

# **White Paper on “CLOUD COMPUTING”**

## **INDEX**

1. Introduction
2. Features of Cloud Computing
3. Benefits of Cloud computing
4. Service models of Cloud Computing
5. Deployment models of Cloud Computing
6. Examples of Cloud Services
7. Areas of Concern
8. Standardization efforts
9. Conclusion
10. Glossary

# Cloud Computing

## 1. Introduction

Cloud computing can be defined as 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.

The term “cloud”, have its origin from the internet which has its schematic representation as a cloud. Cloud computing, as application or service, is not a new concept as it existed in the form of computer systems remotely time-sharing computing resources and applications. Now, cloud computing refers to the many different types of services and applications being delivered in the internet cloud, and the fact that, in many cases, the devices used to access these services and applications do not require any special applications.

At present companies are using the cloud services concept to offer their services. Examples of a few are given below: e.g.

- **Google** has a private cloud that it uses for delivering many different services to its users, including email access, document applications, text translations, maps, web analytics, and much more.
- **Microsoft** has Microsoft® Sharepoint® online service that allows for content and business intelligence tools to be moved into the cloud and Microsoft currently makes its office applications available in a cloud.
- **Salesforce.com** has its application set for its customers in a cloud, and its Force.com and Vmforce.com products provide developers with platforms to build customized cloud services.

## 2. Features of Cloud Computing

The major feature of cloud computing is that it allows for the sharing and scalable deployment of services, as needed, from almost any location, and for which the

customer can be billed based on actual usage. Some of the basic features or characteristics of cloud computing are given below:

- (i). *On-demand self-service*: A consumer can provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with service provider.
- (ii). *Broad network access*. As the capabilities are available over the network and accessed through standard mechanisms, it can be accessed through heterogeneous thin or thick client platforms. In other words, access to user is available through the internet from a broad range of devices such as PCs, laptops, and mobile devices.
- (iii). *Resource pooling or shared Infrastructure*: The computing resources of service providers are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or data centre). Examples of resources include storage, processing, memory, network bandwidth, and virtual machines.
- (iv). *Rapid elasticity*: Capabilities can be rapidly and elastically provisioned, in general automatically, making a consumer feel that the capabilities available for provisioning are unlimited and can be purchased in any quantity at any time.
- (v). *Measured Service*: Cloud systems automatically control and optimize resource use by leveraging a measuring/metering capability appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported providing transparency for both the provider and consumer of the utilized service.

### 3. Benefits of Cloud computing

The following are some of the possible benefits offered or available in cloud computing based services and applications:

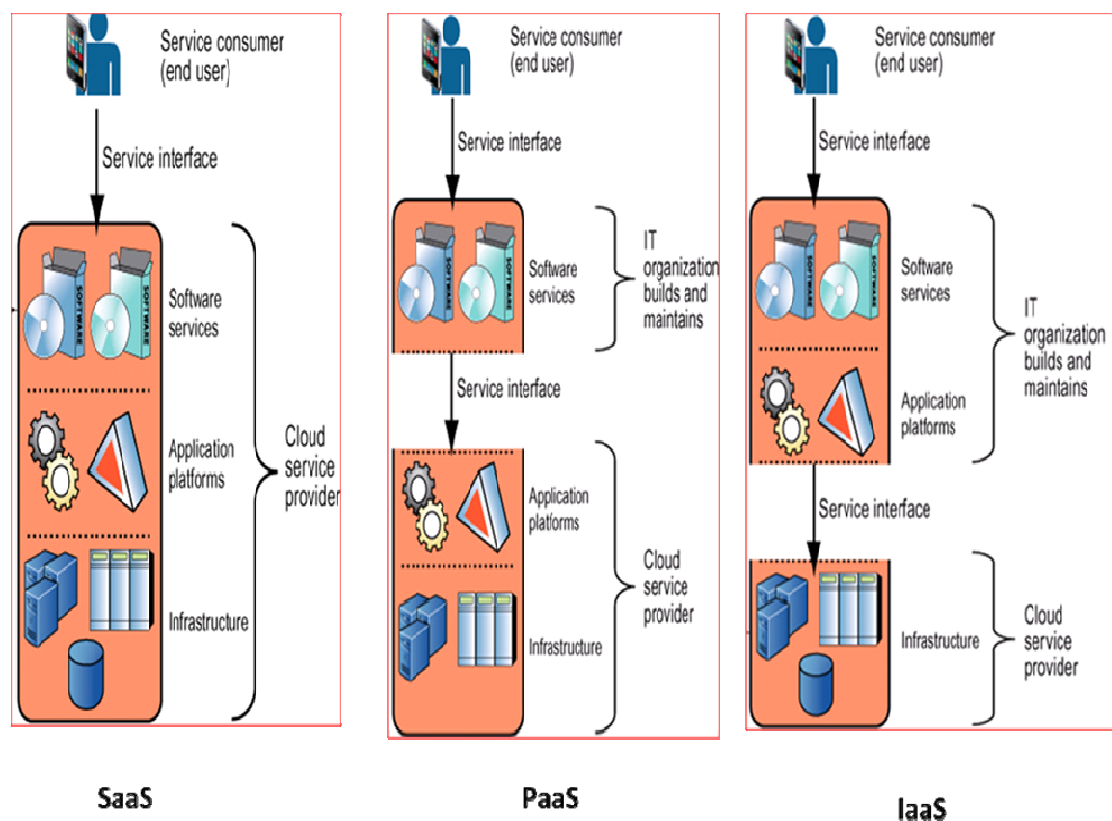
- (i). **Cost Savings:** Cloud computing allows to consumers to reduce their capital expenditures and use operational expenditures for increasing their computing capabilities. It lowers the barrier to entry for new services and also requires fewer in-house IT resources to provide system support.
- (ii). **Scalability/Flexibility:** Companies can start with a small deployment and grow to a large deployment rapidly, and then scale back if necessary. Also, the flexibility of cloud computing allows companies to use extra resources at peak times, enabling them to satisfy consumer demands.
- (iii). **Reliability:** Services using multiple redundant sites can support business continuity and disaster recovery.
- (iv). **Maintenance:** Cloud service providers do the system maintenance, and access is through APIs that do not require application installations onto PCs, thus further reducing maintenance requirements.
- (v). **Mobile Accessible:** Mobile workers have increased productivity due to systems accessible in an infrastructure available from anywhere.

### 4. Service models of Cloud Computing

Cloud Computing services are deployed broadly in three business models viz. SaaS, PaaS and IaaS. A brief of each is given in the following paragraphs and pictorially shown in Figure 1:

- (i). **Software as a Service (SaaS):** In this service model, consumers purchase the ability to access and use an application or service that is

hosted in the cloud. The applications are accessible from various client devices through a thin client interface such as a web browser (e.g., web-based email). The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings. An example of this is Salesforce.com where necessary information for the interaction between the consumer and the service is hosted as part of the service in the cloud.



**Figure 1. Types of Models of Cloud Computing Services**

- (ii). **Platform as a Service (PaaS)** : In this service model the consumers purchase access to the platforms, enabling them to deploy their own software and applications in the cloud. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations. In this there might be constraints as to which applications can be

deployed. *i.e.* consumer can deploy applications created using programming languages and tools supported by the provider.

- (iii). **Infrastructure as a Service (IaaS)** : In this service model the capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly limited control of select networking components (e.g., host firewalls).

## 5. Deployment models of Cloud Computing

Cloud Computing deployment has mainly flowing four deployment models from the point of view of architecture, each with specific characteristics that support the needs of the services and users of the clouds in particular ways :

- (i). **Private Cloud:** The cloud infrastructure is maintained and operated for a specific organization. It may be managed by the organization or a third party and may exist on premise or off premise.

