Cloud Computing For Distributed University Campus: A Prototype Suggestion

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Abstract

In this paper we discuss the "Cloud Computing" architecture, cloud services, layers and types of cloud and propose a cloud infrastructure prototype for distributed university campus. Cloud Computing can be defined as providing resources and capabilities of Information Technology (e.g., applications, storages, communication, collaboration, infrastructure) via services offered by cloud computing providers. Cloud Computing has various characteristics as shared infrastructure, self-service, pay-per-use model, dynamic and virtualized, elastic and scalable. Nowadays, because of the increasing popularity of Cloud Computing many giant IT companies such as Microsoft, IBM, Google, and Amazon interest developing new cloud environments due to advantages of the Cloud Computing technology include cost, availability, and scalability. A Cloud Computing service has ubiquitous access through a Web browser or mobile device with APIs or special desktop applications developed by cloud service provider. Use of Cloud Computing on universities has many benefits such as accessing the file storages, e-mails, databases, educational resources, research applications and tools anywhere for faculty, administrators, staff, students and other users in university, on demand. Furthermore, cloud computing reduces universities' IT complexity and cost. It is argued that cloud computing paradigms and characteristic, service and deployment model of cloud computing technology in first section of this paper. Then we discuss the implementation of cloud services at universities and various opportunities and benefits of cloud services for universities. Finally, we present suggested cloud infrastructure prototype for distributed campus.

1 Introduction

Nowadays, "Cloud Computing" is most discussed term in business and academic environment. Because of the increasing popularity, many giant IT companies such as Microsoft, IBM, Google and Amazon interest Cloud Computing. Cloud Computing refers to the applications, development platforms, and hardware delivered as services over the Internet by cloud providers [1; 2; 3]. Cloud computing is the next natural step in the evolution of on-demand information technology services and products [4].

Many managers in small business and academicians in universities are not aware of benefits and characteristic of minimizing the cost of cloud computing. IT companies are eager to encourage educational adoption of cloud computing; for example, Google has designed cloud based Google-Apps for educational usage [3], and another example, IBM launched IBM Cloud Academy that is provide a global forum for educators, researchers and IT professionals from education industry to pursue cloud computing initiatives, develop skills and share best practices for reducing operating costs while improving quality and access to education [5]. Some benefits of Cloud Computing can be listed:

- Reduced implementation and maintenance costs
- Increased mobility for a global workforce
- Flexible and scalable infrastructures
- Quick time to market
- IT department transformation (focus on innovation vs. Maintenance and implementation)
- "Greening" of the data center
- Increased availability of high-performance applications to small/medium-sized businesses [6].

In this paper we discuss the “Cloud Computing” paradigm and characteristics, service and deployment models, implementations of cloud services at universities, and various opportunities and benefits of Cloud Computing for universities. Finally, we suggest a design prototype of Cloud services for distributed university campus.

1.1 What is Cloud Computing?

Cloud Computing can be defined as providing resources and capabilities of Information Technology (e.g., applications, storages, communication, collaboration, and infrastructure) via services offered by cloud computing providers. According to the definition of National Institute of Standards and Technology (NIST), “Cloud Computing” is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction [7]. Foster et al. define the cloud computing is “a large-scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted, virtualized, dynamically-scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet” [8]. 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 [9]. When analyzed the definitions, there is a consensus on few key points; (1) Cloud Computing ensure on-demand access to a pool of computing resources, (2) dynamically-scalable services, (3) device and media independency, and (4) easier maintenance of applications due to do not need to be installed on users’ computers.
As shown in Figure 1, the computing paradigm is a transformation that took place in six phases; from mainframe computing to personal computing, network computing to internet computing, grid computing to Cloud Computing [10].

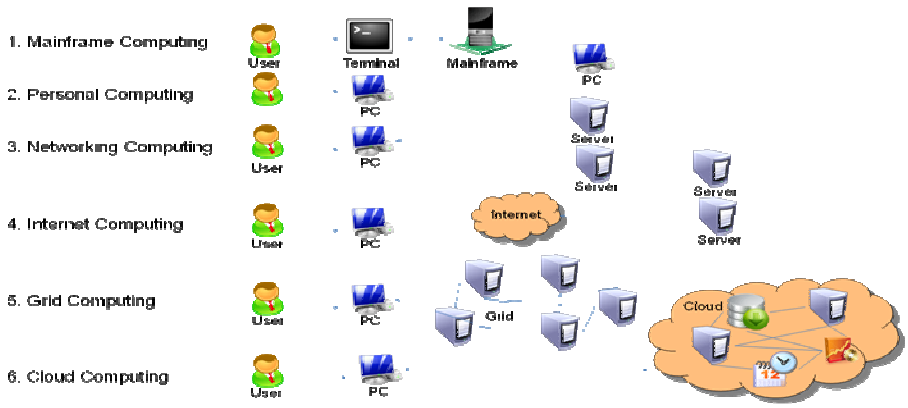

Fig. 1 Six computing paradigms (adapted from Furht and Escalante (2010))

