# Rudiments of Cloud to Green Cloud: Smartness in Power Redeeming

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**Abstract:** ***A computer ideal is substituting to remote data centres on the basis of pay per use. Data centre management faces the problem of power consumption. Green computing can give power to more energy efficient use of computing power. At last, Green computing is discussed.***

**Keywords**: Cloud Computing, Green Computing, VM management, power efficiency, live migration

## 1. Introduction

Cloud computing has recently revealed technology that is used for hosting and delivering services over the Internet. Figure 1 shows the diagrammatical representation of Cloud Computing.

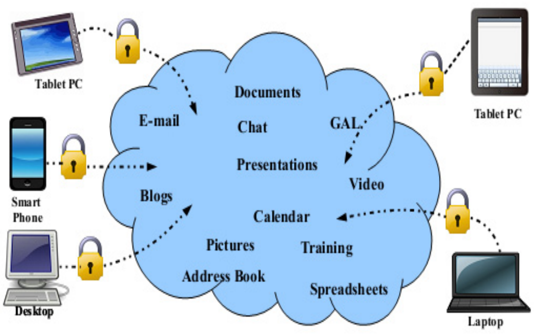


**Figure 1:** Cloud Computing [8]

The definition of cloud computing provided by "The National Institute of Standards and Technology(NIST)",Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction [1].

## 2. Related work

In [2] the author presents that with the advent internet in the 1990s to the present day facilities of ubiquitous computing, the internet has changed the computing world in a drastic way. Cloud computing is a recent trends in IT that moves computing and data away from desktop and portable PCs into large data centers. There is a discussion on architectural design of cloud computing, its applications and issues that are security and privacy with its solutions.

In [3] an author says that cloud computing is becoming an increasingly popular enterprise model in which computing resources are made available on-demand to the user as needed. It provide a comprehensive study on the motivation factors of adopting cloud computing, review the several cloud deployment and service models. There explore certain benefits of cloud computing over traditional IT service environment-including scalability, flexibility, reduced capital and higher resource utilization-are considered as adoption reasons for cloud computing environment. At last, it includes security, privacy, internet dependency and availability as avoidance issues.

In [4] the authors discussed on Cloud Computing that has become a scalable service consumption and delivery platform in the modern IT infrastructure. Cloud Computing is a style of computing which must cater to the following computing needs: Dynamism, Abstraction and Resource Sharing. The architecture, types of cloud, barriers to cloud, and creating an instance in Amazon has been discussed. Besides, the usage of Traditional Enterprise Datacenter Utilization, Virtualized Enterprise Datacenter Utilization and Cloud Enterprise Datacenter Utilization are compared.

In [5] various authors discussed Virtualization as it is a term that refers to the abstraction of computer resources. The purpose of virtual computing environment is to improve resource utilization by providing a unified integrated platform for users and applications based on aggregation of heterogeneous and autonomous resources.

In [11] authors introduces a computer paradigm that is shifted to remote data centers from past few years and the software and hardware services available on the basis of pay for use. Data centre management faces the problem of power consumption. This survey paper shows the requirement of green computing and techniques to save the energy by different approaches.

In [12] authors says Green computing, also called green technology, is the environmentally sustainable to use of computers and related resources like - monitors, printer, storage devices, networking and communication systems - efficiently and effectively with minimal or no impact on the environment.

In [15] author discussed about the pervasive use of cloud computing and the resulting rise in the number of data centers and hosting centers have brought forth many concerns including the electrical energy cost, peak power dissipation, cooling, carbon emission, etc. With power consumption becoming an increasingly important issue for the operation and maintenance of the hosting centers, corporate and business owners are becoming increasingly concerned.

In [21] authors discussed Virtualization Technology has been employed increasingly widely in modern data centers in order to improve its energy efficiency. In particular, the capability of virtual machine (VM) migration brings multiple benefits for such as resources (CPU, memory, et al.) distribution, energy aware consolidation. Results show that the power overhead of migration is much less in the scenario of employing the strategy of consolidation than the regular deployment without using consolidation.

