Session: FD5-2

CLOUD COMPUTING FOR THE CLASSROOM

Susan L. Miertschin and Cheryl L. Willis
Information and Logistics Technology Department
University of Houston
SLMiertsch@Central.UH.EDU

Abstract

Cloud computing is a general term for shared applications and infrastructure provided by an external service provider and paid for on a pay-as-you-go basis. For enterprise computing, the cloud has implications for a business model that relies heavily on in-house computing power and support. Amazon and Google sell computing resources that are generated by very large-scale virtualized, distributed computing systems. The question for enterprises, particularly start-up or small businesses, becomes "Who needs servers?" Cloud computing also has implications for personal computing. Web-based email was one of the first "hot" cloud applications to make it big, with Microsoft's hotmail, Yahoo Mail, and Google's gmail all competing and offering free accounts with practically unlimited storage capacity. Now many other software applications are available through the cloud, and soon there will be many more. Rather than purchasing software and installing it on a local machine, applications like Google Docs provide free computing resources available anywhere and anytime. Office Live Workspace and Microsoft Office Web Apps comprise Microsoft's entrant in the online office productivity market. Together they allow users to take advantage of anytime anywhere access to Office products in addition to online storage and sharing of documents. This paper will first describe the technology behind cloud computing. Then the paper will examine the relevance of online office products for faculty by describing the results from one of the authors' classroom experiences with an online office product. Included in the discussion will be features and functionality of the product, as well as student reactions to its use in class.

1. Introduction

Cloud computing is a general term for shared applications and infrastructure provided by an external service provider and paid for on a pay-per-use basis. For enterprise computing, the cloud has implications for a business model that relies heavily on in-house computing infrastructure. Vendors such as Amazon and Google sell reliable and scalable computing resources that are generated by very large-scale virtualized, distributed computing systems. The question for enterprises, particularly start-up or small businesses, becomes "Who needs in-house servers?"

Cloud computing also has implications for personal computing. Web-based email was one of the first "hot" cloud applications to make it big. For example, Yahoo Mail, Microsoft's hotmail, and Google's Gmail all compete, offering free accounts with practically unlimited storage capacity Now many other software applications are available through the cloud, and soon there will be many more. Rather than purchasing software and installing it on a local machine, applications like Google Docs provide free computing software and storage resources available anywhere and anytime. Coupling with Google Groups provides the power to collaborate. Microsoft Office Live Workspace (beta) and Microsoft Office Web Apps (invited technical preview only) comprise Microsoft's entrant in the online office productivity market. These cloud applications allow users to take advantage of anytime anywhere access to familiar products (built to function similarly to local installs of MS Office) in addition to online storage and sharing of documents.

This paper will first describe the history of cloud computing, then the technology behind cloud computing. Then the paper will examine the results from one of the authors' classroom experiences with an online office product. Included in the discussion will be features and functionality of the product, as well as student reactions to its use in class. The purpose of the paper will be to provide an overview and guidance for others who are considering classroom use of emerging cloud capabilities.

2. History of Cloud Computing

The concept of cloud computing began in the nineteen-sixties as the technologies to interconnect computers were just being born. Even before the first two computers were connected together to exchange data, Joseph Carl Robnett Licklider, the director of Behavioral Sciences Command and Control Research for the Advanced Research Projects Agency (ARPA), envisioned a shared computer network. His vision went beyond what would begin as ARPANET and what ultimately evolved as the World Wide Web. He planned for a network that would share both information and live software applications. This very early plan for cloud computing was called the "Intergalactic Computer Network" (Licklider, 1963). Licklider's Intergalactic Computer Network plan was realized as distributed applications available by terminals connected to the ARPANET. This architecture resembles today's Software As A Service (SaaS) architecture, which is part of cloud computing.

