Application of Cloud Computing to Academic Education

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1. Introduction

"Cloud computing" is a widespread trend in an information technology field[1]. It is said that this trendy word has spread fast by Eric E. Schmidt, CEO of Google Inc. in the Search Engine Strategies Conference, San Jose, CA August 9, 2006. The "cloud" is the symbol of the Internet. The Internet users do not have to know how information resources are deployed and a way of information pass. Then the Internet was represented as a cloud. Then "cloud computing" means a service of information processing using the Internet. Some of typical services through the Internet are from blogs, social networking, and ASPs (Application Service Providers) to hosting services, and those services are not conceptually novel. Nevertheless, from a business point of view, those services are going to acquire customers targeting a far wider range of users and assortments with lower service charge.

The cloud computing services are classified according to layers from infrastructures to applications.

The typical classifications are as follows.

Ⅰ A service of providing an infrastructure such as hardware or an OS (operating system)

Ⅱ A service of providing an application development environment.

Ⅲ A service of providing application software.

IT industrial giants such as Microsoft, Google, and Amazon release products and announce their strategies in rapid succession.

Technologies that underlie the cloud computing, server virtualizations[2] and parallel programming[3] attract attention. Server virtualization, in terms of attracting consumers especially in Ⅰ service, is positioned as an operating technique that runs different OSs (Operating Systems) such as Windows, Linux, MacOS efficiently keeping balance in load distribution. On the other hand, parallel programming is a technique of an efficient utilization of multi-core or many-core processors which have been being replaced single-core processors which reach their processing speed limit.

In this paper, we consider an application

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of cloud computing to academic educations. Section 2 outlines the historical background and hierarchy of cloud computing. We then discuss some concrete applications and the e-Learning in section 3. Finally we describe some foresights of future shape of education which utilizes the cloud computing.

2. The history and overview of computing

Fig.1 describes the change of computing environment.

Since TSS or C/S has the assumption that user-clients such as terminals and low price PCs which have limited processing power connect to and utilize a high processing power server over communication network, they may be original forms of cloud computing. Users of TSS or C/S can only utilize the limited resources of OS and programming languages prepared in the host computers or servers. On the other hand, users of cloud computing can be served many OSs, CPUs, memory resources on demand by the virtualization technology, without being aware of computing resources

layout and locations. Besides, the users can utilize several programming languages.

Cloud computing now classified as follows according to available computing resource layers (Fig. 2) [4].

- Utilizing an infrastructure such as Hardware/OS
- Utilizing a platform such as an application development environment
- Utilizing an application services

Each service is named as follows.

I HaaS/IaaS(Hardware as a Service/ Infrastructure as a Service) : Infrastructure services over the Internet. The services such as a virtualized server and a shared service.

II PaaS(Platform as a Service) : Platform services for an application execution environment. The services such as a database software and an application development environment.

III SaaS (Software as a Service) : Application software package services. The services such as e-mail, Office document, and CRMs.

Examples of I are Amazon EC2(Elastic

1946	The appearance of the first computer ENIAC
1950	Batch computing on mainframes.
1960	Computing using Time Sharing Systems(TSS)
1970	
	Personal computing on microprocessors
1980	
	Client/Server computing using high-speed LAN and workstation.
1990	
	Web computing supported by the growth of the Internet
2000	
	Cloud computing
2010	

Fig.1 The history of computing
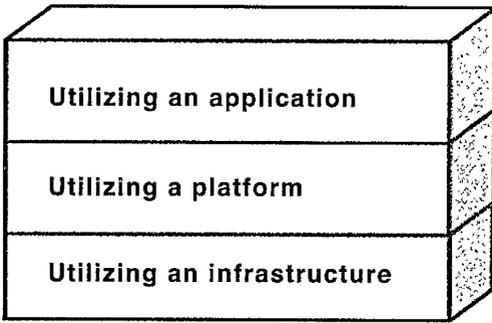
Fig.2 Layers of cloud computing services

Eigenvalue Applet with Sound — 1

Fig.3 A web animation of teaching materials
http://ocw.mit.edu/ans7870/18/18.06/tools/
Appiets_sound/eigen_sound_1.html

Compute Cloud)[5]and Amazon S3(Simple Storage Service)[6].

Examples of Ⅱ are Force.com platform[7], Google App Engine[8], and Microsoft Azure[9]. We discuss them further in Section 4.

