

Implementation and Management of 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. IaaS (Infrastructure as a service), as the name suggests, provides you the computing infrastructure, physical or (quite often) virtual machines and other resources like virtual-machine disk image library, block and file-based storage, firewalls, load balancers, IP addresses, virtual local area networks etc. While in SaaS (Software as a service) model you are provided with access to application softwares often referred to as on-demand softwares. You don't have to worry about the installation, setup and running of the application. Service provider will do that for you. You just have to pay and use it through some client. PaaS (Platform as a service), as the name suggests, provides you computing platforms which typically includes operating system, programming language execution environment, database, web server etc. 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, we introduced all three framework of Cloud SaaS, IaaS, PaaS framework for managing PaaS in a virtual Cloud computing lab. The framework implements the user management, resource management and access management. The system has good expandability and can improve resource's sharing and utilization.

INTRODUCTION

Cloud computing is developing based on year's 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 allow 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]}.

CLOUD ARCHITECTURE

An Enterprise Cloud is a hosted computing environment that delivers software, platform or infrastructure services to business users via a network. Enterprise Cloud Computing provides organizations with the ability to deliver computing services in a controlled and secure manner, since a cloud for the enterprise makes use of a network firewall. Entities that store, manage or process sensitive data, including government agencies and health care organizations, are likely to use enterprise cloud computing services, as opposed to using public cloud computing services.

Many businesses who own on-premise IT systems can maximize their IT investment through Enterprise Cloud Computing. A Cloud for the Enterprise promises to deliver an extremely agile computing environment for client users within private organizations. These organizations can gain many of the same operational benefits available within a public cloud computing environment. Extending a private cloud that incorporates methods such as virtualization, automation and service management; can result in increased operational efficiency within an organization.

Implementing an Enterprise Cloud

Enterprise Cloud Computing can be implemented in one of two ways: as a private cloud that is hosted on the premises of an organization; or as a private cloud that is hosted externally by a third party provider. Organizations that use externally hosted enterprise cloud computing services often experience the benefits of lower IT infrastructure and

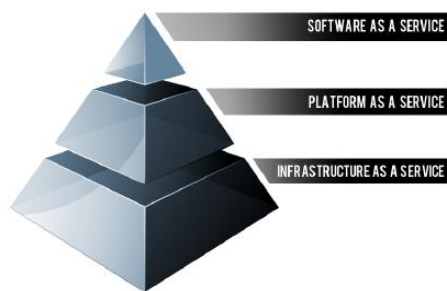
maintenance costs. Another frequent benefit of externally hosted enterprise cloud computing services is lower IT operational expenses, due to a decreased need for internal IT support staff.

Some organizations gain the benefits of both an internally hosted and an externally hosted enterprise cloud computing environment, by implementing hybrid enterprise cloud computing services for their businesses. Under such a configuration, organizations internally host their more sensitive applications that require a highly secure computing environment and move applications with less stringent security requirements to an externally hosted cloud for the enterprise. A hybrid enterprise cloud computing environment typically uses a cloud management interface, to provide a coherent platform for enterprise cloud service delivery. Cloud management methods require the establishment of a cloud as a platform, where an enterprise can provide hybrid cloud computing services on demand from existing IT systems and processes. Cloud management software provides a platform to easily register users, create work group services profiles, manage virtual resources and more.

CLOUD COMPUTING AS STACK

Cloud Computing is often described as a stack, as a response to the broad range of services built on top of one another under the moniker “Cloud”. The generally accepted definition of Cloud Computing comes from the National Institute of Standards and Technology (NIST) [1]. The NIST definition runs to several hundred words [2] but essentially says that; 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. The diagram below depicts the Cloud Computing stack – it shows three distinct categories within Cloud Computing: Software as a Service, Platform as a Service and Infrastructure as a Service.



1).Software as a Service

Software as a Service (SaaS): Instead of writing and maintaining every application, one uses online services. Examples include Google Mail and Salesforce. It is important to note that the SaaS software provided by a vendor might not be running in a cloud, but SaaS offerings often make sense when developing an application for the cloud. For instance, if I develop an e-commerce solution in the cloud, I might not want to reinvent my own load balancers, databases, or payment-processing system. I might not even want to run or operate them; perhaps all I want is to use these services. Using SaaS vendors allows me to concentrate on my own application.

1.a) Characteristics of SaaS

Like other forms of Cloud Computing, it is important to ensure that solutions sold as SaaS in fact comply with generally accepted definitions of Cloud Computing.

