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E-LEARNING DEVELOPMENT AS PUBLIC INFRASTRUCTURE OF CLOUD COMPUTING

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ABSTRACT

The purpose of this article is to describe the model we implement to provides services, such as IaaS, PaaS, and SaaS, for e-learning and collaboration in the educational environment in Salatiga. Currently, the combination of cloud technology and e-learning is being explored. Several efforts of using IaaS cloud technology in education focus on the reservation of the VM for students. This research used Moodle technology as e-learning applications that is installed on the Cloud. Moodle is a software package for a training purpose- web and internet based training commonly known as a Learning Management System (LMS), Course Management System (CMS), or Virtual Learning Environment (VLE). Moodle is free, since it is an open source software (under the GNU Public License). Features of Cloud Computing platform using the OpenStack method quite appropriate for migration of learning system , so that it is able to form learning environments fully and efficiently, provide personalized contents, and facilitate the adaptation to the present model of education.

Keywords: *Cloud Computing, Public Infrastructure, e-learning, Moodle, OpenStack*

1. INTRODUCTION

There are many e-learning softwares that is used extensively in various levels of education, such as universities, high schools, vocational schools, or junior. E-learning provides multiple benefits beyond conventional classroom- based learning. The biggest benefit is the reduction in costs due to the IT physical environment is no longer needed and therefore it can be accessed from any place, at any time, and in accordance with the convenience of students. In addition, teachers can easily update the study materials and incorporate multimedia content in a user friendly fashion, making them easier for students to understand the concepts. Finally, e-learning can be viewed as an approach that emphasizes variation of learning material between teachers, and teachers can review their own materials for improvement.

However there are some drawbacks that should be considered before fully integrate e-learning into the academic framework. The main weakness is in terms of scalability at the infrastructure level. Some resources can only be installed for certain tasks so that when they are burdened with heavy workloads, they require additional resources and new configurations. This certainly adds to the cost and becomes expensive.

The key issue is related to the efficient use of these resources. For example, the lab PC and server will be underutilized in the evening and semester holidays. On the other hand, resource usage becomes very high during the day and the semester goes. In addition it should also consider the costs associated with computer maintenance and licenses for every software package used.

The rapid growth of the number of students, teaching content, services provided and resources available, has made e-learning system grow at an exponential level. The challenge is how to optimize computing resources, storage, communication needs, and dynamic concurrency that require the use of appropriate platform with the scalability and cost control. For such problems, many educational institutions with limited resources and infrastructure then find themselves difficult to continually keep up with the growth.

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Currently, educational institutions develop e-learning system on an individual basis. By running individually, their resources become less efficient and expensive, since they have to invest in the computing infrastructure, perform the maintenance, and improve the scalability. Therefore it is necessary to consider the application of e-learning with the public infrastructure, which is developed on the basis of cloud computing technology.

Cloud Computing is a computing paradigm in which IT resources provide a variety of services, and is available to users through the Internet connection. It is the provision of infrastructure, platform and software as a service (IaaS, PaaS, and SaaS) on the basis of simply pay per use [1], [2], [3]. In other words, it is a model of IT services through catalogs that address users' needs in a flexible and adaptive way, and only charge fees for their actual usage. Therefore, two features of this paradigm are clear, the use of resources on the demand, and transparent scalability so that resources needs can be determined accurately without having to know their details.

The target of users in the development of this cloud computing are staff, student, students, faculty, and external parties for the purpose of collaboration. The purpose of this article is to describe the model we implement to provides services, such as IaaS, PaaS, and SaaS, for e-learning and collaboration in the educational environment in Salatiga.

2. CLOUD COMPUTING

The Cloud references a distributed collection of computing resources where the applications can reside anywhere on the accessible networks. In the Cloud, a large pool of accessible virtualized resources such as hardware, development platforms, and ideally services, can be dynamically reconfigured to adjust to a scalable load, with minimal management effort or SP interaction. This pool of resources is typically exploited by a pay-per-use model and the guarantees are offered by means of a Service Level Agreement (SLA). [2]

In accordance with the definition from the National Institute of Standards and Technology (NIST) Information Technology Laboratory, Cloud Computing actually covers more than just computing technology. As shown in the three dimensional diagram of Figure 1, this Cloud model is composed of five essential characteristics (on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service), three service models (software, platform, and infrastructure), and four deployment models (Private, Community, Hybrid, and Public Clouds). [2]

