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CLOUD COMPUTING: THE ERA OF VIRTUAL WORLD OPPORTUNITIES AND RISKS INVOLVED

Mohd Waqas[*1]

[*1]Department Of Information Technology S.I.W.S. College, Wadala, Mumbai
Maharashtra – 400031, India.

ABSTRACT

Cloud Computing is becoming the most reliable and efficient way to share hardware, software, and platform in the form of services via the Internet. The elastic nature of cloud computing has attracted all strata of business enterprises ranging from small scale to large scale organizations such as Google, IBM, Amazon, and the list goes on. The era of Cloud computing has just begun so there are challenges along with the opportunities in IT industry. This paper elucidates the concepts of cloud computing, foundation stones of cloud computing, Opportunities, and threats that information technology world may witness in near future. The main aim of this paper is to provide key concepts of Cloud computing along with the current statistics of incidents happened in recent years that challenges growth of cloud computing. This paper will also focus on immeasurable opportunities that cloud computing offers to the IT industry.

Keywords: Cloud Computing; Virtualization; Distributed Computing; Threats; Opportunities

I. INTRODUCTION

Cloud computing may seem a new to term to IT industry, but its foundation stones are led down years before when companies started using early storage and Virtualization techniques. In the 1950's Mainframe computers were introduced to share the single processor and storage unit for multiple users. In 1970's Concept of Virtual machine was introduced; this added a flavor to the origin of Cloud computing. Virtual machines next with operating systems brought the revolution in Information technology industry and acted as catalyst in communication and internet evolution to next level. The concept of load balancing and use of physical devices in shared mode is an old concept for telecommunication companies that started in around 1990s, presence of Virtual private network allowed them to share same hardware infrastructure for multiple operators. In this paper, an attempt is made to provide a detailed concept of Cloud computing, opportunities, and threats to networked resources whether we talk about physical storage or software as a service.

II. KEY CONCEPTS OF CLOUD COMPUTING

A. Definition

It has been in debate for years who coined word 'cloud' for years among researchers, but it is said that origin of the term 'cloud computing' was used by employees of Compaq Computer in 1996 and in 1997, it was Professor of University of Texas, Mr. Ramnath Chellappa used it in a lecture talk named as "Intermediaries in Cloud-Computing: A New Computing Paradigm". [1]

"Cloud" is referred to as internet and can be perceived as collection of computing resources. However, many researchers and organizations have defined the 'Clod computing' in different terms and prospects. Cloud computing is a combination of parallel computing, ubiquitous computing, grid computing and distributed computing. Cloud computing is still evolving and gaining the attention of researchers in computer science world, on basis of the features and services provided by Cloud computing, we can define it as follows:

"Cloud computing can be defined as a set of frameworks that provides on demand, scalable, customized, quality services in Software, platform and also provides sharable infrastructure through internet that are accessible and available everywhere".

The National Institute of Standards and Technology (NIST) defined cloud computing as follow: 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. [2]

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B. Deployment Models

There are various deployment models of cloud computing based on the type of its usage and sometimes these models are clubbed together to assure the quality of Service. Following deployment models are defined by NIST [2]

1. Private cloud: In this deployment model, cloud infrastructure is solely governed and operated for a single organization that may consist of multiple business units. It can be managed and owned by either. organization itself or a third party or mix of both. It is also sometime referred as 'Enterprise cloud' due to its nature of deployment. It can exist on or off premises.

2. Community Cloud: The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, or compliance considerations). It may be managed by the organizations, or a third party and it can exist on-premises or off-premises.

3. Public cloud: The cloud infrastructure is provisioned for open use by the public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider.

