

A Survey on Current Initiatives on Educational Cloud Computing

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Abstract— The cloud computing has evolved in recent years as a very promising and popular technology in the implementation of IT solutions for large companies and organizations. It can be observed that it also provides an excellent alternative in cost reductions in high education institutes, because infrastructure maintenance is the responsibility of the provider cloud service. This paper presents the current initiatives in the use of cloud computing in education institutes, presenting aspects such as adopted migration strategies and learning environments that use cloud computing for education.

Index Terms— Colaborative Learning, Cloud Computing, Initiatives on Cloud Service, Informatics in Education.

1 INTRODUCTION

With the advancement of technology and the need for reducing costs to achieve better results with lower budgets, education institutes spread in the world are seeking alternatives to improve their IT infrastructure, providing cost reduction and quality service for its students, teachers and staff. In this context, Cloud computing is an interesting alternative to the education institutes reduce costs and increase the computational resources, such as software and hardware, on their campus.

Cloud computing environments offer tools that facilitate and simplify the sharing and dissemination of knowledge [1]. The solutions offered by the cloud enables, for example, collaborative learning, using technology in order to bring students and teachers together in a common environment, providing a significant improvement in the development of the studies and post classroom research. The Cloud computing offers many advantages to the solutions of e-learning, by providing through virtualization infrastructure, platform and application as a services and facilities for data access control [2] [3].

Despite of the fact that Cloud Computing is an interesting alternative for educational institutions, it is not considered a simple task to be implemented. There are currently several different initiatives, and these initiatives differs significantly on how to use the cloud (e.g. using hardware resources such as processor and storage or using softwares available in the cloud) and how to desing it (e.g. using public cloud such as Amazon or to design and implement a private cloud).

This paper aims to present current initiatives in the use of cloud computing in education institutes, bringing case studies, experience reports, migration strategies and implemented cloud solutions. This document is divided as follows. Section 2 shows basic concepts of cloud computing, which are needed to a better understanding of this work. Section 3 describes how cloud computing can be used by educational institutes in theory. Section 4 presents different initiatives that address the use of cloud computing in education. Finally, Section 5 presents conclusions and future work.

2 Basic Concepts

This section aims to presents basic concepts that are relevant to achieve a better understanding of the work.

2.1 Cloud computing

Cloud computing is considered an essential topic in the technology world. With the growing demand for hosting web server or storage data in cloud, the number of companies that offer this type of service also increases. The term cloud computing, according to Taurion [4] appeared in 2006 in a talk by Erick Schmidt on Google. To Velve [5], cloud computing is an idea which allows the use of the most varied applications on the Internet anywhere or anytime, and independent of the operational system used.

In practice, cloud computing provides a hardware abstraction to end user, that is, this user has the feeling of having infinite resources, but there is actually a limited physical infrastructure managed by a CSP(Cloud Service Provide). Each part of this infrastructure is provided as a service, and these services are allocated using shared hardware for computing and storage [6].

2.2 Cloud Computing Services Model

The model of services in Cloud Computing is often divided into three layers and these layers are described as follows.

The SaaS (Software as a service) layer provides a platform of access to software systems that are available over the Internet and these systems are accessible by the user through computers or devices, such smartphone or tablets. In this type of model the user does not have administrative control over the platform infrastructure, such as platform servers or operating

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systems.

The Paas (Platform as a service) is the middleware layer, a layer available between the operating system and the distributed applications. Its provides service such as operating systems, database and storage services data to developers based on the model pay per usage, i.e. the charge is directed related to the resource utilization.

The Iaas (Infrastructure as a service) is the layer that is closer to the hardware level, and provides hardware virtualization services, where the costumer can access the settings and services of the environment, especially aspects such as processing, networking and data storage. In general, the Iaas offers a variety of advantages, such as the cost reduction on equipments use such as machines, servers and network assets. Table 1 shows the three presented models and their target users.

TABLE 1
Cloud computing layers and services.

Layer	Service	Target	Examples
1 - Application	SaaS	End user	Google Docs and One-Drive
2 - Development platforms	PaaS	Developers	Microsoft Azure and Google App Engine
3 - Infrastructure	IaaS	IT Managers	EC2 Amazon Eucalyptus OpenNebula

3 EDUCATIONAL CLOUD COMPUTING

Cloud computing appears to be an attractive technology for education institutions, and several initiatives describes cloud computing applied in educational institutions as an excellent alternative for 1) the improvement of it internal process 2) improving the structure of the courses and 3) the reduction of costs[7][8][9][10][11].

