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Green Cloud: Emerging trends and their Impacts

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Abstract:

Cloud computing is a highly scalable and cost-effective infrastructure for running HPC, enterprise and Web applications. However, the growing demand of Cloud infrastructure has drastically increased the energy consumption of data centers. Data centre hosting cloud computing applications consume huge amounts of energy, thereby contributing to high operational costs and carbon footprints to the environment. With energy shortages and global climate change leading our concerns these days, the power consumption of data centers has become a key issue. Green Cloud can be used to develop novel solutions in monitoring, resource allocation, workload scheduling as well as optimization of communication protocols and network infrastructures. Green cloud is a buzzword that refers to the potential environmental benefits that information technology (IT) services delivered over the Internet can offer society. The term combines the words green meaning environmentally friendly and cloud, the traditional symbol for the Internet .and the shortened name for a type of service delivery model known as cloud computing. Green Cloud can be used to develop novel solutions in monitoring, resource allocation, workload scheduling as well as optimization of communication protocols and network infrastructures. This paper review new trends in green cloud computing and their impact on environment and global warming.

***Key words**: Green Computing, Carbon footprints*

1. INTRODUCTION

Cloud computing platform is got more attention for its reliability, high performance, scalability and high availability. In the social environment in pursuit of low carbon energy, green cloud computing platform is received more attention and research by the industry and academia. Cloud computing needs to become green, which means provisioning cloud service while considering energy consumption under a set of energy consumption criteria, and it is called GCC.[1]

A user simply submits its service request to the cloud service provider with the connection of Internet or wired/wireless networks. The result of the requested service is delivered back to the user in time, whereas the information storage and process, interoperating protocols, service composition, communications and distributed computing, are all smoothly interactive by the networks. In this section, we first introduce the impact of cloud computing on environment and global warming then focus on concept and history of green cloud computing, emerging trends in green cloud computing

1.1 Cloud Computing: Environment & Global Warming

Cloud computing is a paradigm that has the potential to transform and revolutionize the next generation IT industry by making everything available to end-users as a service. Cloud computing delivers infrastructure, platform, and software (applications) as services.[2]

Types of Cloud Computing:

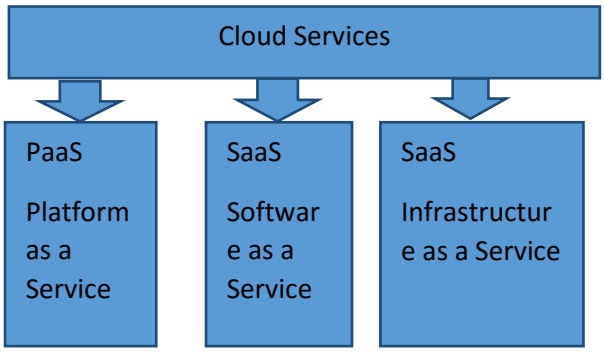

Figure 1: Services of Cloud Computing

Models Of Cloud Computing:

i) Private Cloud: It is deployed, controlled and maintained for a particular organization or a company.

ii) Public Cloud: It is available for commercial basis which allows the users to build up and deploy a service the environment of cloud.

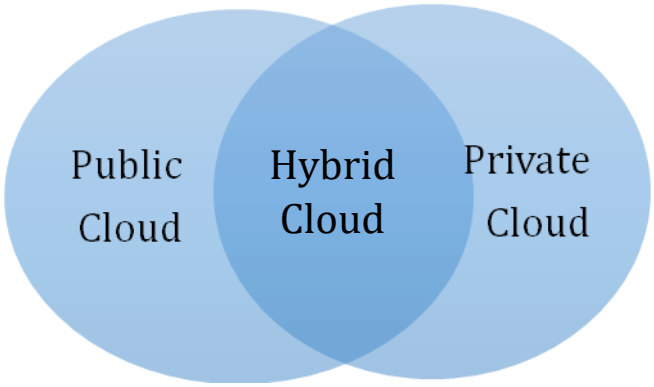

Figure 2: Models of Cloud Computing

iii) Community Cloud: It is utilized by number of organizations which are having common needs and interests.

iv) Hybrid Cloud: It exhibits a number of clouds with different types but having the potentiality through their Hybrid Cloud interfaces to allow and move applications or data between one to another cloud. It can be a combination of two or more clouds.

