Implementing and Managing framework for PaaS in Cloud Computing

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ABSTRACT

With the rapid development of Internet and Cloud computing, there are more and more network resources. Sharing, management and on-demand allocation of network resources are particularly important in Cloud computing. Platform as a Service (PaaS) is one of the key services in Cloud computing. PaaS is very attractive for schools, research institutions and enterprises which need reducing IT costs, improving computing platform sharing and meeting license constraints. However, nearly all current available cloud computing platforms are either proprietary or their software infrastructure is invisible to the research community except for a few open-source platforms. For universities and research institutes, more open and testable experimental platforms are needed in a lab-level with PCs. In this paper, a framework for managing PaaS in a virtual Cloud computing lab is developed. The framework implements the user management, resource management and access management. The system has good expandability and can improve resource's sharing and utilization.

1. INTRODUCTION

Cloud computing is developing based on years' achievement on virtualization, Grid computing, Web computing, utility computing and related technologies. Cloud computing provides both platforms and applications on-demand through Internet or intranet [1][2][7][13]. Some examples of emerging Cloud computing platforms are Google App Engine [14], IBM blue Cloud [16], Amazon EC2 [17] and Microsoft Azure [18]. The Cloud allows sharing, allocation and aggregation of software, computational and storage network resources on-demand. Some of the key benefits of Cloud computing include hiding and abstraction of complexity, virtualized resources and efficient use of distributed resources [2]; Cloud computing is still considered in its infancy, there are many challenging issues waiting for tackling [1][2][5][6][7][13]. Platform as a Service (PaaS) is one of the key services in Cloud computing. "PaaS is the delivery of a computing platform and solution stack as a service without software downloads or installation for developers, IT managers or end-users,… It's also known as Cloudware." [14] It is very important to develop an on-demand resource management system for PaaS in Cloud environments. In this paper, a framework for platform as a service is developed. It is also possible to apply the proposed solution to real and vitual Cloud computing environment. The system implements the user management, resource management and remote access. For schools,

research institutes and small/medium size enterprises, reducing the IT cost is especially important. For example, in the traditional school lab, because of software license and hardware constraints, many useful application software and platforms are not accessible to students "anytime and anywhere". This problem may be solved using PaaS in Cloud computing. Through virtualization and other resource sharing mechanisms, Cloud computing can dramatically reduces user costs and meet large-scale applications' demands. Using virtualization techniques, it is possible to open a few platforms in a single physical machine (Windows, Linux or others) so that resources can be shared better and more users can be served. Most of Cloud computing platform is based on virtualized environments. In a virtualized Cloud computing lab, there are four major parts: software and hardware platforms provided from real and virtualized servers (narrowly speaking, PaaS resources); resource management node; database servers and users who access resources through Internet or Intranet. Generally speaking, above mentioned platforms and users can all be called resources in the Cloud. In the following sections, we consider a framework of design and implementation of PaaS in the Cloud, especially focusing on the resource management. Section 3 discusses the design architecture and major modules in the system; section 4 introduces the implementation technologies and operational environment; Related work in the literature are introduced in Section 5; finally a conclusion is provided in section 6.

2. CLOUD COMPUTING HIERARCHICAL STRUCTURE

The present study achievements haven't achieved an agreement on the definition of "cloud" and "cloud computing". Could computing is generally viewed as the development of Parallel Computing, Distributed Computing and Grid Computing or the commercial realization of these computer science conceptions. Cloud computing is a production of the mixing, evolution and development of several conceptions such like virtualization, utility computing, IaaS, PaaS and SaaS.

2.1 SaaS (Software as-a-Service)

SaaS is the supreme, first appeared and the most common type of cloud computing. It includes a complete application provided to a service through multitenancy demand. The software instances are used as providers' infrastructure and provide services for several end-users or customer organizations. The basic idea of SaaS is to put software on providers' servers and let the operators in charge of the management of maintenance and upgrades. Users who purchase the software only buy the network's permission to use the software instead of installing the software locally. As for the users, they will save the expenses of server and software license. As for the suppliers, they only need to maintain a program so they will reduce the cost.

2.2 PaaS (Platform as-a-Service)

PaaS is not only abstract packages of development environment and also packages of effective service load. PaaS productions can execute the software development and testing of various stages or be used for a certain field. PaaS service can provide great flexibility, but might be affected by the suppliers' ability. Users can develop their own program by middlemen's infrastructure equipments and deliver it through Internet and their server to other users.

2.3 IaaS (Infrastructure as-a-Service)

IaaS is in the lowest level and is a mean of providing basic storage and computing ability on line as a standardize service. Servers, storage systems, switches and routers and other systems are operable and can be used to handle workload from application components to the high performance computing applications.