In [28] authors says that survey shows that management techniques tailored to different types of servers and their associated workloads can provide substantial energy savings with little or no performance degradation. In [29] authors presented the today's environmental challenge is global warming, which caused by emission of carbon. The energy crisis brings green computing and green computing needs algorithm and mechanism to be redesigned for energy efficiency. This paper concluded that task consolidation particularly in clouds has become an important approach to streamline resources usage and in turn improve energy efficiency. The result in this study should not have only a direct impact on the reduction of electricity bills of cloud infrastructure providers, but also imply possible savings in other operational cost.

## 3. Data Center Architectures

**Two-tier data center architectures** engage in the structure illustrated in Figure 2. In this architecture, computing Servers (S) physically arranged into racks form the tier-one network. At the tier-two network, Layer-3 (L3) switches provide full mesh connectivity using 10 GE links.

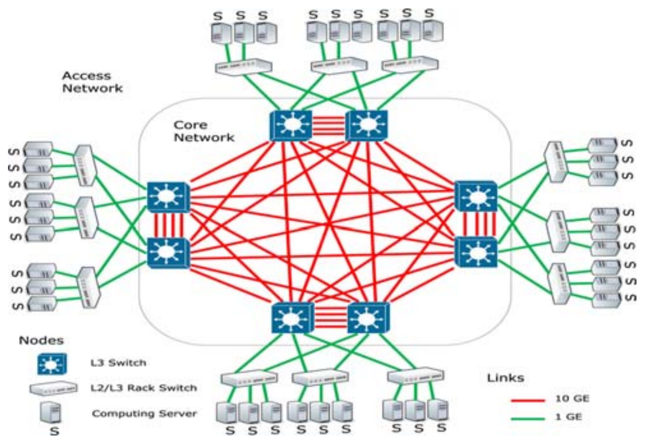


**Figure 2:** Two-tier data center architecture

The two-tier architecture worked well for early data centers with a limited number of computing servers. Depending on the type of switches used in the access network, the two-tier data centers may support up to 5500 nodes[34]. The number of core switches and capacity of the core links defines the maxmum network bandwidth allocated per computing server.

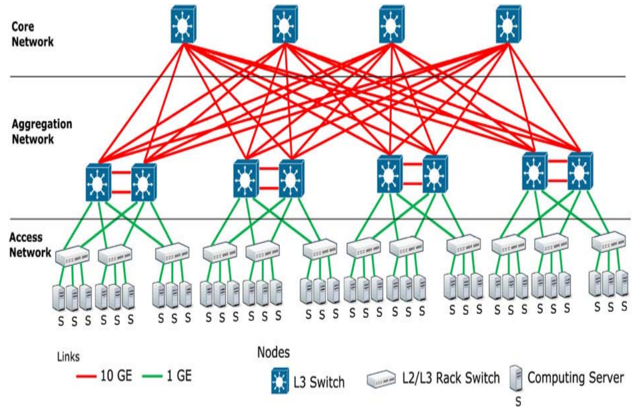


**Figure 3:** Three-tier data center architecture

**Three-tier data center architectures** are the most shared nowadays. They include:(a) access, (b) aggregation, and (c) core layers as presented in Figure 3.

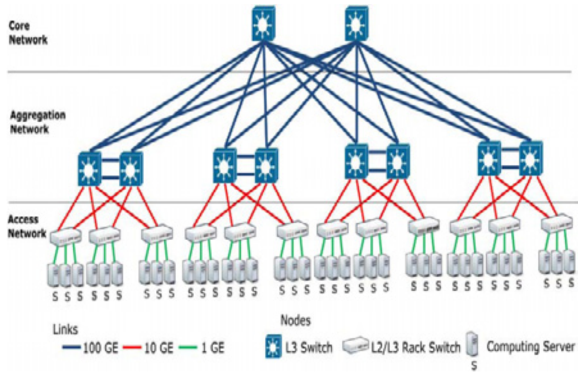


**Figure 4:** Three-tier high-speed data center architecture

The availability of the aggregation layer facilitates the increase in the number of server nodes (to over 10,000 servers) while keeping inexpensive Layer-2 (L2) switches in the access network, which provides a loop-free topology [34].