Chihi [1] states that with the cloud use, universities can reduce infrastructure maintenance costs and can give their partners, teachers, students and staff, access to optimized resources. The potential and effectiveness of the Cloud computing use in higher education has been recognized by many universities from which include among others the University of California [12], offering services such as Office 365 Email, Google Apps for Education and more for students and teachers. In another interesting example, the Digital Paris Ile de France University, in collaboration with French start-up, founded an inter-university Cloud, called UnivCloud. It offers, among other online services including online courses, storage spaces and collaborative spaces [13].

In order to better illustrate the idea of cost reduction in practical terms, an article [14] describes a concrete example: Italy's first Open University, Marconi University, reduced costs by 23% by moving to a cloud computing platform from an existing collocation facility. This also facilitated the university to

provide "educational resources via an e-learning platform and mobile devices such as laptops, tablets and smartphones".

Moreover, cloud computing connects all the university faculties and departments together and enables the access to the data storages, e-mails, databases, educational resources, research applications and tools anywhere for teachers, administrators, staff, students and other users when needed [15]. Figure 1 shows a diagram describing the advantages in the use of cloud computing applied to educational institutions.



Fig. 1. Advantages in the use of educational clouds

4 EDUCATIONAL CLOUDS - CURRENT INITIATIVES

This section aims to identify and present case studies and initiatives in the area related to the use or implementation of cloud computing considering education purposes.

4.1 Migration Strategy for Cloud Computing Usage in Educational Environments

In this initiative, the main contribution of the author is a migration strategy of the IT infrastructure of higher education institutions for a cloud solution, proposing a linear structure of steps to enable this migration. The author also illustrates how universities can move from the use of local servers to the use of software as a service in clouds [1].

The author proposed a migration strategy that involves six steps. The first of it the Knowledge development (1), focuses on spreading knowledge about the cloud should be addressed in lecture, Seminars and conferences in order to present the solution to users, in this case students, teachers and staff. For this the University should compose a team of qualified professionals who have experience in the field.

Another step would be University state evaluation (2), this step necessary to assess the current state of the university regarding their computational needs, the first stage is to under-

stand the IT infrastructure of the university. Figure 2 shows the migration model proposed by the author.



Fig. 2. Migration strategy proposed by Chihi

Another important step of the migration strategy is the Classification of university services (3), necessary to identify which data, applications and operating are used in the university. The second point in this step would be to determine criteria for each given application or the level of reliability, integrity and availability. The Cloud solution will allow all types of users to access to the stored files, emails, databases and other applications from anywhere, on demand and with the consideration of the user's profile to ensure data privacy.[1]

According to Chihi, after classifying and identifying the services of the institution, the next step is to choose which cloud solution (4) should be used in the presented scenario (e.g. private, public or hybrid cloud). For each function, identified processes and services which service level can be set (SaaS, PaaS, or IaaS) to institution and finally the final two steps, implement the cloud solution (5) and integrate the cloud solution (6), where a monitoring team to access the design and integrate the cloud solution will be necessary to avoid a radical migration, and have a continuous migration process, and this team is responsible for providing documentation and training.

The author has prepared a survey on cloud computing in Tunisian Universities. Initially is describes the problems often encountered in the process of migration, and the author interviewed IT managers, students and teachers of institutions. The major obstacle is still in information security according to research presented by the author.

According to the participants of this survey, these risks are still valid for the use of the Cloud. In response to the question of whether respondents have perceived these risks "as new risk" compared to a traditional hosting arrangement, 61% have answered "yes" while 29% have answered "no"[1]. Analyzing this point, it is possible to state that not all students and teachers will have the financial resources or material resources to develop a study or research post classroom.

Another question reported by the author is the scope of knowledge relative to the degree of experience that each of the respondents to cloud computing and the vast majority had a good experience in the use of applications or cloud services. About 75% of respondents have reported that they had an understanding of "average" to "good" of the Cloud computing and about 25% of respondents have indicated that they had a "poor" or "no" understanding on the field of the Cloud.[1]

The author concludes that the current situation of the institutions forces the the conscious use of computational resources, and the cloud appears as a solution that brings several advantages, including the reduction of maintenance costs.

