INTERNATIONAL JOURNAL OF
NUMERICAL ANALYSIS AND MODELING, *SERIES B*
Volume 5, Number 1-2, Pages 162–169

CLOUD COMPUTING IN ENTERPRISE: PRACTICE, IMPACT AND PROSPECT

WEI XU, LI FU, WENHAO ZHU AND WU ZHANG

Abstract. In recent years, cloud computing has set off a new upsurge of IT industry. And related research has been carried on by more and more companies, universities and research institutions. With this new business model, IT ecosystem is experiencing great changes and the role of IT department in either university of enterprise is also needed to transform by modern information technique. In this paper, we first give a brief review on cloud computing and then introduces some application cases of cloud computing implementation in Shanghai University. Finally, based on our practical experience, we analyze the influence of cloud computing on enterprise development and looks forward to its impact and prospect.

Key words. Cloud Computing, Digital Media Services, Supercomputing Services, Cloud Computing Laboratory.

1. Introduction

The development of Internet led to rapid growth of information and data, as well as new demand for the computing power and storage capacity of existing hardware. Although purchasing hardware devices and software licenses can overcome these problems to some extent, they increase the maintenance burden and operational costs. And normally, the user may just hope to hire the required services with a small fee when they need. In this way, people can conserve resources and the daily life will be more convenient. Under this background, the cloud computing was born.

Cloud computing is a new commercial computing model which converges a lot of computer and network technique, such as grid computing, distributed computing, parallel computing, network storage, virtualization, load balancing, etc [1]. Its core idea is scheduling and managing the resources in a unified way, so as to reduce the processing cost of user terminals and provide strong manipulated ability as required [2]. Currently, the main cloud services platforms on the market include IBM "Blue Cloud", Amazon Web Services, Microsoft's Azure platform, Vmware vCloud, Google App Engine and so on. As a new service and service pattern, cloud computing has become the important transition and symbolic transformation in the area of IT service delivery.

In our opinions, the dispute revolved about cloud computing now becomes very limited despite its inherent drawbacks. In fact, it is turning into new standardization rules gradually. In this paper, we take some typical application cases of adopting clouding computing in Shanghai University as a living example to reveal its impact in enterprise development. Through the introduction and analyzing of these cases, we believe that enterprise is experiencing the transformation which includes industrial development, new opportunities and strategies. While all of these also promote the evolution of cloud computing and help the enterprise to discover new commercial value simultaneously.

Received by the editors January 19, 2014 and, in revised form, March 20, 2014.
2000 *Mathematics Subject Classification.* 68N01, 68P01, 68Q01.

This paper is organized as follow. Section 2 describes the development situation and tendency in domestic and foreign countries. Section 3 presents the deployment practice of Shanghai University on cloud computing platform. Then we analyze the influence of cloud computing on enterprise development in section 4. Finally, in section 5 we propose the future trends and prospect of cloud technology.

2. Related Work

Cloud computing firstly originated from the research and development of Eucalyptus, an open source infrastructure architecture for cloud computing, at the University of California, Santa Barbara. Then more and more colleges and institutions in the world started researching this topic, such as NASA Nebula Cloud Computing Platform, EU's OpenNebula, UK government's G-Cloud plan, etc [3]. After that, many large multinational companies have introduced into their internal cloud platform architecture too, such as Amazon EC2, Microsoft's Azure platform, Abiquo's Abicloud programs and so on [4]. At present, our government also strong supports this area and a great many of enterprises, colleges and scientific institutions have conducted related researches [5]. Most of them are launching their own research projects or products of cloud computing actively, including "China Cloud" plan, Century Interconnection's CloudEX, Tsinghua Mass Storage System, and provide convenient, reliable and efficient cloud services for the users [6].

In the academia, Dr. Rajkumar Buyya, a professor of Computer Science and Software Engineering in Melbourne University, proposed a cloud architecture for market-oriented allocation of resources in 2009 which transformed the traditional information processing model [7]. In 2010, Michael Armbrustin and his collaborators of UC Berkeley RAD Lab, analyze the ten obstacles and opportunities in cloud computing development [8]. In their opinions, whether the cloud provider sells EC2 or App Engine, computing, storage and networking all focus on horizontal scalability of virtualized resources rather than single node performance. Then in 2013, Daji Ergu and his co-workers present a model for task-oriented resource allocation in cloud computing environment. By pairwise comparison matrix technique and the Analytic Hierarchy Process, the resource can be allocated by ranking their availability and user preferences. Simultaneously, this paper introduces induced bias matrix to identify the inconsistent elements [9]. Furthermore, MMYA Younis insisted that some technical barriers hinder the development of cloud computing, such as security and quality of services. He explores the potential security issues, security challenge and security requirement related to the security of cloud computing for critical infrastructure providers [10].

