An exploratory essay on Cloud Computing and its Impact on the use of Information and Communication Technologies in Education.

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This chapter intends to describe the Cloud Computing technology in a language aimed at Educators, describing its basic concepts and its advantages for teaching institutions and researchers in Education, as follows: not to consume provider resources (in this case, a teaching institution); costs based on demand (pay per use); interoperability among various operational systems and; not to require installation of software on users’ equipment (e.g. students, Professors and Researchers). The experiments developed by LTIA – Laboratory of Applied Information Technology on the development of Open Source migration applications of the well-known Moodle to Cloud Computing will be described and made available through the Codeplex Brazil site.

Key words: Cloud Computing. Cloud Computing in Education. Interoperability.

1. Introduction

To understand the meaning of Cloud Computing, it is necessary to understand the origin of such name. It derives from an old practice of representing the Internet as a “small cloud”, in an attempt to depict with this metaphor what the Internet actually is – a gargantuan net formed by hundreds, thousands of sub-networks, some available for the general public, others restricted to private use, all interconnected.

Figure 1: Classic illustration of the Internet as a “cloud”

Source: http://www.infowester.com/cloudcomputing.php

There are different types of services available to Internet users on these sub-networks. Services that can be totally or partially paid for, such as those of Newspapers and Magazines; free services, which intend to become charged, such as Linkedin; services that bear a cost, but are sponsored, so there is no expense to the user, such as Yahoo; services that are totally free, which certainly intend to bear a price in the future; Private Services, such as Banks and Airway Services, which exist to assist their clients; Public services, offered by government bodies or institutions to provide citizens with information and services, such as City Administrations, State or Federal Government Secretariats; and, of course, learning computational environments made available by the teaching institutions.

In this chapter, we will use as example, a hypothetical major educational institution, with units across the country. This educational institution has to be concerned over its administrative, academic and pedagogic support systems. We are aware that the use of Information and Communication Technologies (ICT) and its results on teaching and learning have been studied for a long time by Education researchers [1,2]. They have observed huge government and private investments in schools to equip them to use information technology; the various forms of use of these Technologies pro education have already been classified, and it has been highlighted the importance of computational learning environments, where simulations and animations need to be integrated, and where the interaction occurs mediated by the computer. Invariably, researchers recommend deeper studies, which might bring about more conclusive results, necessarily implying broader scale research, as the currently available technological frameworks only allow limited experiments. Focusing on educational environments available at teaching institutions, we verified that they are all offered by the institutions themselves through their data-centers – groups of application and databank servers, such as the institutions that are Moodle [3] or TeleEduc [4] users. The greater the success of this computational learning environment, the bigger will the data-center have to be and the better will the communication have to be, between the
data-center and the Internet. This great framework demands a powerful computing infrastructure in order to be functional, along with its inherent costs.

2. The Cloud Computing

The Cloud Computing technology allows services provided by a site to be transferred to the “Internet cloud”, that is, it allows applications and databases of a data-center to be transferred to an Internet sub-network. This activity is facilitated by companies specialized in handling data-center services, transferring data to their own data-centers, strategically positioned on the Internet - large organizations [5] such as IBM, SUN, Microsoft, Accenture, EDS, Google, etc; which study the best location for specific installations, manage performance through demand analysis and take on responsibility for the data integrity. Ultimately, all the physical structure (hardware) as well as the logical structure (systems and data) can be replaced through a “Cloud computing” transfer.

Although the Cloud Computing is not free of charges, it offers 4 (four) great advantages for a teaching institution: it does not consume resources from the local data-center; its cost is based on demand (pay per use); it provides Interoperability, as it allows the usage of technologies from various sources, such as Windows and Linux applications; and it does not require software installation on users’ equipment (in our case, students, Professors and Researchers).

It is not an experimental technology, as it was launched in 2008 [5] and it is currently utilized by practically all known social networks. We can easily identify services that are already on Cloud Computing, just by asking: Can we use them directly from our web browser? Without any new installation? Can we access these services from any computer, even from someone else’s? MSN Messenger, Facebook, Linkedin and Live@Edu are classical examples of Cloud applications.

