Proposed Cloud Architecture for Automated & Reliable Service Provisioning of Engineering Educational Domain

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Abstract— Cloud Computing is an emerged technology of the domain High Performance Computing and serves the community for getting their services executed over the internet. Cloud Computing has become the most popular distributed computing environment because it does not requires management and controlling on lower level implementation at user level. Rapid growth of the cloud technology pushed numerous educational institutions to revise their IT infrastructure and follow the cloud development. Cloud computing entails many challenges related to the management of on- demand virtual infrastructures. One of these challenges is the automated provisioning of resources and services in cloud infrastructure. However, efficient resource provisioning is a key challenge for cloud computing and resolving such kind of problem can reduce under or over utilization of resources, increase user satisfaction by serving more users during peak hours, reduce implementation cost for providers and service cost for users. This architecture is intended to provision efficient and reliable resources and to enable users to select a predefined service, customize it according to user's requirements and deploy it automatically. To provision the services as a resource, it provisioned based on SLA.

Index Terms- Resource and Service Provisioning, Cloud Computing, Service Level Agreement (SLA) ,Quality of Service(QoS).

I.INTRODUCTION

Over the last few years, cloud computing has been paid wide attention by academic organizations, government as well as small, medium and large scale industries. The providers of cloud computing technology offer different kinds of services to users which include programs, storage, application-development platforms over the Internet, hardware resources for deploying user friendly platform etc. Users can access cloud computing services using a variety of devices including PCs, Smart Phones, laptops, PDAs etc.

The services provided by cloud platform are much more reliable than services in grid computing and are much more scalable than services provisioned in large commodity clusters. The name cloud computing was inspired by the cloud symbol that is often used to represent the Internet in flowcharts and diagrams as shown in figure 1.

Figure 1- Cloud view

However, cloud computing still encounters a number of challenges including an efficient model

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of virtual machine provisioning which will ensure QoS (Quality of Service). Achieving QoS includes a number of parameters and properties to be fulfilled include user experience as well as degree of satisfaction, response time, trust, privacy concern etc. To enhance user satisfaction and to justify the investment in cloud based deployments, meeting up target QoS is necessary. Some existing works on QoS[1]-[9] have tried to provide assurance in meeting the SLA (Service Level Agreement). Some other works including tried to control VM provisioning in proactive or reactive manner[10]. However, the target of fulfilling SLA is a great challenge because of the uncertain and dynamic characteristics of network and IT resources in the distributed cloud platform. Figure 2 shows ability to automate the dynamic provisioning and placement of VMs taking into account both application-level SLAs and resource exploitation costs, support for heterogeneous applications and workloads including both enterprise online applications. QoS requirements and the VM for similar type of requests has been recycled so that the VM creation time can be minimized and used to serve more user requests.

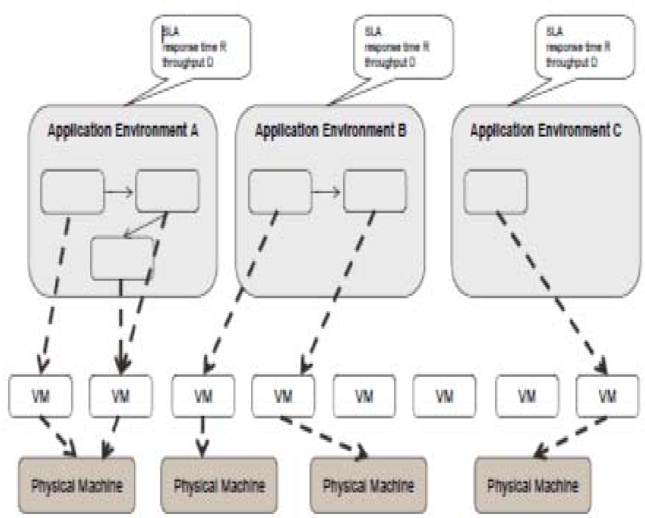

Figure 2- Dynamic Resource Allocation [3]

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[11]. With this new outsourcing service model, users no longer have to invest heavily on or maintain their own computing infrastructure, and are not constrained to specific computing service providers. Instead, they just have to pay for what they use whenever they want by outsourcing jobs to dedicated computing service providers. Since users pay for using services, they want to define and expect their service needs to be delivered by computing service providers. The initiative of cloud computing enables new business models in which businesses and researchers can create cloud services on- demand according to their continuously changing needs while only paying for the actual usage of the resources involved. In cloud computing, computing infrastructure and services should always be available on computing servers (which are distributed among all continents) such that companies are able to access their business services and applications anywhere in the world whenever they need.

