CLOUD COMPUTING TECHNOLOGY: SERVICES AND OPPORTUNITIES

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ABSTRACT: Cloud computing has emerged as the next big technological breakthrough in the field of computing. In this paper we provide an overview of cloud computing so that the importance of the brand new technology is properly understood. We first discuss the prevalent concepts of cloud computing. We then try to discuss the services of the cloud and its types in order to provide a clearer picture of cloud computing. Then we discuss certain parameters that are essential components of cloud computing and without which a service could not be considered cloud oriented. This way we eventually explain cloud computing in great detail and provide an adequate review of its characteristics and services so that the whole concept of cloud computing is better understood. Cloud computing has been ironically associated with having a cloud of confusion over its true meaning and the common user is often found wanting when it comes to the meaning of the technology itself. This paper helps the reader to understand the whole cloud computing arena, explaining all its major components in detail.

Keywords: *Cloud computing, services of cloud computing, types of cloud computing, characteristics of cloud computing, review of cloud computing.*

INTRODUCTION

Cloud computing is the use of computing resources (hardware and software) that are shared as services over a network (typically the Internet). It is called "Cloud" computing because a cloud-shaped symbol is often used to represent large networks especially the internet. The cloud is in fact a symbol that emphasises the complexity of infrastructure combined in system diagrams. Cloud computing uses remote services to deal with a user's data, software and computation needs and relieves the user of the responsibility of managing these needs. Financially, the main benefit of cloud computing is that customers only use the resources they actually need without caring for peak usage, and only pay for what they actually use without speculating and worrying about the future. Resources are available to be accessed from the cloud at any time, and from any location through the internet. There is no need to worry about how things are being managed at the back end. The users simply purchase the IT service they require as they would any other utility. Because of this, cloud computing has also been referred extensively as utility computing (Bal, 2012). In a computing world where physical resource as well as development platform is increasingly becoming a huge investment for the IT industry, the concept of a highly scalable (Armbrust, 2010) pool of hardware and software resources has emerged as a breath of fresh air. The notion of no upfront commitment by the resource user leading to a pay as you go scenario gives cloud computing a powerful backbone that allows organizations to save a huge amount of investment. The fact that now companies do not necessarily have to pre-emptively buy resources to meet peak usage allows them to only pay for as many resources as they use saving a huge chunk of money for them.

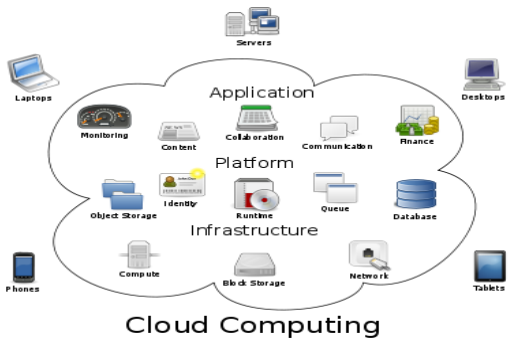

Figure 1 Basic Cloud Computing Architecture

Characteristics of Cloud Computing: Cloud computing is a technology aimed at facilitating convenient network access to a shared collection of configurable computing resources (i.e. networks , servers, physical and virtual storage devices, applications and services) that can be rapidly provided and launched with the least amount of management effort or service-provider interaction (NIST Publications). Following are the necessary requisites for cloud computing. These parameters should be achieved in order to truly deem any service as being cloud-based and without them being manifested the true cloud computing technology would not be implemented. (Dillon, 2010)

On demand self-service: A consumer who needs computing resources instantly at a certain time can be provided with the required resources (such as CPU-time, network storage, software, virtual storage, development platform etc.) in an automatic (i.e. convenient, self-

provisioned and scalable) fashion without having the need of any human being interacting with providers of such resources.

Broad network access: The required computing resources are provided over the network mostly the internet and are used by various clients (applications) that have varied platforms including cell phones and micro-computers typically laptops and PDAs located at the consumer's end. The broad network access provides extreme utility and enhances the scope of the benefits provided by cloud computing.

Resource pooling: Computing resources provided by cloud service providers are pooled (i.e. collected together) in an effort to serve multiple consumers. This is achieved by either using "multi-tenancy" featuring multiple users of the same resources or by virtualization featuring virtual machines representing physical hardware. This is made possible by having different physical resources as well as virtual resources dynamically assigned and reassigned in wake of fluctuating demand of the consumer (Mell, 2009). Economies of scaleand specialization of resources act as the motivational forces behind the concept of a pool oriented computing paradigm. The result of such a collective model is the obscurity of physical computing resources. This means that the resources are hidden from the consumers. The consumers do not have the knowledge of the location, structure, and origins of the resources they are using. For example, consumers are unable to tell the location where their data is supposed to be stored in a particular Cloud. This allows a truly flexible provision of resources to the consumers and hence enables resource pooling without giving away the management structure of the resource provisioning mechanism.