3. Application Case of Adopting Cloud Computing in University

Cloud computing is now widely implemented and practiced in Shanghai University. It is a reliable and dynamically extensible cloud computing and service platform which integrates all the IT equipment and resources in school. The detailed design is illustrated in figure 1.

The main modules include Cloud-based Digital Media Services, Cloud Storage Applications, Virtualization Experience Laboratory and Supercomputing Services, etc. Through its powerful computing and storage capacity, user can access the required services directly with a simple thin-client device. In addition, IT equipment and resources integration can largely reduce the energy consumption and operational cost. In a word, it not only provides high quality and efficient information services, but also offers a public infrastructure environment.

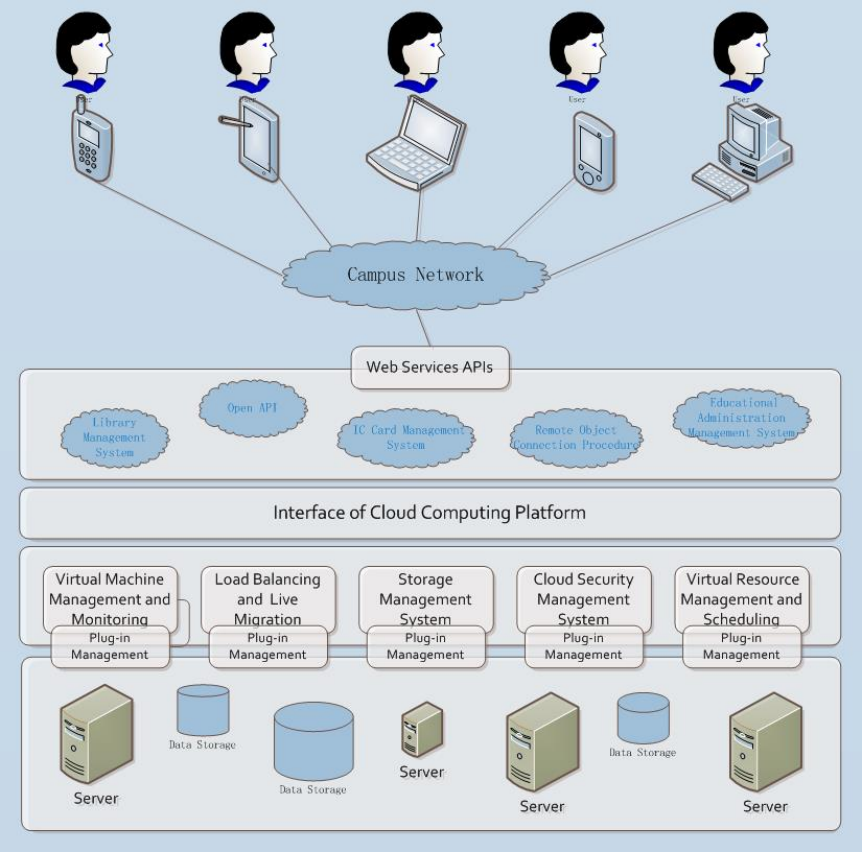

FIGURE 1. All resource are scheduled and managed on this platform unified. Through using various computer and network technique, we deploy daily system on this platform and provide the corresponding services by web services APIS. And user can access the required service by a simple thin-client device ultimately.

3.1. Nova digital media services. Nova is a VoD/P2P system which explores and practices a lot of technologies, such as encoding storage, virtual money mechanism and delivery mode, etc. In this system, every video can be dragged with two seconds and finishes buffering with five seconds. And all the resources are stored in the cloud which can be scheduled and assigned as required. In 2013, Hu Guannan [11] put forward a dynamic user-integrated cloud computing architecture which permits the data center changing dynamically and accelerates collaborations between end users and data center. The print screen is showed in figure 2.

3.2. The cloud computing laboratory. As early as 2008, we have established a Joint Laboratory for Cloud Computing which began the researching in infrastructure of cloud computing, basic platform, economical model, and so on. After creating and assigning the virtual machine in the management platform, the user can deploy the required service in allocated machines. In this laboratory, every machine is a thin-client and the applications all run in the server. Finally, the user can access the required service by requesting the corresponding mirror image. The details are showed in figure 3.

