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Green Cloud Computing and Environmental Sustainability

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Abstract: *Cloud computing and green computing are actually complementary to each other. Both of these advance computing gradients have an important role in technological advancement and transformation. Cloud computing is a kind of network grid in which network and communication technology plays an important role in complete virtualization of information technological infrastructure. On the other hand, green computing is nothing but reusing of information technological product. In green computing, recycling can play an important role. Cloud computing and virtualization is an important method of green computing, which make less use of computers, products, and energy. We also discuss the main challenges and issues of these technologies in India scenario. High energy consumption not only translates to high operational cost, which reduces the profit margin of Cloud providers but also leads to high carbon emissions which are not environmentally friendly. Hence, energy-efficient solutions are needed to minimize the influence of Cloud computing on the environment. In order to design such solutions, deep analysis of Cloud is required with respect to their power efficiency. Although data centers storing applications of cloud computing consumes very large amounts of energy, granting to high operational costs of products and carbon footprints to the environment that makes non-friendly. The area of Green computing is also becoming tremendously an important role in a world with the limited use of energy resources and an ever-rising pressure for more computational power. Therefore, we now require green cloud computing results that not only saves energy but also reduces operational costs, makes high productivity and makes eco-friendly.*

Keywords: *Cloud Computing, Green computing, Green Technology, Material Recycling, Energy Management*

I. Introduction

Cloud computing is a form for enabling appropriate and on-demand network right to make use of a shared pool of supplying configurable computing resources that can be quickly provisioned and released with minimal management effort or service provider interaction. Cloud computing is a tremendously growing "Internet-Based Computing" which provides the different users to host their data on the web using cloud services technology. Cloud computing is a delivery model that allows users to connect to the server and use hardware, software and other resources.[1] In cloud technology, the software and resources will be shared on the remote servers. The client can access the resources from the server with a high-speed internet connection. Cloud computing provides reliable and user-friendly services like Infrastructure as a service (IAAS), Platform as a Service (PAAS) and Software as a service (SAAS) as a subscription-based services.

II. Literature Review

In this paper, green computing goals, objectives, approaches and the uses are explained initially [1]. In this paper, by applying green computing how it enhancing environmental sustainability is explained briefly [2]. In this paper, reducing the energy consumption by using the green technology was illustrated as Computers have toxin metals and pollutants that can emit The best practices and strategies should aim at reduction of usage of non conventional resources, by reducing usage of paper and recycling of old machineries and systems in order to nullify e-wastes from organizations.[3]. In this paper, Owing to global warming, various regulations and laws related to environmental norms forces manufacturers of I.T equipments to meet various energy requirements. Green computing is a well balanced and sustainable approach towards the achievement of a greener, healthier and safer environment without compromising technological needs of the current and future generations are referenced [5]. In this paper, Typically data centers account for 25% of total corporate IT budgets and their costs are expected to continue to increase as the number of servers rise and the cost of electricity increases faster than revenues. One study indicated that the cost of running data centers is increasing 20% per year on average and the high and increasing use of electricity makes data centers an important source of greenhouse gases. For information-intensive organizations, data centers can account for over 50% of the total corporate carbon footprint [6].

III. Models Of Cloud Computing

Cloud Computing:

The major objective of cloud computing is "to maximize the shared resources and at the same time and the demerits are its high infrastructure cost and unnecessary power consumption." Global warming became a major threat to the environment, with high power consumption and CO2 emission. The Deployment models of the cloud include Public Cloud, Private Cloud, Hybrid Cloud, Community cloud.

Public Cloud: A public cloud is one in which the services and infrastructure are provided off-site over the internet. Service providers use the internet to make resources, such as applications (SaaS) and storage that are available to the public on a "public cloud". Amazon Web Services (AWS) Microsoft Azure and Google Cloud Platform (GCP) are all examples of public cloud service providers.[18]

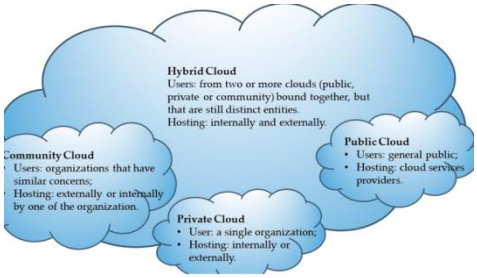

Figure 1.1 Models of Cloud

Public Clouds provide the best economical merit and are the very least expensive to set-up since it offers a pay-per-usage model and the only costs sustains are based on scope used. In addition, the cloud provider covers hardware, application and bandwidth costs.