Licklider's vision and plan for his Intergalactic Computer Network more closely resemble cloud computing than the heavily html-based World Wide Web that has held prevalence for the past fifteen years. Further bolstering the idea of SaaS was cognitive and computer scientist, John McCarthy. At a speech commemorating MIT's 100th anniversary in 1961, McCarthy was the first to publicly propose a time sharing computer network that would sell computing resources and applications in a way similar to the way natural gas, water, and electric companies sold utilities at the time (Hongfei, 2003). This concept was sometimes referred to as "grid computing" since it mirrored the concept of the electrical grid.
Both Licklider and McCarthy continued to rally for their software sharing networks throughout the nineteen-sixties. However, by the dawn of the seventies, it was apparent that computing power and networking were not then at levels where SaaS would be practical (Mohamed, 2009). By the mid-nineteen-seventies, Licklider and McCarthy's vision was all but abandoned. It would stay this way for another twenty-plus years.

The SaaS ball was picked up again by Bill Atkinson, Andy Hertzfeld, and Marc Porat in the nineteen-nineties when the three formed the company General Magic. General Magic's concept was to provide thin, mobile clients to customers. The client devices would contain a light-weight operating system, called Magic Cap. Magic Cap applications were based on a proprietary language created by General Magic called Telescript. The concept behind Telescript applications on the General Magic devices was that all of the computing power was handled by large servers provided by General Magic. Telescript handled the communications between the handheld devices and the General Magic servers. This group of servers would come to be known as the “Telescript Cloud” (Armbrust, et al., 2009). Unfortunate for General Magic was the fact that the Telescript Cloud was not adequately built out and the lack of reliable and highly accessible infrastructure left many customers unhappy. This lack of planning coupled with the introduction of the Mosaic browser led to the ultimate demise of General Magic, but cloud computing and SaaS was back in vogue.

It was not long before another SaaS provider was on the scene. Using the infrastructure of the now-commonly-available Internet (instead of the proprietary infrastructure that General Magic relied on), the cloud computing model could be built without the need to reinvent the technology to connect the client to the server. In 1999, Salesforce.com introduced the first cloud computing service that resembles today’s SaaS offerings.

Much of the concept behind Salesforce.com was not new ("Salesforce.com Exposed - Background & History," 2009). Google and Yahoo had also been employing SaaS in a novel way to provide software applications as services to users via the Internet. However, most of these offerings were trivial and geared toward personal use. What was new was that Salesforce.com utilized this grouping of technologies to provide a business-focused service. Salesforce.com created an online sales force automation solution that helped large businesses organize geographically diverse sales teams. Salesforce.com stuck to their goal of requiring the end user to never have to install software. Instead the software and computing power was located on Salesforce.com’s servers ("Editions and Pricing," 2009).
After Salesforce.com paved the way to serious business applications delivered via cloud computing, a number of other providers came on the scene. Today Amazon, Microsoft, IBM, Google, and many other companies provide cloud computing applications for business and personal users (Armbrust, et al., 2009). These companies are the latest in a trend that was foretold by Licklider and McCarthy decades ago.

3. Technology Overview

In the near future, the dominant model for providing computing and information infrastructure to businesses will likely involve cloud computing. Infrastructure includes both hardware and software, and the location of the infrastructure in a cloud computing architecture is the cloud, which refers to the global network of information and communication technologies and devices, the Internet. One research team likens the cloud model to multiple users sitting at dumb terminals and accessing a mainframe. But they quickly qualify the comparison with a reminder that a cloud user will not be connected to a limited-functionality mainframe, but to all the resources of the Internet, both what is there today and what will be there tomorrow (Voas & Zhang, 2009). In addition, the user is not sitting at a dumb terminal, but at a laptop, workstation, or mobile PC with a significant amount of computing power and storage capacity of its own. Tim O’Reilly (credited with coining the term Web 2.0), in an interview during Web 2.0 Expo 2008, describes cloud computing this way:

Everything we think of as a computer today is just a device that connects to the big computer we are all collectively building. Cloud computing is really the movement of computing into the network of all connected devices, this network of networks. ("What is Cloud Computing?," 2008).

Researchers have identified a minimum set of features that are generally included in the cloud paradigm. These are scalability, a pay-per-use utility model, and virtualization (Vaquero, Rodero-Merino, Caceres, & Lindner, 2009). In other words, cloud computing refers to the provision of computing infrastructure that is highly scalable, that is offered on a pay-for-use basis, and that involves access to application and data servers over the network rather than ownership of tangible servers and software.