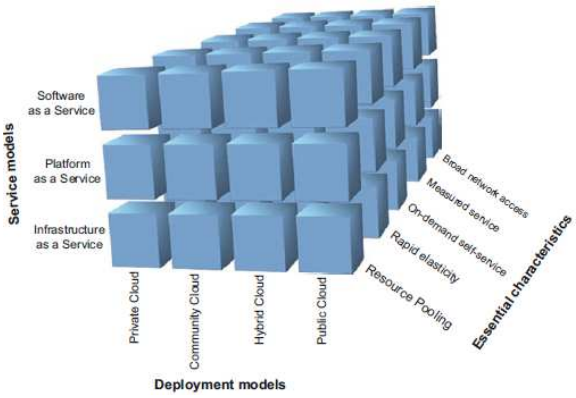

Figure 1. The NIST's model of Cloud computing[2]

Cloud Computing is a technology services through the use of information on the Internet, but not all of the services that exist on the Internet can be categorized as a Cloud Computing service. There are several requirements that must be met by an internet-based services to be categorized as cloud computing [2], namely: 1) The services must be on demand. There is freedom to choose any services provided by the provider and the users pay based on what they use, 2) The services must be elastic or scalable. The service must be able to accommodate the requests and needs of the user at any time, 3) The Services must be available and fully managed by the provider while users only need an Internet connection to use the service, 4) The services must be measurable. Cloud resources are transparently available, can be optimized and scalable, and become a reference in determining users' needs, 5) The services must be resource pooling. The Providers provide services through the resources that are grouped in one or many locations data center consisting of a number of servers with multi-tenant mechanism. This multi-tenant mechanism allows a number of computing resources be used jointly by a number of users, because these resources, either in the form of physical or virtual, can be dynamically allocated on demand needs. Thus, customers do not need to know how and where the demand for computing resources met by the provider. What is important is that every request can be fulfilled. The computing

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resources include storage, memory, processor, network bandwidth , and virtual machine.

The existence of cloud computing change the way companies and organizations see information communication technology investments. Because IT investment capitals are now simply operating costs which are more efficient. This makes the users free to concentrate on more creative things than to think about infrastructure (data center, processing power, storage, applications to the desktop), since everything has been provided virtually

Currently the need for security of information systems has been increasing. Since companies and organizations in general do not have adequate resources to secure their systems, it is likely that Cloud Computing would be the first choice, and growing, especially in Indonesia.

3. ADVANTAGES OF CLOUD-BASED E-LEARNING

Electronic Learning, or E-Learning [4], is defined as an Internet- enabled learning. Components of e-Learning can include content of multiple formats, management of the learning experience, online community of learners, content developers and experts. The study summarized the main advantages, which include flexibility, convenience, easy accessibility, consistency and its repeatability.

The virtual courses that are supported by the e-Learning approach favors the achievement of a higher impact for the educative framework than those of the classical attendance group. As an example, in the first edition of the "Machine Learning" course of Stanford2 more than 160,000 worldwide students were registered. These dimensions affects different issues; on the one hand, the infrastructure provisions that are necessary to give a concurrent service for that amount of students clearly exceed the capabilities of a conventional web server. Furthermore, the demand of the teaching resources usually vary in a dynamic and very quick way, and presents high peaks of activity. To attend requests during these periods of time without other system services to be resented, it will be necessary to prepare a quite superior infrastructure than that required for the regular working of the learning institution. An alternative would be to provide those services depending on the demand and only paying for the resources that are actually used. The answer to these necessities is the Cloud Computing environment.

Cloud Computing [5, 6] is a computation paradigm in which the resources of an IT system are offered as services, available to the users through net connections, frequently the Internet. It is a model of provision of IT services offered through a catalog that answers to the necessities of the user in a flexible and adaptive way, only billing for the actual usage that is made. Therefore, two of the distinctive features of this paradigm are, on the one hand, the use of resources under demand and, on the other hand, the transparent scalability in such a way that the computational resources are assigned in a dynamical and accurate manner when they are strictly necessary, without the requirement of a detailed understanding of the infrastructure from the user's point of view.

E-Learning in the cloud can be seen as Education Software-as-a-Service. The installation can be done quickly, because of very low hardware requirements. In addition, maintenance is also supported by the vendor, which provides system updates and allows users to focus on their core business of learning.

The following are consequences and implications associated with the development of e-learning in the cloud environment as demonstrated by Masud-Huang [7]: 1) Accessed via the Web. This reflects the ease of access from anywhere, and anytime people can access the application,2) Does not require any software on the client-side. Therefore, this will reduce costs for users, since no installation, software maintenance, deployment, and server administration costs. In other words, the total cost of ownership is lower, the time to implement is shorter, and the number IT staff required is fewer, 3) Pay per use, 4) SaaS Server can support many educational institutions. Since the applications run in the server group, then scalability is maintained, for example, if the number of studens who use the system is increased, the performce will not degraded, 5) All customer data is at SaaS Server. Therefore, the SaaS provider needs a high level of security system and a sophisticated software architecture to gain the trust of customers .

