

11. Guoli, Z., Wanjun, L., 2010. The applied research of cloud computing platform architecture in the E-Learning area, The 2nd International Conference on Computer and Automation Engineering (ICCAE), 3: 356-359, http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5451399&isnumber=5451200 , [Access Date: 20.07.2011].

12. Jangra, A. and Bala, R., 2011. Spectrum of Cloud Computing Architecture: Adoption andAvoidence Issues. International Journal of Computing and Business Research, 2 (2), http://www.researchmanuscripts.com/PapersVol2N2/IJCBRVOL2N2P13.pdf, [Access Date: 07.07.2011].

13. Krasne, A., 2008. Buy, Lease or Move to Cloud Computing, Pc World, http://www.pcworld.com/businesscenter/article/154206/buy_leaseor_move_to_cloud_computing.html, [Access Date: 12.07.2011].

14. Kuyucu, A. D. H, 2011. The Playground of Cloud Computing in Turkey, Procedia Computer Science, 3, 459–463, http://www.sciencedirect.com/science/article/pii/S1877050910004527, [Access Date: 05.07.2011].

15. Marenzi, I., Demidova, E., Nejdl, W., 2008. LearnWeb 2.0 Integrating Social Software for Lifelong Learning, Proceedings of the ED-Media 2008, http://citeseerx.ist.psu.edu/viewdoc/ download?doi=10.1.1.157.9622andrep=rep1andtype=pdf, [Access Date: 08.07.2011].

16. Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., Ghalsasi, A., 2011. Cloud computing — The business perspective, Decision Support Systems, 51, 176–189,http://www. sciencedirect. com/science/article/pii/S1877042810001709, [Access Date: 05.07.2011].

17. Mell, P., Grance, T., 2011. The NIST Definition of Cloud Computing, National Institute of Standards and Technology Special Publication 800-145 (Draft), 6-7. http://docs. ismgcorp. com/ files/external/Draft-SP-800-145_cloud-definition.pdf, [Access Date: 05.07.2011].

18. Pocatilu, P., Alecu, F., Vetrici, M., 2010. Measuring the Efficiency of Cloud Computing for E-learning Systems, WSEAS Transactions on Computers, 1 (9): 42-51, http://www.wseas.us/e-library/transactions/computers/2010/89-159.pdf, [Access Date: 07.07.2011].

19. Praveena, K., Betsy, T., 2009. Application Of Cloud Computing in Academia, In: Iup Journal Of Systems Management, 7 (3): 50-54.

20. Rosenthal, A., Mork, P., Li, M. H., Stanford, J., Koester, D., & Reynolds, P., 2010. Cloud computing: A new business paradigm for biomedical information sharing. Journal of Biomedical Informatics, 43(2): 342-353. doi: 10.1016/j.jbi.2009.08.014.

21. Sanli, O., 2011, Cloud Computing, Refereed Program of the E-Leader Conference at Zagreb, Croatia, http://g-casa.com/conferences/zagreb/ppt/Sanli-Cloud%20%5 BCompatibility%20Mode%5D.pdf , http://www.g-casa.com/conferences/ zagreb/papers/Sanli-Cloud-final.pdf, ISSN 1935-4819, Chinese American Scholars Association, New York, USA.

22. Sasikala, S., Prema, S., 2010. Massive Centralized Cloud Computing (Mccc) Exploration in Higher Education, In:Advances in Computational Sciences & Technology, 3 (2): 111-118.

23. Strickland, J., 2008. How Cloud Computing Works, http://computer.howstuffworks.com/cloud-computing.htm, [Access Date: 17.06.2011].

24. Sultan, N., 2010. Cloud computing for education: A new dawn?,International Journal of Information Management, 30, 109–116, http://www.sciencedirect.com/science/ article/pii/ S0268401209001170, [Access Date: 05.07.2011].

25. Sultan, N.A., 2011. Reaching for the cloud: How SMEs can manage, International Journal of Information Management, 31 (3): 272-278.