Cloud Computing has the potential to solve three big concerns. First, it reduces initial investments of a teaching institution, which would have no need to assemble, maintain or expand its physical infrastructure to hold its computational learning environments; second, costs become variable because charges are on demand, that is, many users at a certain moment, make costs go up, few users at another moment, lower the costs; and third, it sorts out the technical issue of site location, since this problem is transferred to the company that operates the Cloud services, which is interested in maintaining excellence in services.

3. The impact of Cloud Computing on Educational Institutions

Regarding the evolution of Information Technology, Cloud Computing is as revolutionary as, or even more than, the earlier big technological leaps, such as “time-sharing”, which in the 1970’s, allowed large computers to perform various jobs at the same time, increasing their processing power dramatically; and, later, in the 80’s/90’s, client-server computing, which enabled “job sharing” between computers of different sizes, such as personal computers, which assisted users through their user-friendly interface, exchanging information with larger machines, with more processing capacity and speed – where bulk volumes of data were processed and stored. By the advent of local, regional networks, and then, the Internet, the client-server computing became the basis of all the accelerated development of the use of Information Technology in wide scale, such as we have today. It has evolved from a business support framework to become an inherent part of it. Today, we cannot devise companies or institutions such as banks, telecommunications operators or large educational institutions, deprived of Information Technology.

The main advantages of a migration to Cloud Computing are linked to development, cost cutting and performance [6,7]:

- Interoperability – capacity to develop with different software platforms;
- High computing capacity – HPC capacity (high processing computing);
- Data in Cloud – security and enormous storage capacity in servers;
- Cost cutting, by pay per use (not by licenses);
- Fast system implementation, quick to adapt or change systems;
- Possibility of cutting fixed costs, enabling their change into variable costs.

In addition to these advantages, there are two other very important ones, though obvious, given that they derive from general concept. They are usually overlooked as far as Cloud Computing is concerned: one is the freedom and flexibility that teaching institutions have gained in being disconnected from the physical world of their data-centers and entering a virtual/logical world, where everything is possible with various options of implementation of Cloud Computing strategy; and the other is the interoperability, which is the capability of integration of different platform systems (Windows and Linux; Linux and Windows), which seems to be an intrinsic quality of Cloud Services Platforms. The interoperability ensures even more freedom to organizations. Unhindered from the physical world, they free themselves from restrictions and polemics of the “old World”.

In the case, for instance, of our major teaching institution, with various units in the country, the advantages are evident. Seeking to motivate the collaboration between Professors and students to share material, learning methods, academic notes, the Cloud Computing would greatly facilitate the Knowledge Management systems. Major e-learning or Collaboration systems in Education would benefit from a migration to Cloud Computing, through the use of
applications, such as Microsoft SharePoint [8] or Moodle [3]. The differentiated access control required between students and Professors can be implemented easily on a Software framework as a Service, which does not depend on client-applications, and, mainly, it can be implemented, managed, reconfigured, and modified, without difficulty, in a centralized manner, to thousands of students in the entire country. Most importantly, it will not consume hardware and software resources of the teaching institution - a current significant barrier to these educational centers, as they usually experience a serious disproportion between the number of students and the number of Professors.

Another issue to be considered is that in average usage situations, thousands of Internet users operate accessing hundreds of different sites, distributing statistically the traffic on the net and the load on servers, which are hosting the services. An Educational activity, using a virtual environment, which hosts an e-learning system, entails a different behavior – hundreds of users accessing the same site, at the same time, causing a “traffic jam” problem. This problem may be resolved through Cloud Computing, given that the traffic management becomes a responsibility of the company in charge of the Cloud processing.

4. Classification of Cloud Computing Environments

The Cloud Computing environments may be classified in terms of access and location as Public, Private or Hybrid:

- **General Public Cloud**: available to anyone on the Internet; that is, any user may access and use a public Cloud. Its benefits are as follows:
  - **Easy and low cost infrastructure management** - since its hardware and software can be managed by the service provider;
  - **Scalability and Elasticity** – processing and storing resources are used on demand,
  - **Eliminates complex cycles of search for resources** – increasing speed of delivery application, once resources are always available, when necessary;
  - **Relieves the IT team of the user company** – from concerns about infrastructure to pursue the development of business applications.