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Finally, Ouf et al in [8] give several values of cloud computing potential for education include: 1) No back up required both to drive and transfer from one platform to another. This means that students can create their own information repository, 3) Almost no crash recovery needed. If a computer crashes, then virtually there is no missing data, because everything is stored in the cloud, 4) Allowing access from a variety of places (home, classroom, library, etc.). Students can find and edit a file via the cloud. In addition, browser-based applications enable students to access through a variety of platform (mobile, laptop and PC), 6) Flexibility. Cloud computing allows users to increase their demand for cloud services dynamically, 7) Almost no stolen data. Since it is almost impossible for students to determine the location of the server that stores a desired data (test, exam questions, exam results, grades, etc.), 8) Virtualization. Cloud computing allows quick replacement of servers without great expense or damage, 9) Centralized data storage. The loss of a client is no longer an issue, because the main part of the application and the data are stored in the cloud so that new clients can be connected very quickly. This is very different with when a laptop that stores examination questions is stolen, 10)

Monitoring data access becomes easier given the fact that only one place to be watched, even though there are thousands of computers spread over a wide geographical area. Also, changes in security procedures can easily be tested and applied.

4. CLOUD COMPUTING ARCHITECTURE FOR E-LEARNING

Figure 2 shows the platform of Cloud Computing architecture that we use for e-learning. This architecture has been used for most of the e-learning that is placed in the cloud. The first layer is the interface that connects to the Cloud environment. This layer contains several management subsystem to determine users' needs for computing resources, planners in storage services, load distribution management executed among virtual machines, system administrators to monitor and initiate activities of each layer, and security components to ensure privacy, recovery, integrity and security of users' transaction and data. The second layer is a virtual machine, and finally, the third layer includes all of the physical architecture of the system.

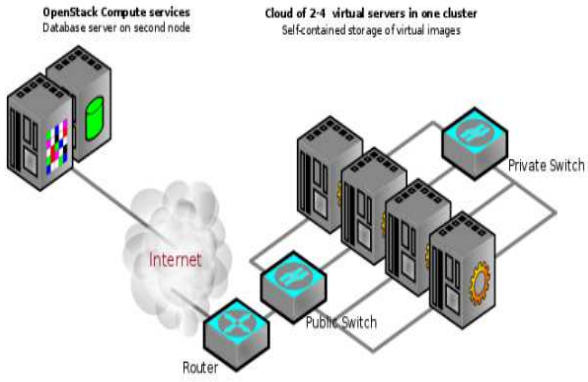

Figure 2. Cloud computing Architecture for E-Learning

Figure 3 shows the Infrastructure as a Services (IaaS) and Software as a Services (SaaS). The details of the features are as follows: 1) From the perspective of IaaS: a) Storage management for learning system and the user, b) Load Balance for all the learning system, c) Scaling management for virtual machines, d) Backup and Restore for learning applications; 2) From the perspective of SaaS: a) Management application registry, b) Server application for managing and deploying learning content to users, c) Account management system for authorized users, d) Virtual Desktop Deployment providing personal desktop that includes learning content, e) Session Management to ensure Virtual Desktop is used by authorized users, f) Personalized management for registration management of popular learning content.

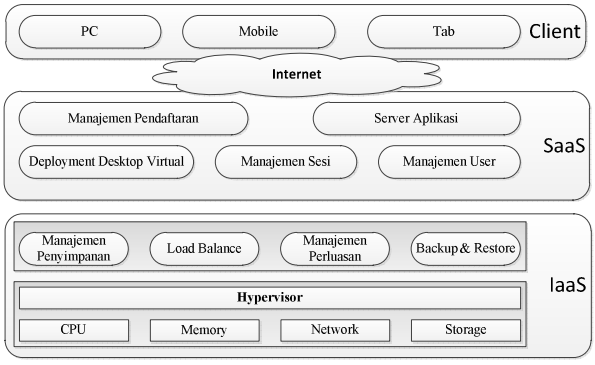

Figure 3 Architecture Of Personalized E-Learning Environment

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5. USE OF OPENSTACK AS IAAS

OpenStack is an open source cloud computing software for building reliable cloud infrastructure. OpenStack goal is to allow any organization to create and offer cloud computing services using open source software running on standard hardware.

There are two types of OpenStack, namely OpenStack Compute and OpenStack Storage. The OpenStack Compute is software to perform automation when creating or managing a virtual private server (VPS) in large numbers. While OpenStack Storage is software for creating object storage in scalable and redundant manner using clusters to store the data in terabytes or even petabytes.

The entire OpenStack code is under the Apache 2.0 license. This allows anyone to run, or build other software on OpenStack software, or send modified codes either as a patch or new features.