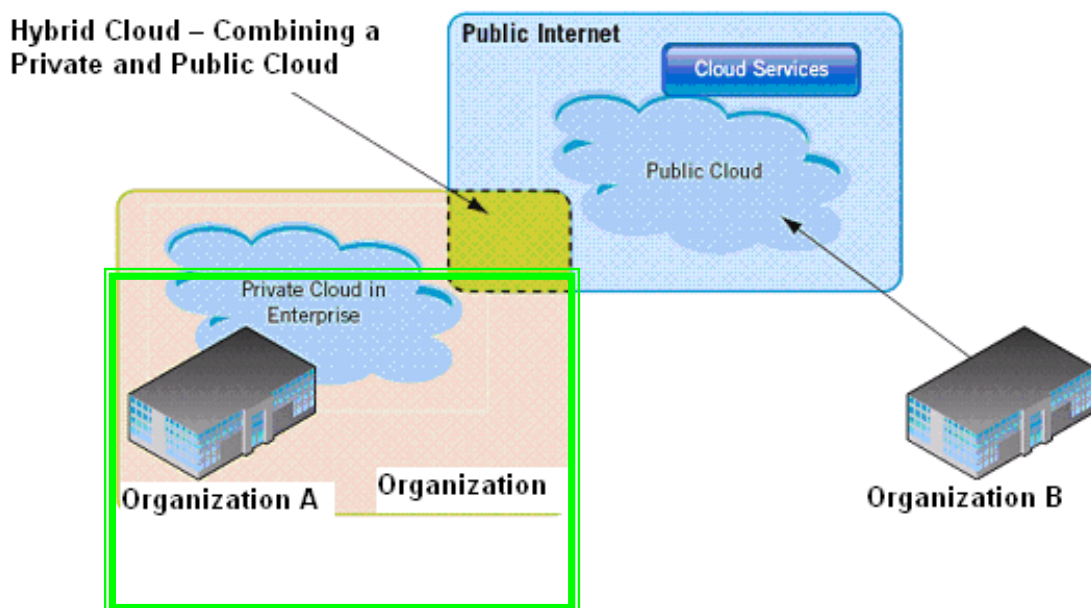


Figure 2: Deployment Models

- (ii). **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, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise.
- (iii). **Public Cloud:** The cloud infrastructure is available to the public on a commercial basis by the cloud service provider. A consumer can develop and deploy a service in the cloud with very little financial outlay compared to the capital expenditure requirements normally associated with other deployment options.
- (iv). **Hybrid Cloud :** The cloud infrastructure is a composition of two or more clouds (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).

While there are different pricing models but the consumption-based models also referred to as “Pay As You Go” (PAYG), are quite popular and measure the resources used to determine charges, e.g.,

- Computing time, measured in machine hours
- Transmissions to and from the data centre, measured in GB
- Storage capacity, measured in GB
- Transactions, measured as application requests

In these types of arrangements, consumers are not tied to monthly subscription rates, or other advance payments; they pay only for what they use.

## 6. Examples of Cloud Services

Some of the examples of cloud computing based services are given below:

- (i). Amazon Web Services (AWS) provide companies of all sizes with an infrastructure platform in the cloud, which includes computational power,

storage, and other infrastructure services. The AWS product range includes EC2 (Elastic Compute Cloud), a web service that provides computing capacity in the cloud, and S3 (Simple Storage Service), a scalable storage for the Internet, that can be used to store and retrieve any amount of data, at any time, from anywhere on the web.

- (ii). Google App Engine is a platform for building and hosting web applications on infrastructure operated by Google. The service is currently in “preview”, allowing developers to sign up for free and to use up to 500MB of persistent storage and enough CPU and bandwidth for about 5 million page views a month.
- (iii). Salesforce.com is a vendor of Customer Relationship Management (CRM) solutions, which it delivers using the software as a service model. CRM solutions include applications for sales, service and support, and marketing. Force.com is a Platform-as-a-Service product of the same vendor that allows external developers to create add-on applications that integrate into the CRM applications and to host them on the vendor’s infrastructure.
- (iv). The Azure Services Platform (Azure) is a cloud services platform hosted in Microsoft data centres, which provides an operating system and a set of developer services that can be used individually or together. After completing its “Community Technology Preview”, the services will be priced and licensed through a consumption-based model.

## 7. Areas of Concern

The following are some of the challenges associated with cloud computing which are being addressed or to be addressed for successful and further deployment of cloud services:

- (i). **Security and Privacy:** Security and privacy involving storing and securing data, and monitoring the use of the cloud by the service providers is one of the main concerns. The security mechanisms between organization and the cloud need to be robust.



- (ii). **Lack of Standards:** Clouds have no standards associated with interfaces and thus it is unlikely that most clouds will be interoperable. The Open Grid Forum is developing an Open Cloud Computing Interface to resolve this issue and the Open Cloud Consortium is working on cloud computing standards and practices. The findings of these groups will need to mature, but it is not known whether they will address the needs of the people deploying the services and the specific interfaces these services need.
- (iii). **Continuously Evolving:** User requirements are continuously evolving, as are the requirements for interfaces, networking, and storage. This means that a “cloud,” especially a public one, does not remain static and is also continuously evolving.
- (iv). **Compliance Concerns** — The Sarbanes-Oxley Act (SOX) in the US and Data Protection directives in the EU are just two among many compliance issues affecting cloud computing, based on the type of data and application for which the cloud is being used. The EU has a legislative backing for data protection across all member states, but in the US data protection is different and can vary from state to state.