Some defining characteristics of SaaS include;

- Web access to commercial software
- Software is managed from a central location
- Software delivered in a “one to many” model
- Users not required to handle software upgrades and patches
- Application Programming Interfaces (APIs) allow for integration between different pieces of software

1.b) Where SaaS Makes Sense

Cloud Computing generally, and SaaS in particular, is a rapidly growing method of delivering technology. That said, organizations considering a move to the cloud will want to consider which applications they move to SaaS. As such there are particular solutions we consider prime candidate for an initial move to SaaS;

- “Vanilla” offerings where the solution is largely undifferentiated. A good example of a vanilla offering would include email where many times competitors use the same software precisely because this fundamental technology is a requirement for doing business, but does not itself confer an competitive advantage
- Applications where there is significant interplay between the organization and the outside world. For example, email newsletter campaign software

- Applications that have a significant need for web or mobile access. An example would be mobile sales management software
- Software that is only to be used for a short term need. An example would be collaboration software for a specific project
- Software where demand spikes significantly, for example tax or billing software used once a month

SaaS is widely accepted to have been introduced to the business world by the Salesforce Customer Relationship Management (CRM) product. As one of the earliest entrants it is not surprising that CRM is the most popular SaaS application area however e-mail, financial management, customer service and expense management have also gotten good uptake via SaaS.

1.c) Where SaaS May Not be the Best Option

While SaaS is a very valuable tool, there are certain situations where we believe it is not the best option for software delivery. Examples where SaaS may not be appropriate include;

- Applications where extremely fast processing of real time data is required
- Applications where legislation or other regulation does not permit data being hosted externally
- Applications where an existing on-premise solution fulfills all of the organization's needs

Software as a Service may be the best known aspect of Cloud Computing, but developers and organizations all around the world are leveraging Platform as a Service, which mixes the simplicity of SaaS with the power of IaaS, to great effect.

2). Infrastructure as a Service

Infrastructure as a Service (IaaS) is a way of delivering Cloud Computing infrastructure – servers, storage, network and operating systems – as an on-demand service. Rather than purchasing servers, software, datacenter space or network equipment, clients instead buy those resources as a fully outsourced service on demand. As we detailed in a previous whitepaper, within IaaS, there are some sub-categories that are worth noting. Generally IaaS can be obtained as public or private infrastructure or a combination of the two. “Public cloud” is considered infrastructure that consists of shared resources, deployed on a self-service basis over the Internet. By contrast, “private cloud” is infrastructure that emulates some of Cloud Computing features, like virtualization, but does so on a private network. Additionally, some hosting providers are beginning to offer a combination of traditional dedicated hosting alongside public and/ or private cloud networks. This combination approach is generally called “Hybrid Cloud”.

Characteristics of IaaS

As with the two previous sections, SaaS and PaaS, IaaS is a rapidly developing field. That said there are some core characteristics which describe what IaaS is. IaaS is generally accepted to comply with the following;

- Resources are distributed as a service
- Allows for dynamic scaling
- Has a variable cost, utility pricing model
- Generally includes multiple users on a single piece of hardware

There are a plethora of IaaS providers out there from the largest Cloud players like Amazon Web Services and Rackspace to more boutique regional players.

Proposed Architectural Framework for Cloud IaaS

- Infrastructure Services Modelling Framework (ISMF) that provides a basis for the infrastructure

resources virtualisation and management, including description, discovery, modelling, composition

and monitoring

- Combines common/unified infrastructure services description language (both network and IT

resources) and supporting infrastructure information services

- Composable Services Architecture (CSA) that provides a conceptual and architectural framework

for developing dynamically configurable virtualised infrastructure services

- Provides a basis for defining Composable Services middleware for Cloud IaaS

- Service Delivery Framework (SDF) that provides a basis for defining the whole composable services

life cycle management and supporting infrastructure services

- Defines the Composable (Infrastructure) Services provisioning workflow

- (Optionally) Service Control and Management Plane/Framework may be defined as combination of

management functionality at all architecture layers

- (Optionally) Security services/infrastructure have a dual role:

- Virtual Security Infrastructure - provisioned as a part of virtualised infrastructure

- Support normal/secure operation of the whole provisioning framework

Where IaaS Makes Sense

IaaS makes sense in a number of situations and these are closely related to the benefits that Cloud Computing bring. Situations that are particularly suitable for Cloud infrastructure include;

