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Cloud computing for education: A new dawn?

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ABSTRACT

Educational establishments continue to seek opportunities to rationalize the way they manage their resources. The economic crisis that befell the world following the near collapse of the global financial system and the subsequent bailouts of local banks with billions of tax payers' money will continue to affect educational establishments that are likely to discover that governments will have less money than before to invest in them. It is argued in this article that cloud computing is likely to be one of those opportunities sought by the cash-strapped educational establishments in these difficult times and could prove to be of immense benefit (and empowering in some situations) to them due to its flexibility and pay-as-you-go cost structure. Cloud computing is an emerging new computing paradigm for delivering computing services. This computing approach relies on a number of existing technologies, e.g., the Internet, virtualization, grid computing, Web services, etc. The provision of this service in a pay-as-you-go way through (largely) the popular medium of the Internet gives this service a new distinctiveness. In this article, some aspects of this distinctiveness will be highlighted and some light will be shed on the current concerns that might be preventing some organizations from adopting it.

1. Introduction

Providing software as a service is not a new computing practice. Some companies, known as Application Service Providers (ASPs), were providing businesses with software programs as a service via the medium of the Internet during the 1990s. However, such attempts at "utility computing" did not take off. This was largely attributed to lack of sufficient bandwidth. During that period broadband was neither cheap nor plentiful enough for utilities to deliver computing services with the speed and reliability that businesses enjoyed with their local machines (Carr, 2009). Then came Web services (especially those based on the XML-based SOAP[1] message protocol) that represented a model of software delivery based on the notion that pieces of software applications can be developed and then published to a registry where they can be dynamically discovered and consumed by other client applications over different transport protocols (e.g., HTTP, TCP/IP, etc.) irrespective of the language used to develop those applications or the platforms (e.g., operation systems, Internet servers) on which they are implemented. This was a dramatic improvement over the services provided by ASPs which relied on proprietary (and hence un-portable) software.

The advent of Web services promised many exciting possibilities. Some of these promised possibilities initially received a great deal of attention and were a frequent subject of media discussions and futuristic scenarios (sometimes amounting to "hype") such as the ability to automate the process of discovery, binding, and invocation of Web services on the Internet without human intervention (Manes, 2004; Nakhimovsky & Myers, 2004). One technology analyst and author (David Chappell) in 2003 even doubted if there was a business case for Web services (Chappell, 2003).

However, Web services are nowhere near achieving the full potential that was hoped for. Nevertheless, the technology is being implemented successfully (and commercially) by many of the big players such as eBay, Amazon and Google (Iskold, 2006). Furthermore, the technology has also created the foundation for a new Enterprise Application Integration (EAI) paradigm known as Service-Oriented Architecture (SOA). The extensible XML-based nature of SOAP has enabled many organizations to expose some of their legacy and disparate systems as Web services in order to achieve total integration of their systems (Clark, 2007; Flinders, 2007; Mohamed, 2007).

Most importantly, SOAP-based Web services are now being used in the delivery of some aspects of a new computing paradigm (namely cloud computing) which not only promises to deliver

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[1] SOAP is an XML-based and open source message transport protocol. It stands for Simple Object Access Protocol.

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software remotely but also other computing-related functionality thanks also to other relatively new technologies such as virtualization[2] and grid computing.[3]

2. What is cloud computing?

There seems to be many definitions of cloud computing around. A study by McKinsey (the global management consulting firm) found that there are 22 possible separate definitions of cloud computing. In fact, no common standard or definition for cloud computing seems to exist (Grossman, 2009; Voas & Zhang, 2009). A more commonly used definition describes it as clusters of distributed computers (largely vast data centers and server farms) which provide on-demand resources and services over a networked medium (usually the Internet). 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.

However, by understanding the type of services offered by cloud computing, one begins to understand what this new approach is all about. The following is a list of the three main types of services that can be offered by the cloud[4]:

- Infrastructure as a Service (IaaS): Products offered via this mode include the remote delivery (through the Internet) of a full computer infrastructure (e.g., virtual computers, servers, storage devices, etc.);
- Platform as a Service (PaaS): To understand this cloud computing layer one needs to remember the traditional computing model where each application managed locally required hardware, an operating system, a database, middleware, Web servers, and other software. One also needs to remember the team of network, database, and system management experts that are needed to keep everything up and running. With cloud computing, these services are now provided remotely by cloud providers under this layer;
- Software as a Service (Saas): Under this layer, applications are delivered through the medium of the Internet as a service. Instead of installing and maintaining software, you simply access it via the Internet, freeing yourself from complex software and hardware management. This type of cloud service offers a complete application functionality that ranges from productivity (e.g., office-type) applications to programs such as those for Customer Relationship Management (CRM) or enterprise-resource management.