These services are broadly divided into three categories / delivery models [11]:

- Software-as-a-Service (Saas) (Sales Force, CRM, LotusLive),
- Infrastructure-as-a-Service (Iaas) (Amazon EC2, Racksapce),
- Platform-as-a-Service (Paas) (GoogleApps).

Cloud Computing has become the most popular distributed computing environment because it does not requires management and controlling on lower level implementation at user level. However, efficient resource provisioning is a key challenge for cloud computing and resolving such kind of problem can reduce under or over utilization of resources, increase user satisfaction by serving more users during peak hours, reduce implementation cost for providers and service cost for users. Existing works on cloud computing focuses estimation to accurate capacity needs, static or dynamic VM (Virtual Machine) creation and scheduling. But significant amount of time is

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required to create and destroy VMs which could be used to serve more user requests. In this template, an QoS (Quality of Service) aware VM provisioning mechanism is developed that ensures efficient utilization of the system resources. The VM for similar type of requests has been recycled so that the VM creation time can be minimized and used to serve more user requests. In the proposed model, QoS is ensured by serving all the tasks within the requirements described in SLA. After the development of infrastructure of cloud, provisioning of services as per the requirement of user is proposed. The user can choose one or more services depending on the requirements. These all the services provisioned including different criteria like resources, application, software or platform. Provisioning of all the services are focused for education domain. The use of the Internet and Information and Communication Technologies (ICTs) to deliver educational resources is considered mainstream in the Higher Education (HE)[12]. It is increasingly accepted that in the future most information sources and desktop applications currently used will be mainly accessed through the Internet, now increasingly referred to as the cloud. Teachers and learners will no longer have to physically carry their documents and data around them; instead they will be able to access them in the cloud anywhere, from any connected device. Using the cloud computing concept, the proposed framework will become portable and be generalized to offer a wider range of resources and services for education domain.

II. SYSTEM ANALYSIS FOR THE DEVELOPMENT OF ARCHITECTURE

For the development of architecture of private cloud to provision resources and services some analysis have been done as per the requirement of establishment.

Analysis of different Cloud Computing MiddleWare:-

Eucalyptus:[13]

- Supports Linux (Ubuntu, Fedora, CentOS, OpenSUSE et Debian)
- Live migration not supported
- Compatible with EC2.[14]
- Users are mainly from enterprises
- Architecture is hierarchical
- VM location is in node controller
- Main purpose: EC2 cloud

Opennebula:[15][16]

- Supports Linux (Ubuntu, RedHat Enterprise Linux, Fedora)
- Live migration possible through shared FS
- Compatible with EC2
- Users are mainly researchers on cloud computing and virtualization
- Architecture is centralized
- VM location in cluster node
- Main purpose: private cloud

Nimbus:[17][18]

- Supports most of Linux distributions
- Live migration is not supported
- Compatible with EC2
- Users are mainly scientific communities
- Architecture is centralized
- VM location in physical nodes
- Main purpose: Cloud computing scientific solutions

XCP, AbiCloud, Openstack also provides cloud platform as a middleware.

Analysis of different hypervisor technologies:

KVM: [19]

- Compatible Host OS: Linux included in Linux kernel
- Compatible Guest OS: All OS
- Virtualization type support: Full virtualization
- Platform support:32 bit
- Major global users: none
- License: GPL

Xen:[20]

- Compatible Host OS: Linux certain versions
- Compatible Guest OS: All Windows and Linux and Solaris

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- Virtualization type support: Full virtualization and paravirtualization
- Platform support:32 bit ,64 bit , ARM , PowerAMC
- Major global users: Amazon,Rackspace,Cloud.com
- License: GPL

VMware:[21]

- Compatible Host OS: Most windows and Linux versions
- Compatible Guest OS: All windows versions, Linux, Solaris
- Virtualization type support: Full virtualization
- Platform support:64 bit
- Major global users: Google, Salesforce
- License: shareware

Other hypervisor like OpenVZ, VirtualBox, HyperV are also studied which were less suitable comparison to the above hypervisor due to lack of support or suitability according to existing infrastructure.