A principle advantage claimed for cloud computing is a reduction in costs associated with the management of hardware and software resources (Hayes, 2008). One report refers to cloud computing as an infrastructure management methodology (Seeding the Clouds: Key Infrastructure Elements for Cloud Computing, 2009). Typical labor and ownership costs of installation, configuration, and updates that are associated with software installed on desktop computers are transferred to Service Providers (SPs) whose core business is providing Software as a Service (SaaS) over the network. The company pays the SPs a negotiated fee for the services, contracted through service level agreements. Typical labor and ownership costs of increasing storage capacity and increasing processing capacity to accommodate newer power-hungry software releases that are associated with in-house hardware ownership are transferred to Infrastructure Providers(IPs) (Vaquero, et al., 2009). The company pays the IPs a fee for the infrastructure services they provide, again contracting through service level agreements. The complexity of the underlying resource infrastructure is made simple by high-level web-based management interfaces and tools that enable users to request resources (applications, storage, data, training, etc.) and be granted the resources quickly and in an automated way that requires minimal hands-on support by skilled IT personnel. The resource allocation model when using cloud computing requires users to define a start and end date for their need for the resource. So, for example, in the case of software, a license for the software will be consumed by a user for only a predefined period of time. This frees up licenses to be reallocated as needed without having to purchase additional licenses. This model provides for better use of existing resources, with less waste in the form of allocated software licenses going unused. It is not difficult to see where cost advantages might be derived with this approach, which is compatible with the TPS philosophy of only paying for a resource just as it is needed as part of production. In this case, the resource is computing infrastructure (software, hardware, storage capacity, e.g.) that no longer needs to be installed on every computer where it may be used only a small amount of the workday. The software resides on the server and users access it and use it as needed through the cloud, and the client only pays fees when it is used, not when it sits idle.

There are some disadvantages identified for cloud computing. An important one has to do with security and privacy. If data is kept in-house, then companies control policies related to deleting and archiving data. It is not yet clear who controls policy regarding data deletion when the data is stored by one company as a service to another (Hayes, 2008). Data preservation and availability is generally covered with service level agreements between provider and user. For a company with sensitive data assets, it is important to negotiate security policies with the SPs and IPs. Another disadvantage may have to do with the complexity and sophistication of software that can be made available through the cloud at this time and the somewhat early stage of the development of this technology. As seen from the history of the technology, it is not new, but it is evolving. There are limitations to what software can be distributed via the cloud at this time. Certainly many office productivity tools can be made available through the cloud, but processor hungry design suites might not be available in this format for a few years. Platform as a Service providers are focusing on the delivery of software development tools that include version tracking as cloud services. These are sophisticated applications yet they target the one industry of software development.

Thus, in terms of the technology lifecycle, cloud computing is probably in the introduction stage, perhaps just transitioning to the growth phase. Recognized problems associated with early adoption are uncertainty, lack of standards, and no performance benchmarks. Uncertainty and lack of performance benchmarks are, perhaps, not as much of a risk since cloud computing really represents a composite of proven technologies (networking, distributed applications, virtualization). Lack of standards is also, perhaps, less of a risk since cloud computing relies on the standardization of the underlying technologies to work, and these underlying technologies do adhere to established standards. The cloud provider is as much an integrator and management provider as it is a technology provider.

One vendor working to define cloud computing for its clients is IBM. Their offering is complete service support for building the necessary infrastructure and managing it. They provide several case studies of client implementations lead by IBM with proven ROI in terms of cost savings and innovation fostered by the technology (Seeding the Clouds: Key Infrastructure Elements for Cloud Computing, 2009).

4. Implications for STEM Disciplines

Two broad areas of the cloud computing spectrum are seen in the STEM literature—the use of virtualization for remote student access to application and the use of internet-based office productivity tools like Google Apps. The rest of this paper describes the use of another version of an internet-based productivity tool, known as Microsoft OfficeLive (MOL). The discussion involves an action research implementation for the use of MOL in a sophomore-level information systems database course. The process of action research provides a way of thinking systematically about what happens in teaching practice.