Rapid elasticity: Rapid elasticity ensures that computing resources become scalable rather than absolutely fixed. This means that for the consumers there are no upfront commitments or contracts. The users can scale up resources whenever they want and get rid of them once they are no more in need of them and decide to scale down. Moreover, resource provisioning appears to be infinite to them. This ensures that resource availability can rapidly rise in order to meet peak requirements at any time and can then come down to the daily requirement by releasing resources that are not required.

Measured Service: Computing resources maybe shared by multiple users (i.e. multi-tenancy) in a cloud environment yet the cloud infrastructure can use prescribed mechanisms to measure the use of these resources for individual users. Multiple consumers benefiting from the cloud can be metered individually using the metering methods employing in cloud computing.

Types and services of clouds computing: Cloud computing can be explained according to two categorizations. There are normally two ways of classifying the clouds. One way generates from the different services provided by the clouds while the other originates from the types of the clouds based upon the size and user access mechanisms displayed by the clouds.

Types of cloud: Clouds can be divided into three types based primarily on the size of the network, the number of users and the security of access. They are public clouds, private clouds and hybrid clouds.

Public Clouds: Public clouds describe the traditional meaning of cloud computing technology. They represent scalable, dynamically available, usually virtualized resources shared over the Internet. The offsite third party provider rations resources and bills its customers on the basis of utilization also termed as pay-as-you-go. An example is Think Grid, a company that provides a multitenant architecture for providing services including Software-as-a-Service, Platform-as-a-Service, hosted storage etc. Other popular cloud vendors include Sales-force and Amazon EC2.

Private Cloud: Private cloud is a term used to refer to a computing architecture providing hosted services on private networks. Large companies employ this type of cloud computing to provide in-house services for customers within the organization. The corporate network and data-centre administrators can setup a local cloud for their customers. However, private clouds nullify many of the benefits of cloud computing mainly because organizations need to buy, configure and manage their personal clouds and hence cannot avail the true benefits of cloud computing in terms of a commitment-less flexible availability of resources.

Hybrid Cloud: A hybrid cloud environment combines resources from both internal and external providers and hence has the potential to become the most popular choice for businesses and organizations. For example, a company could choose to use a public cloud service for day to day computing, but would store its business-critical data employing its own data centre. One of the reasons of employing a hybrid cloud may be that organizations of magnitude and repute are likely to have already made heavy investments in the infrastructure required to provide resources in-house. Another reason could be that they may be concerned about the security of public clouds. In fact a major obstacle in the use of public clouds has been the lack of data security (Ryan, 2011) offered by the public clouds and perhaps that is the reason private clouds have emerged as a choice for enterprises.

Virtual private cloud: A specialized type of cloud is the cryptographic cloud storage (Anthes, 2010) introduced by

researchers at Microsoft. This specialized storage solution provides the security rendered by a private cloud while ensuring cost savings inherent of a public cloud.

Services of cloud: While many people differentiate cloud on the basis of three different service models, we believe that all the three basic services of the cloud are hierarchal in a way that one provides the platform for the others. The service models are as follows:

Software as Services (SaaS): In this service model the cloud consumers introduce their respective applications on a hosting environment that can be accessed through various network-based clients by different users. The clients could be web browsers, PDAs, desktops etc. This is the most commonly used service of the cloud but it also is the most misunderstood one and hence a lot of confusion and debate has come forth in relation to this service model.

Figure 2 Software as a Service

Platform as a service (PaaS): Cloud consumers can develop and release their applications on the cloud by using the PaaS provided by the cloud. The developed applications are then available for SaaS users to use. With the platform licenses becoming increasingly expensive and with software development emerging as a huge industry PaaS has become a potentially ground breaking aspect of cloud computing. If harnessed properly this service of the cloud can reap unimaginable benefits in the times to come.

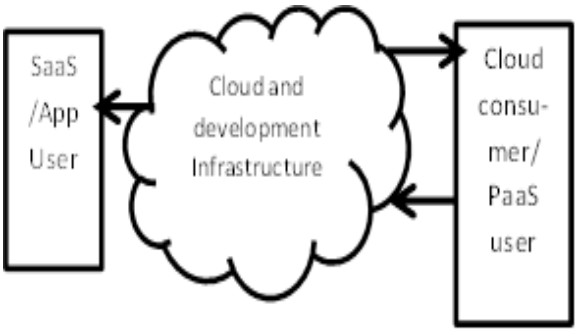

Figure 3 Platform as a service

Infrastructure as a service (IaaS). Cloud consumers in this scenario are direct users of the infrastructure and normally comprise of PaaS or SaaS providers. They use the hardware resources provided by the cloud in form of virtual machines and data centers. This allows them to have high end physical resources without the huge cost associated.