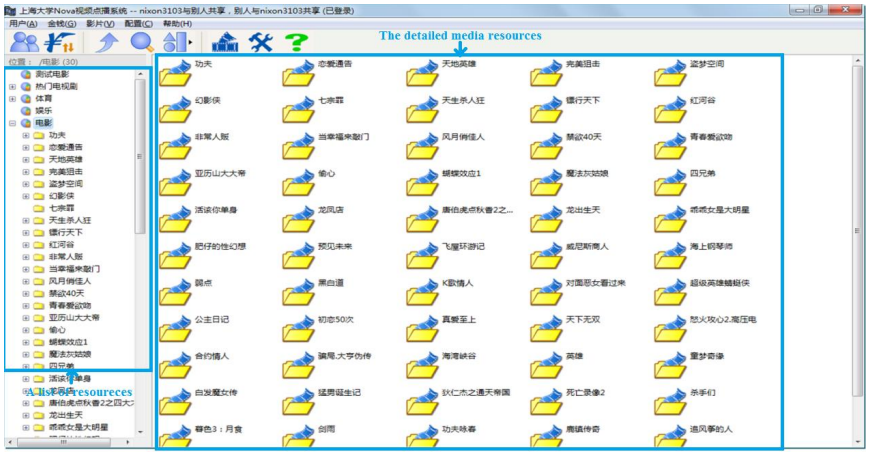

FIGURE 2. The left navigation bar shows a list of resources. For example movies, TV plays and sports videos, etc. On the right side of the screen are the detailed media resources. User can click the required one to access the corresponding service.

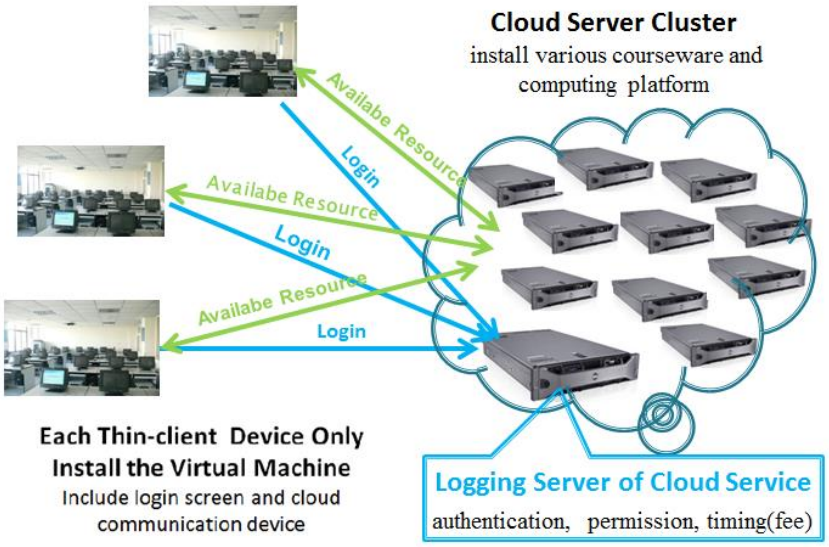

FIGURE 3. Every machine in the laboratory is a thin-client and only installs the virtual machine. The computing platform and courseware are installed in the cloud server cluster. After logging the cloud servers, user with permission can access the required service and just pay for it based on the usage.

3.3. Network U-disk. The network U-disk is able to effectively solve the difficult problems of spreading viruses and the upload and download of homework. Every real-name account can apply 50 megabytes and expand the space by virtual gold coins. Contemporary, user can use uploading, sharing and exchanging services directly from this system without worrying about the security of data. Moreover, this platform support compressing and editing the office documents online, email,

