Cloud Computing

1 What is Cloud Computing?

"Cloud computing is a style of computing where dynamically scalable and virtualized resources are provided as a service over the internet."

In his book "Cloud Computing Bible" Barrie Sosinsky defines cloud computing as:

"Cloud computing refers to applications and services that run on a distributed network using virtualized resources and accessed by common Internet protocols and networking standards."

Research firm Gartner defines cloud computing as:

"a style of computing whose massively scalable and elastic IT-related capabilities are provided as a service to external customers using Internet technologies."

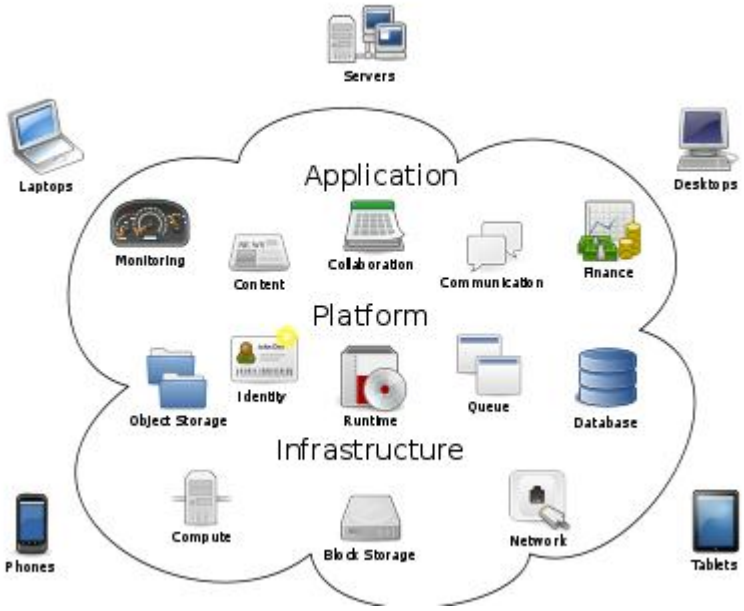

Figure (2) Cloud

In layman terms we can say that customers may rent data center resources from cloud service providers to get data storage, software application and processing power on demand on pay as you use bases. The most important and distinguished aspect of cloud computing is the virtualization and abstraction of the resources and that there is no limit on the capacity and number of resources a user can have.

2 Cloud Service Models

The service models of cloud computing can be viewed as the "layers" of cloud architecture which corresponds the physical layers of building cloud. The architecture of cloud computing is based on three major layers:

- Cloud infrastructure also known as Infrastructure as a Service or IaaS.
- Cloud application platform also known as Platform as a Service or PaaS.
- Cloud application also known as Software as a Service or SaaS.

These layers define the various responsibilities for cloud participants (consumers, providers) i.e. what to be managed by consumers and what to be managed by providers. Following figure clearly shows the responsibilities of the two players:

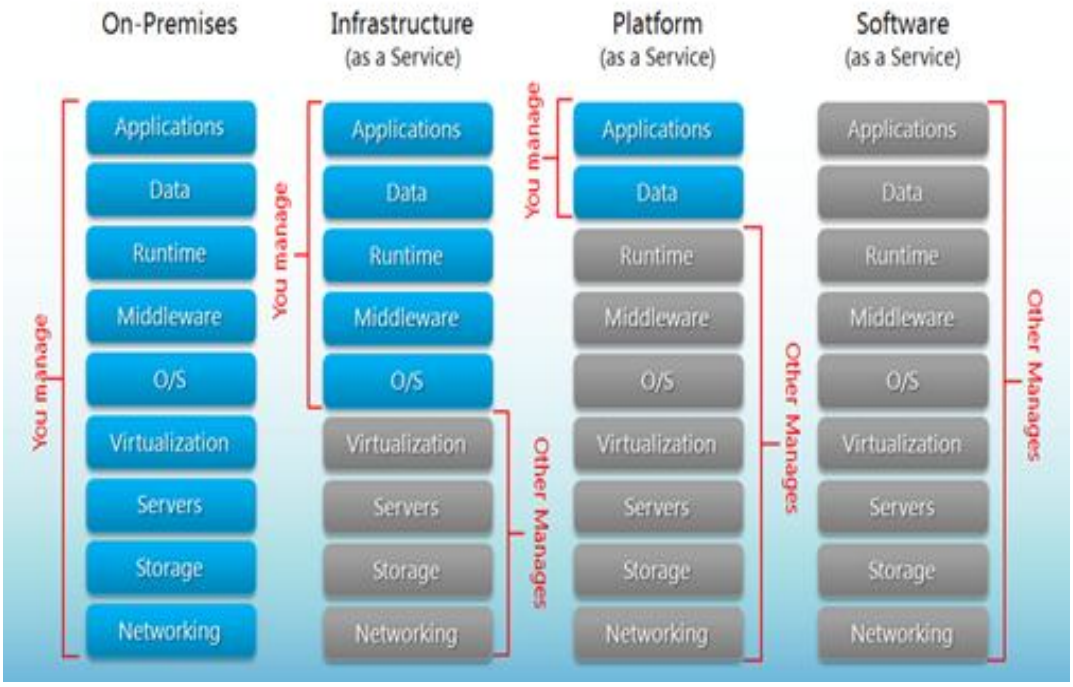

Figure (4) Separation of Responsibilities

2.1 Software as a Service (SaaS)

Software-as-a-Service is the service model of cloud computing where the providers provides the software functionality as a service to the consumers through internet. The consumers just need to maintain a computer with internet connection; all other facilities i.e. application, middleware, O/S, storage will be managed by providers. The benefits to the service consumers of SaaS are no initial cost to purchase software, accessibility through internet, high availability and pay-per-use pricing. This layer of cloud architecture may be regarded as *user level* layer, because the services provided by this layer are directly used by the application user.

The licensing of application between SaaS provider and SaaS customer will take place in different ways such as service on demand, through a subscription, in a "pay-as-you-go" model or at no charge when revenue generates from advertisements. Google docs, Gmail, Hotmail and SalesForce are some well known SaaS products and providers.

2.1.1 Key Features of SaaS

Following are some key features of SaaS.

- ***Reusability:*** The main concept of reusability here is to reuse various types of internet based services. In case of SaaS, software itself is used as a reusable service.
- ***Data Managed by Providers:*** Since software is provided as a service; the installation and data management is also the responsibility of service providers. The data produced by the service consumers is stored and managed by providers and the consumers don't have to worry about where the data is stored and how the data is managed.
- ***Customizability:*** It is impossible for SaaS providers to customize their cloud services to meet the varying needs of different service consumers. Thus SaaS provides their consumers to customize services according to their requirements.
- ***Pay per Use:*** SaaS consumers do not pay a fix amount for the services they are using; instead they utilize the service and then pay the amount for which they have used such as utility like electricity or gas.
- Web access to commercial software.
- There is no need to handle software upgrades and patches by users.

2.2 Platform as a Service (PaaS)

Platform as a Service is the second layer of cloud stack. PaaS vendors provide platform and different programming languages to developers to develop their applications and made available on the web.

Platform as a Service is analogous to Software as a Service except that, instead of delivering the software over the web, it is the platform for the creation of software delivered over the web. This layer of cloud architecture may be regarded as *developer level* layer, because the services provided by this layer are used by the application developers. Google App Engine, Windows Azure, Force.com are some well know PaaS providers.

2.2.1 Key Features of PaaS

Following are some key features of PaaS.

- Developers don't need to configure their own servers for developing applications.
- No need to buy operating system and programming languages.
- Developer collaboration is supported by PaaS, since code is present online makes it easy to access, modify and return the code.
- No need to hire professionals such as database administrators, network administrators etc.

2.3 Infrastructure as a Service (IaaS)

Infrastructure as a Service is the lowest layer of cloud stack and is sometimes referred to as Hardware as s Service (HaaS). IaaS serves as a foundation for the execution of other two layers. IaaS providers supplies the whole cloud infrastructure i.e. servers, routers, hardware based load balancing, firewalls, storage and other network equipment. Now the companies don't need to manage expensive datacenters; instead they can buy these datacenters on the basis of pay-as-you-go as a service from IaaS providers. Cloud computing is primarily based on IaaS layer to provide processing power, data storage and other shared resources. Amazon Elastic Compute Cloud (EC2), GoGrid and Rackspace are some examples of IaaS providers.

2.3.1 Key Features of IaaS

Following are some key features of IaaS describing IaaS in a broader way:

- User pay for the resources he consumed i.e. utility pricing model is followed.
- Multiple users use a single piece of hardware by virtualizing the computer resources (e.g. network, CPUs, memory and storage).
- Dynamic scaling can easily be achieved.

3 Cloud Deployment Models

Cloud computing comprises mainly four kinds of deployment models. Public, private, community and hybrid deployment models. Each one of these is composed of its individual

features and characteristics which distinguish them from the other. The variation in the services that individual company is providing either SaaS, PaaS or IaaS also help them to decide the deployment model.

3.1 Private Deployment Model

The cloud infrastructure is operated solely for an organization

The private deployment model called as private if it includes a single entity, call it an organization. This sort of infrastructure can be operated by the organization itself or a third party. There can be a possibility of the existence of the deployment infrastructure within the organization or anywhere at the remote location.

One of the main reasons to deploy private cloud infrastructure is to use it for mission critical systems that requires privacy and controlled circumstances. The organization fetch the required bandwidth, hosts, virtual machines and other required infrastructure for testing and implementation of the mission critical system. Organization also decide to go for private clouds when they want to continue with their current equipment and routine while desire to make it more scalable. Under these conditions the most suitable way is to adopt private cloud deployment model.

Examples:

- Eucalyptus
- Ubuntu Enterprise Cloud - UEC (powered by Eucalyptus)
- Amazon VPC (Virtual Private Cloud)
- VMware Cloud Infrastructure Suite
- Microsoft ECI data center.

3.2 Public Deployment Model

A public cloud is one based on the standard cloud computing model, in which a service provider makes resources, such as applications and storage, available to the general public over the Internet [1].