1.2 Cloud characteristics, service and deployment models

Examined the definition made by the NIST, Cloud Computing’s five key characteristics that may occur; (1) On-demand self-service; customers can adjust their services without needing anyone’s help. Best of breed self-service provides users the ability to upload, build, deploy, schedule, manage, and report on their business on demand. (2) Ubiquitous network access; available through standard Internet-enabled devices. (3) Location independent resource pooling; processing and storage demands are balanced across a common infrastructure with no particular resource assigned to any individual user. (4) Rapid elasticity; consumers can increase or decrease capacity. (5) Pay per use; Consumers pay for only what resources they use and therefore are charged or billed [7; 11; 12].
Cloud Computing is composed three service models that are Software as a Service (SaaS), Platform as a Service (PaaS),and Infrastructure as a Service(IaaS), and it can be set up four deployment models that are Public, Private, Community, and Hybrid Cloud. SaaS is a software delivery service that provides access to applications and data through internet connection anytime and anywhere. The software is accessible from various devices that can connect to internet through user interface such as a browser or API [13; 7]. PaaS provides a platform on cloud for application developers. This model of Cloud Computing delivers the development tools as a service over internet. Developers can build their applications on the development platform that run on providers’ infrastructure and applications are

delivered to users via the internet from the providers' servers [14]. IaaS is the capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications [7]. These service models can be summarized as shown in Figure 2.

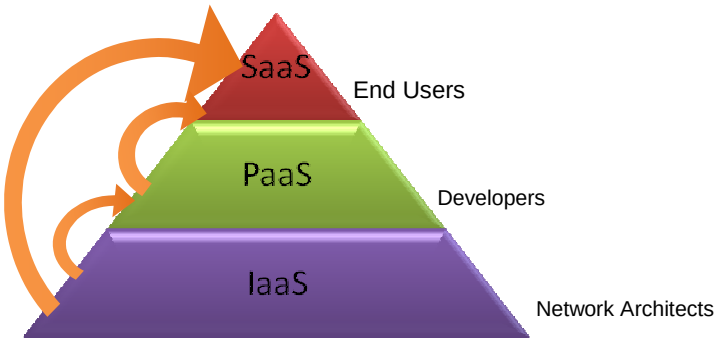

Fig. 2 Cloud Computing service models

Public cloud model represent an environment that is openly access. The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services [2]. Private cloud refers cloud computing on private networks. Private clouds are built for the exclusive use of one client, providing full control over data, security, and quality of service [10]. The community cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns. The hybrid cloud is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability [7].

1.3 Cloud in universities

In recent days, many research institutes are struggling to adapt Cloud Computing for solving problems that are continuous increasing computing and storage. There are three main factors interests in Cloud Computing: (1) rapid decrease in hardware cost and increase in computing power and storage capacity, and the advent of multi-core architecture and modern supercomputers consisting of hundreds of thousands of cores; (2) the exponentially growing data size in scientific instrumentation/simulation and Internet publishing and archiving; and (3) the wide-spread adoption of Services Computing and Web 2.0 applications [8].
The Cloud Computing trend of replacing software traditionally installed on campus computers (and the computers themselves) with applications delivered via the internet is driven by aims of reducing universities' IT complexity and cost [15]. Cloud Computing could be a technological innovation that both reduces IT costs for the college and eliminates many of the time-related constraints for students, making learning tools accessible for a larger number of students [3]. There are many benefits of cloud computing for educational institute and below are listed a few of them;

- With cloud computing, universities can open their technology infrastructures to businesses and industries for research advancements.
- The efficiencies of cloud computing can help universities keep pace with ever-growing resource requirements and energy costs.
- The extended reach of cloud computing enables institutions to teach students in new, different ways and help them manage projects and massive workloads.
- When students enter the global workforce they will better understand the value of new technologies [16].
- Cloud computing allows students and teachers to use applications without installing them on their computers and also allows access to saved files from any computer with an Internet connection [17].

Suggested Cloud Infrastructure Prototype for Distributed University Campus

In this study, we aim to suggest a Cloud Computing infrastructure scenario to using universities that have distributed campus. Shown as Figure 3, we propose a community cloud occurred computing and storage infrastructure, development platform, and software delivering.

