Survey of Cloud Computing Platforms

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***Abstract*— This Cloud computing is an emerging computing paradigm aimed at running services over the internet to provide scalability and flexibility. The advantages of using the cloud for start-up and small businesses which lack infrastructure have been shown to far outweigh the disadvantages. Cloud platform services, also known as Platform as a Service (PaaS), provide a computing platform or solution stack on which software can be developed for later deployment in a cloud. Many IT companies are involved in the cloud research and they do provide different cloud computing services to users. This paper focuses on comparison of different Cloud Computing Platforms: Eucalyptus, OpenNebula, Amazon Web Services, Microsoft Azure, Google App Engine.**

Keywords – PaaS, architecture, Eucalyptus, OpenNebula, Amazon Web Services, Microsoft Azure, Google App Engine.

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 and on-demand network access to a shared configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort [1]."

Many IT companies 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.

II. CLOUD COMPUTING PLATFORMS

A. Eucalytpus

Eucalyptus which stands for 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. Fig. 1 shows the various components of Eucalyptus Cloud Platform.

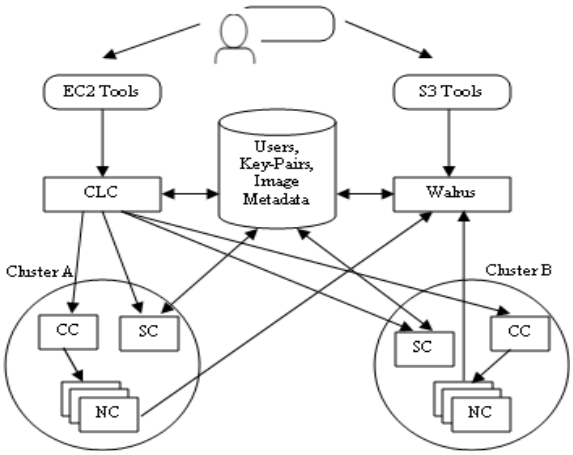

Fig. 1 Eucalyptus Components

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.

B. 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. Fig. 2 shows the OpenNebula architecture and its main components.

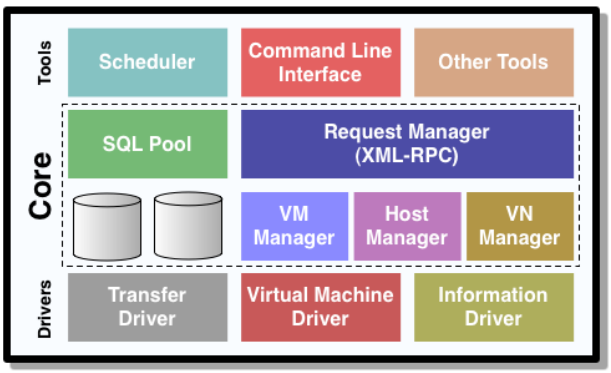

Fig. 2 OpenNebula Core Architecture

- 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 the libvirt API implementation or the Cloud RESTful interfaces and also other third party tools.

C. Microsoft's Windows Azure platform

Microsoft's Windows Azure platform is a group of cloud technologies which provides a specific set of services to developers. This platform can be used both by applications running in the cloud as well as by applications running on local systems [4]. It contains the following components as shown in Fig. 3.

- Windows Azure: A Windows-based environment for running applications in Microsoft data centers.
- SQL Azure: SQL Server based data services.
- .NET Services: Distributed infrastructure services to cloud-based and local applications.

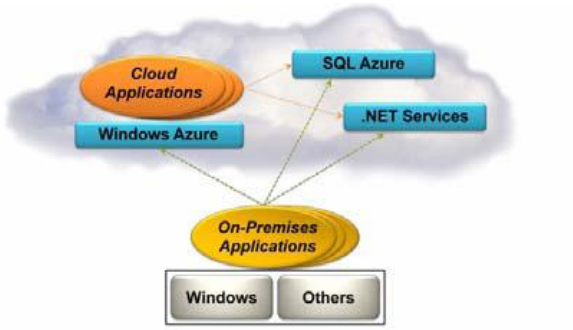

Fig. 3. The Windows Azure platform

1) Windows Azure

Windows Azure runs on a large number of machines which are all located in Microsoft data centers and accessible via the Internet. A common Windows Azure fabric knits this surplus of processing power into a unified whole. Windows Azure storage services are built on top of this fabric.

2) Sql azure

SQL Azure eventually includes a range of data-oriented capabilities, including features like reporting, data analytics, and others, the first SQL Azure components to appear are SQL Azure Database and "Huron"Data Sync.

- SQL Azure Database: SQL Azure Database is built on Microsoft SQL Server.
- "Huron" Data Sync: "Huron" Data Sync. technology synchronizes relational data across various on-premises DBMSs. The owners of that data can determine what has to be synchronized, how conflicts have to be handled, and more.

3) .Net services

.NET Services provides infrastructure services that can be used by either on-premises applications or cloud applications. Service Bus provides a mechanism to manage Web services exposed by applications.

D. Amazon Web Services

Amazon Web Services (AWS) provides a highly scalable cloud computing platform with high availability, dependability and flexibility, so as to help customers build a wide range of applications [5]. Amazon Web Services for Cloud Computing contains the following components.