3. DESIGNING PaaS SYSTEM

3.1 The Architecture of a Virtual Cloud Computing Lab

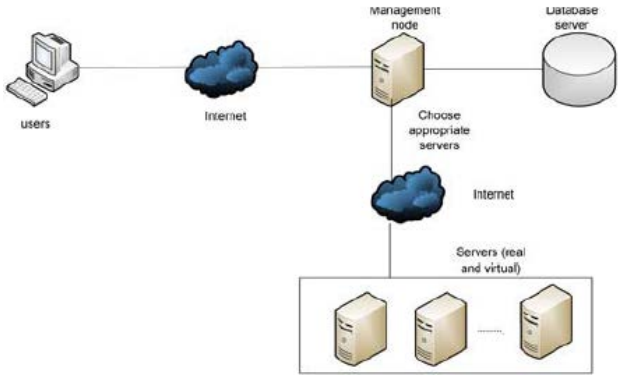
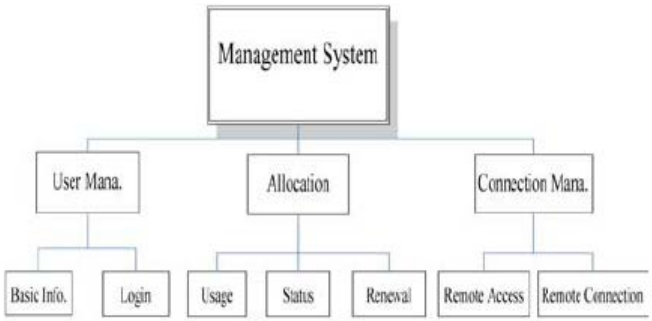


Figure 1 A virtual Cloud Computing Lab

A simplified Cloud computing environment is shown in Figure 1, where users send requests for computing platforms through Internet or intranet (Cloud); management node which may be physically in the same cloud as server groups, verifies the user account, finds available real and virtual servers with requested platforms and allocates them to the user for some periods of time; database servers keeps users authentication, resource availability and other information; after some time, the user finishes the service and leaves the system or chooses to renew. This paper discusses how to design and implement the lab with focus on the management system.

Management System of On-demand Resource Allocation.



The management system includes a user management module, resource allocation module and connection management module. These three modules can be divided into the corresponding sub-modules. User Management module includes basic information management and user access management. Basic information management is mainly concerned with users' information changes to database records; user login management is mainly responsible for the user login and authentication, as well as the user interface. Resource allocation subsystem is the core of the management system, including resource usage, resource status and resource renewal subsystem. Resource usage manages the immediate users and books resources for future users; resources status management maintenances status of all resources; resources renewal management lets user renew the use of resources if possible. Connection management module is to deal with users' accessing resources, including remote access management and remote connection management. These can be done in the remote servers together with management node. PaaS resources can be controlled by one management node or many nodes in the Cloud.

3.2 Communication Among Core Modules

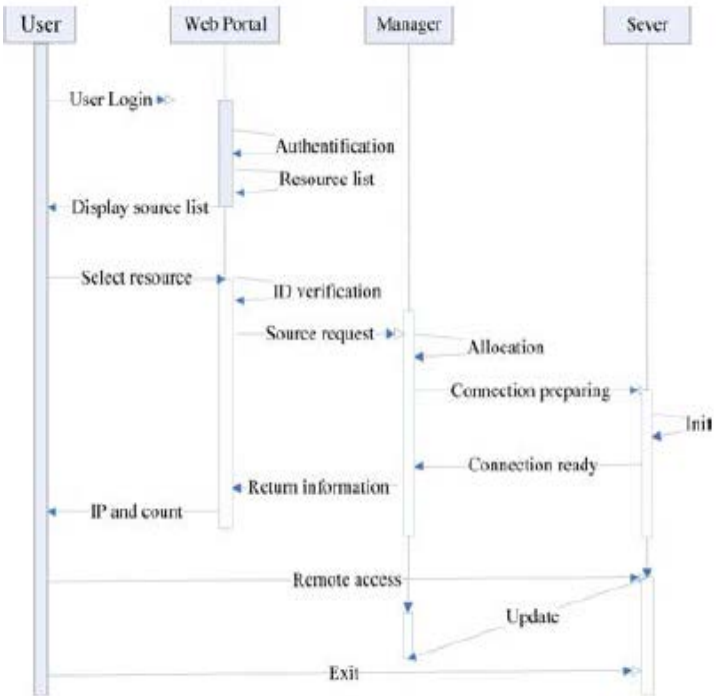


Figure 3 Communication Among Core Modules

In Figure 3, Web Portal is users Web access interface; Manager refers the resource allocation manager; Server refers to a group of real or virtual servers. From the figure we can see that the major communications among core modules: users access Web servers and resources list, and selects resources; Web server forwards the user request to resource management node for processing; then, resource management node sends back Web server the resources information by IP address and users account; Finally, users get access to resources in real or virtual servers. The management system of PaaS needs to coordinate among these four parts to efficiently manage users, platforms resource and remote connections.

3.3 User Management

There may be four kinds of users in PaaS: end users, personnel who manage access to the resources and allocate resources, creators of the PaaS service and PaaS framework developers. In this paper users refer the end-user only, who accesses PaaS service through a web portal. The user can select from a menu list of a combination of applications and operating systems. The user can request for immediate use or for sometime in the future (reservation). There are time windows for user to choose. Once authenticated, user can access remote PaaS service use security remote connection such as openSSH.