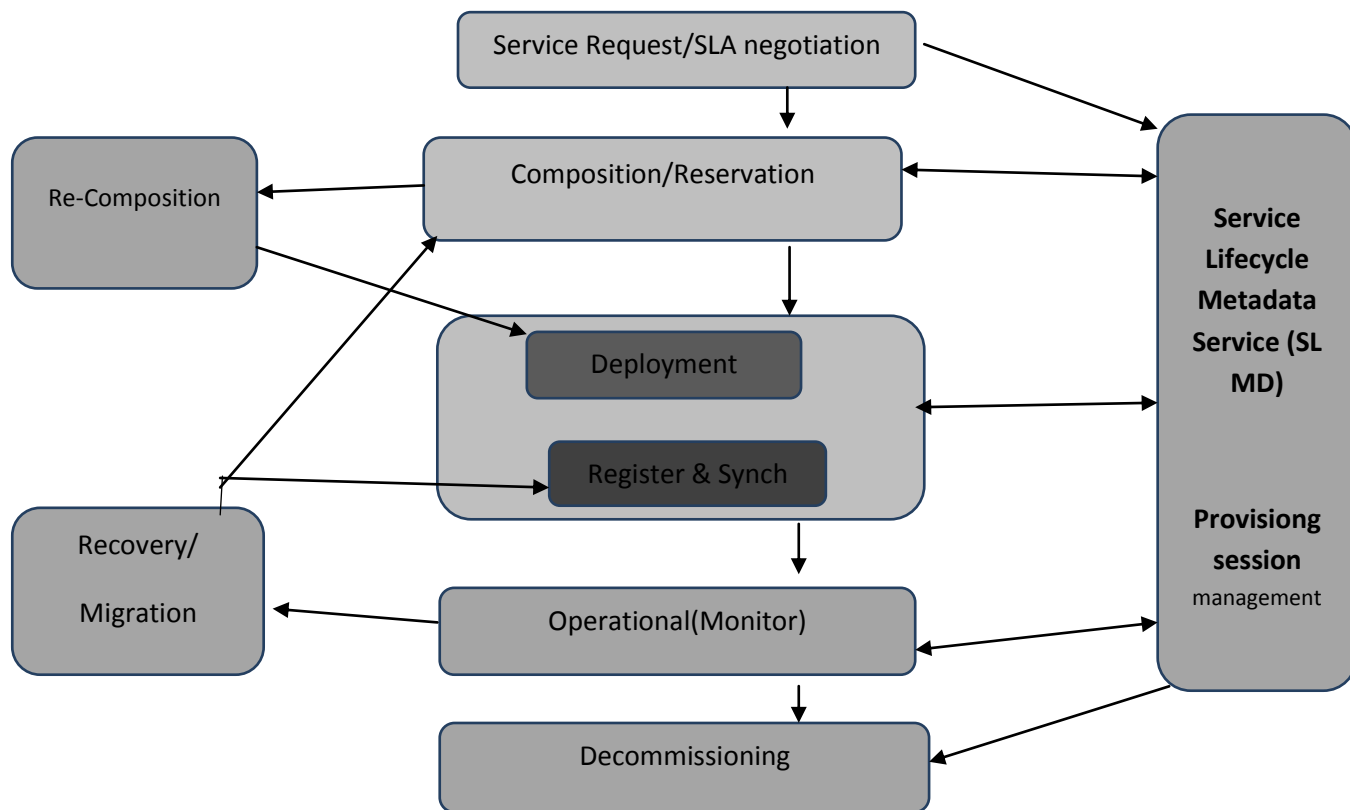
- Where demand is very volatile – any time there are significant spikes and troughs in terms of demand on the infrastructure

- For new organizations without the capital to invest in hardware

- Where the organization is growing rapidly and scaling hardware would be problematic

- Where there is pressure on the organization to limit capital expenditure and to move to operating expenditure

- For specific line of business, trial or temporary infrastructural needs



Service Delivery Framework for IaaS

SDF defines the Composable Services provisioning workflow and the Services Lifecycle Management Model (SSLM)

Main stages/phases

- (1) Service Request (including SLA negotiation)
- (2) Composition/Reservation (aka design)
- (3) Deployment, including
Registration/Synchronisation
- (4) Operation (including Monitoring)
- (5) Decommissioning

Additional stages

- (a) Re-Composition should address incremental infrastructure changes

- (b) Recovery/Migration can use SL-MD to initiate resources re-synchronisation but may require re-composition

The SDF workflow is supported by the Service Lifecycle Metadata Service (SL MD).