Private Cloud: A private cloud is one in which the services and infrastructure are maintained on a private network. The goal of a private cloud is not providing Software as a Service like public cloud providers, but rather, in advance the benefits of cloud architecture while maintaining control of your own data center. Private clouds can be somewhat pricey and are generally not the finest option for the average small to medium-sized business. Organizations usually decide to go with a private cloud because they have security options and agreement concerns. However, the public cloud is just as secure.

Hybrid Cloud: A hybrid cloud model contains a variety of public and private options with multiple service providers. This allows companies to continue control of an internally managed private cloud and rely on the public cloud as needed. The disadvantage of using a hybrid cloud is that you have to keep tracking of multiple security platforms. Hybrid cloud mechanism works best if your company desires to use a Software as a Service model but also requires a private cloud for additional security purpose. From each of the organization's point of view, public cloud, private cloud, and hybrid clouds will all.

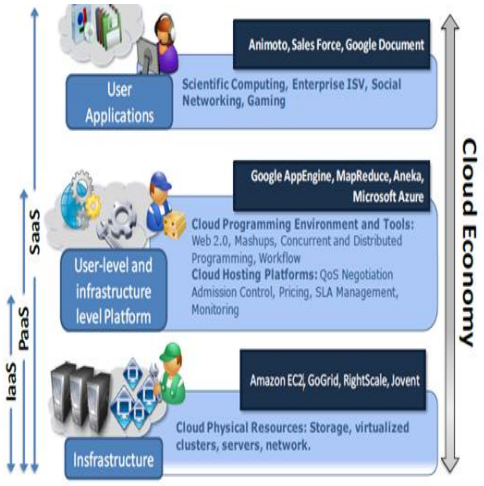

Figure 1.2 Cloud Architecture

IV. Role Of Cloud Computing

Cloud Computing play an important role in the creation of virtual world and virtualization through the information technological designing and development. The major benefits of cloud computing include:

i. Greater efficiencies in information activities.
ii. Reduction of Information Technological cost.
iii. Hassle-free deployment of database and software.
iv. Hassle-free deployment and maintenance of user database.
v. Better collaboration and cooperation among the entities and section of the organization.
vi. Cloud Computing gives us easily available IT solutions.
vii. To save money and human resource- directly and indirectly.
viii. It creates green computing infrastructure.
ix. It requires less hardware and software.

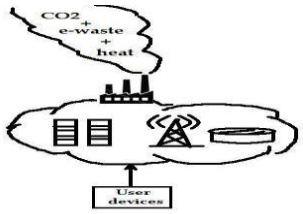

Figure 1.3 Dark Face of Cloud

V. Green Computing

Green cloud computing is the term which is mainly used to reduce energy consumption and improve the efficient use of resources in cloud computing. Nowadays, Data centers and IT industry use cloud computing where the user can access the application as a service from anywhere in the world. Cloud computing refers to the delivery of services including applications, resources, and data over the Internet on demand[3]. Green IT embraces the measurements of environmental sustainability, the economics of energy efficiency, and the total cost of ownership. It is the study and practice of using computing resources iciently. As per the survey conducted by EPA-US Environmental Protection Agency on Global Greenhouse Gas Emissions, 65% of carbon dioxide is generated by fossil fuel and industrial processes whereas industry alone produces 21% of Greenhouse gas which primarily involves fossil fuels burned on-site at facilities for energy. Electricity production by the burning of coal, natural gas, and oil for electricity contributes 25% of global greenhouse gas emissions which is supplied to these industries that generates heat and which is the largest single source of global greenhouse gas emissions[2]. The extensive consumption of energy in IT industry is one of the main root causes of current global warming. In this situation, need to save energy have become a topmost priority in almost all segments of the IT market.

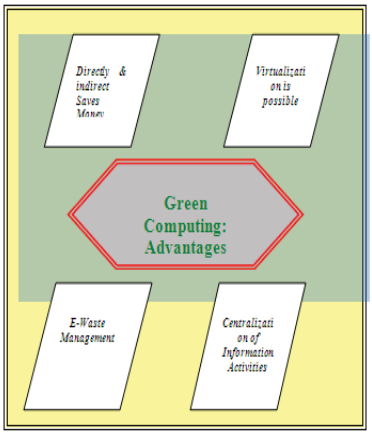

Figure 1.4 Merits of Green Computing

VI. Need Of Green Computing

The main approaches of Green Computing like virtualization, Power management, Material cycling, and telecommuting gives various importances to the organizations. Data center facilities are heavy consumers of energy, accounting for between 1.1% and 1.5% of the world's total energy use in 2010 [1]. The U.S.