3.4 Database Management

Authentication, resource availability and other information is kept in a database server. Therefore, database server has to maintain and manage four kinds of information: user information (UserInfo), platform information (resourceInfo), platform state information (stateInfo) and user connection information (connectionInfo). Their contents and relationship are shown in Figure 4 MySQL is used for this purpose to keep information of authentication, resource availability and other information.

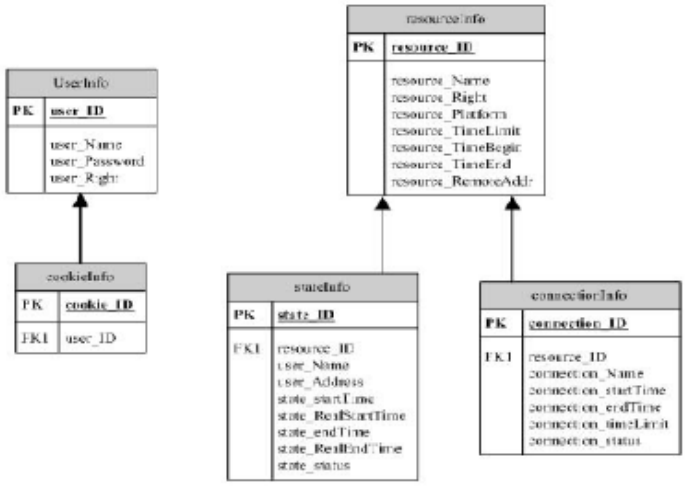


Figure 4 Database Management System

3.5 Virtualization in Operating System Level

Virtualization is one of key technology in Cloud computing. There are many levels of virtualization such as operating system level, hardware location level and network level. Operating system level virtualization is considered only in this paper. Using VMware workstation and other related virtualization software, it is possible to open a few platforms in a single physical machine (Windows, Linux or others) so that resources can be shared Efficiently and more users can be served.

4. IMPLEMENTATIONAL AND OPERATIONAL ENVIRONMENT

The system is developed using open resources including Apache web server, MySQL database server, OpenSSH remote access tools; also VMWare workstation 5.5 is used to create virtual platforms.The user can select appropriate operating platforms with application software. There are two kinds of choices: immediate (now) application and reservation for future use. The user should choose amount of time for his application.

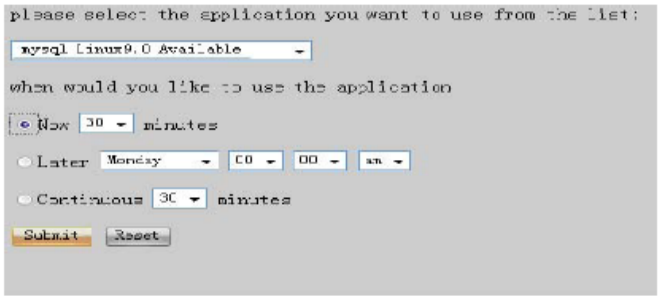


Figure 5 Web Interface for PaaS

The system will be open source in the near future under Eclipse open source license. Theoretically it is possible to provide and manage hundreds of real and virtual platforms; more test and evaluation results are conducting in the following work.

5. RELATED WORK

There may be no consistent definition for Cloud computing yet, however, practitioners are designing and implementing some application examples such as Google App Engine, IBM blue Cloud, Amazon EC2 and Microsoft Azure. There are many pioneering work in this area, many people think that Cloud computing becomes popular after IBM and Google jointly announced Cloud computing plan in 2007. IBM introduces its blue Cloud in [2][16], Google's App Engine[15] and related Google file system [8], BigTable [4] and MapReduce [6] are considered to have laid foundation for Cloud computing. A virtual computing lab (and then Cloud computing) was built since 2004 [12]. Cloud implementation and research related issues are discussed in [2][7][12][13]. As this writing, more than 30,000 teachers and students use VCL [12] at NCSU each year. Eucalyptus [7] is among one of a few an open-source systems for implementing on-premise private and hybrid clouds using the hardware and software infrastructure. Eucalyptus adds capabilities such as end-user customization, self-service provisioning, and legacy application support to data center virtualization features, making IT customer service easier, more fully featured, and less expensive. To understand Cloud computing better and quantify the performance of scheduling and allocation policy on a Cloud infrastructure, simulation tool CloudSim is proposed [3]. Approaches of dimensioning a virtual computing lab with job priorities and QoS constraints is discussed in [9]. Three techniques to improve the efficiency of virtual Cloud computing lab based on queuing model are introduced in [10]; some of these techniques are applied in this paper. Adaptive dimensioning approaches of Cloud datacenters are introduced in [11]. There are many other related work and many more to come in Cloud computing.

6. CONCLUSION

In this paper, a framework implementing and managing platform as a service in a virtual Cloud computing lab is developed. The system has good expandability and can improve resource's sharing and utilization. In the future we will extend the framework to include imaging of software and hardware platforms, load balancing and complete automatic provisioning of resources so that the system can be applied in large-scale and distributed environment.

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