

# Overview of Green Cloud Computing

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**Abstract:** *Cloud computing is a vital field of information and communication technologies, introducing new summons for environmental protection. Cloud computing technologies have a variety of application domains, since they offer scalability, are trustworthy and reliable, and offer high performance at relatively low cost. The cloud computing revolution is redesigning modern networking, and offering promising environmental protection prospects as well as economic and technological advantages. These technologies have the potential to improve energy efficiency and to reduce carbon footprints and (e-)waste. These features can transform cloud computing into green cloud computing. In this survey, we review the main achievements of green cloud computing. First, an overview of cloud computing is given. Then, recent studies and developments are summarized, and environmental issues are specifically addressed. Finally, future research directions and open problems regarding green cloud computing are presented. This survey is intended to serve as up-to-date guidance for research with respect to green cloud computing.*

**Keywords:** Cloud computing

## I. INTRODUCTION

Sustainability has been gaining importance among software and hardware developers and users in the last two decades, due to the rapid growth in energy consumption. The influence of information and communication technologies (ICTs) on the environment throughout the entire life cycle has been studied, in order to promote green and sustainable developments. These can contribute significantly to the improvement of the current condition of the environment by weakening the negative impacts that have intensified during the last decades. There is a great deal of pressure on producers to fall into line with environmental regulations and to develop products and services that minimize negative influences on the ecosystem.

- Green Cloud computing is used to achieve not only efficient processing and utilization of computing infrastructure, but also minimize energy consumption.
- It is also called as GREEN IT.
- Practice of using computer products efficiently.

## II. SCOPE OF GREEN CLOUD COMPUTING

Software design is important for green cloud computing. Applications can improve energy efficiency and resource management. The communication between software components has to be efficient. The typology has to be dynamic: resources should be automatically added or removed based on server loading. Some of the open problems are: the dynamic allocation of resources and energy, the reduction of execution costs and time of the tasks, and the reduction of energy consumption.

A VM allocation strategy could reduce energy consumption and expenses. The virtualization techniques could be improved by the migration of workload between machines, along with VM migration, between geographically distributed data centres. The workloads could be concentrated in green cloud data centres. Open problems in this case are: balancing the workload between energy efficient data centres, especially to those based on renewable energy; reducing the number of physical servers but increasing the processing power; increasing the VM size while maintaining or reducing energy consumption.

For enabling green cloud data centers, we will understand and analyze the existing data center power and cooling designs, power consumption by the servers and their cooling requirements to achieve maximum efficiency.

**III. CONSTITUTES GREEN CLOUD COMPUTING**

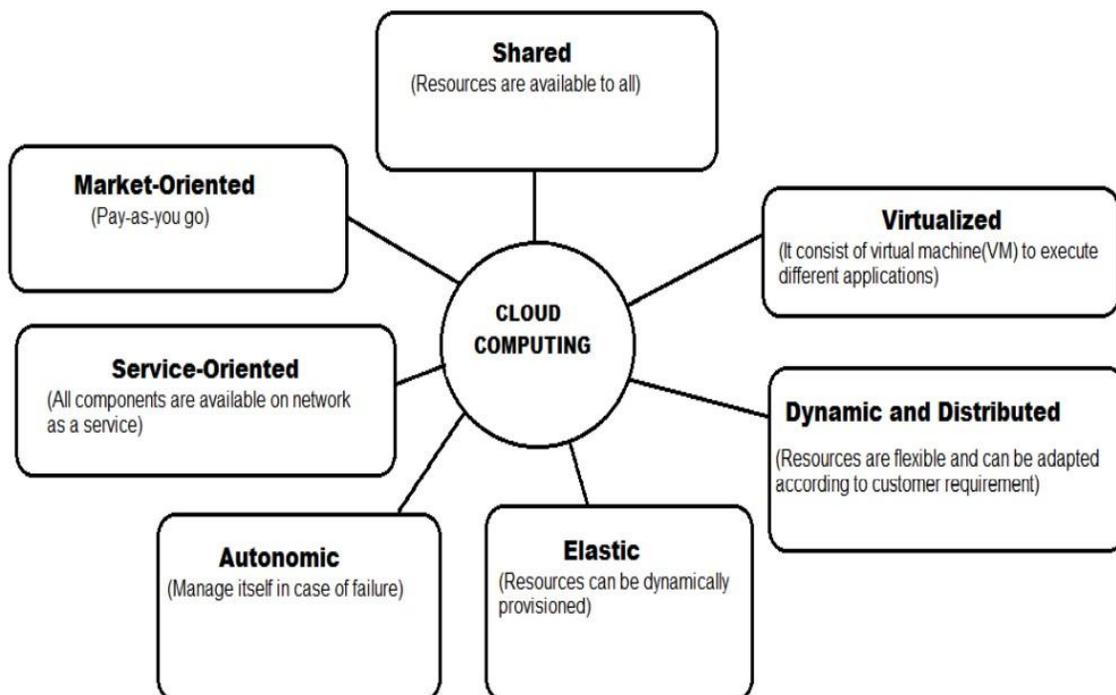
**3.1 Cloud Computing**

A cloud is a distributed computing system consisting of a collection of interconnected and virtualized computers. Cloud is dynamically provisioned and presented as unified computing resources based on service level agreements established through negotiation between the service provider and consumers.