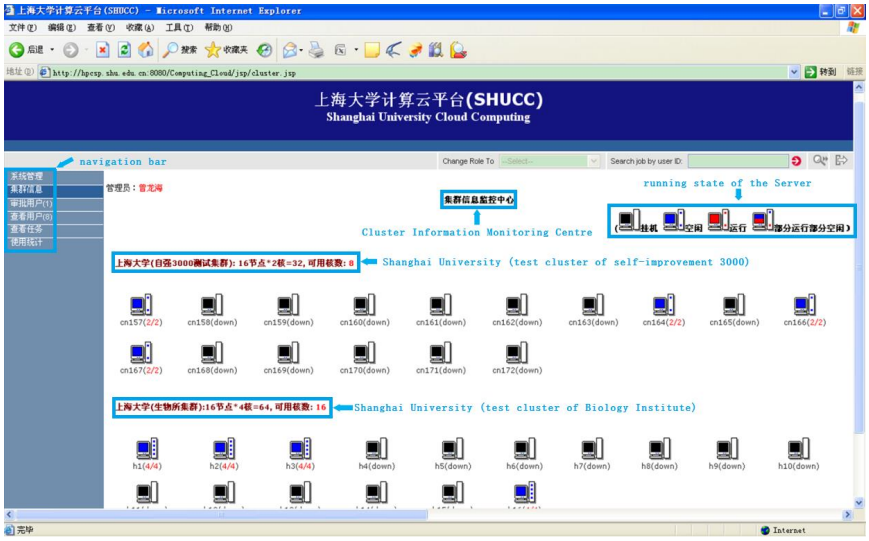

FIGURE 4. The left side is the menu of SHUCC. Administrator can schedule and monitor the task on the Internet and the details are showed on the right of screen.

address book and so on. Everyone in the school can enjoy the convenience and flexibility in teaching, research and management of cloud services at anywhere at any time.

3.4. Supercomputing Services. Offering parallel computing service by cloud computing pattern is another cloud service practice of Shanghai University. It clusters all of the high-performance computers on one platform where user can assign and schedule the task on the Web. The basic deployment is illustrated in figure 4.

3.5. Conclusions. This Platform integrates all the software and hardware resources in the school and provides efficient, high quality, real-time service for teachers and students. Meanwhile, it has achieved the migrating of existing Web application services, storage services and other computing tasks progressively. Through storing all the information on the cloud, the platform reduces the resource waste of redundant construction and sparing devices. And with its advantage of dynamically extension, schools can promote the hardware resource sharing among various departments too. Consequently, everyone in school can access the cloud resource and enjoy high quality and efficient services.

4. Impact of Cloud Computing in Enterprise Development

The development of Internet has generated big data and increasing business costs, and this makes the companies be urgent for low-cost IT technologies. On the other hand, relying on high processing performance, low cost, high scalability and the dynamic sharing of resource, cloud computing has garnered so much attention and significantly influence the enterprise development.

4.1. Promoting industrial development. Cloud computing technology covers almost all directions in the field of informatization [12], which includes network bandwidth, virtualization, storage, distributed computing and system architecture.

This makes it not only promotes the technological innovation within information industry, but also drives the innovative development of related industries and ultimately promotes the industry transformation. Therefore, cloud computing is not just a technology, but a service, a commercial model as well.

Cloud computing is a kind of service. At present, the construction of informatization faces some problems, including insufficient understanding, increasing construction, operation and maintenance cost, etc. However, the diversity and popularization of mobile devices provides rich demand and imagination for cloud computing becoming a kind of service. With cloud-enabled IT resources, users can access cloud services on demand only through the network from anywhere at any time, and pay for it based on the usage.

Cloud computing is a kind of business model. As an integrated system of product, service and information flow, business model reflects the relationship among enterprises, users, providers and other partners in the market, such as logistics, information flow and cash flow, etc. In this new "cloud model", the enterprise will transform from product manufacturer to infrastructure service providers of cloud computing. Then users can indirectly rent computing space and capacity, some specific applications from these providers, and then concentrate more on data management or other business.

4.2. Changing from CIO to CDO. For the CIO (Chief information officer), companies just have built excellent IT infrastructure, and now IT value is shifting from old basic pattern to creating new business value. So, how to create new business value has also attracted the full attention of CIO. Besides, big data in cloud era help these CIOs find new commercial opportunity. According to the cooperated white paper released by IBM and Oxford, CIO's function is changing from information management to data based enterprise content management, which is named CDO (Chief data officer). Through analyzing the log files, Cookies, Emails, communities and other data, and combing with its financial data and revenue, CDOs can judge and understand the user behavior, so as to provide scientific strategies for constructing and developing business informatization.

4.3. Adjusting with concerns for data security. In the past, companies always adopted multi-level Data Monitor and Intrusion Prevention System to ensure the security of data. It is a very practical method because: 1) Storing data on internal data processing platform makes it easier to manage; 2) Traditional data processors are more stable and easier to monitor; 3) High sensitivity of intrusion is able to curb the external intrusion to some extent.

While in cloud environment, controlling and defensing in cloud are useful tools in reducing the risk of data loss and virus invasion efficiently. Users never need to worry about inaccessible website and information because multiple copies of data have enhanced the security of data. However, security concerns still exist. For example, sudden failure or disaster of cloud platform, leaking, malicious intercepting and destructing in data storing and transmitting, illegal stealing, distorts or destruction of other tenants or cloud service providers, etc.