Examples of Ⅲ are Google Docs[10] which allows us to edit documents over the Internet, and Google Apps[11] which provide e-mail and calendar functions in addition are the representative services of SaaS.

Microsoft announced that the new version of Microsoft Office 2010 consists of traditional stand-alone type and Web formed type [12]. We discuss them further in 3.2. Educators especially for university are perhaps interested in a upper layer of cloud computing, that is, SaaS.

3. Daily Utilization of Cloud Computing in Academic Education

3.1 Utilization of Web to education

Academic educators are now adopting electronic materials such as Microsoft PowerPoint in their daily lectures. One of the advantages of adopting a presentation software is that being easier to read, visually understandable by using diagrams, pictures, and animations. Recently, "Open Course Ware (OCW)", the movement of sharing electron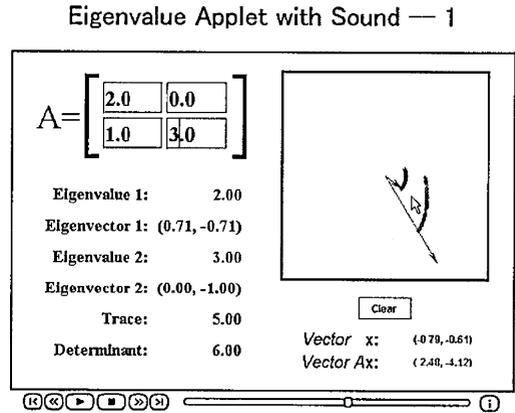ic materials freely with the public via the World Wide Web (WWW), is attracting attentions. The OCW movement took off with the launch of MIT (Massachusetts Institute of Technology) in USA in 2001. In Japan, University of Tokyo, Kyoto University, Osaka University, and many other universities engage in the OCW movement. Only course syllabuses or lecture notes were opened to the public at the beginning of the movement. Today, lecture videos and Web animations (Fig. 3) using scripting in DHTML(Dynamic HTML) are now also included, and the kind of contents is also increasing.

As the OCW movement, some professors maintain their servers individually and utilize WWW and e-mails for their lectures. However, for utilizing Web in education by themselves, they must be familiar with computer technologies such as server technologies and must maintain the servers. If one can utilize Web by oneself, on-line storage services are convenient. Some service providers provide those services, SkyDrive, which is one of Windows Live Services by Microsoft, provides us with an easy on-line storage utilization via Web. For instance, if a professor upload a teaching material on SkyDrive with the
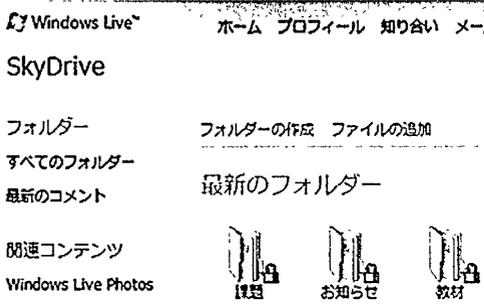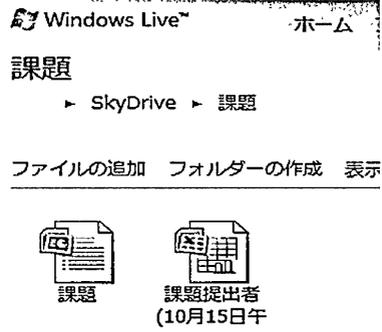
Fig.4-1 Material folders on SkyDrive

Fig.4-2 A part of contents in a material folder

username and the password with his/her students in each lecture course, and his/her students can download the teaching material anytime and anywhere through the Internet. Professors can freely correct the teaching material because they need not distribute the copy of the teaching material to the student. Fig. 4-1 shows the folders of the teaching materials, assignments, and announcements etc. on Windows Live SkyDrive. Fig. 4-2 shows a part of contents in a folder of the teaching material. Because the user name often becomes an e-mail address as it is in service like SkyDrive, the e-mail service can be used all together, to contact the student or to accept

the report and the question from the student. However, the teaching material should be read-only against a falsification. Besides, functions like bulletin board is needed because any corrections of the teaching materials must be announced.