A public cloud comprises of the services that are accessible publically with the help of some standards and protocols. Usually APIs are used over the internet for this purpose. Using these publically available infrastructure like cloud web hosting, development infrastructure or any of the SaaS, PaaS or IaaS, it can be free or paid depending upon the services that is being absorbed by the organization. A private cloud can be turned into public cloud by converting the private features into the public features like exposing the API for public with may or may not based on certain conditions.

Public deployment model should not be confused with the term free public services. As public cloud infrastructure does not mean that the personal content of the user will be exposed to the public environment. In this case the resources are dynamically provisioned over the internet and it depends upon the organizational requirements to choose a single service provider for the services or agree with multiple services organizations for individual services.

The integration part in case of public deployment model is owned by the service provider. These third party management is responsible for all sort of services like conflict resolution while change in web browser, operating system etc. For example one of the user is accessing the services while using Opera internet explorer on Windows 7 while the other is accessing while using Safari over Mac machine and the service provider is dealing with the mail services then in this case the clients does not require individual email client application. It would be the responsibility of the third party email service provider to deal with the compatibility issues at browser level as well as at the operating system level.

Examples:

- Google App Engine
- Microsoft Windows Azure
- IBM Smart Cloud
- Amazon EC2

3.3 Hybrid Deployment Model

The use of physical hardware and virtualized cloud server instances together to provide a single common service [1].

Cloud deployment model is hybrid in a situation when the organization is using a combination of the any two or more above discussed cloud deployment models. The cloud itself may behave as unique entity while they bound with certain technology to provide the desired services to the organization. One of the most common examples of hybrid cloud is while using hybrid web hosting in which the website hosting is mix between cloud hosting and managed on the dedicated hardware servers. This is one of the example in which some nodes of the application resides physically while others are managed over cloud infrastructure.

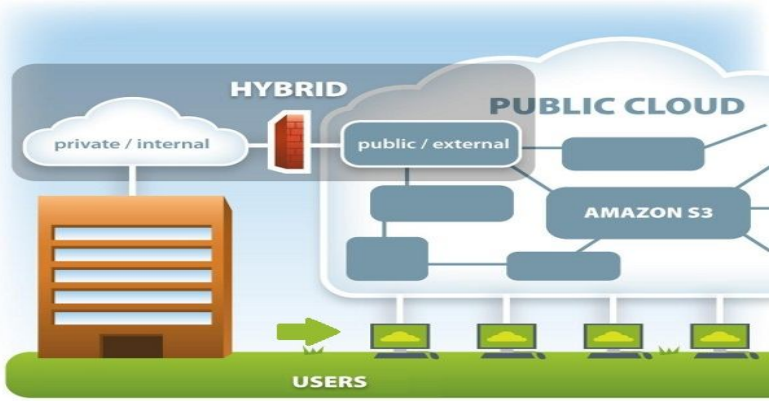

Figure (8) Hybrid Deployment Model

Cloud will also said to be hybrid if the data scheduling needed the security and for this the organization sets the data on private cloud while other supplementary services over the public cloud. This will result in secured private data and the services would be easily achievable by the users. Organizations also desire to use hybrid environment when they need to secure the information and yet it is not possible to rely for services on third party. For example for a mission critical or business critical system the organization will secure the information on the private cloud and will depend upon the services that they think difficult to manage on private cloud or within organization.

Hybrid clouds supports data and application portability specifically for the to maintain the condition of load balancing and to deal with the issues like cloud bursting.

Examples:

- Windows Azure (capable of Hybrid Cloud)
- VMware vCloud (Hybrid Cloud Services)

4 Application Areas of Cloud Computing

In this section we will focus on the organizations that are using the mentioned services of the cloud computing.

4.1 IaaS Based Organization

Amazon is one of the online pioneers that are using cloud computing service. It has built repute in the field of web services by introducing Amazon Elastic Computing (EC2). It is a flexible web service that produces resizable compute capacity in the clouds. Amazon EC2 dishes up the users full control of the computing devices and allow them to run on the Amazon's recommended computing environment. This service is economical as charges are made for only the capacity that is used.

4.2 PaaS based Organization

Google is one of the main organizations that are using PaaS. Google has introduced Google Application Engine that makes the user to host the web applications on the same system that power Google Application. This facility is for developers and administrators in flexible manners. Users are complete distraction free about the hardware and software resources. This facility is free to some extent but when more resources and bandwidth is required, charges are implemented to some extent. Beta version of this application was introduced in April 2008 that got the shape of full version in September 2011.Currently the Google Application Engine is supporting the following features

- *Python*
- *Go*
- *Java*

In future Google will offer this facility for other programming languages.

4.3 SaaS based Organization

There are many organizations round the world that are using SaaS but in this report our main concern is with Accelops. AccelOps stands for Accelerate Operation. Accelops dishes up integrated datacenter monitoring and business service management software delivered as Software as-a-Service. It also introduced service oriented platform that can monitor, alter, analyze and can report many features like performance, availability, security and change of management by keeping in view business services.