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Cloud Platforms – A Comparison

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Abstract—Cloud Computing has emerged to be the potential area of research. The cloud computing concept provides users with access to a shared pool of resources on-demand. It avoids the up-front infrastructure costs incurred and lets the organizations pay only for the resources they have utilized. Many IT companies are involved in the cloud research and they do provide different cloud computing services to users. This paper presents a comparison of the architecture, characteristics and benefits of different cloud platforms.

Keywords — Cloud computing, Cloud platforms, Eucalyptus, Amazon, OpenStack.

I. INTRODUCTION

A cloud is a collection of computers and servers and is accessed via the Internet. Cloud computing enables users access their applications and documents from anywhere in the world, thus freeing them from the availability of resource and time constraints.

According to NIST (National Institute of Standards and Technology), "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 [1]."

Cloud Computing Offers three kinds of services to end-users which include Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). With IaaS, the computing infrastructure (servers, network, and storage) is provided to user's on-demand. With PaaS, a complete development environment is provided to developers where they can design, develop, test and deploy their applications. With SaaS, specific software is provided to users and they can be customized to meet the requirements of the end-users. Clouds can be deployed in four different modes namely, private cloud, community cloud, public cloud, and hybrid cloud. In private cloud, the cloud infrastructure is used and managed within the organization thereby achieving high security. A community cloud is formed by a group of organizations that have similar requirements. With public cloud, the cloud infrastructure is given to the general public where resources can be dynamically accessed based on the requirements. A hybrid cloud is a combination of two or more clouds (private, community, public).

There are many IT companies that provide a variety of cloud services to end-users. Examples include EC2 from Amazon, AppEngine from Google, Blue Cloud from IBM, Azure Services from Microsoft, Eucalyptus, etc. In this paper, the architecture, characteristics and benefits of Eucalyptus cloud platform, Azure Services cloud platform, and salesforce.com CRM are discussed and compared.

This paper is organized as follows: Section 2 describes the Eucalyptus Cloud Platform. Section 3 describes OpenNebula. Section 4 describes Microsoft Azure Services Platform. Section 5 describes OpenStack. Section 6 shows the comparison of the four platforms and finally section 7 concludes the paper.

II. EUCALYPTUS

Eucalyptus (Elastic Utility Computing Architecture for Linking Your Programs To Useful Systems) is an open source software architecture that can be used to build private and hybrid clouds [2]. It lets user's access the infrastructure resources like servers, network, storage, etc., available in private clouds that are implemented by Eucalyptus inside an organization's existing data center and it also lets user's access resources available externally in public clouds. It was developed by Eucalyptus Systems Inc. Eucalyptus is interface compatible with Amazon EC2, Sun Cloud, etc. Eucalyptus supports different virtualization techniques like VMWare, Xen and KVM Hypervisors. Benefits of Eucalyptus cloud include automated self service, easily customizable and scalable. Figure 1 shows the various components of Eucalyptus Cloud Platform.

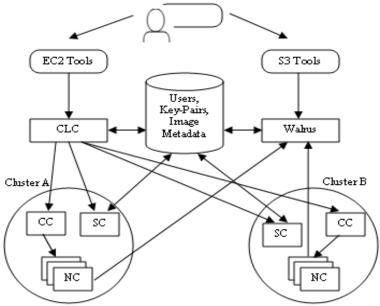


Fig. 1 Eucalyptus Components

The Eucalyptus cloud platform has five higher-level components that are implemented as a stand-alone web service. Each component has its own web interface.

- The Cloud Controller (CLC) takes care of presenting the virtualized resources to end-users through an interface. CLC is also responsible for gathering information on resources, making scheduling decisions and implementing the decisions made through requests to CC.
- The Cluster Controller (CC) is responsible for gathering information on VM's and scheduling VM execution on a specific NC and also manages the virtual networking between VM's and between VM's and users.
- The Node Controller (NC) is responsible for set up, scrutiny, and termination of VM instances. Node controllers that are logic connected form a virtual cluster and are under the control of the cluster controller.
- The Storage Controller (SC) implements block-level network storage.
- The Walrus is the central storage system wherein users can store persistent data. The data is organized as buckets and objects.