4. Hybrid cloud: The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

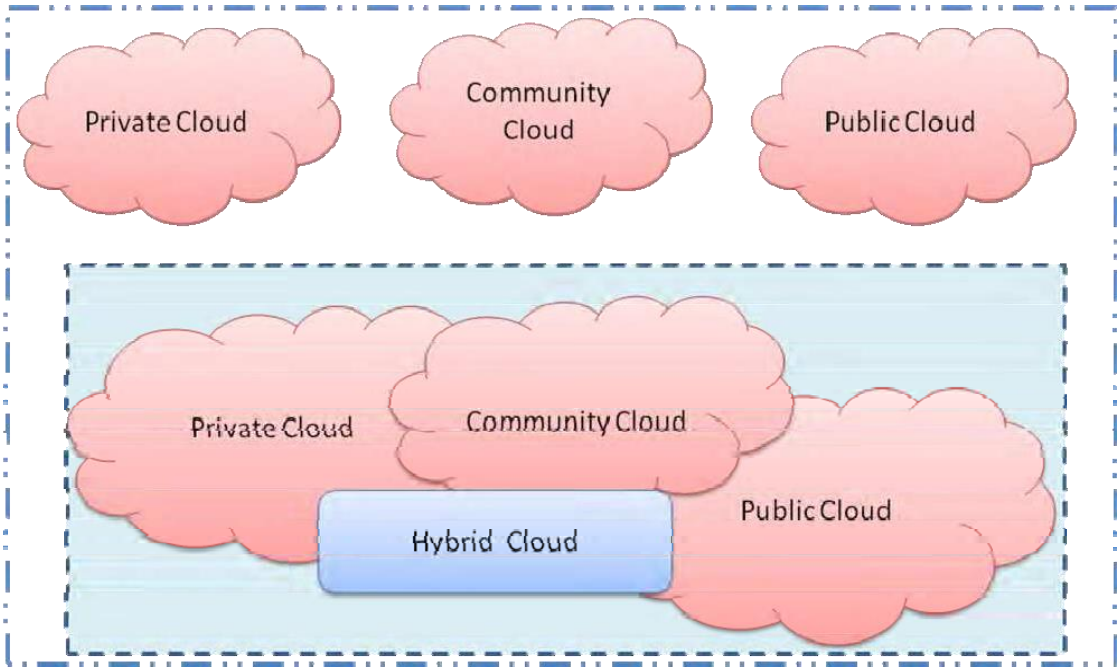

Figure 1: Deployment Models of Cloud Computing

C. Architecture of cloud computing

According to Zhang, Cheng, Boutaba [3] described the architecture of Cloud computing in [3]. According to [3] the architecture of a cloud computing architecture consists of 4 layers: the hardware/datacenter layer, the infrastructure layer, the platform layer, and the application layer. All the layers are loosely coupled with each other, and architectural modular nature provides support to huge line of application requirement and also reduces management and maintenance overhead.

1. The hardware layer: Hardware layer caters the responsibility to manage the physical resources for example servers, routers, switches, power, and cooling systems. In practice, the hardware layer is typically implemented in data centers.[3]

2. The infrastructure layer: this layer is also known as Virtualization layer, it shares physical resources using Virtual technologies such as VMware, XEN and KVM. This layer provides a hub of physical computing and

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storage resources. Dynamic Resource allocation is done this layer only so it is one of critical part of cloud computing.

3. The Platform layer: It falls over infrastructure layer and it consists of operating system and application frameworks.

4. The Application layer: It is the highest layer in Architecture of cloud computing and consists of cloud applications. It provides automatic scaling to boost the performance as well as availability of services besides lowering the cost of operation.

