Virtual Personalized Learning Environment (VPLE) on the Cloud

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Abstract. With the virtualization technology maturity and the growing up fast of the cloud computing services, the application service providers have changed the way to server customers. Meanwhile, the new service model let users access the resource with the browser of their thin devices. By the way, the application service providers do not need to buy many machines for the uncertain backup or expanded requirement. Because the Cloud Service can provision the computing resources for customers dynamically, the users also pay as their use. The innovation of information science and technology drives e-learning system to produce a new type of service and the personalization requirements of the users are fast growing up. This paper presents a solution for building a virtual and personalized learning environment which combines the technology of Cloud Infrastructure as a Service (IaaS) and Cloud Software as a Service (SaaS) to create a service oriented model for the application service providers and the learners.

The proposed environment "Virtual Personalized Learning Environment" is intended for subscribing and excising of the selected learning resources as well as creating a personalized virtual classroom. This VPLE system allows the learning content providers to registry their applications in the server and the learners integrate other internet learning resources to their learning application pools.

Keywords: Cloud computing, e-learning, virtual personalized learning environment.

1 Introduction

Cloud computing is an extension of this paradigm where the capabilities of applications are exposed as services. These services enable the development of scalable web application in which dynamically scalable and often virtualized resources are provided as a service over the Internet [10, 16]. It is true that many international application providers such as Amazon, Google, IBM, Microsoft, and Sun Microsystems have begun to establish new type of data centers for hosting Cloud

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computing applications to provide redundancy and great reliability for meeting their Service Level Agreement. Since user requirements for cloud services are varied, service providers have to ensure that they can be flexible in their service delivery. Cloud computing makes it possible for almost anyone to deploy tools that can scale on demand to serve as many users as required [10].

The purpose of this paper is to present a cloud based solution for building a personalized learning environment for education. The rest of this paper organized as follows: Section 2 gives an overview of several kinds of learning environments and the critical factors proved by the TAM. Section 3 describes the characteristics and the advantages of the Cloud Computing. Section 4 presents the proposed Virtual Personal Learning Environment and the prototype system. Finally, Section 5 ends this paper with conclusion and future work.

2 E-Learning Environment

E-learning is defined as an Internet-enabled learning [18]. Components of e-learning can include content of multiple formats, management of the learning experience, and an online community of learners, content developers and experts. The study summarized the main advantages, which include flexibility, convenience, easy accessibility, consistency and its repeatability. Among the learning technologies, the Web-based learning offers the following benefits over conventional classroom-based learning including: (1) it can be used at any time and place; (2) the learning material is easy to update; (3) it fosters the interaction between the learner and the teacher in several ways; (4)it can incorporate multiple media such as text, audio, graphics, video and animation; (5) it enables learners to form learning communities; (6) facilitators can easily check learners progress, and (7) it allows for a learner-centered approach that can address the many differences between learners [15].

There are three main strategies in the fields of e-learning: Virtual Learning Environment (VLE), Personal Learning Environment (PLE), and Network Learning Environment (NLE).

2.1 Virtual Learning Environment (VLE)

A Virtual Learning Environment (VLE) is an electronic platform that can be used to provide and track e-learning courses and enhance instruction with online components [7, 18]. The VLE can automate the administration of learning by facilitating and then recording learner activity and it has evolved quite differently for formal education and corporate training to meet different needs. The contents are developed by teachers, which are mainly experts of a special domain. The VLE provides an easy to use system for flexibly delivering learning materials, activities, and support to students across an institution. For the administrator, a VLE provides a set of tools which allows course contents and students to be managed efficiently and provides a single point of integration with student record systems [7].

Nowadays, the trends of e-learning are to put emphasis on learner-personalized learning. This kind of learning places learner at its heart. Learners are expected to actively engage in the process to construct their own learning contents. Thus they would pay more intensions for their learning [9, 13].

2.2 Personal Learning Environment (PLE)

Applying Web 2.0 technologies to e-learning can enhance the interactive communication and the collaboration, or can help to discover and obtain the resources, or are able to exchange and share the resources with others. Thus, Web 2.0 provides a learning environment have the potential to fundamentally change the nature of learning and teaching, through the creation of learner controlled learning web. This learning environment is named a Personal Learning Environment (PLE) [13].

There are several reasons for adopting PLE as the platform for e-learning. The most important reason is that the PLE can help learners control and manage their learning contents. A PLE also permits learners to join into other learning groups and provides a suitable environment to practice social skills. Furthermore, the PLE can provide support for lifelong learning that is mainly informal and occurs over the life of the learner [13].

2.3 Network Learning Environment (NLE)

A Networked Learning Environment (NLE) is about the learning that takes place in a vibrant community of people and resources [19]. The Internet has removed the limits of time and proximity that once restricted this community. Similar to the Internet, a Networked Learning Environment is really a network of networks and the power of the NLE today is that it creates more possibilities for students and faculty, far beyond the limitation of books, bricks and mortar [20].