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Where IaaS May Not be the Best Option

While IaaS provides massive advantages for situations where scalability and quick provisioning are beneficial, there are situations where its limitations may be problematic. Examples of situations where we would advise caution with regards IaaS include;

- Where regulatory compliance makes the offshoring or outsourcing of data storage and processing difficult
- Where the highest levels of performance are required, and on-premise or dedicated hosted infrastructure has the capacity to meet the organization's needs

3).Platform as a service(PaaS)

It is a category of cloud computing services that provides a computing platform and a solution stack as a service.[1] Along with software as a service (SaaS) and infrastructure as a service (IaaS), it is a service model of cloud computing. In this model, the consumer creates the software using tools

and/or libraries from the provider. The consumer also controls software deployment and configuration settings. The provider provides the networks, servers, storage, and other services that are required to host the consumer's application.[2]

PaaS offerings facilitate the deployment of applications without the cost and complexity of buying and managing the underlying hardware and software and provisioning hosting capabilities.[3]

There are various types of PaaS vendors; however, all offer application hosting and a deployment environment, along with various integrated services. Services offer varying levels of scalability and maintenance.[4]

PaaS offerings may also include facilities for application design, application development, testing, and deployment as well as services such as team collaboration, web service integration, and marshalling, database integration, security, scalability, storage, persistence, state management, application versioning, application instrumentation, and developer community facilitation.

Besides the service engineering aspects, PaaS offerings include mechanisms for service management, such as monitoring, workflow management, discovery, reservation, etc.[5][6]

Characteristics of PaaS

There are a number of different takes on what constitutes PaaS but some basic characteristics include [16];

- Services to develop, test, deploy, host and maintain applications in the same integrated development environment. All the varying services needed to fulfil the application development process
- Web based user interface creation tools help to create, modify, test and deploy different UI scenarios
- Multi-tenant architecture where multiple concurrent users utilize the same development application
- Built in scalability of deployed software including load balancing and failover
- Integration with web services and databases via common standards
- Support for development team collaboration – some PaaS solutions include project planning and communication tools
- Tools to handle billing and subscription management

Difference between IaaS PaaS

PaaS, which is similar in many ways to Infrastructure as a Service that will be discussed above, is differentiated from IaaS by the addition of value added services and comes in two distinct flavours;

1. A collaborative platform for software development, focused on workflow management regardless of the data source being used for the application. An example of this approach would be Heroku, a PaaS that utilizes the Ruby on Rails development language.

2. A platform that allows for the creation of software utilizing proprietary data from an application. This sort of PaaS can be seen as a method to create applications with a common data form or type.

An example of this sort of platform would be the Force.com PaaS from Salesforce.com which is used almost exclusively to develop applications that work with the Salesforce.com CRM

Where PaaS Makes Sense

PaaS is especially useful in any situation where multiple developers will be working on a development project or where other external parties need to interact with the development process. As the case study below illustrates, it is proving invaluable for those who have an existing data source – for example sales information from a customer relationship management tool, and want to create applications which leverage that data. Finally PaaS is useful where developers wish to automate testing and deployment services.

The popularity of agile software development, a group of software development methodologies based on iterative and incremental development, will also increase the uptake of PaaS as it eases the difficulties around rapid development and iteration of software.

Some examples of PaaS include Google App Engine [17], Microsoft Azure Services [18], and the Force.com [19] platform.

Where PaaS May Not be the Best Option

We contend that PaaS will become the predominant approach towards software development. The ability to automate processes, use pre-defined components and building blocks and deploy automatically to production will provide sufficient value to be highly persuasive. That said, there are certain situations where PaaS may not be ideal, examples include;

- Where the application needs to be highly portable in terms of where it is hosted

- Where proprietary languages or approaches would impact on the development process

- Where a proprietary language would hinder later moves to another provider – concerns are raised about vendor lock-in [20]

- Where application performance requires customization of the underlying hardware and software