D. Service Models

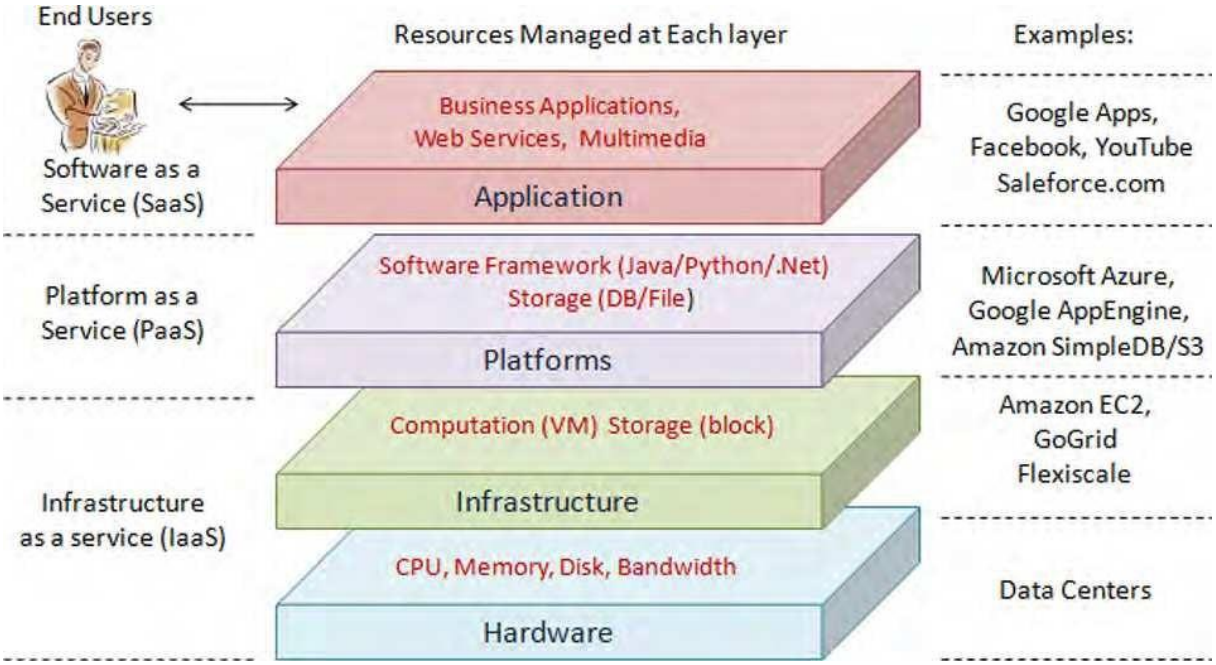

Figure 2: Cloud computing architecture

According to NIST definition [2], there are three types of services in cloud computing. They are software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS). It involves a service driven business model that is all the computing resources are made available as per demand by customer/user.

1. Software as a Service (SaaS): It refers to a service model in which on demand software applications are provided over the internet. Major players in SaaS are Salesforce, SAP, and Rackspace. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, except for limited user specific configuration settings [2].

2. Platform as a Service (PaaS): PaaS refers to providing platform layer resources such as Operating system and development framework. Google App Engine, Force.com and Windows azure are a few examples of PaaS.

3. Infrastructure as a Service (IaaS): It provides capability to consumer to provision on demand processing, storage, networks, and other computing resources via virtual machines. The consumer does not control or manage the cloud infrastructure but has control over operating system, storage, and deployed software applications. [2] Examples of IaaS providers are Amazon (EC2), GoGrid, Rackspace, Softlayer etc.

E. Features of Cloud Computing

Cloud computing offers a wide range of features as compared to the traditional approach of using software and hardware before introduction of cloud computing. Following are the main features of Cloud computing:

- On Demand Services: consumers can provision their requirement and providers can customize the demand as per consumers' requirement. The resources are scalable as per the consumers' needs.
- Resource Pooling: many consumers can access cloud resources that serve other consumers according to

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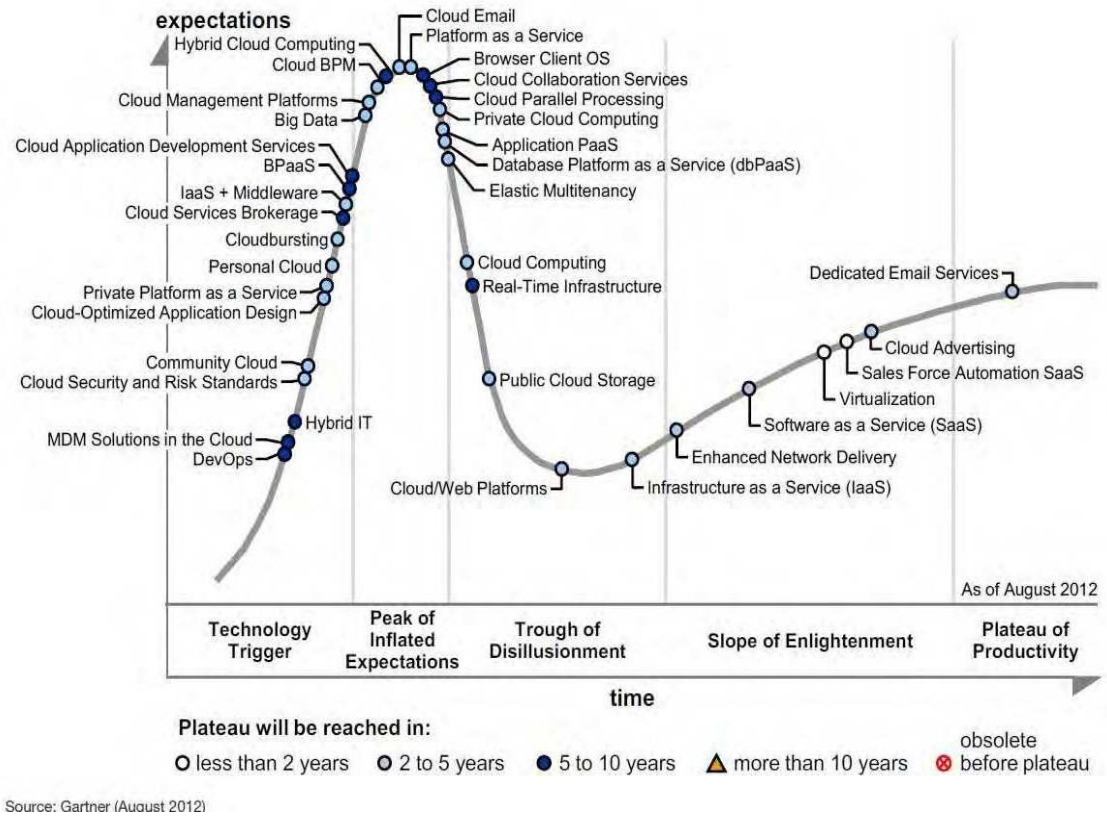
demand.