## 4. Architecture of Green Cloud

GreenCloud is an extension to the network simulator Ns2 which we developed for the study of cloud computing environments. The GreenCloud offers users a detailed fine-grained modeling of the energy consumed by the elements of the data center, such as servers, switches, and links. Moreover, GreenCloud offers a thorough investigation of workload distributions[34].

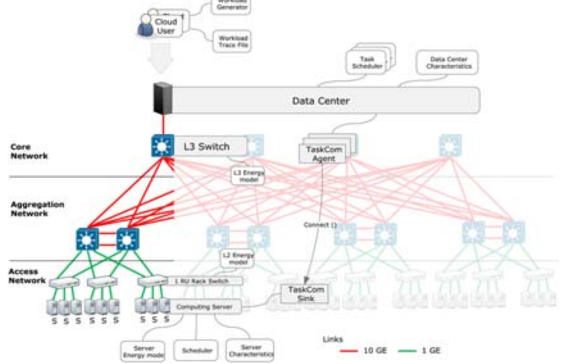


**Figure 5:** Architecture of the GreenCloud simulation environment

Furthermore, a specific focus is devoted on the packet-level simulations of communications in the data center infrastructure, which provide the finest-grain control and is not present in any cloud computing simulation environment. Figure 5 presents the structure of the GreenCloud extension mapped onto the three-tier data center architecture.

Servers (S) are the regularly used of a data center that are responsible for task execution. In GreenCloud, the server components implement single core nodes that have a preset on a processing power limit in MIPS (million instructions per second) or FLOPS (floating point operations per second), associated size of the memory/storage resources, and contain different task scheduling mechanisms ranging from the simple round-robin to the sophisticated DVFS- and DNS-enabled. The servers are arranged into racks with a Top-of-Rack (ToR) switch connecting it to the access part of the network. The power model followed by server components is dependent on the server state and its CPU utilization. As reported in during low load conditions, a huge amount of energy can be saved. an idle server consumes about 66% of energy compared to its fully loaded configuration. This is due to the fact that servers must manage memory modules, disks, I/O resources, and other peripherals in an acceptable state. Then, the power consumption linearly increases with the level of CPU load. As a result, the aforementioned model allows implementation of power saving in a centralized scheduler that can provision the consolidation of workloads in a minimum possible amount of the computing servers. Another option for power management is Dynamic Voltage/Frequency Scaling (DVFS)which introduces a tradeoff between computing performance and the energy consumed by the server. The DVFS is based on the fact that switching power in a chip decreases proportionally to $V^2 \cdot f$, where $V$ is voltage, and $f$ is the switching frequency. Moreover, voltage reduction requires frequency downshift. This implies a cubic relationship from $f$ in the CPU power consumption. Note that server components, such as bus, memory, and disks, do not depend on the CPU frequency.

Therefore, the power consumption of an average server can be expressed as:

$P = P_{\text{fixed}} + P_f \cdot f^3$,

where $P_{\text{fixed}}$ accounts for the portion of the consumed power which does not scale with the operating frequency $f$, while $P_f$ is a frequency dependent CPU power consumption [34].

## 5. Objective of Research

The aim is to reduce the energy consumption by the data centers by performing optimal management of resources so as to keep some of the nodes in the data center groundless during low load conditions in the data centers. There is a possibility of Migrating VM in order to make some of the nodes groundless so that they can be shut down and the energy consumed by these nodes may be perpetuate. The objective of this research is to define an efficient scheduling technique for resource management (preferably an approach) by application of which a machine can accommodate the load of lightly loaded machine as exemplify in the figure 6 and also sympathize which processor can handle which virtual machine.

