

## Green cloud computing: A survey

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### Abstract

In the IT industry the growing technology that is in demand is Cloud Computing. Cloud Computing is an infrastructure for running HPC, enterprise and Web applications. Huge data centers are used in this industry. The growing demand of Cloud Computing has drastically increased the consumption of energy that is used in data centers and also leads to high carbon emission which is not environment friendly, and that is the most critical issue. Hence, to minimize the impact of e-wastes and harmful gases produced by data centres, on the environment energy-efficient solutions are required. And in order to design such solutions, deep analysis is required of Cloud with respect to their power efficiency. This paper focuses on the elements of Clouds which contribute to the total energy consumption and on security in such a power saving data centres we call them as Green Cloud Computers, and this technology is called as Green Cloud Computing. We have suggested the Virtualization technique for energy saving and security for the Green Cloud.

### 1. Introduction

“Cloud Computing” is a technology used to deliver host services over the Internet. It is also known as on-demand computing and a kind of Internet based computing, where data, shared resources and information are provided to computers and other devices. It consists of a shared pool of configurable computing resources rather than having local servers or personal devices to handle applications that can be accessed on demand.

The term “Cloud” in Cloud Computing is used as metaphor for the “Internet”. Cloud basically consists of a number of machines that are used to store data that can be accessed anytime and anywhere with the help of internet. It is market oriented computing systems that consist of a collection of inter connected and virtualized computers that are provisioned as one unified computing resource. It is a model for enabling on demand network access to a Cloud that is shared pool of configurable computing resources. Cloud computing has now become a highly demanded service as it is having advantages of cheap cost of services, high performance, high computing power, scalability accessibility as well as availability. Cloud Computing is a pay-as-you-go service, that means customers have to pay that much only for what they used. The pricing model can vary

depending on the QoS of application. Customers can exceed their service demand according to their requirement and pay only for the service that they have been added.

The characteristics of Cloud include broad network access, rapid elasticity, on demand self service, and measured service. There are different Cloud models classified on the service and deployment basis. On service basis it can be classified as SaaS (Software-as-a-Service), PaaS (Platform-as-a-Service), IaaS (Infrastructure-as-a-Service). On the basis of deployment it can be categorized as public, private, and hybrid Clouds.

### 2. Cloud Computing Characteristics

There are mainly five characteristics of Cloud computing that are discussed as follows:

**On-demand Capabilities:** The user and the customers can customize the access to their data or their services that are deployed on the Cloud. This can be done through an online control panel. Typically, they are billed on a monthly basis according to their requirements or a pay-for-what-you-use-scenario.

**Broad network access:** The basic advantage that it provides is mobility. The team or individual can access it using their smart phones, laptops, tablets, and office computers. They can use these devices

wherever they are located with the help of a simple online access point.

**Resource pooling:** All the resources and services that are deployed on the cloud are always shared, that means a single resource or service can be accessed by more than one person at the same time, from any location, and at any time.

**Rapid elasticity:** The Cloud is flexible and adjustable enough so that we can add or remove users, services, software resources and other features according to the concerned changes made to the business management.

**Measured Service:** Concerning to the affordable nature of the cloud, we only pay for what we use. Storage levels, processing, bandwidth and number of user accounts that are billed can be measured appropriately. The amount of resources that we may use can be controlled and monitored from both the sides and cloud providers will provide transparency for the same.

### 3. Deployment models of Cloud Computing

Clouds are deployed on physical infrastructure where Cloud middleware is implemented for delivering services to the customers. Infrastructure and middleware differs in their administrative domain, services and user access. Therefore, the Cloud on the basis of deployment can be classified mainly in three types: Public Cloud, Private Cloud and Hybrid Cloud.

**Public Clouds:** It is the most common deployment model that was introduced where services on the Cloud are available to anyone on the Internet. Thousands of servers with high speed network are used in datacenters to support thousands of users. Some common famous public clouds are Amazon Web Services (AWS), Google AppEngine, and Microsoft Azure. A public cloud can offer any of these services: IaaS, PaaS, SaaS. Public cloud offers very good solutions to the customers having small enterprise since it provides a very good option to tackle with the peak loads for an effective capacity planning.

