Green Cloud Computing: Carbon Emission Impact And Energy Efficiency

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Abstract: This paper compares between cloud computing and GCC. It points out the various pros and cons between the two and provide survey for the energy efficiency methods. This paper focuses on the use of the recently developed green cloud computing (GCC) in reducing the carbon emission induced in the environment by the ever-increasing usage of data centers and their increasing numbers. This paper also introduces the variety of the energy efficient methods that are made possible via GCC.

Keywords: GCC, Energy Efficiency, Carbon Emission

I. INTRODUCTION

"Cloud Computing is a phenomenon of mass optimization of resources in a virtual pool that can even avert massive disasters" - Norman Borlaug

Cloud computing is a way for issuing information technology (IT) services in which resources are recovered from the Internet through web-based application types and services, as opposed to a direct connection to a server. Rather than keeping files on a proprietary hard drive or local storage device in a physical manner, cloud-based storage makes it possible to save them to a virtual and far-off database. As long as an electronic device has access to the web and internet, it can access the data and all the software programs to run it. The various types of clouds available are:

1) **Public Cloud:** Type of computing in which the service provider allows the public to access the freely available resources via. Internet.
2) **Private Cloud:** Model of cloud computing that imbibes a distinct and secure cloud based environment in which only the involved client can operate.
3) **Hybrid Cloud:** It is an integrated cloud service that applies the principles of both, the private and public clouds to conduct distinct functions within an organization.

SPI Model

a) **Software-as-a-Service:** It is a cloud computing technology that allows vendors to provide software and resources remotely or virtually over the internet with implementation of web based services.
b) **Platform-as-a-Service:** It enables us to share the platform (basis) on which the software and resources can be implemented on. This platform would be shared amongst the users with the help of Internet.
c) **Infrastructure-as-a-Service**: It is the method of sharing the infrastructure among the users. By infrastructure, we mean like sharing hardware, storage media, networking hardware etc.

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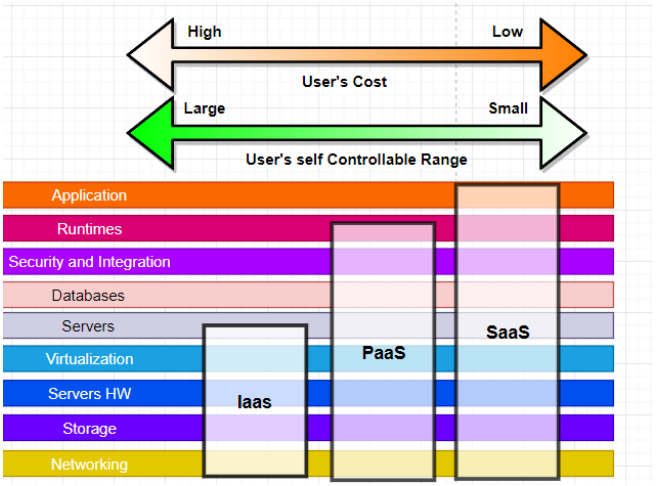

Fig. 1. *SPI Model*

II. LITERATURE REVIEW

A. What is Green Cloud Computing?

Green Cloud is the term that is used to define the potential environmental perks that information technology (IT) services which are issued virtually over the Internet offered to the society. The term constitutes two parts: green which symbolizes environment co-operative and cloud which indicates the Internet and virtual resource pooling. [1]

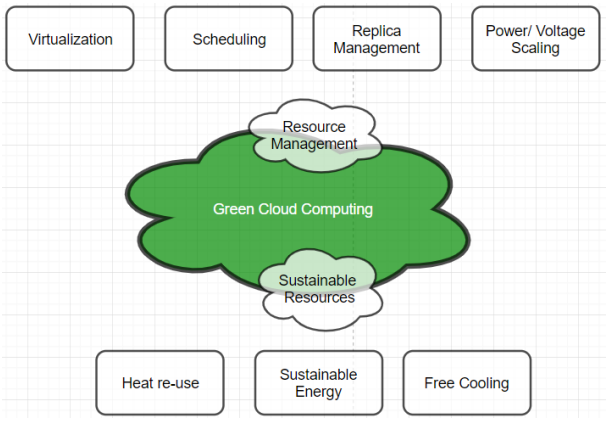

Fig. 2. *Green Cloud Computing*

Green Cloud Computing is a development and proposal of new computing models that are used to make the IT

resources more energy efficient both in terms of cost and power. While using the IT resources there can be number of key areas that should be taken care of.

B. Why is Green Computing Required?

Data centers, used for managing, processing and storage of data, though was a great technical leap but with the booming industry, the need for these data centers have also increased. These data centers, due to their high processing needs release high amount of heat that needs to be continuously cooled. This extensive cooling system require a huge amount of power and energy. This particular obstacle was removed via cloud computing. All the data resources can be virtually pooled and kept at a remote data center.