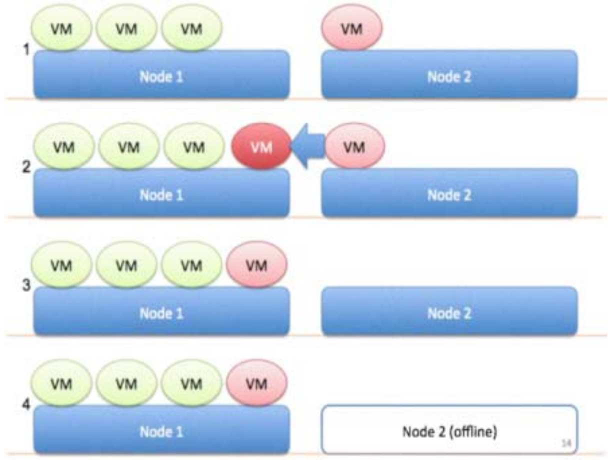


**Figure 6:** Illustration of power savings management [13]

Once a machine is groundless it can be made offline or either shut down. When a large number of machines in a huge data center are shut down during low load conditions, a huge amount of energy can be saved. The proposed work here is to consolidate virtual machines through Live Migration on an optimal number of servers and selectively switch off underutilized servers to reduce data centers power consumption. Some virtual machines leave the processor in a short span of time and some takes more. Moreover, as all knows that CLOUD is very dynamic in nature. So,there is a need to have some time stamps during which the calculations about the free nodes or occupied nodes are to be done and at that time there is a need to migrate the virtual machine to free cores so as to free some processor and save energy.

## 6. Motivation for Research

The data centers consist of thousands of heterogeneous servers that consume lots of power and produce large amounts of heat [13]. Green computing, green IT or ICT Sustainability, is the study and practice of environmentally sustainable computing or IT. There are two competing types of Green scheduling systems for Data centers: Power-aware and Thermal- aware Scheduling.

In thermal-aware scheduling, jobs are scheduled in a manner that minimizes the overall data center temperature. The goal is not always to conserve the energy used to the servers, but instead to reduce the energy needed to operate the data center cooling systems. In power-aware scheduling [33], jobs are scheduled to nodes in such a way to minimize the server's total power. The largest operating cost acquired in a Cloud data center is in operating the servers. So, concentration is put on power-aware scheduling in this research.

There are a number of implicit technologies, services, and infrastructure-level formation that make Cloud computing possible. One of the most important technologies is the use of virtualization. This is performed in the Cloud environment across a large set of servers using a Hypervisor or Virtual Machine Monitor (VMM) which lies in between the hardware and the Operating System (OS). From here, one or more virtualized OSs can be started accordantly leading to one of the key advantages of Cloud computing. Nowadays with the advent of processors having multiple cores like Intel Dual Core and Core 2 Duo, allows for a consolidation of resources within any data center. It is the Cloud provider's job to fully utilize this capability to its maximum possibility while still maintaining a given QoS.

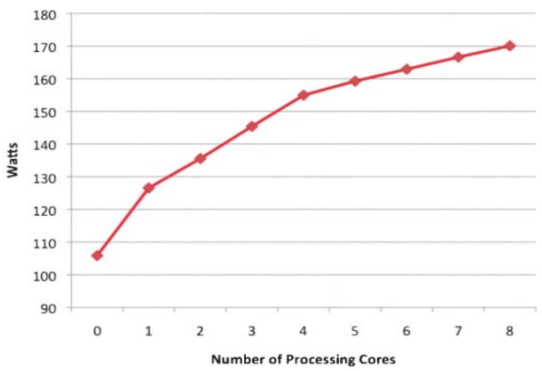


**Figure 7:** Power consumption curve of an Intel Core i7 920 CPU [13]


**Figure 8:** Illustration of power savings [13]

Figure 7 and 8 clarify the motivation behind power-aware VM scheduling. The Intel Core i7 920 CPU has 8 cores. VM can be build upon every single core, so this means we can have 8 VMs running on every core of Intel Core i7 920 CPU. This graph represents the recent research findings regarding watts of energy consumed verses the number of processing cores in use. The power consumption curve embellish that as the number of processing cores increases, the amount of energy used does not increase proportionally. In fact the change in power consumption decreases. When only one processing core is used, the change in power consumption meet with by using another processing core is over 20 watts. The change from 7 processing cores to all 8 processing cores results in an increase of only 3.5 watts. The impact of this finding is considerable [13].