**Private Clouds:** For cutting IT costs, there are many scenarios where organizations many want to maintain their own clouds for their particular needs, for these purpose private clouds are used. Private clouds are deployed within premise of an

organization provides IT services for their internal users. Private clouds services offer better control over the infrastructure for improving security and services because its access is restricted to the internal users of the organization or to one or few organizations. Such private deployments poses limitation to end users application i.e. inability to scale elastically on demand that can be done using public Cloud services. Private Clouds are much securing than public clouds.

**Hybrid clouds:** Hybrid cloud is a combination of both the private clouds and the public clouds. It emerged due to diffusion of both public and private Clouds' advantages. In these organizations outsources non-critical information and processing to the public Cloud, while keeping critical services and data in their control. Therefore, organizations can keep their sensitive information within the premises, and auto-scaling their resources using public Clouds.

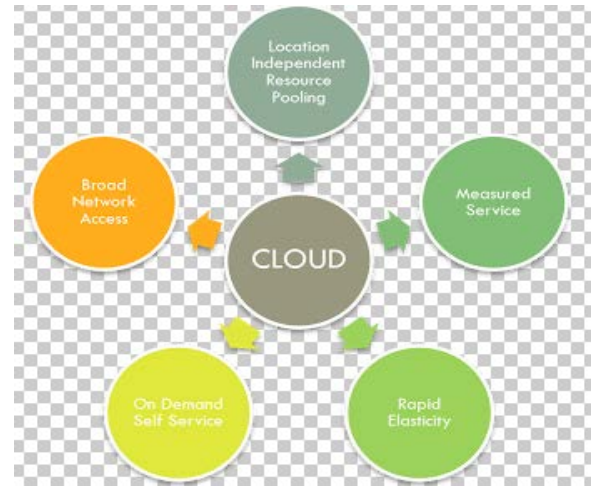


Figure 1:

### Types of Cloud Deployment Models

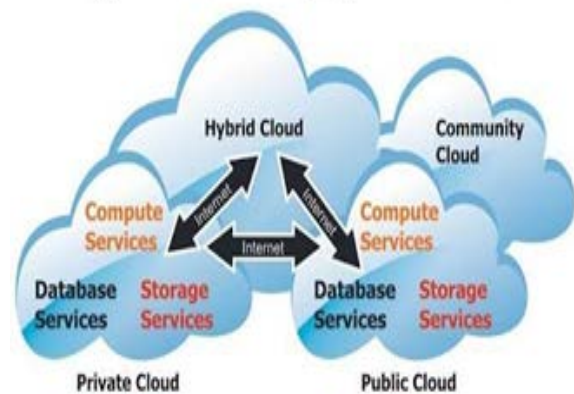


Figure 2:

#### 4. Service models of Cloud Computing

Cloud computing mainly composed of three layers that cover all the computing stack of a system. Each of these layers offers different services to the end users. The lowest layer is Infrastructure-as-a-Service (IaaS) another layer is Platform-as-a-Service (PaaS) and the top layer is Software-as-a-Service (SaaS).

**Infrastructure-as-a-Service (IaaS):** It consists of virtual machines or physical machines, storage, and clusters. It provides an infrastructure to the end users to process services and data and to develop applications. The infrastructure in general is managed by an upper management layer that guarantees to provide runtime environment, virtualization tools, such as hypervisors, application isolation, accounting and quality of service. Depending on the end user requirements, the virtualized infrastructure is pre-configured with programming environment and storage that saves time for users while building their system.

**Platform-as-a-Service:** It offers the Cloud users a development platform to build their applications. PaaS offers only the user level middleware that allows development and deployment of applications on any Cloud infrastructure. Some prominent example of PaaS clouds are Google AppEngine, Aneka, and Microsoft Azure. The essential characteristics that identify a Platform-as-a-Service solution:

- Runtime Framework
- Abstraction
- Cloud Services

**Software-as-a-Service:** It is a software delivery model that provides on-demand access to the applications. In general, SaaS providers also constitute all the layers of Cloud computing and thus maintain the customer data and configure the applications according to the customer requirements. The customers do not need to maintain any infrastructure or install anything within their premises. They just require a high speed network to get instant access to their applications.