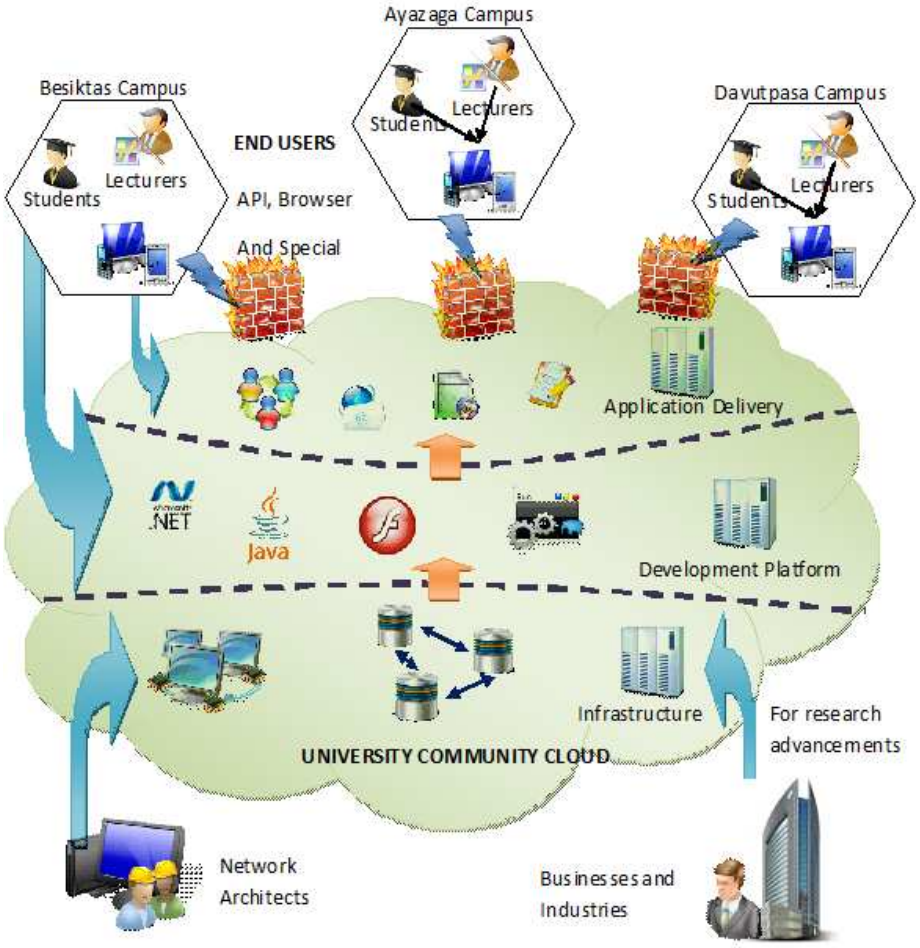

Fig. 3 Proposed cloud computing structure schematic diagram

Every day that goes by, research and educational needs of universities' change with developing technology. All the software and hardware of universities' must be renewed in accordance with the changes. For example, there are office applications, programming language, and multimedia developing courses in Computer Education & Instructional Technology department of education faculty. Also every year, the new versions of applications were used for courses with respect to the needs of industry. As a natural result of this progress, new software cause new hardware costs. Students frequently use both the software and development platforms during the training. The large majority of university budgets are devoted to meet these needs. In addition, students and researchers do not study together and don't use potential of collaboration-based research due to the varied location of university campuses. However, the issues such as setup, configure, and transport the new software tools would cause to loss of the researchers' workforce, and researchers don't focus their basic tasks. There is a new IT approaches for managing effectively the technological needs of universities such as delivery of software, providing of development platform, storage of data, and computing. Cloud Computing can be said as a new approach to solution for all the problems mentioned. Students will have access to all software anytime, anywhere and any technological devices connected internet by suggested cloud structure. Also, students will have access to development platform, and develop their applications, and store on university infrastructure. In this way, lecturers will focus their basic tasks and not lose their workforce. With suggested cloud structure, universities can open their technology infrastructures to businesses and industries for research advancements and develop university-industry collaboration.

Conclusion

Cloud Computing paradigm is a new approach to produce a solution for old problems. This paradigm offers many benefits to enterprises, industries and universities. Many huge IT companies develop new cloud-based applications, and construct new cloud infrastructure. Most of the research in literature focused on benefits, opportunities, advantages, disadvantages, risks and configuration of Cloud computing for enterprises. We have tried to show that the Cloud Computing can also be used for universities. Use of Cloud Computing on universities has many benefits such as accessing the file storages, e-mails, databases, educational resources, research applications and tools anywhere for faculty, administrators, staff, students and other users in university, on demand. A few universities already started cloud computing technology for educational use. The main goal of suggested prototype is; managing effectively the technological needs of universities such as delivery of software, providing of development platform, storage of data, and computing.

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