Critical Factors of e-learning systems.

Many researches proved the technology acceptance model (TAM) to be a good theoretical tool to understand users' acceptance of e-learning [1-8]. E-learning self-efficacy was one of the important construct, followed by subjective norm in explicating the causal process in the model [6]. The success of Web-based learning depends on learner loyalty, and the results indicated that performance expectancy, effort expectancy, computer self-efficacy, attainment value, utility value, and intrinsic value were significant predictors, should be examined at the same time [2, 5]. In other studies, the research results indicate that perceived usefulness has a direct effect on VLE use. Perceived ease of use and subjective norm have only indirect effects via perceived usefulness. Both personal innovativeness and computer anxiety have direct effects on perceived ease of use only [4, 7].

The proposed VPLE is developed on these critical factors:

- Ease use of learning systems
- Stability and Performance of learning systems
- Perceived ease of use
- Perceived usefulness

3 Overview of Cloud Computing

Cloud computing provides the new kinds of on-demand information technology services and products [26]. According the related studies of cloud computing [21-25],

several most characteristics of the cloud computing are summarized as the following descriptions: (1) On demand service, (2) Ubiquitous network access, (3) Location-independent resource pooling, (4) Rapid elasticity, and (5) Pay per use.

In order to meet the characteristics of the cloud service, the fundamental action is to make resources virtualized [26]. Thus we can find that data centers can dynamically "provision" on demand to meet a specific service-level agreement [27, 28].

The types of on-demand Cloud service in Table 1 are respectively referred to as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) [21, 27, 28, 29].

The other critical technologies for cloud resource management, conducted in our proposed platform, are described as follows [10, 16]:

1. To provide the dynamic scale-in and scale-out of applications by the (de-) provisioning of resources (for example, via virtualization).
2. To provide the monitoring of resource utilization to support dynamic load-balancing and reallocations of applications and resources.

Table 1. Three types of basic cloud services

Type	Description
Infrastructure as a Service (IaaS)	• Deploy the virtualized hardware resources as a service. • Users do not need to buy the server, network equipment, and storage equipment, only need through Internet lease can put up one's own application system.
Platform as a Service (PaaS)	• Offer application platform for internet programming interface, operation platform, and etc. • Users can structure and dispose their own application by the platform.
Software as a Service (SaaS)	• Customers use the software service on Internet through standard Web browser. • Provide multi-tenancy support. • Customers needn't buy the software, only need to rent the software as required.

4 Virtualized Personalized Learning Environment (VPLE)

Many e-learning and educational institutions are beginning to take advantage of existing applications hosted on a cloud that enable users to perform tasks that have usually required site licensing, installation, and maintenance of individual software packages [11,12,14,17]. Many applications such as word processing, spreadsheets, presentations, databases and more can all be accessed through a web browser, while the objects are housed in the cloud. Furthermore, it is very easy to share content created with these tools, both in terms of collaborating on its creation and distributing the completed work. In the current online Application Markets, such as Apple App

Store for iPhone, Mac App Store, and Android App market, the applications are ease to be put into the application server by the owners and the users can subscribe and get the application software on demand through the network. The users can create their personalized software environment and the application creators can get the incomes from subscribed users' payment. This successful service model is proved by markets and there are more service providers willing to conduct this service model for their business.

Virtual Personalized Learning Environment (VPLE), proposed in this paper, is a web-based platform that is built on the Cloud, and conducts a service oriented mechanism of the learning environment to serve the learners and the content providers. Based on the browser-based applications can be accessible with a variety of computer and even mobile platforms, making these tools available anywhere the Internet can be accessed. The purpose of this research was to develop a solution which integrates multiple disparate application systems of schools into one integrated online system that may be accessed via a single sign-on process. The intent of this system is to utilize new web-based technologies to enhance teacher performance and student learning.

4.1 Architecture of VPLE

Figure 1 shows the architecture of the proposed Virtual Personalized Learning Environment (VPLE). The system combines the virtual resource management functions of the Cloud IaaS and the personalized learning management system in the Cloud SaaS.

- The functions used in the Cloud IaaS: (1)Storage management for the learning system and the users, (2)Load Balance for all learning systems, (3)Scaling management for virtual machines, and (4)Backup and Restore for the learning applications.
- The functions used in the Cloud SaaS: (1)Application Registry management for the commercial provides to register their applications, (2)Application Server for managing and deploying the subscribed learning contents to the users, (3) Account manage system for the authorized users, (4)Virtual Desktop Deployment for providing the personalized desktop including the subscribed learning contents, (5)Session Management for ensuring the Virtual Desktop used by the authorized user, and (6)Personalized management for managing the subscription of the favorite learning contents.