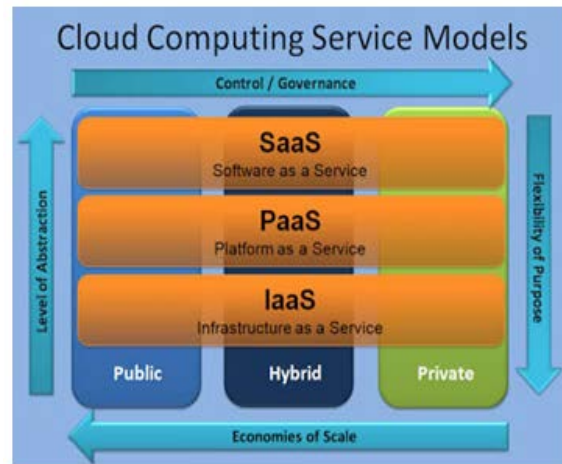


Figure 3:

#### 5. Green Cloud Computing

The term “Green Cloud Computing” refers to the technology that focuses on controlling and reducing the emission of carbon from the huge data centers that are used in Cloud Computing. Cloud Computing allows us to run at high utilization of resources; fewer number of computers can be used that allow us to have higher utilization, saving on environment cost of building those computers. Energy demand in computing is increasing and it gets shifted to cloud computing that is to become green. Due to this increasing demand and development with the energy efficient and environment eco-friendly infrastructure is needed. Privacy and integrity is needed in IT infrastructure. The successful implementation of cloud computing is when it is adopted on a large scale users. Resource management and network between virtual machines (VM) of different users are required.

##### Need of virtualization

Virtualization can be used to make Cloud Computing Green. Virtualization basically refers to the abstraction of computer resources or the processes of two or more operating systems on a single hardware machine. It consists of a system admin to combine physical systems into VM in an energy efficient manner. Virtualization assists in work load distribution and management that gives significantly improved utilization.

The data centers impact on the environment by producing heat and thus, virtualization is used to make the Cloud Computing eco-friendly. Most companies use hypervisors to manage the various aspects of virtualization. The hypervisor has become an ideal delivery mechanism to allow us to show the

same application on lots of different systems. As hypervisors can load multiple operating systems, they are a practical way of getting things virtualized quickly and efficiently.

Cloud Computing may look like Virtualization because it appears that your application is running on a virtual server detached from any reliance or connection to a single physical host. However, Cloud Computing can be better described as a service where Virtualization is part of a physical infrastructure. Cloud Computing builds on top of a virtualized infrastructure using standardization and automated delivery to provide service management. Thus, it makes monitoring of the virtualized resources and the deployment of these resources possible. Virtualization is a necessary for adopting a cloud computing infrastructure.

Virtualization makes easing the administrative burden of deploying, managing, delivering resources, and providing the ability for end users to request and use virtualized resources. Virtualized hypervisor environment and can utilize additional security tools such as intrusion detection systems. However, it is vulnerable because the hypervisor has a single point at which it comes across failure. In case, if the hypervisor gets crashed or the attacker gains control over it or hacks it, then all VMs are under the attacker's control. However, taking control over the hypervisor from the virtual machine level user is difficult, though not impossible.

#### **How Virtualization works in Green Cloud Computing:**

The data center consumes the power as huge as that can be used to power thousands of homes. The environmentalists and computer scientists are working on reducing the huge amount of power used and make data centers more energy-efficient than they currently are.

The virtualization can be the solution for it. It can be used to reduce power consumption by data centers. The main purpose of the virtualization is that to make the most efficient use of available system resources,

including energy. A data center, installing virtual infrastructure allows several operating systems and applications to run on a lesser number of servers, it can help to reduce the overall energy used for the data center and the energy consumed for its cooling. Once the number of servers is reduced, it also means that data center can reduce the building size as well.

#### **6. Conclusion**

Cloud computing in the environmental point of view has been discussed and the concept of Green Cloud Computing is explored. While simply improving the efficiency of equipment, it has lead to a series of discussion whether Cloud Computing is really green. The thing that is important is to make the usage of Cloud Computing more carbon efficient. The concept of virtualization has been introduced to claim the Cloud Computing to be Green.

The electricity demands of clouds are need to reduce, renewable sources should be used in order to make our Cloud Computing environment friendly and admit to be green for better use of Cloud Computing.

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