In addition, since data is all processed and exchanged on the Internet, its volume becomes large and the related security requirements are also growing rapidly. Nevertheless, simple technology updates and software upgrading are no longer suitable for dealing with these risks too. Traditional data security concepts and strategies need to adjust and change.

5. Prospects of Cloud Computing

During the process from theory to application, the definition, products, technologies and security risks of cloud computing all make users feel uncertain and confused. But it just means this technology has the potential to change the IT market situation. Now days, companies will need more than studying and accepting cloud computing, but developing and deploying practical strategies. Thus, this paper proposes the following prospects for the future development by analyzing the influence of cloud computing in enterprise development.

5.1. Three forms coexist: public, private and personal cloud. In the public cloud, cloud resource pools are released on the Internet and allow the user who has permission to access; Private cloud, who is able to control data, security and quality of service well, is built for a specialized client; Personal cloud can organize, store, distribute and reprocess various personal information over the Internet. By centralizing the merits of above three clouds, user can perchance the required cloud service of low prices, good flexibility, high security and powerful computing capacity, and improve the availability of resources.

5.2. New delivery methods for cloud service. New cloud service model has spawned new cloud service delivery channels. Service users can access the service and communicate with each other at home, in the office and car by smartphone, laptop, netbook, tablet computer and so on. The powerful computing and storage capacity of cloud computing platform protect the speed of delivery and transaction responding, which accelerate the arrival of information exchange in Internet era.

5.3. The value of data in the cloud era. As a business model, cloud service shifts the company from product manufacturer to cloud service provider. That is, the role changes from IT salesman to IT broker, which also let the CDOs realize the potential commercial value of data. In the cloud era, data not only includes the unstructured one from "we media", UGC, social websites, but also structured one from its own business. By integrating the related data and combing with data analysis, data mining and knowledge discovery theory, companies can understand the market demand and orientation correctly, so as to achieve the real two-way communication between companies and society.

Acknowledgments

The work of this paper is supported by National Natural Science Foundation of China (No. 61303097), Shanghai Leading Academic Discipline Project (J50103), Ph.D Programs Foundation of Ministry of Education of China (20123108120026) and Shanghai Municipal Science and Technology Commission (11510500300).

References

[1] RobertL, Grossman, YunhongGu and Michael Sabala. Compute and storage clouds using wide area high performance networks, Future Generation Computer Systems, 179-183(2009), 2009.

[2] Wang L, Tao J, Kunze M, et al. Scientific cloud computing: Early definition and experience. HPCC, 825-830(2008), 2008.

[3] Chen K, Zheng W M. Cloud computing: system instances and current research. Journal of Software, 20(5), 1337-1348(2009), 2009.

[4] Armbrust M, Fox A, Griffith R, et al. A view of cloud computing. Communications of the ACM, 53(4), 50-58(2010), 2010.

[5] Buyya R, Yeo C S, Venugopal S. Market-oriented cloud computing: Vision, hype, and reality for delivering it services as computing utilities. HPCC, 5-13(2008), 2008.

[6] M. Vouk. Cloud computing - issues, research and implementations. Journal of Computing and Information Technology, 16(4), 235-246(2008), 2008.
[7] Buyya R, Yeo C S, Venugopal S, et al. Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility. Future Generation computer systems, 25(6), 599-616(2009), 2009.
[8] Armbrust M, Fox A, Griffith R, et al. A view of cloud computing. Communications of the ACM, 53(4), 50-58(2010), 2010.
[9] Ergu D, Kou G, Peng Y, et al. The analytic hierarchy process: task scheduling and resource allocation in cloud computing environment. The Journal of Supercomputing, 1-14(2013), 2013.
[10] Younis MMYA, Kifayat K. Secure cloud computing for critical infrastructure: A survey. Liverpool John Moores University, United Kingdom, Tech. Rep, 2013.
[11] HU Guan-nan, LU Zhi-guo, ZHAN Hua-qing, LU Ming, ZHU Wen-hao, LIU Wei, WANG Xiao-wei, ZHANG Wu. Dynamic User-Integrated Architecture for Cloud Computing. JOURNAL OF SHANGHAI UNIVERSITY (NATURAL SCIENCE), 19(1), 2013.
[12] Grossman R L, Gu Y, Sabala M, et al. Compute and storage clouds using wide area high performance networks. Future Generation Computer Systems, 25(2), 179-183(2009), 2

School of Computer Engineering and Science, High performance computing center, Shanghai University, Shanghai, 200444, China

E-mail: xw@shu.edu.cn, fuli@shu.edu.cn, whzhu@shu.edu.cn, and wzhang@shu.edu.cn