- Elasticity: Quick Provisioning is offered and scales out or in based on need
- Quality of Service (QoS) - Cloud computing assures quality of service offered to users for hardware efficiency or processor performance, or storage capacity.
- User-Centric Interface – Cloud resources are pervasive in nature and can be accessed anytime and anywhere through the internet.
- Metered or measured service: Pay per usage as like utilities that are paid for by the metered parameters, cloud resources can be optimized and controlled as per highest level of service performance and can be paid as per usage of storage or processing.
- Provides Distributed computing at massive scale.
- Business driven model

III. BENEFITS AND THREATS OF USING CLOUD COMPUTING

Cloud computing is getting the attention of all the leading business players due to its untapped potential of growth and service efficiency. Although, it is also open to threats and challenges in data integrity and leakage from cyber-attacks. According to an article on Forbes.com that talks about analysis of the Gartner Hype Cycle for Cloud Computing, 2012, the best results are being attained by enterprises that focus on a very specific strategy and look to cloud-based technologies to accelerate their performance. Leading with a strategic framework of goals and objectives increases the probability of cloud-based platform success. Those enterprises that look to cloud platforms only for cost reduction miss out on their full potential. [4]



Source: Gartner (August 2012)

Figure 3: Gartner Hype Cycle for Cloud Computing, 2012

A. Trends and statistics in Cloud computing

Following are the latest trends and statistics adopted from [4]:

- The Cloud BPM (bpmPaaS) market is slated to grow 25% year over year, and 40% of companies doing BPM are already using BPM in the cloud.
- Cloud Email is expected to have a 10% adoption rate in enterprises by 2014, down from the 20% Gartner

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had forecasted in previous Hype Cycles. This represents modest growth as the adoption rate of this category had been between 5 and 6% in 2011.

- Big Data will deliver transformational benefits to enterprises within 2 to 5 years, and by 2015 will enable enterprises adopting this technology to outperform competitors by 20% in every available financial metric.
- SaaS is rapidly gaining adoption in enterprises, leading Gartner to forecast more than 50% of enterprises will have some form of SaaS-based application strategy by 2015.
- More than 50% of all virtualization workloads are based on the x86 architecture. This is expected to increase to 75% by 2015. Gartner reports this is a disruptive innovation which is changing the relationship between IT and enterprise where service levels and usage can be tracked.
- Highest Growth rate is observed in Cloud Infrastructure Services as per Gartner reports.