A recent Berkeley report[3] stated "Cloud Computing, the long-held dream of computing as a utility, has the potential to transform a large part of the IT industry, making software even more attractive as a service"

Many computing service providers, including Microsoft, Yahoo, Google and IBM are rapidly deploying data centers in various locations around the world to deliver Cloud computing services. These data centers host a variety of applications on shared hardware platforms.
A large data center may require many megawatts of electricity, enough to power thousands of Homes. Organizations of large networked systems cannot ignore their energy costs. Besides the expensive maintaining cost, data centers are unfriendly to the environment
Something we are looking here is Green Cloud Computing.

1.2 GREEN CLOUD COMPUTING

History
A recent research by Accenture [3] shows that moving business applications to Cloud can reduce carbon footprint of organizations. According to the report, small businesses saw the most dramatic reduction in emissions – up to 90 percent while using Cloud resources. Large corporations can save at least 30-60 percent in carbon emissions using Cloud applications, and mid-size businesses can save 60-90 percent.
Green Computing is started in 1987, when the report named "Our Common Future is issued by the World Commission. It basically stated the idea about "sustainable development In 1992, one consumer Energy Star plan is launched by the U.S. Environmental Protection Agency (EPA).
Green Cloud computing is growing as a new domain for studying technology and optimizing the process of communication along with resource management to save energy.

Concept

Green Cloud Computing is the blend of energy efficient computing and cloud computing. Cloud computing is the rising technology that uses data centers to maintain the data.The industrial and academic infrastructure is being on cloud system. So, most of the organization and companies heading towards cloud computing to secure their relevant data, this raise to creation of large scale Data Centers. But, Data centers consumes enormous amount of electrical power. As the computing infrastructure consumes excess amount of power which results in emission of carbon dioxide (CO_2) and this leads to affects our environment.

With cloud computing platform developing, regional energy crisis, which is caused by high energy consumption of platform, will make development of green cloud computing technology[4].

In the technical way, the Green Computing can have 2 aspects:

(i) For software technology the purpose is to create such methods that can enhance the efficiency of program, storage and energy.

While (ii) In hardware aspect there is need of such technologies which can not only minimize the consumption of energy but also make it economically efficient with the help of recycling.

The gcc[4] is developing metrics to measure data center productivity as well as efficiency metrics for all major power consuming subsystems in the data center.

In 2007, gcc proposed the use of power usage effectiveness (PUE) and its reciprocal, data center efficiency (DCE) metrics, which enable data center operators to quickly estimate the energy efficiency of their data centers, compare the results against other data centers, and determine if any energy efficiency improvements need to be made.

1.3 GREEN CLOUD ARCHITECTURE:

In the Green Cloud architecture, users submit their Cloud service requests through a new middleware Green Broker that manages the selection of the greenest Cloud provider to serve the user's request. A user service request can be of three types i.e., software, platform or infrastructure. The Cloud providers can register their services to a public directory which is accessed by Green Broker. The green offers consist of green services, pricing and time when it should be accessed for least carbon emission. Green Broker gets the current status of energy parameters for using various Cloud services from Carbon Emission Directory.