3.2 Application of SaaS to education

Basically, Windows SkyDrive described in 3.1 is a service only that downloads teaching materials and it is limited to submitting reports with an e-mail. Two or more people can edit the same Office documents on Web servers by using Google docs (Fig.5) of Google or Office Web Applications of Microsoft as ones
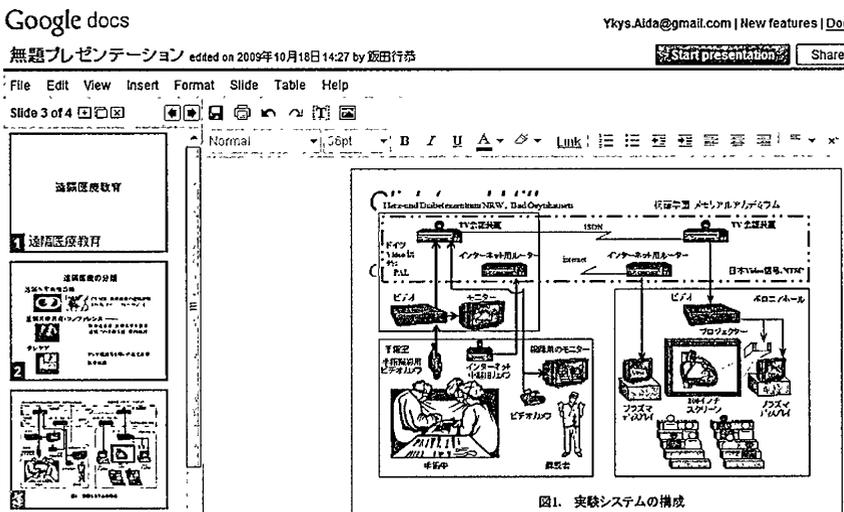

Fig.5 A sample of material documents in Google Docs

of SaaS. By using this shared edit functions for collaborative, a novel education method utilizing Web can be devised.

For instance, comments on reports can be written directly on the report document. Moreover, it is possible to divide student into two or more groups, to make the research report together in each group, and to have the round-table discussion on Web. The newer manner of utilization will be appear depending on ideas.

4. Future development and problems of e-Learning

In section 3, we described the application of Web to a daily education, in this section, we discuss an application of Web to an e-Learning. The e-Learning system on Web usually has not only contents creation and utilization but also has a management function of study progress. In August 2009, Google opened JavaScript service which can associate Google Docs contents with an e-mail (Gmail). For instance, JavaScript allows us to send an e-mail by clicking a button in a spreadsheet. If you want to manage an access control to the teaching materials, a status of collecting reports from students, comments for reports, and emails, you can only write a simple script for contents such as Office Web Applications and emails described in section 3. For the professors who can write JavaScript, it is not very difficult to make a simple e-Learning system. Of course if it becomes a high performance e-Learning system that has automatic grading functions or study progress management functions, it is not what professors can construct in their side job. Nevertheless, the development efficiency of the e-Learning system constructed with SaaS is greater than that of the e-Learning system constructed from scratch. Then we can

utilize the e- Learning system with affordable price. In fact, Fujitsu who is the vender of a domestic major company of the e-Learning system installs "Internet Navigware" in the SaaS platform, and is offering it as service. In this service, it is assumed to be a big sale point need not secure a special operation worker, and to be able to begin e-Learning of a little initial investment. In addition, when PaaS utilization is prevailing, this can be used for the information processing, especially programming education. Now supported programming languages are limited to Java and Python in Google App Engine, PssS of Google, and limited to the .NET language in the Windows Azure service that Microsoft turns on in 2010. In the plan of the two companies, it is heard that the language is scheduled to be expanded, including script language Ruby, which is developed in Japan. It depends on universities what language should be adopted for programming education, then if they want to adopt several kinds of languages, PaaS, which primarily provides many common functions for system development, will become a powerful tool for programming education.

5. Conclusion

In this paper, we discuss the cloud computing in a historical background of computing, then classify and instantiate the cloud computing in section 2. In section 3, we then introduced some concrete examples that how we utilize SaaS for an education in terms of support of education. In section 4, we explained e-Learning services and its implementation utilizing PaaS. Is "cloud computing" a buzzword ? We may not be too anxious to catch this explosive industry-wide trend. Nevertheless we can appreciate many advantages as below:

1. We need not have computing assets.

2. Initial cost is low.

3. We need not have maintainer.

4. The latest, highest service can be selected at any time.

5. There are a lot of choices of services.

An inscrutable effect can be expected after many examples of the application of cloud computing to the education appear and utilization technique is established in near future.

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