III. Development of $(CE)^2$ Architecture

Rapid growth of the cloud technology pushed numerous educational institutions to revise their IT infrastructure and follow the cloud development. Cloud computing entails many challenges related to the management of on-demand virtual infrastructures. One of these challenges is the automated provisioning of resources and services in cloud infrastructures. This paper aims to establish an architecture that enables the automated provisioning of resources and services which will be beneficial in an educational environment. SLA based resource provisioning task performed as per the request of the user. Figure 3 shows the request of the user to provide VMs as per their requirement. Other services provisioning task performed after the development of private cloud infrastructure. To provision the services as a hardware and software , it requires first step to development of cloud infrastructure. Cloud computing system can be divided into two sections, one is Frontend and other is Worker-node. The frontend gets the request from the client and accordingly fulfills the requirement by getting the resources from the worker nodes to provide infrastructure as a service.

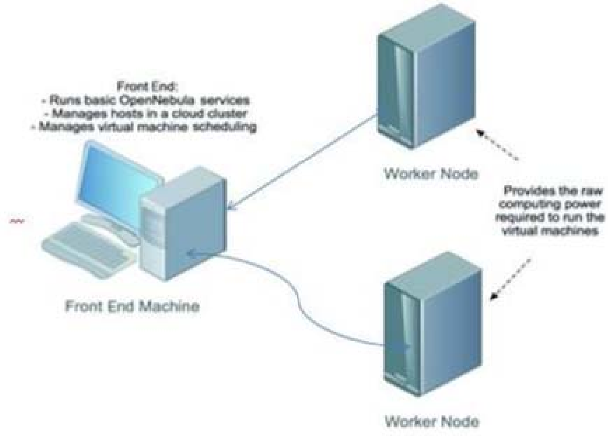

Figure 3- Cloud Infrastructure

Infrastructure as a Service

As shown in the figure 3, it fulfills services as infrastructure.

Front-End: Frontend section divided into three sub section. First section and most important section which hold the one of the main part of cloud infrastructure for controlling, monitoring, and most appreciable management task of the every kind of resources is middleware. Second section of the Frontend is called image repository. Image repository is one kind of storage of the image. Here image means operating system image and data storage images which can be given to the virtual machine according to user requirement. Third section is connection with worker node which will actually execute the virtual machine according to the user requirement.

Worker-Nodes: It holds infrastructure in the form of physical peripherals of cloud. Worker-node is highly configure, hypervisor enable, necessary server (NFS, SSH) enabled computation resources. It must have virtualized technology enable processor for best performance.

Worker-node actually does the computation and execution task of the virtual machine. Worker-node is hidden from user point of view and also where and when virtual machine will be executed is not decided by it but it will be decided by middleware. So responsibility of the worker-node is to start and stop the execution of the virtual machine according to instruction given by middleware.

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For the configuration of frontend and backend, required packages have to be configured to support OpenNebula environment. Scons, Ruby>=1.8.7, XMLRPC-C and SQLite are the required packages for the frontend and backend configuration.

Two operation methods for VM Deployment:

a. Via SSH: Images are copied via SSH to the Cluster Node partitions

b. On a Shared File System

- Resource Provisioning Algorithm:-

To provision resources as per the request of the user it has to base on the parameters of the service provider. This algorithm considers preemptable task execution and multiple SLA parameters for the dynamic allocation of resources.

$T_{service}$ = Maximum Affordable time by Service provider.

T_{req_neg} = Requested negotiated time within which the service needs to be provided.

$T_{require}$ = Estimated require time to Complete the task.

$T_{total\_service}$ = Total time required for completing all the jobs in service and in queue.

$T_{reserved\_tine}$= Reserved time to reserve VM as per requirement of user.