Currently OpenStack has been used by large hosting companies like Rackspace Hosting and NASA. They use this technology to manage tens of thousands compute instances and storage in petabytes size.

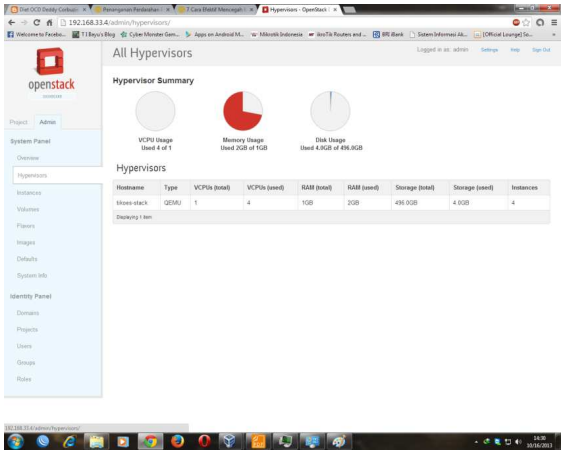

Figure 4 The Use Of Openstack As Iaas

6. APPLICATION OF E-LEARNING-BASED CLOUD COMPUTING

Cloud computing opens a new era of learning through e-learning application hosting in the cloud and features of the virtualization hardware, will reduce the cost of developing of and maintenance of learning resources significantly. Currently, the combination of cloud technology and e-learning is being explored. Several efforts of using IaaS cloud technology in education focus on the reservation of the VM for students.

This research used Moodle technology as e-learning applications that is installed on the Cloud (Figure 5). Moodle is a software package for a training purpose- web and internet based training commonly known as a Learning Management System (LMS), Course Management System (CMS), or Virtual Learning Environment (VLE). Moodle is free, since it is an open source software (under the GNU Public License).

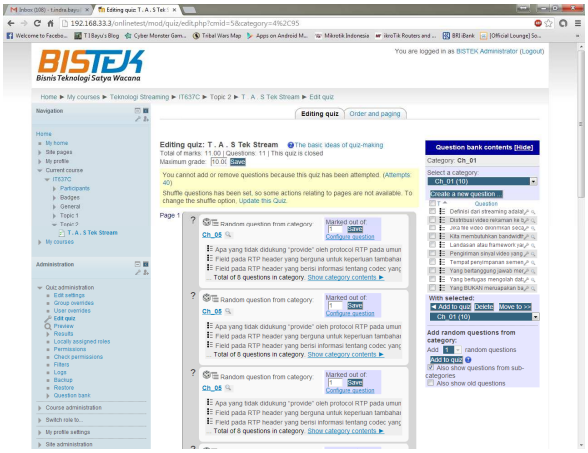

Figure 5 Model Of E-Learning Using Moodle Installed On Openstack

Moodle provides 7 layers of users as follows: 1) Administrator. An administrator is the person who manages the site in general such as website displays, menus, or users' privilege s (roles); 2) Course Creator. A course creator is a person who can create a course subject, teach the subject, assign another teacher to teach the subject, or monitor subjects that have not been published. This role is usually performed by the head of study program; 3) Teacher. A teacher is the person who manage a taught subject, e.g changing the activity of course, giving marks,dropping out students , or appointing a non editing teacher to teach the subject; 4) Non-editing teacher. A non-editing teacher is a teacher who can teach a subject, such as giving marks, but he/she cannot change the activities created by a taught teacher. A non-editing teacher can be considered as an assistant teacher or lecturer; 5) Student. A student is a user who is

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taking a subject. The student must register in advance on the subject before he or she can attend the subject. The teacher who teach the subject will give the grade of the student achievement at the end of the course; 6) Guest. A guest is a user who has a read-only access. Any user not listed in Moodle is a guest. A guest can joint any course provided he/she is allowed. However, a guest is not allowed to follow any activity in the course; 7) Authenticated Users. By default all users who have logged in are authenticated users. Even though a user acts as a teacher in a subject, but in another subject he/she only acts as an authenticated user who has the same status as a guest. There is a clear difference between a guest with an authenticated user. An authenticated user can enroll into a subject, but guest can not.

7. CONCLUSION

This study has shown the main components of e-Learning system that is placed on OpenStack Cloud Computing, which focused on flexibility, comfort, ease of access, consistency and repeatability in the system .

Features of Cloud Computing platform using the OpenStack method quite appropriate for migration of learning system , so that it is able to form learning environments fully and efficiently, provide personalized contents, and facilitate the adaptation to the present model of education.

Integration of e-learning systems with Cloud Computing has enabled the flexibility and scalability of resources include storage, computing, and network access, with lower costs, due to the use of pay-per-use payment system, thus saving the use of new hardware and software licenses for educational programs.

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