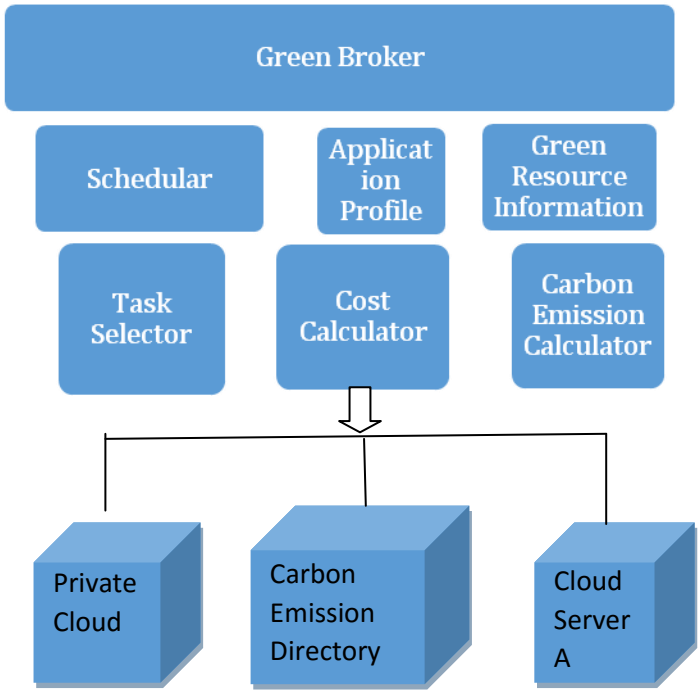

Figure 3: Architecture of Cloud Computing

The Carbon Emission Directory maintains all the data related to energy efficiency of Cloud service. This data may include PUE and cooling efficiency of Cloud datacenter which is providing the service, the network cost and carbon emission rate of electricity, Green Broker calculates the carbon emission of all the Cloud providers who are offering the requested Cloud service. Then, it selects the set of services that will result in least carbon emission and buy these services on behalf users.[5]

Table 1.Comparison of significant Cloud Datacenters[7]

Cloud data centers	Location	Estimated power usage Effectiveness	% of Dirty Energy Generation	% of Renewable Electricity
Google	Lenoir	1.22	50.5% Coal, 38.7% Nuclear	3.8%
Apple	Apple, NC	1.21	50.5% Coal, 38.7% Nuclear	3.8%
Micro-soft	Chicago, IL		72.8% Coal, 22.3% Nuclear	1.1%
Yahoo	La vista, NE	1.16	73.1% Coal, 14.6% Nuclear	7%

2. EMERGING TRENDS IN GREEN CLOUD COMPUTING

So far there are three approaches have been tried out to make cloud computing environments more environmental friendly in the data centers under experimental conditions. The practical applications of these methods are still under study and methods are:-

2.1 DYNAMIC VOLTAGE FREQUENCY SCALING TECHNIQUE

Dynamic voltage and frequency scaling (DVFS) is a commonly-used power-management technique where the clock frequency of a processor is decreased to allow a corresponding reduction in the supply voltage. This reduces power consumption, which can lead to significant reduction in the energy required for a computation, particularly for memory-bound workloads.

2.2 RESOURCE ALLOCATION OR VIRTUAL MACHINE MIGRATION TECHNIQUES

A useful feature provided by Virtual Machine (VM) technologies is the ability to migrate running OS instances across distinct physical nodes. Migration is the ability to move a VM from one physical server to another. This capability is being increasingly utilized in today's enterprise environments to provide efficient online system maintenance, reconfiguration, load balancing and proactive fault tolerance. They provide desirable features to meet requirements of computing resources in modern computing systems, including server consolidation, performance isolation and ease of management. As a result, many implementations are available which support the feature using disparate functionality

Virtualization is the current technology by which we can adopt energy efficient operations in data centers [6]. Virtualization allows multiple operating systems to be executed simultaneously on the same physical machine. Virtualization and the dynamic migration of virtual machines allow Cloud Computing to make the most efficient use of the currently available physical resources.

2.3 THE COMPUTATIONAL FLUID DYNAMICS (CFD) models may be the most elaborate thermal aware schedule algorithms for tasks in data centers, they presents a detailed three dimensional CFD-based thermal modeling tool, called ThermoStat, for rack-mounted server systems

There are other more examples such as sensor-based fast thermal evaluation model , Generic Algorithm & Quadratic Programming and the Weatherman – an automated online predictive thermal mapping .

Some steps can be followed to achieve green cloud computing.

- Design control schemes for sharing
- computing resources
- Analyse the system model for computing labs
- Sharing limited resources

3. CONCLUSION

As the prevalence of computing still continues to rise, the need for power saving mechanisms and reducing CO2 footprints is increasing.
Overall, this paper presents a new idea of evaluation of green cloud computing platform. These policies also enable us to cut down data centre energy costs, thus leading to a strong, competitive cloud computing industry. End users will also benefit from the decreased energy bills. In this study it is also observed that to sustain the natural resource, to provide green and cost efficiency, reduce carbon emissions, Virtualization resource migration is required.

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