5. Action Planning

The problem to be solved was providing students experience in using a workplace-type cloud computing (internet based) application. The goal of using an internet-based application for collaboration, storage, and viewing word processing, spreadsheet, and presentation slides was to provide students with access to documents, both individually- and team developed, anytime and anywhere. Since the university computer labs provided students with Microsoft Office productivity tools and that it was likely students who had computers at home would have access to these same productivity tools, students needed to know how to store or revise Word, Excel, and PowerPoint documents. Microsoft OfficeLive (MOL) was chosen as the platform to provide such experience. They would then need to know how these documents are made available to team members or the instructor through Microsoft OfficeLive (MOL). Students also needed to know how to communicate with the instructor and team members about individual or team assignments.

6. Actions Taken

To set the stage for the introduction to the cloud computing concept, students were given an assignment of sending an email to the instructor from their university email account. This forced the students to access their university accounts, which may not had been used recently. The university account was used to protect the privacy of students. The instructor created a distribution list of the students' email addresses for each class, and a confirmation email was sent to the students by the instructor. Students were asked in class to make sure each had received the instructor's email. Those who had not received the confirmation had to see the College IT help desk staff to work out their email issues.

Next, the plan to enable students to use a cloud computing application for class assignments was implemented in four parts. First, an introduction to information systems that facilitate collaboration was given. A class discussion of the characteristics of a collaborative environment and the requirements of an effective collaboration effort was conducted. Also included in the discussion was an explanation of the various types of permission levels.

The next part of the process included viewing a demonstration video of the process to create a Microsoft OfficeLive account, and then the students were walked through the steps for setting up their own account. Once in the OfficeLive site (www.officelive.com), their university email became their Microsoft OfficeLive account user id. The MOL system sent an invitation to an account via the participant's user id (email). Most students received their invitation in their university email account within five minutes. Accepting the invitation took the student to their MOL account. The interface for the MOL has the look and feel of a Microsoft Sharepoint account. Those students not receiving the confirmation typically still had an issue with their university account.

As an administration tool, students were given a class number that corresponds to their place in the alphabetical listing found in the roster. The numbering system provided a more useful mechanism for recognition and retrieval by the instructor than a list ordered by email account that started with the student's first initial. This number is used in the next step of the process when students are instructed on creating a folder, or a workspace in Sharepoint parlance. Students each created a workspace using the naming convention NNN Workspace, where the student's assigned class number is substituted for NNN. Within their course workspace, students created folders for Inclass, Homework, Project, and Tests.

Finally, the students went through the process of sharing their course workspace with the instructor. In the “Share your workspace” window of MOL, students gave the instructor Editor permissions to create and edit documents by typing her university email address in their Editors text box. A brief message to the instructor was also completed. A sharing invitation for the course workspace was then sent to the instructor. This invitation contained the link to the student workspace. The instructor saved all workspace invitations for a class to one folder in her email application to make access to student accounts available in a central location.
Throughout the semester, students submitted all assignments via their course workspace. The naming convention for assignment files to be submitted started with the course number. The student uploaded the assignment to the appropriate folder in the workspace. Activity emails were sent to the instructor each time a change was made to a workspace. All activity emails can be cancelled if so desired. To communicate with the student, the instructor sent a comment on each individual assignment to the student via the course workspace. Students could respond to the instructor’s communication or send a question to the instructor through the MOL comment facility.

The above process for workspace creation also was used for teamwork assignments. One member of the team created a team workspace and became its owner. The other members of the team, as well as the instructor, were then invited as editors (create and edit permissions) by the workspace owner. The team members had to accept the owner’s invitation. The students collaborated on in-class and homework assignments, as well as project work. Any student could upload a document to the workspace. All students were instructed on possible scenarios for completing collaboration assignments and how to use the version control feature of MOL.
As a means of distributing course documents to students, such as syllabus, class schedule, weekly checklists, presentation slides, and class handouts, the instructor established her own workspace for each class. Students were invited to the workspace as viewers (read only). The students had to accept the invitation to the workspace. They could choose to receive activity emails when changes were made to the repository.

7. Observation and Reflection

The creation and use of the student workspaces was successful for the most part. Students were most satisfied with having a place to save documents for all their classes that was accessible anytime from anywhere with internet access. They also liked being able to use productivity tools that they had experience with and that had greater functionality than other internet-based products. Students had difficulty understanding the concept of sharing a workspace versus sharing a document. In spite of sharing their workspace, they would also share a document within the workspace. This step prevented the instructor from having access to the entire workspace rather than just a document. Also some students could not gain access to their university email accounts for two to three weeks, so they got behind in completing and uploading their assignments. Although the instructor provided grades for each assignment and periodic summaries of their grades, some students wanted an overall view of their grades in one place online. From the instructor perspective, grading online can become quite time consuming. This fact would be true whether using a cloud platform and a learning management system.