1) Amazon Elastic Compute Cloud (EC2)

Amazon Elastic Compute Cloud (Amazon EC2) shown in Fig. 4 is a web service that enables customers to launch and manage Linux/UNIX/Windows server instances in the data centers of Amazon.

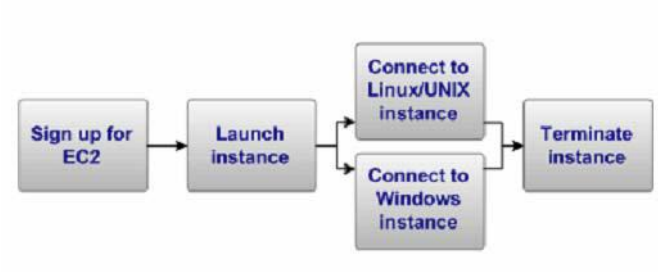

Fig. 4. Amazon Elastic Compute Cloud (Amazon EC2)

Amazon EC2 has following major features:
a) Resource delivered as AMI (Amazon Machine Image).
b) Compute instance.
c) Explicit access control

2) Amazon Simple Storage Service (S3)
Amazon S3 allows people to upload, store, and download data via the Internet. The data can be used in conjunction with other AWS services such as EC2, Amazon Import/Export, and Amazon Elastic MapReduce.
The features of Amazon S3 are listed as follows.
a) Object storage model with key.
b) Bucket as object container.
c) Establish connection.
d) Create bucket.
e) Upload file.
f) Standards-based Interfaces: REST and SOAP with URL for each object.

3) Amazon SimpleDB (SDB)
Amazon SimpleDB is also a web service for running queries in real time on structured data. This service works together with Amazon S3 and Amazon EC2, providing the ability to process, store and query data in the cloud. Amazon SimpleDB is designed to provide the following features.
a) Simple.
b) Flexible.
c) Scalable.
d) Fast.
e) Reliable.
f) Works with other Amazon Web Services.
g) Inexpensive.

4) Amazon Flexible Payment Service
Amazon Flexible Payments Service is designed for developers in the form of the first payments service and it allows develop highly customized payment solutions for kinds of businesses. Amazon FPS service is so vast that its functionality is divided into five Quick Start implementations below.
a) Amazon FPS Basic Quick Start
b) Amazon FPS Marketplace Quick Start
c) Amazon FPS Advanced Quick Start
d) Amazon FPS Aggregated Payments Quick Start

E. Google Cloud
1) Google Engine
Google App Engine also supports Application Programming Interfaces (APIs) for the data store, Google Accounts, URL fetch, image manipulation, and email services [6].

2) Google Apps
Google Apps is one of the most sophisticated and comprehensive collaborative products available. The program includes applications for email, calendars, instant messaging, room reservations, document storage and editing and video sharing.

3) Google File system (GFS)
GFS provides a reliable distributed storage system that can be up to petabyte scale by keeping data in 64- megabyte "chunks" stored on disks, which is spread across thousands of machines. Each chunk is replicated, usually 3 times, on different machines so GFS can recover seamlessly from disk or machine failure. Fig. 5 shows its Architecture.

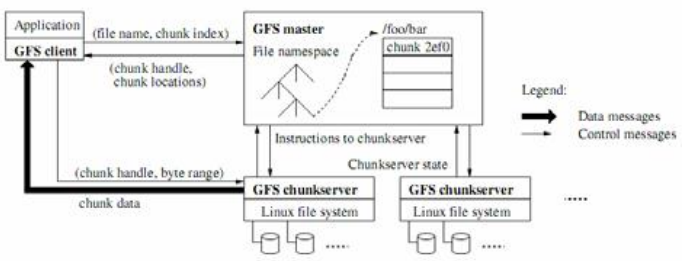

Fig. 5 Google File System Architecture

III. DIFFERENCE

Table I . Cloud Platforms

	Eucalyptus	OpenNebula	Microsoft Azure	Amazon web Service	Google
Developer	Eucalyptus System, Inc	OpenNebula Community	Microsoft	Amazon	Google Inc.
Cloud Type	Private/Hybrid	Public/Private/Hybrid	Public/Private/Hybrid	Public/Private/Hybrid	Public/Private/Hybrid
Hypervisor support	Xen, KVM, VMWare	Xen, KVM, VMWare	Hyper-V	Xen	KVM
Service Type	IaaS	IaaS	IaaS, PaaS, SaaS	IaaS	IaaS,PaaS
Development language	Java	Java	Java, python, Javascript, PHP	Java, C++	Ruby, Java , Python
OS Support	Linux	Linux	Linux, Windows	Linux, Windows	Linux, Windows

IV. CONCLUSION

Cloud computing is a new internet based technology widely used and studied in recent memories. Currently, there are lots of cloud computing platform with varying level of application, architecture, characteristic etc. Now, the difference in the platform is becoming an issue in terms of understanding and usage. In this paper a detailed comparison of four major cloud computing platform has been presented. Based on the analysis, users now have the opportunity to understand the features and be able to make choices of cloud computing platform in respect to cloud computing module, services, development supports, cloud interfaces, deployment, OS supports and compatibility.

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