III. OPENNEBULA

OpenNebula [3] is an open-source toolkit that manages a data center's virtual infrastructure to build private, public or hybrid cloud. It offers Infrastructure as a Service. The OpenNebula toolkit includes features for management, integration, scalability and security. It also supports portability and interoperability thereby it provides several cloud interfaces and hypervisor to cloud users. The datacenters also can support multiple hardware and software configurations. Figure 2 shows the OpenNebula architecture and its main components.

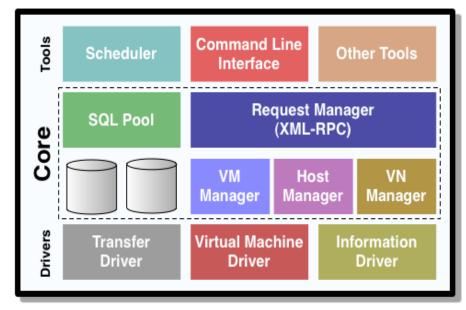


Fig. 2 OpenNebula Core Architecture

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- Drivers contains pluggable features that can be used to interact with specific middleware (eg., file transfer machanisms, information services or virtualization hypervisor).
- Core –contains a set of components that can be used to control and monitor virtual machines, virtual networks, hosts and storage. The components include: Request Manager –handles client requests, Virtual Machine Manager-manages and monitors VM's, Host Manager-manages and monitors physical resources, Virtual Network Manager-manages virtual networks, Database-provides persistent storage.
- Tools contains the command line interface that can be used by users to manually manipulate the virtual infrastructure, the scheduler that manages the functionality of the core, the libvirt API implementation or the Cloud RESTful interfaces and also other third party tools

IV. MICROSOFT'S WINDOWS AZURE

All paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified. Microsoft's Windows Azure Platform is a collection of cloud technologies, each offering a specific set of services to application developers. The services offered can be used by both the applications that run on the cloud and by applications that run on local systems [4]. Figure 3 show the services offered by the Azure Platform.

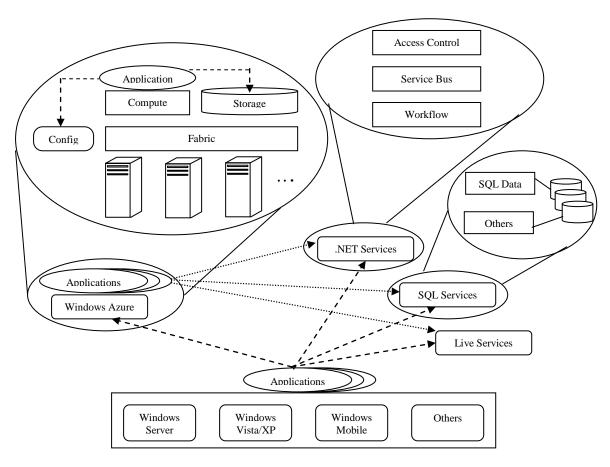


Fig. 3 Azure Services Platform

The Azure Platform includes the following services:

- Windows Azure: Provides an environment that is windows-based for running applications and storing data on servers that reside on Microsoft data centers.
- .NET Services: Provides distributed infrastructure services to cloud-based and on-premise applications (access control, service bus, workflow, etc).
- **SQL Services**: Lets on-premise and cloud applications to store and access data from servers that reside on Microsoft data centers. SQL Data Services is built on Microsoft SQL Server.
- **Live Services**: Set of services that enable developers to connect their applications to Windows Live family. These applications let users send instant messages, store and share contacts, search, etc.