4.2 Research on the Implementation of Cloud Solutions in Education Institutes

Another relevant initiative in the area is the work carried out by Mitchell [16]. In this initiative, the author aims to search relevant information related to the cloud use in education on the author's country. Interviews were carried out with a specific view to learn the reasons for deploying cloud computing solutions, the benefits and challenges encountered and how cloud computing solutions have impacted the education institutes [16].

According to the author, students use cloud technology both inside and outside the campus of the institutes through personal computers or smart devices (tablet, smartphone, etc).The students can use, for example, their email from a public CSP such as Google mail, can use the Moodle learning environment, which is deployed on a private cloud within the institute or they can access the student registration system, which is a SaaS provided by An Chéim using HEAnet community cloud infrastructure[16].

The University IT managers are responsible for managing and providing cloud services for technology area of each institute, taking into account the recent budget cuts applied on Irish public services, causing them to seek alternatives for more sustainable and economic investment.

A new strategy should be used in order to make the reallocation of resources and their rational use to provide emerging technologies to students, teachers and staff.

There are many types of hypervisor and e-mail services in used within the researched institutes. Hypervisor is a platform that allows the users creates and manages virtual machines. The author conducted a survey with the IT managers of the institutes to verify which cloud solution types and Hypervisors were adopted by the institutes and the results are shown in Table 2.

TABLE 2
Hypervisors and software in cloud used in institutes

Type of e-mail server	MS public cloud Office 365	Google public cloud email	E-mail on Private cloud in-house
Values in %	50	30	20
Type of Hypervisor used	Microsoft Hyper-V	VMware VShere	Critrix Xen-Server
Values in %	60	30	10

The author also describes another research that focus on the analysis of the benefits of deploying cloud computing in Irish Institutes of Technology.

One of the most important attributes highlighted by the interviewed IT managers is the availability, which is the percentage of time that the resource is available. 80% of the respondents answered that availability is an important benefit that the cloud offers.

In addition, cost reduction was one of the main advantages mentioned (90% of IT managers) in the interviews with IT, and

all of them stressed that the reduction in maintenance and electricity are important advantages in the use of cloud technology.

The reduction in maintenance is another advantage highlighted by respondents. Approximately 100% of the interviewed users appointed this factor, evaluating the infrastructure the cloud model is managed by the provider of services.

The author concludes that cloud solutions are accessible to educational institutions, bringing an alternative to replace or upgrade the technological resources, offering a flexible and resilient service.

4.3 Implementation of Educational Private Clouds

Another interesting initiative is the implementation of an educational cloud at the Federal University of Rio Grande do Norte, in Brazil. The author describes implement a private cloud in the educational institute, called IMDcloud [17]. Instructions such as which software and which is the minimum structure necessary for the full operation of the solution are provided.

According to Souza [17], the teaching, research, extension and technological innovation strongly depends on increasing computational resources to achieve the needed goals

For the implementation of the cloud computing solution in the education institute, the author lists some requirements [17]:

- Compatibility with VMware vSphere - hypervisor in use in the target environment (Datacenter Digital Metropolis Institute - IMD / UFRN);
- Scalability, high-availability and fault tolerance;
- Usage of an open cloud platform, with interoperability assured with several technologies, APIs and communication protocols;
- Integration with authentication and authorization mechanisms available in the target environment.

The author chose these requirements to meet both the demands of the academic environment and innovation technological on the university.

Based on the requirements, the solution adopted for the implementation of the educational cloud was OpenStack [18] as cloud / service orchestration. OpenStack is a key element in the cloud platforms industry, both adopting free software community as the business market [19].

In addition, the VMware Integrated OpenStack (VIO) is a provided distribution and OpenStack supported by VMware, Inc., prepared to work in an infrastructure existing VMware virtualization [17]. The VIO It provides control of cloud resources through the OpenStack APIs and allows a process of rapid and safe deployment of a cloud OpenStack.

The author that for a cloud solution geared for production environments the VIO configuration must be robust. According Abdelrazi [20] need at least 56 vCPUs, 192GB of memory and 605GB of disk storage and all that configuration is necessary to provide the many services in solution of cloud computing.

The main feature of the IMDcloud is the possibility that the user has to create and manage their own virtual machine, thus avoiding long application process done for the IT department. In some cases, teachers need to constantly manage the

process. Souza shows that it is a must have resource access environment for managing virtual instances.

Finally, the author realized an online questionnaire for evaluating among with the teachers of the services offered by the cloud (IMDcloud), and the result was that 80% of docents evaluated as positive using the services.