## 7. Approaches to Green Computing

There are three approaches to green computing are discussed as:

a) Clients
End users interact with the clients to manage information related to the cloud [15].

b) Green Data Center
Datacenter is nothing but a collection of servers hosting different applications. A green data center is a data center which has efficient management of the system and associated system less power consumed environment. [11] [15].

c) Distributed Servers

Distributed servers are the parts of a cloud which are present throughout the Internet hosting different applications. [15].

## 8. Virtualization

Virtualization is a term that refers to the abstraction of computer resources. Virtualization means "something which isn't real", but gives all the facilities of a real. It is the software implementation of a computer which will execute different programs like a real machine [6] [11] [15].

<table>
<tr><td>APP1</td><td>APP2</td></tr>
<tr><td>OS1</td><td>OS2</td></tr>
<tr><td colspan="2">Virtualizing software</td></tr>
<tr><td colspan="2">Hardware</td></tr>
</table>

**Figure 9:** Virtual machine

At the very lowest layer is the actual hardware (Server). Above it is the virtualizing software Xen or VMware. The virtual machines capable of supporting a full operating system are known as system virtual machines. The hardware platform on which VM run is known as the host and the operating system running on the VM is known as the guest. The hardware has a specific (Instruction set architecture) ISA. So it can support only those operating systems which are compatible with that particular ISA.

## 9. Green Computing Architecture

The aim of this paper is to addresses the problem of enabling energy-efficiency, hence leading to Green Cloud computing data centers, to satisfy competing demand for computing services and save energy [19].

**a) Consumers/Brokers:** Cloud consumers or their brokers submit service requests from anywhere in the world to the Cloud.

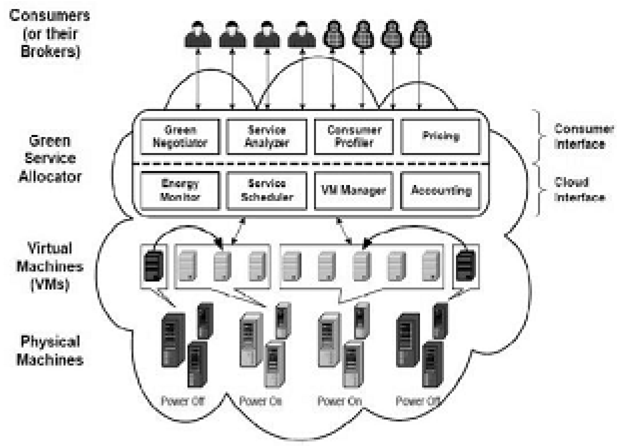


**Figure 10:** Green Cloud Architectural Elements [19]

**b) Green Resource Allocator:** Acts as the interface between the Cloud infrastructure and consumers. It requires the interaction of the following components to support energy-efficient resource management:

- **Green Negotiator:** Negotiates with the consumers/brokers to finalize the SLA with specified prices and penalties (for violations of SLA) between the Cloud provider and consumer depending on the consumer's QoS requirements and energy saving schemes.

- **Service Analyzer**: Interprets and analyses the service requirements of a submitted request before deciding whether to accept or reject it.
- **Energy Monitor**: Observes and determines which physical machines to power on/off.
- **Service Scheduler:** Assigns requests to VMs and also decides when VMs are to be added or removed to meet demand.
- **VM Manager:** Keeps track of the availability of VMs and their resource entitlements.

**c) Virtual Machines** different from physical machines

**d) Physical Machines:** The underlying physical computing servers provide hardware infrastructure for creating virtualized resources to meet service demands.

## 10. Conclusion

The green computing framework and its related approaches and terms are discussed in this paper. The task here is to have some time stamps during which we can make the calculations about the seized nodes and also migrate the virtual machine to free cores so as to free some processor and save energy and also to identify which processor can handle which virtual machine and on what parameters.

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