4.2 Service Model of VPLE

In order to indicate the difference of the VPLE from other PLE and VLE, the service model and the critical process flows are illustrated in Fig. 2. The following three process flows explicate the core ideas of the application store like and the personalization in the VPLE. The first process flow is that the commercial application manager or the teacher would like to register a new application into the application server. The second process shows the authorized learner how to get the virtual desktop. At last, the process of the Personalization emphasis on users can select the additional learning contents for their favorites.

Based on this service oriented model, the learning content providers can dynamically register new applications at any time and users can personalize the contents of their learning environments. Further, all systems in the VPLE are virtual machines. If the performance of the system became slower than the standard of the SLA, the load balance system of the hypervisor would be enabled to share the workloads with other virtual machines of the same application.

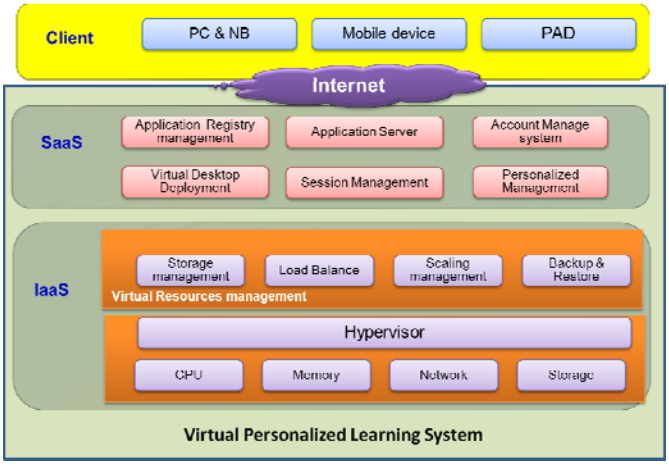

Fig. 1. The Architecture of the Virtual Personalized Learning Environment

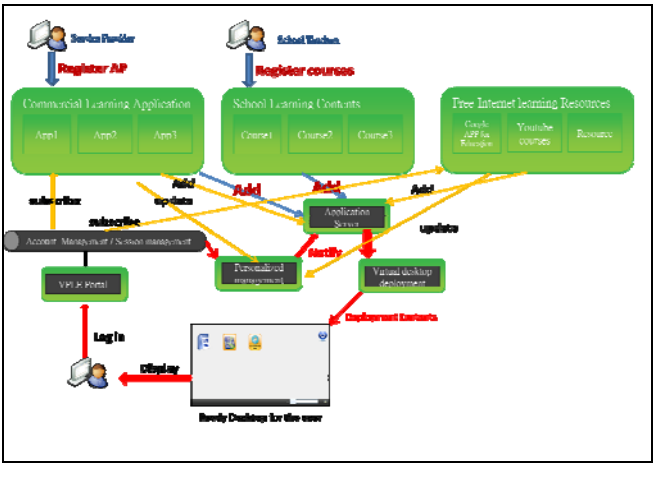

Fig. 2. The Service Model and the Process Flow of the VPLE

4.3 Implementation and Evaluation of Performance

The prototype system was established and ever demonstrated for the teachers of the primary school and the junior high school. In our environment, there were four virtual machines created for the VPLE.

The next demonstration is to explore the performance of the portal virtual machine. The core hardware configuration of the portal virtual machine is 4 vCPUs and 2048 mega RAM. The stress tool used is Pylot and it is an open source web performance tool. The stress testing was conducted with several agent parameters and the testing results were gathered in Table 2.

Each testing agent would run with the same configuration which includes the duration of sixty seconds, the ram up time of zero second, and the interval time of zero millisecond. As the analysis of the test results, there are several findings for the future improvement: (1) the CPU utilization was increased with the numbers of the testing Agents, (2) the upper bound of the successful requests would be smaller than 4,900, and (3) the average response time can be provided to the VPLE service provider for the Service Level Agreement.

Table 2. The results of the web performance testing

Testing Agent #	Testing results			
	CPU ult	Total Requests	Avg Resp time(sec)	Throughput (req/sec)
1	24%	1250	0.048	20.492
10	75%	4750	0.124	78.230
50	67%	4684	0.630	75.548
100	59%	4580	1.291	75.082
120	69%	4710	1508	76213
130	65%	4649	1656	76.213
135	78%	4874	1.646	78.613
140	69%	3392	1.924	69.079

5 Conclusion

Ease use and system performance of e-learning system are of vital importance to the learners [3, 4]. From IT perspective, cloud computing is a cost down and efficient IT management technology for the application service providers [1-5]. Certain cloud enabled investments that will have implications for version migration and new application development.

In this paper, we investigate how the new service models brought about by cloud computing enhance the improvement on the efficiency within the VPLE. From elastic infrastructure aspect, the capabilities and implementation mechanism of cloud SaaS based e-learning solution is presented. Finally, the performance and capacities of the VPLE portal site is tested by Pylot and the testing results are analyzed at the same time.

Although the VPLE has been proved of concept, there are many aspects need to be improved. Our future works will focus on how to load balance the workloads from the large users over the internet and how to make users feel ease use.

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