The collaboration process did not go as smoothly as turning in individual assignments. The problem was not so much with the platform but more with the lack of responsibility on the part of some students. As with any group project, some members were not responsible in getting back to others in a timely manner nor did they follow through on their commitments. Oftentimes, this behavior would lead to last minute synchronization of documents just prior to submission time. Some students did indicate that they would continue to use OfficeLive at least for its storage capability in future classes.

The instructor was satisfied with the results of using a cloud computing platform. Future implementations will be handled similarly, with hope that the problems experienced with email accounts will be minimized. On the horizon is a completely web-based version of the Microsoft Office tools which should make the implementation even more appealing.

8. Conclusions

This paper reviewed the historical underpinnings of cloud computing along with an overview of the technology background of cloud computing. The final sections of the paper described the results of an action research project that was implemented to address the implementation of a cloud computing application in an undergraduate information systems class.

Bibliography

[1] Armbrust, M., Fox, A., Griffith, R., Joseph, A. D., Katz, R. H., Konwinski, A., et al. (2009). Above the Clouds: A Berkeley View of Cloud Computing EECS Department, University of California, Berkeley.
[2] Editions and Pricing. (2009). Retrieved from http://www.salesforce.com/crm/editions-pricing.jsp
[3] Hayes, B. (2008). Cloud computing. Commun. ACM, 51(7), 9-11.
[4] Hongfei, T. (2003). Grid computing as an integrating force in virtual enterprises. Department of Civil and Environmental Engineering - Massachusetts Institute of Technology.
[5] Licklider, J. C. R. (1963). Memorandum for members and affiliates of the Intergalactic Computer Network.
[6] Mohamed, A. (2009, 27 Mar, 2009). A history of cloud computing. ComputerWeekly.
[7] Salesforce.com Exposed - Background & History (2009). Retrieved 19 July, 2009, 2009, from http://www.crmexposed.com/compare-salesforcecom-background-history.php
[8] Seeding the Clouds: Key Infrastructure Elements for Cloud Computing (2009).
[9] Vaquero, L. M., Rodero-Merino, L., Caceres, J., & Lindner, M. (2009). A break in the clouds: towards a cloud definition. SIGCOMM Comput. Commun. Rev., 39(1), 50-55.
[10] Voas, J., & Zhang, J. (2009). Cloud Computing: New Wine or Just a New Bottle? IT Professional, 11(2), 15-17.
[11] What is Cloud Computing? (2008). joyent.com.

SUSAN L. MIERTSCHIN
Susan L. Miertschin has long demonstrated a passion for the application of technology to instruction. She began her career in education in the field of mathematics and quickly found a niche in an environment that valued applied mathematics as opposed to theoretical presentation and emphasis. Through her interest in applied mathematics, she has supported students in Engineering Technology programs. Her demonstrated interest in applying information and communication technologies to instruction illustrated her depth of knowledge of computer applications and systems, which allowed her to change her teaching focus from applied mathematics to computer information systems. Recently, she has completed graduate coursework in the area of Information Systems and Medical Informatics in order to deepen and broaden her knowledge and understanding of these areas. Professor Miertschin also has

experience in the application of ICTs to teaching through her commitment to online learning.

CHERYL L. WILLIS
Dr. Cheryl L. Willis is a professional educator with a consistent and noteworthy record in career and workforce development for secondary students and teachers. She has completed projects related to information technology and business career clusters for the Texas Education Agency (1992-2007). In addition, she has spearheaded research in the application of tablet PCs for knowledge work in academia and has established a recent record of inquiry related to visual learning and active learning strategies to enhance critical thinking skills in computer information systems students. Her dedication to educating computer information systems professionals in an environment that is supportive of women and minorities demonstrates a personal commitment to equal opportunity for all. She received her Ph.D. from the University of Florida in Postsecondary Education.