**3.2 Types of Cloud Computing**

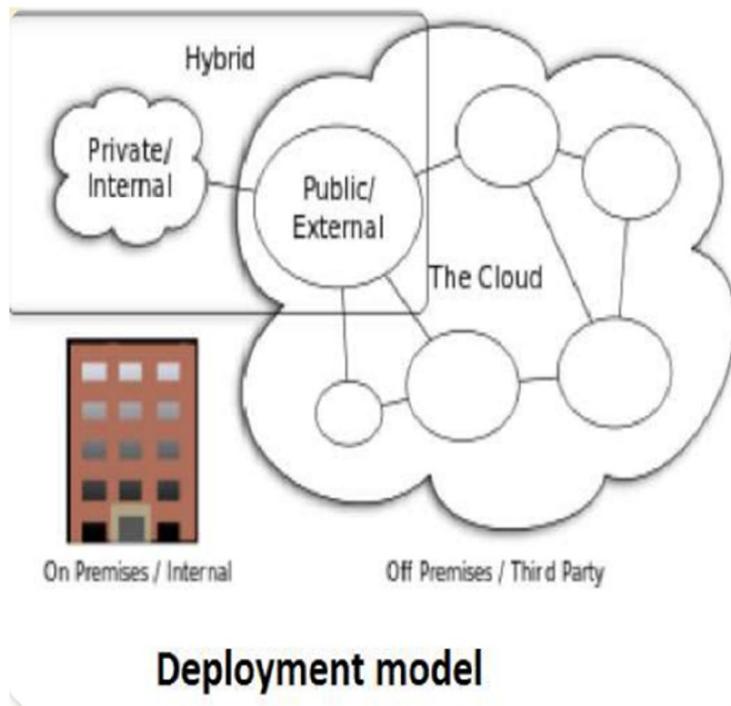
1. Software as a Service (SaaS)
2. Platform as a service (PaaS)
3. Infrastructure as a Service (IaaS)

**3.3 Characteristics of Cloud Computing**



**3.4 Deployment Models of Cloud Computing**

- Public cloud
- Private cloud
- Community cloud
- Hybrid cloud



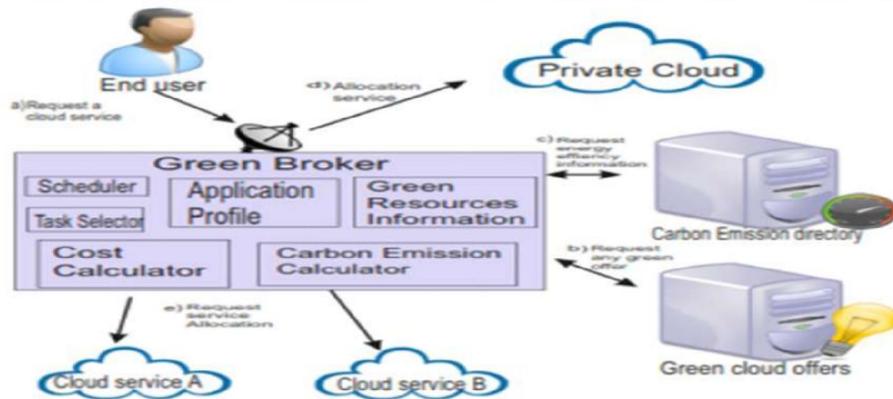
#### IV. GREEN COMPUTING

- Green computing is the study and practice of environmentally sustainable computing or Information Technology.
- The green computing can be achieved by reducing the overall power consumption.
- This can be accomplished by redesigning the infrastructure of network by reducing the number of servers, switches and cables or by applying the different power consumption schemes and patterns.



#### 4.1 Green Cloud Computing

- The concept of Green cloud computing has come after the addition of the advantage of green computing with the cloud computing.
- The green cloud presents a simulation environment for energy aware cloud computing data centers.



#### 4.2 Green Cloud Simulator

The baseline of Green cloud is derived from NS-2 network simulator.

It comes as a pre-confined virtual machine (VM) which works with VMWare player.

This VM contains:

1. A default Ubuntu 12.04 Desktop 32-bit installation, with many extra packages removed.
2. Use of Languages like TCL, TK, OTCL and TclCL to be built from source.
3. NS2 and Green Cloud simulator is installed from source by merging process.
4. It also includes Eclipse IDE with the NS2/Green Cloud project already set up.

#### V. CHALLENGES OF GREEN CLOUD COMPUTING

Research into environmental protection is a challenge, with winners and losers. All efforts are important and could lead to constructive results. The final winner is the entire society and the next generation. Green ICT is very important in this field, and it is seen as solution and problem for the environment. Green cloud computing is an important component of this field. A significant part of research was focused on cloud computing security and on quality of services. This quality has to include both customer satisfaction and meeting the requirement of environmental protection. The design of a green cloud has two types of challenges: technical and non-technical. Some of the technical aspects related to green cloud computing are software design, virtualization techniques, and thermal-aware management techniques.

“Non-technical aspects” refers to standards, internal and international regulations regarding the environment, and the internal policies and strategies of the organization. There are two problems in this case: the international regulations are focused on security issues in the cloud, and the international regulations are different across countries. Some of them have adopted and applied strict environmental protection regulations. Others are very permissive in this field—they either do not have regulations, or do not apply them properly. Another non-technical issue is the cost of green cloud computing. These costs are transferred from the cloud providers to the cloud customers, and providers will increase the price of services. The use of renewable energy is a non-technical issue. The intermittency of this energy is a challenge for cloud computing providers and disrupts the conventional methods for planning operations in the cloud. To ensure that SLAs’ requirements are respected, the use of a mix of energy sources that complement one another is necessary. Some cloud providers have already built data centers in geographical areas where renewable energy sources are available or may become available during the operational stage.

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