Total Data Set	289 Data Centers which have Reported the data
Total Annual Electricity Consumption	3,735,735 MWh
Average DC floor area	2616 m^2
Average rated IT load	1956 kW
Average annual power consumption	13,684 MWh
Average annual IT consumption	7871 MWh
Average PUE	1.80

Fig. 3. *Data Center*

C. Carbon Emission Impact on Environment

Carbon Footprint is the measure of the amount of greenhouse gases, also constituting carbon dioxide (CO_2) caused by several basic activities such as construction of data center, driving a vehicle or powering a utility plant. The measurement includes power generation, transmission and distribution losses incurred during delivery of the electricity to its point of usage CO_2, commonly known to contribute most to the planetary greenhouse effect, making up to 76% of the greenhouse gases in the atmosphere. In terms of an overall data center lifecycle perspective, the general term “carbon emission” includes CO_2 emitted during the manufacturing stage of all the components that constitute a data center (UPS, servers, building shell, cooling). The three primary factors that affect the carbon footprint of a data center are:

i. Location
ii. IT Load
iii. Electrical Efficiency

I. Location: The geographic position of a data center also matters. For example, if the data center is located near any power plant or electricity generation unit, then due to its proximity, the transmission energy required is less, thus it would have a lower carbon footprint.

II. IT Load: IT load plays an directly proportional relation to the carbon footprint. When the IT load increases, the need for processing power increases, then the need for energy and in turn electricity also rises.This causes increase in the generation of CO_2.

III. Electrical Efficiency: Electrical Efficiency can be dependent upon several factors ranging from design of a data center, server design, level of redundancy, capactiy and IT load to use of emerging technology to reduce load such as UPS,chillers, economizers etc.

Materials- Building Shell 5700 ft^2	*Tonnes of CO_2*	*Percentage of Total*
Foundation (Concrete)	4.7	4%
Flooring (Concrete Slab , Insulation)	39.9	31%
Ceiling(Plaster Board)	2.3	2%
Structure (Steel Beams)	15.4	12%
External Walls(Bricks, Insulation)	32.1	25%
Internal Walls(Wood Frame and Plasterboard)	8.7	7%
Stairs(Concrete)	1.1	1%
Windows (Glass and Frame)	0.59	0.4%
Internal Doors(Particle Board)	-0.4	-0.3%
External Doors (Plastic)	0.6	0.5%
Roof(Wood, Concrete,Insulation)	23.4	18%
Total	128.3	100%

Table1: *Emission of CO2*

D. Electrical Carbon Emission

Energy related carbon dioxide emissions account for 60% of the global carbon dioxide emissions. The utility, which generates various form of raw power and convert into electricity, is rarely one monolithic entity. Electricity generation is considered one of the three main sources of greenhouse gas emissions in the world. One of the major challenges faced when trying to reduce a data center’s electrical consumption is to link data center activities to its electricity usage. Production of electricity leads to higher generation of CO_2 in the atmosphere.

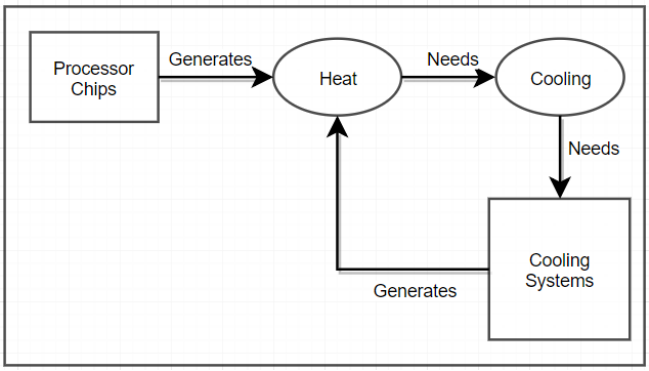

Fig. 4. *Electricity Need*

III. ADVANTAGES AND DISADVANTAGES

According to case study done by Google in 2013, if organizations switched their common and generally used software programs to cloud based services, then total energy consumption can be reduced by 87%. Data Centers require constant cooling system to avoid over-heating and also for their disposure. One of the biggest advantages about green cloud computing is the ability for their employees to work from anyplace at any time from any device. It allows remote workers thus reducing fuel consumption, number of cars and real estate footprint. The cloud computing also enables us to reduce paper wastage by uploading all the data onto the web. Green computing reduces the need for physical documents, contracts and legal documents. But cloud computing does tend to pose some disadvantages that can be prove it a dangerous move. The cloud computing has a variety of security issues such as malware practices, cyber crime and also is hackable if not properly protected. Also, latency issues also provide a problem to cloud computing.

IV. PROPOSED SOLUTION

Through this paper, several problems were reviewed and the proposed solution is to place the data center in a remote and naturally cool place to reduce the cost of cooling. Also, to reduce the cost by shifting most of the work to virtually cloud centers.

CONCLUSION

In this review paper, the fact emerges that with the technological advancement, rises the need for processing abilities thus increasing the number of data centers. This leads to a disastrous amount of greenhouse gases in the atmosphere, impacting it in a negative way. Cloud computing offers a lucrative way of reducing the carbon impact by storing the resources virtually in a remote database.

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