- **Private Clouds**: Cloud environments which can only be accessed by a limited number of users. They are Clouds normally installed within the limits of a data-center, behind a firewall. Their benefits are as follows:
  - **Exclusive use** – greatest control on data, security and quality of services;
  - **Ownership** – total control of the infrastructure and of how applications are executed;
  - **Management by the IT team of the user organization** – which implies high level of control.
  - **OBS**: in this case, most advantages of the Cloud Computing application are restricted to savings on hardware and management of physical infrastructure, because though costs are reduced they still remain at high levels.

- **Hybrid Clouds**: also known as “virtual private clouds”, they offer services that are performed on a Public Cloud, but within the limits of a VPN (Virtual Private Network). Their benefits are:
  - A mix of the two previously mentioned, but they may be very attractive to companies interested in global coverage associated with total control.

5. What Cloud Computing is not

Every major supplier of Cloud services, such as Google App Engine [10] and Microsoft Windows Azure, offers free options for experimental use, within certain limits, allowing tests and experiments. Costs of more complex services depend on the category of the services and the volume of transactions involved. These costs, usually linked to demand, are much lower than the fixed costs of a complete installation suitable to provide equivalent services. The latter offers the opportunity to clarify some misconceptions of what Cloud Computing is not:

- It is not the next generation nor an alternative to the Internet – but a set of functionalities that complement it;
- It is not a free source of unrestricted virtual resources – its use depends on the adherence to policies, accountability, management and costs;
- It “shall not conquer the world” and it will not make current data-centers obsolete – maybe small and medium-sized companies will make their data-centers redundant, but large organizations and teaching institutions will continue working with them, in a joint operation with Cloud Computing;
- The interoperability between different clouds is not possible yet, and the migration from one cloud to another is not a simple operation – the technology is still relatively recent and it needs to evolve;
It is not possible to “shut down a data Center today” and “wake up tomorrow on the cloud” – there is a migration process that needs to be planned and carried out cautiously. The advantages will make this operation worthwhile, but it is still an operation of migration from one environment to the other.

6. Development in Cloud Computing of the Applied Technology Laboratory of Unesp

The LTIA – Laboratory of Applied Information Technology of Unesp/SP, Brazil has been developing an application of Interoperability and Cloud Computing for a few years. Its main achievement has been the development in Open Source of “plug-ins”, which allow Moodle 2.0 to run on a Microsoft Windows Azure environment, demonstrating the flexibility of the Azure solution and its easy application in Education.

Migration Project Azure to Moodle: Moodle 2.0 Migration to Microsoft Windows Azure platform, to facilitate the migration of Moodle for education organizations that uses Moodle as their e-learning platform. Contains instruction manuals and walkthrough guides. 
Source: Developed by LTIA - Laboratory of Applied Information Technology, Department of Computer Science, UNESP / Bauru and freely available on the Microsoft Codeplex site, which can be accessed at http://moodle2azure.codeplex.com/

7. Conclusions

Cloud Computing has the potential to help teaching institutions reduce costs in their offer of access to computational learning and collaboration environments, leading to educational experiments in wider scale and offering conditions for deeper and broader experiments to be conducted by researchers using the ICTs in Education. This favors the adoption of more adequate uses promoting the improvement of both teaching and learning. Furthermore, the various application modalities of Cloud Computing allow an optimal use of resources of the current data-centers, which may be kept for activities that are less susceptible to demand fluctuations.

Professors and students will be able to increase the experience of spontaneous creation of collaborative sites and the practice of sharing information on the projects being developed, through access from home and school, allowing the discovery of new paths that favor the improvement of teaching and learning.

Finally, we can state that we are on the threshold of a new technological era, which will contribute to the expansion of the use of Information and Communication Technologies in Education, research and knowledge of the area, in as much as it generates more and more support and contributions from researchers.

References

[6] Sun Microsystems; Take your Business to a Higher Level, 2009