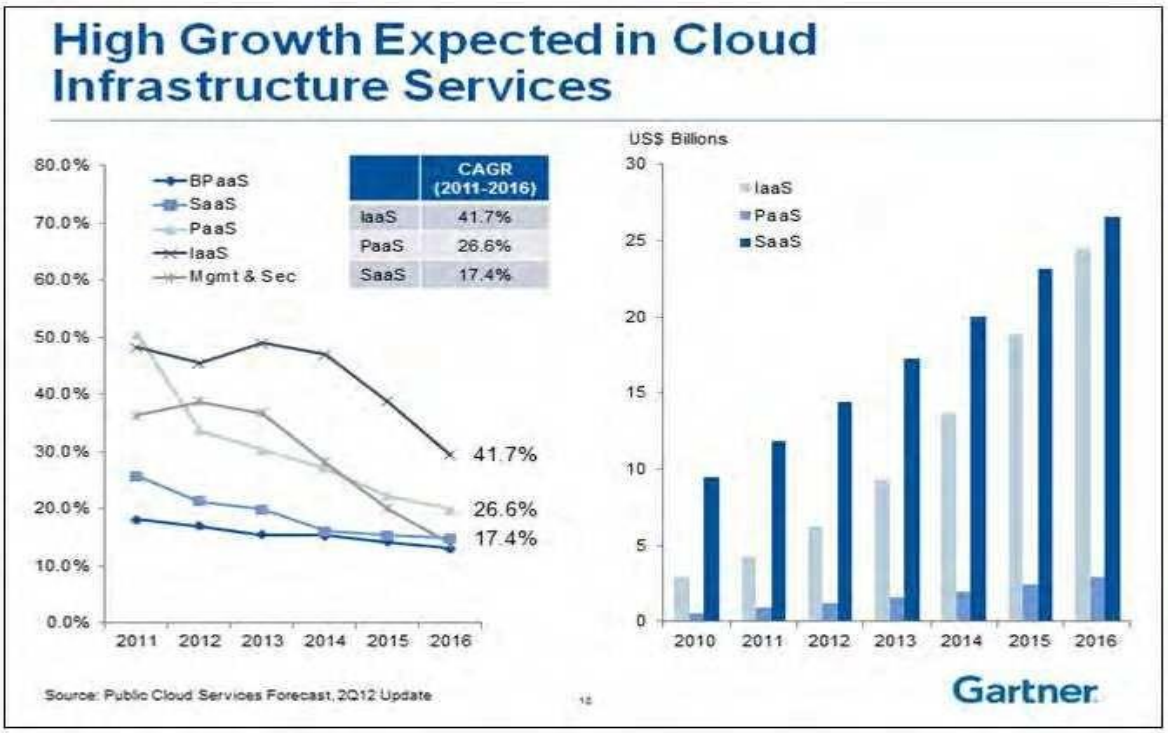

Figure 4: Expected Growth in Cloud Computing

B. Threats and Vulnerabilities in cloud Computing

In recent years, cloud computing has grown from being a gifted logic and potential and business is virtualization concept to one of the fastest growing segments of the IT industry. Now, recession-hit companies are increasingly realizing that simply by tapping into the cloud and gaining fast access to best-of-breed business applications or drastically boost their infrastructure resources, all at negligible cost. However, there are still a number of issues, challenges and implications identified, which are currently addressed by researchers, academicians and BI (business intelligence) practitioners. [5]

Following are the few listed know threats to users of cloud computing:

1. Reliability: Although Cloud computing promises 24 by 7 availability, there can be few hours of outages. The cloud servers also face slowdown and downtime during peak hours of usage. But here the risk goes with sticking to single cloud service provider (CSP), once you are dependent on him, business can suffer if the CSP suffers.

2. Security: Security is a by default issue and top concern for the cloud companies. Users are still open to vulnerabilities and cyber-attacks. It is also an important concern to maintain the company's data integrity located on cloud servers.

3. Privacy: Cloud computing uses the Virtual technology; same datacenters can be used by competition companies and unknowingly data can be leaked and it can be intentional attack as well.

4. Open standard: There is no open standard available in cloud computing. All companies are working on their own standards, so it is difficult for users to switch from one CSP to another.
5. Performance: Users at distant locations can face issues of high latency and delay.
6. Bandwidth cost: Bandwidth cost increases with Data intensive applications.
7. Long Term Feasibility: Users are still in the illusion of what will happen to their data located on cloud servers if the CSP get acquired by larger company or go broken down.
8. Legal Issues: The lack of standardization on charges creates a point of discussion across the border as cloud services may cost higher in some countries while lower in another country.

IV. CONCLUSION

In this paper, there is an attempt made to discuss key concepts of cloud computing, discuss its deployment model, service models and focus on the evolving and untapped potential of cloud computing as IaaS, SaaS, and PaaS. Cloud computing offers infinite growth and at the same time vulnerable to cyber-attacks as well. This paper gives an overview of recent trends and statistics in cloud computing and major threats to the consumers of cloud computing.

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