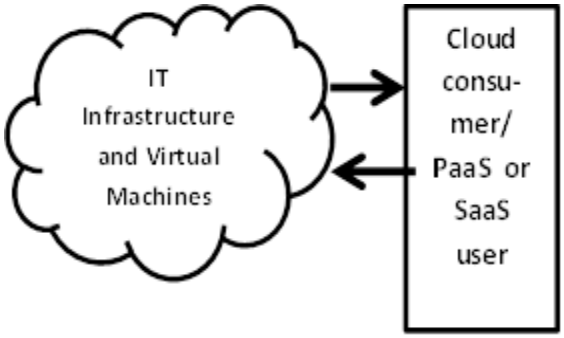

Figure 4 Infrastructure as a Service

The services in a way represent functionality of the cloud in layered structure with infrastructure as a services being the base on which platform-as-a-service rests which in turn provides a base for software as a service.

Having closely studied cloud computing with reference to the services and properties of cloud computing. We have understood the software as a service is often wrongly considered as an example of cloud computing without ensuring if the infrastructure was scalable flexible and was paid for on the basis of usage.

According to our understanding IaaS is essential for the provision of PaaS and only a prerequisite combination of IaaS and PaaS can ensure proper cloud base SaaS. Hence to refer to every SaaS as being cloud-based is not appropriate until a proper analysis of the platform and infrastructure in use is carried out to see if the infrastructure and/or the platform was truly scalable or not.

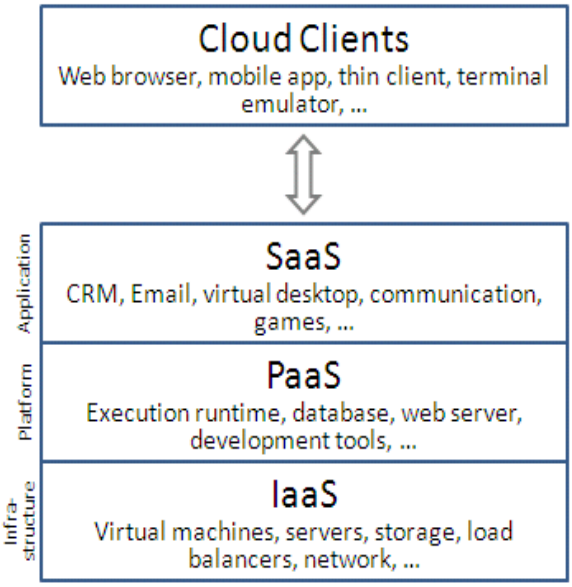

Figure 5 Layered Structure of Services of the clouds

MATERIALS AND METHODS

The nature of this paper is more of review rather than research. The methods employed therefore are more related to collection of data and study of conflicting views over the technology. In wake of the reading material we went through it was clear that there were more than one views about cloud computing and its effectiveness. We came across views ranging from people deeming the technology as the next big thing, to others ridiculing it as a repackaged product offering nothing new. We realized that the only we cloud computing was to be understood properly was to be very strict about what a cloud is and what it can do. It seemed to us during our hunt through material that people were hastily branding every new thing with the name of cloud computing and that in turn resulted in the current confusion about the cloud where the cloud seems to be an all consuming entity encompassing anything and everything in its folds. We as a principal identified that there were particular pre-requisites for a setup to be cloud oriented, namely, the payment structure commonly known as "pay as you go", the flexible resource pool, the concept of a rented, scalable infrastructure, platform and service structure. Our method, thereafter, was simply to stick to what we believed was pure cloud computing and the paper is a reflection of that.

RESULTS AND DISCUSSIONS

As a result of the above laid out overview of cloud computing's service structure and parameters it adheres to we have found that contrary to common belief cloud computing is much more restrictive. A cloud computing structure strongly adheres to IaaS, PaaS and SaaS concepts and these three are stages of a cloud computing environment rather than standalone cloud computing functionalities. What this means is that for a cloud computing environment to exist and function all three have to present simultaneously, otherwise we would achieve a part of the cloud and not the cloud with its complete effectivity.

Conclusion: Cloud computing is definitely the technology of tomorrow. The emergence of public clouds in the past few years has caused a paradigm shift from reliance on heavy physical storage to a concentration on utility computation whereby resources (both hardware and software) are acquired when needed and released when not required. This way the unnecessary wastage of expensive resources has been immensely diminished. With cloud computing providing different types of structures in regards to user access, both private organizations and the general public can benefit from the advantages of this emerging technology. Moreover, the different service models of cloud computing allow different types of users at different layers of the cloud architecture to avail the services rendered by cloud computing.

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