Before proceeding any further at this stage, a word of caution is necessary. One must not assume that cloud products offered by any of the above services are likely to work out-of-the-box. In some cases they might. Google Apps, a messaging and collaboration cloud platform from Google, is probably one good example of those out-of-the-box products (even though it does require some level of configuration nevertheless). Many of the products that are offered by those three types of cloud services will require some degree of programming (by the user or indeed the cloud provider) in order to access the functionality that exists in those services. Cloud providers will have created their own APIs (application programming interfaces) so that software developers can use them to create client applications in order to access that functionality. Currently, some of those APIs are proprietary; an issue which will be revisited later when examining some of the limitations of cloud computing. However, some are based on open source standards such as SOAP or REST.[5]

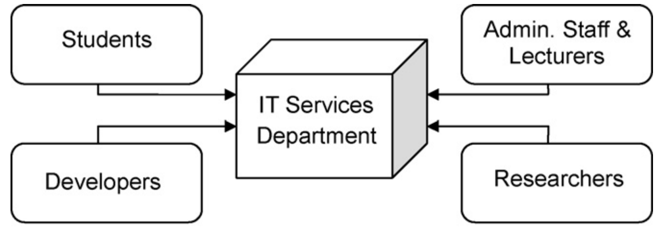

Fig. 1. Simplified structure of the main users of IT services in a typical university.

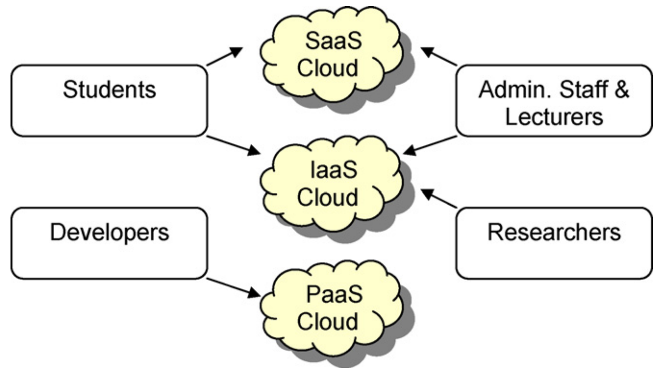

Fig. 2. Simplified structure of the main users of IT services in a typical university now using the services of cloud computing.

To demonstrate how those services can be utilized and the processes involved in their utilization (in a very simplified manner), a hypothetical example can be given. Take, for example, a typical university with an IT infrastructure that caters for the needs of students, teaching staff and management, research staff and software developers (e.g., Web developers). As illustrated in Fig. 1, demand for IT services in this environment is directed to the IT Services Department (pictured in the middle) whose job is to:

- provide students and staff with software (e.g., email accounts, operating systems, productivity applications, malware detectors and cleaners, etc.) and hardware (e.g., PCs, Servers, etc.);
- provide researchers and postgraduate students with the required special software and hardware to run experiments that are likely to involve a great deal of processing and computation;
- provide Web developers with the development tools needed to write and host Web applications.

Many aspects of this arrangement can be migrated to the cloud as demonstrated in Fig. 2. For example, students, administrative staff and lecturers can be made to use the services of providers of SaaS and IaaS clouds. These services will be ideally accessed through thin clients.[6] Any software launched by these groups of people resides on the servers of the SaaS cloud provider and is accessed online. Any requirement for disk space or additional hardware (e.g., a virtual PC or a virtual Server) is executed immediately online by

[2] Virtualization is the technology that enables the creation of a virtual (as opposed to actual) version of something e.g. an operating system, a server, a storage device or network resources.

[3] Grid computing is the technology that enables the sharing of tasks over multiple computers (joined together to form a supercomputer). These tasks can range from data storage to complex calculations and can be spread over large geographical areas.

[4] Some sources expand this list.

[5] REST, which stands for Representational State Transfer, is a style of programming which relies on well established protocols and standards (e.g., HTTP, URI, XML, etc.) to store, retrieve and process data.

[6] A thin client is a dumb terminal that is no more than a screen and a keyboard.