## 8. Standardization efforts

Although there are many organizations working on Cloud computing but these are mostly related to software and IT e.g. Cloud Security Alliance (CSA), Open Grid Forum (OGF), Open Cloud Consortium (OCC), Internet Engineering Task Force (IETF), Object Management Group (OMG), etc.

However, from the perspective of telecommunication ITU-T and ETSI has taken some initiatives.

ITU-T has established Focus Group on Cloud Computing (FG Cloud) in May 2010. The Focus Group will, from the standardization view points and within the competences of ITU-T, contribute with the telecommunication aspects, i.e., the transport via telecommunications networks, security aspects of telecommunications, service requirements, etc., in order to support

services/applications of “cloud computing” making use of telecommunication networks; specifically:

- identify potential impacts on standards development and priorities for standards needed to promote and facilitate telecommunication/ICT support for cloud computing
- investigate the need for future study items for fixed and mobile networks in the scope of ITU-T
- analyze which components would benefit most from interoperability and standardization
- familiarize ITU-T and standardization communities with emerging attributes and challenges of telecommunication/ICT support for cloud computing
- analyze the rate of change for cloud computing attributes, functions and features for the purpose of assessing the appropriate timing of standardization of telecommunication/ICT in support of cloud computing

The Focus Group will collaborate with worldwide cloud computing communities (e.g., research institutes, forums, and academia) including other SDOs and consortia.

European Telecommunication Standards Institute (ETSI) has set up ‘Technical Committee (TC) GRID’. The goal of ETSI TC GRID is to address issues associated with the convergence between IT (Information Technology) and Telecommunications. Since TC GRID has particular interest in interoperable solutions in situations which involve contributions from both the IT and Telecom industries, the emphasis is on the Infrastructure as a Service (IaaS) delivery model

## **9. Conclusion**

The application of Cloud computing architecture allows enterprises to achieve more efficient use of their IT hardware and software investments. Pooling

resources into large clouds reduces the costs and increases utilization by delivering resources only for as long as those resources are needed.

While there are many benefits of cloud computing from economies of scale to acceleration of speed to market, there are also some risks or challenges associated with it. Some of these are interoperability of clouds, integration of IT and network resources, testing and deploying applications, SLAs, data protection, privacy, security in clouds, regulatory aspects and software licensing.

Much of the efforts in the area of cloud computing are driven or carried out by forum related to Software & Hardware of IT industries. As there has been not much scope for telecommunication except mainly as a transport network provider, not much initiative was taken by Telecommunications standardization organizations. Now recently ITU-T and ETSI has taken initiatives to identify the role and address standardization in the area of Cloud Computing.

## 10. Glossary

<b>API</b>	Application Program Interface
<b>AWS</b>	Amazon Web Services
<b>CPU</b>	Central Processing Unit
<b>CRM</b>	Customer Relationship Management
<b>CSA</b>	Cloud Security Alliance
<b>EC2</b>	Elastic Compute Cloud
<b>ETSI</b>	European Telecommunications Standards Institute
<b>FG Cloud</b>	Focus Group Cloud
<b>GB</b>	Gigabyte
<b>IaaS</b>	Infrastructure as a Service
<b>ICT</b>	Information and communications technology
<b>IETF</b>	Internet Engineering Task Force
<b>IT</b>	Information technology
<b>ITU-T</b>	International Telecommunications Union- Telecommunication Standardization
<b>OCC</b>	Open Cloud Consortium

<b>OGF</b>	Open Grid Forum
<b>OMG</b>	Object Management Group
<b>PaaS</b>	Platform as a Service
<b>PAYG</b>	Pay As You Go
<b>S3</b>	Simple Storage Service
<b>SaaS</b>	Software as a Service
<b>SDO</b>	Standards Development Organization
<b>SOX</b>	Sarbanes-Oxley Act
<b>TC GRID</b>	Technical Committee GRID

***-END-***