5 CONCLUSIONS AND FUTURE WORK

Cloud computing has become an excellent alternative to reduce cost and improve the technology infrastructure of various institutes of education in the world, offering students, teachers and staff of the institution access to university content, anywhere, anytime through services offered by cloud solutions.

The main contribution of this work is the presentation of current initiatives focused on the use of cloud computing in the education field. After the analysis of these initiatives, it can be noted that cloud computing have shown numerous benefits considering educations purposes, such as cost savings, reduce it maintenance, scalability, flexibility, green campus, online course delivery and collaborative learning.

As future work, the proposal is to develop a cloud computing deployment strategy applied in educational institutions, and this strategy should be designed for the evaluation of the costs and challenges, as well as hardware and software required for the use of cloud services.

REFERENCES

- [1] H. Chihi, W. Chainbi, and K. Ghdira, "Cloud Computing Architecture and Migration Strategy For Universities and Higher Education" *IEEE 12th International Computer Systems and Applications(AICCSA)* Nov. 2015.(IEEE Conference)
- [2] P. Cemim, L. Jersak, G. Lopes, J. deMello and T. Ferreto,"EduCloud: A private Cloud tool for academic environments. *IEEE Latin America Conference on Cloud Computing and Communications(LatinCloud)* pp. 6671, 2012.(IEE Latin Coference)
- [3] A. Oman, S. Abdalrahman, A. Elgelany, "Proposed academic Cloud Computing for Saudi universities and higher institutes", *Fourth International Conference on e-Learning Best Practices in Management, Design and Development of e-Courses: Standards of Excellence and Creativity*, p 113-119, 2013.
- [4] C Taurion, "Cloud Computing: Transforming the world of information technology", Rio de Janeiro Brasport, 2009.
- [5] T. Velve, "Cloud Computing: An Practical Approach", Rio de Janeiro Alta Books, 2011.
- [6] F. Sousa, L. Moreira and J. Machado, "Cloud Computing: Concepts, Technologies, applications and chagellenges", *SBC Brazil Conference* pp.150-175, 2009.
- [7] Gartner, "Gartner Special Reports Examines the Outlook for Hybrid Cloud", *Gartner Symposium/ITxpo*, Florida, 2013.
- [8] R. Katz, "Cloud Computing in Higher Education" *EduCause*, http://net.educause.edu/section_params/conf/CCW vol 10, 2010.
- [9] M. Brito, "Cloud Computing in Higher Education" *Library Student Journal* pp.289-321, Jan. 2012.
- [10] M. Masud, X. Huang and J. Yong, "Cloud Computing for Higher Education: A roadmap", *Cooperative Work in Design (CSCWD) IEE 16th International Conference*, pp. 552-557, May. 2012.

- [11] D. Chandra and D. Malaya, "Role of cloud computing in education" Computing Electronics and Electrical Technologies (ICCEET), International Conference, pp.832-836, Marc, 2012.
- [12] Ucdavis, "Information and educational technolog", <http://cloud.ucdavis.edu/>, 2016.
- [13] UnivCloud, "UnivCloud: Universities will have their collaborative cloud," <http://univCloud.fr/>, 2016.
- [14] Computer Weekly, "News: Italian university reduces cost by 23% with cloud platform," <http://www.computerweekly.com/>, 2016
- [15] I. Al-Ghatrifi, "Cloud Computing: A Key Enabler for Higher Education in Sultanate of Oman" IEEE Computer, Communications, and Control Technology (14CT) 2015 International Conference, April. 2015.(IEEE Conference)
- [16] A. Mitchell and L Cunningham, "Impact of Cloud Computing in Ireland's Insitutes of Higher Education" International Information Management Corporation IEEE, 2014.
- [17] W. Souza, A. Bezerra and D. Santos "IMDcloud: A Cloud Computing Geared to Practice Lecturer in IT and Innovation" Regional Congress on Technologies in Education Brazil (Ctrl+E Congress), 2016.
- [18] Openstack, "Open Source software for creating private and public clouds", <http://www.openstack.org/>, 2016.
- [19] D. Radez, "OpenStack Essentials", Packt Publishing, Birmingham, UK, 2015.
- [20] A. Abdelrazik, "VMware Integrated OpenStack: First Look," <http://blogs.vmware.com/openstack/vmware-integrated-openstack-first-look>, 2016.

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