26. Tallon, P., Eng, G., Quigley, N., 2010. GlassHouse Technologies' Whitepaper Details Risks and Rewards of Cloud Computing in Academia. http://www.glasshouse.com/sites/default/files/whitepapers/ Clouds%20on%20Campus%20Whitepaper.pdf, [Access Date: 07.07.2011].

27. URL1, http://www.manageengine.com/products/applications_manager/four-keys-for-monitoring -cloud-services.pdf, [Access Date: 20.07.2011].

28. URL2, Harris, T., Cloud Computing An Overview, http://www.thbs.com/pdfs/Cloud-Computing-Overview.pdf, [Access Date: 06.07.2011].

29. URL3, Zen and the Art of Nonprofit Technology, http://zenofnptech.org/2008/08/what-is-cloud-computing.html, [Access Date: 06.07.2011].

30. URL4, Dedicated Server School, http://www.serverschool.com/cloud-computing/benefits-and-disadvantages-of-cloud-computing/, [Access Date: 06.07.2011].

31. URL5, http://opennebula.org/about:about, [Access Date: 05.07.2011].

32. URL6, http://www.eucalyptus.com/, [Access Date: 05.07.2011].

33. URL7, http://www.nimbusproject.org/about/, [Access Date: 05.07.2011].

34. URL8, http://www.cloud.com/index.php?option=com_k2andview=itemandlayout=itemandid= 114andItemid= 346, [Access Date: 05.07.2011].

35. URL9, http://www.cloud.com/index.php?option=com_k2andview=itemandlayout=itemandid= 118andItemid=350, [Access Date: 05.07.2011].

36. URL10, http://www.cloudbook.net/directories/research-clouds/research-project.php?id= 100014, [Access Date: 05.07.2011].

37. URL11, http://code.google.com/p/typhoonae/, [Access Date: 05.07.2011].

38. URL12, http://hadoop.apache.org/, [Access Date: 05.07.2011].

39. URL13, https://opencirrus.org/, [Access Date: 05.07.2011].

40. URL14, http://aws.amazon.com/ec2/, [Access Date: 06.07.2011].

41. URL15, http://www.microsoft.com/windowsazure/, [Access Date: 06.07.2011].

42. URL16, http://www.gigaspaces.com/cloudify , [Access Date: 12.02.2012].

43. URL17, http://www.oerc.ox.ac.uk/news/oxford-e-research-centre-provides-cloud-computing, [Access Date: 12.07.2011].

44. URL18, http://inews.berkeley.edu/articles/Spring2009/cloud-computing, [Access Date: 06.07. 2011].

45. URL19, http://vcl.ncsu.edu/, [Access Date: 19.07.2011].

УДК 004

Облачные вычисления и несколько сценариев их применения в университетах

[1] Чигдэм Сельчукджан Эрол
[2] Элиф Картал Караташ
[3] Зеки Озен
[4] Севинч Гюльсечен

[1-4] Стамбульский университет, Турция
Беязит, 34452, Стамбул
[1] Кандидат биологических наук, ассистент профессор
E-mail: cigdems@istanbul.edu.tr
[2] Магистр, ассистент исследователь
E-mail: elifk@istanbul.edu.tr
[3] Магистр, ассистент исследователь
E-mail: zekiozen@istanbul.edu.tr
[4] Кандидат наук, профессор
E-mail: gulsecen@istanbul.edu.tr

Аннотация. Облачные вычисления – это новая технология и новое направление. В последние годы большинство организаций начали выбирать свои модели облачности. Образовательные учреждения, особенно университеты, не могут оставить без внимания огромную выгоду, которую облачные вычисления могут им принести. В данной работе мы детально объясняем концепцию облачного вычисления, ее модели и области применения, принцип работы, преимущества и недостатки. Мы особенно делаем упор на их значимость для университетов, приводим примеры ее применения в дистанционном обучении.

Ключевые слова: облачные вычисления; IT-услуги; облачные вычисления в университетах; дистанционное обучение.