Designing a PaaS System

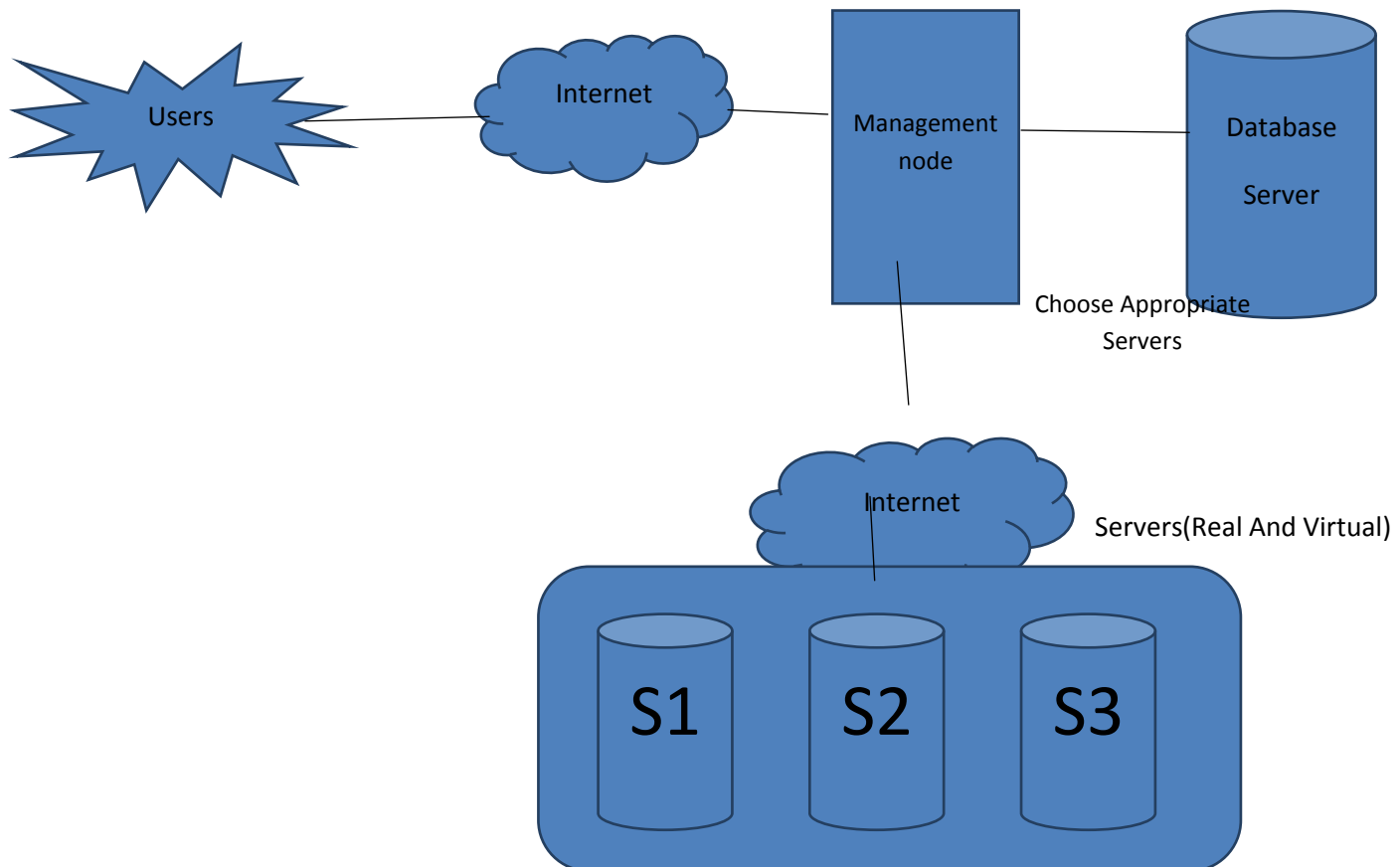
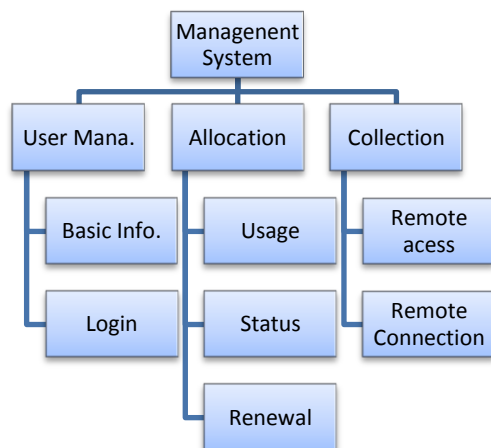


Fig: A virtual Cloud Computing Lab

A simplified Cloud computing environment is shown in Figure, 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.

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 maintains 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.

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.

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 2 MySQL is used for this purpose to keep information of authentication, resource availability and other information.

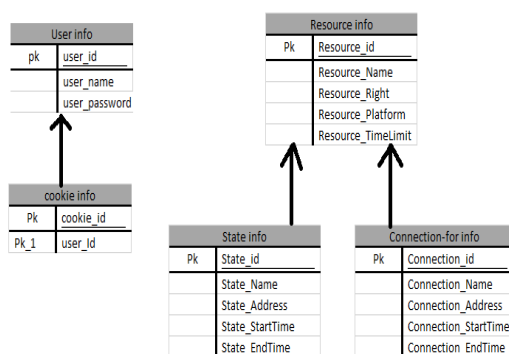


Fig: Database Management System

Virtualization in Operating System Level

Virtualization is one of key technology in Cloudcomputing. 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.

IMPLEMENTATIONALAND OPERATIONAL ENVIRONMENT

The system is developed using open resources including Apache web server, MySQL database server, OpenSSH remote access tools; also VMWare workstation 10 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. 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.

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.

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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