$T_{total} = T_{total\_service} + T_{reserved\_time}$.

```
If T_req_neg > T_total and T_service > T_require
then
        Allow Job to enter into the input queue.
else
        Reject Job to enter into input queue.
Endif
```

For Priority

```
  If Resources are available for new VM
        Then
            Calculate Priority for Each queue.
        Else
            Wait for VM of similar type to complete
            current Job.
  end if
```

After the development of infrastructure it aims to establish an architecture that enables the automated provisioning of cloud services which will be beneficial in an engineering educational environment. The architecture is intended to enable users to select a predefined service, customize it according to user's requirements and deploy it automatically. It will also allow the user to share a pool of resources which may be available in the form of software or Hardware. In this architecture category of cloud is initialized as private cloud. Gradually this will expand and cross administrative boundaries to become the hybrid cloud. The education process in engineering involves theory and practical material, lecture notes, individual study, group-based projects, experiments which includes simulation/emulation software packages, tools and different applications. This private cloud will enable to provision resources to the user who is a stakeholder in an engineering education environment. Here we propose an engineering educational cloud architecture which will be build using open source middleware and will be recognized as campus cloud and provide automated services to the users. After the development of infrastructure, it divided in two layers: User Interface and service models. Figure 4 depicts about the architecture of hybrid cloud infrastructure. Service model is categorized in two section SaaS and PaaS.

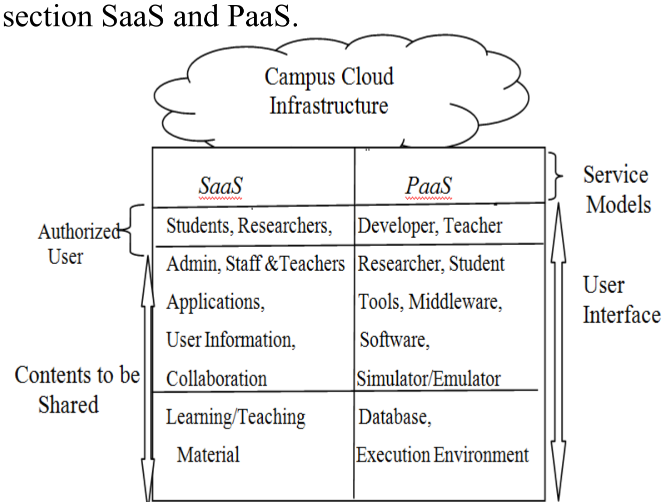

Figure 4- Architecture of $(CE)^2$ domain

SaaS in campus Cloud-: This service model provides services to deliver the educational applications to the browser of the user from the learning hybrid cloud. It helps to the faculties and departments with limited IT resources to deploy and maintain needed software in a timely manner.

PaaS in campus Cloud-: This service model deliver services to facilitate the development and deployment of applications, such as laboratory simulation software packages like Matlab, NS, middleware etc…without the cost and complexity of buying and managing the underlying infrastructure. With PaaS, user will develop new applications or services on the cloud that do not depend on a specific platform to run. Specific user will make them widely available to other users through the Internet. Based on the identified courses and selected cloud services will be provided to the user as illustrated in figure 4.

By using the cloud computing engineering education (CE)2 domain as shown in the figure 4, teachers will upload lecture notes, study materials, assignments ,schedule of exam and students will use it and also submit completed tasks given by teachers on time from anywhere. Postgraduate students and research scholars can submit their research reports and results to the respective guide. This platform will provide advanced services such as online courses, tutorials and webinars. In recent years, teachers are focusing on collaborative learning (online course/tutoring/mentoring) for the postgraduate engineering students and research scholars. The focus here is how to integrate the courses on the cloud and how the cloud can be integrated in the teaching process. This automated service provisioning architecture will provide services to the teachers and students as per their requirements at any time at anywhere. From an architecture point of view, a cloud service can be defined as a number of software components with their accompanying configuration parameters, running on top of a cloud infrastructure platform, delivering a service over the Internet.

IV. CONCLUSION

The services provided by cloud computing platform are more reliable than services provisioned in grid computing and cluster computing. This architecture is intended to provision efficient and reliable services as per the requirement of users. Resource provisioning services work based on SLA parameters. For the dynamic resource allocation, resource provisioning algorithm considered preemptable task execution and multiple SLA parameters. After the development of infrastructure of cloud, $(CE)^2$ cloud computing engineering education domain is proposed to provision the services like software as a service(SaaS) and platform as a service(PaaS). This automated service provisioning architecture will provide services to the teachers and students as per their requirements at anytime and anywhere.

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