V. OPENSTACK

OpenStack [5] is an initiative of Rackspace Hosting and NASA. It is an open source cloud computing platform that can be used to create and manage large networks of virtual machines. OpenStack provides an Infrastructure as a Service (Iaas) through a set of interrelated services. Figure 4 shows the different services that make up the architecture of OpenStack.

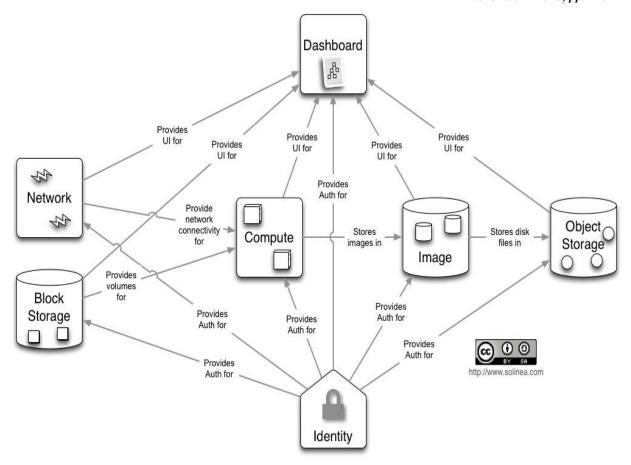


Fig. 4 OpenStack Conceptual Architecture

- Dashboard ("Horizon") provides a graphical interface to users and administrators to access, provision and automate other OpenStack services.
- Compute ("Nova") is a cloud computing fabric controller. It is used to provision and manage large networks of virtual machines and it scales horizontally. OpenStack Compute supports a variety of hardware configurations and hypervisors. It interacts with the Dashboard for the user interface, Identity Service for authentication and Image Service for images.
- Object Storage ("Swift") provides a scalable and redundant storage system. To ensure availability and integrity, the files and objects are replicated on multiple disk drives. The Storage clusters scale horizontally.
- Block Storage ("Cinder") provides persistent block storage.
- Network ("Neutron", formerly "Quantum") provides virtual network connectivity among interface devices that
 are managed by other OpenStack services, usually for Compute. It enables users to create and attach interfaces
 to networks.
- Identity Service ("Keystone") can be used to authenticate and authorize users. It usually provides a directory comprising user details that are mapped to the OpenStack services that they can access.
- Image ("Glance") provides services for discovery, registration and delivery of disk and server images.

VI. COMPARISON OF CLOUD PLATFORMS

The comparative study of the platforms – Eucalyptus, OpenNebula, Azure, OpenStack and SalesForce.com CRM is shown in table 1.

	Eucalyptus	OpenNubula	Azure	OpenStack
Developer	Eucalyptus	OpenNebula	Microsoft	Rackspace
	System, Inc	Community		and NASA
Deployment	Private/Hybrid	Private/Public/	Private/Public	Public/Privat
Model		Hybrid		e
Service Type	IaaS	IaaS	PaaS	IaaS
Virtualization	Hepervisors	Hypervisors	Hypervisor	Hypervisors
Management	(Xen, KVM,	(Xen, KVM,	(based on	(Xen, KVM,
Support	VMWare)	VMWare)	Hyper-V)	HyperV,
				VMWare)

TABLE I: COMPARISON

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Scalability	Scalable	Scalable	Scalable	Scalable
Compatibility	Amazon EC2,	Supports	Aneka	Amazon
	S3, Sun Cloud	multiple		EC2, S3
		platforms		

VII. CONCLUSIONS

Focused on aspects such as architecture, characteristics, application and so on, a detailed comparison has been presented in this paper. This helps users to better understand and choose the appropriate cloud platforms based on service type, compatibility, deployment models, etc.

REFERENCES

- [1] Peter Mell and Tim Grance, The NIST Definition of Cloud Computing, Version 15, July 2009.
- [2] www.eucalyptus.com
- [3] www.opennebula.org
- [4] http://www.microsoft.com/windowsazure/
- [5] http://docs.openstack.org/