Department of Energy estimates the amount of those data center facilities consumed up to 100 to 200 times more energy than standard office buildings that takes energy. Designing energy efficient and environmentally sound components, computers, servers and cooling equipment. Manufacturing electronic components, computers and other associated subsystems with minimal impact or no impact on the environment. The main requirement of Green Computing includes,

- The better algorithm helps to save energy, thus it helps in power management.
- As virtualization helps to use IT infrastructure through remote places; so indirectly it helps in Energy management with less component uses.
- It helps in the recycling process and helps to solve the main problems of unused computers.
- The centralization of computing infrastructure is possible through this.
- It keeps theeco-friendly atmosphere.
- It helps to make use of hexavalent and chromium-free IT infrastructure

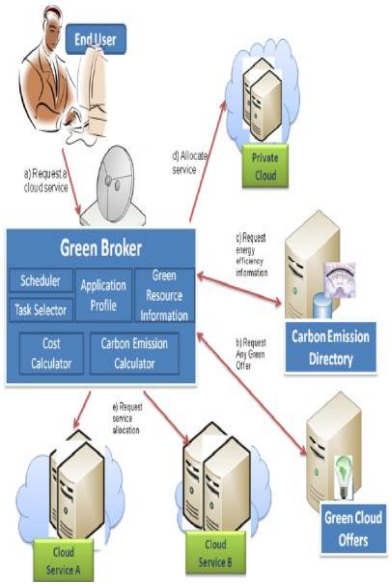

Figure 1.5 Green - Cloud Architecture

VII. Features Of Clouds Enabling Green Computing

1. Dynamic Provisioning: In traditional setting of architecture, data centers and private infrastructure are used to be maintained to fulfill worst case demand. Thus, IT companies end up deploying far more infrastructure than needed. There are various reasons available for such over-provisioning feature: a) The dynamic provisioning is very difficult to predict the demand at a time; this is particularly true for Web applications and b) to guarantee the availability of services and to maintain the certain level of service quality to end users. Cloud providers gradually monitor and predicting the demand and thus allocate the resources according to the demand. Those applications that require the less number of resources can be consolidated on the same server. Thus, datacenters tremendously maintain backup servers according to current demand, which gives results in low energy consumption than the conservative approach of over-provisioning.

2. Multi-tenancy**:**Using the multi-tenancy approach, Cloud computing infrastructure service reducing the overall energy usages and associated material of carbon emissions. The SaaS providers serve multiple companies on same infrastructure and software. This type of approach is clearly more energy efficient than multiple copies of software installed on different infrastructure. The smaller variation in demand results in better prediction and final output in greater energy savings.

3. Server Utilization**:**In wide-ranging, on-premise infrastructure run with the very low power utilization, sometimes it goes down up to 5 to 10 percent of average unit utilization. Using virtualization technologies, multiple applications can be hosted and executed on the same server in isolation, thus lead to utilization levels up to 70%. Thus, it significantly lowers the number of active servers. Although higher utilization of servers always results in more unit of power consumption, a server running at higher utilization can process more workload with similar power usage.

4. Datacenter Efficiency**:**As already discussed with the features, the power efficiency of data centers has a large impact on the total energy usage of Cloud computing service. By using the most energy-efficient technologies, Cloud providers can appreciably improve the PUE of their datacenters. Today's state-of-the-art data center

designs for large Cloud service providers can achieve PUE levels as low as 1.1 to 1.2, which is about 40% more power efficiency than the traditional datacenters [9]. The server level of design is in the form of modular containers, water or air-based cooling, or advanced high power management through power supply optimization, is all approaches that have significantly improved PUE approach in data centers. Additionally, Cloud computing allows services to be moved between the multiple datacenters which are running with more better PUE values. This is finally achieved by using high-speed networking, the virtualized basis of services and measurement, and monitoring and accounting of datacenter.

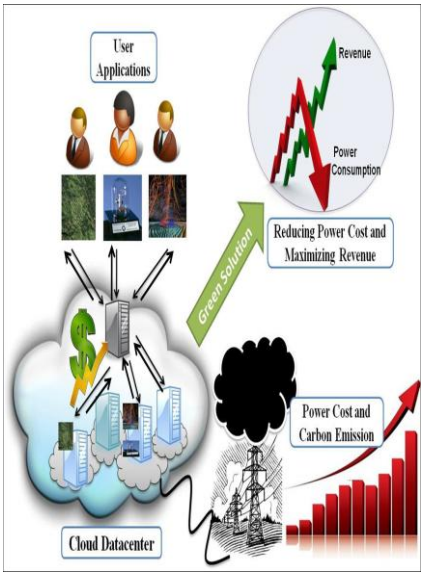

Figure 1.6 Green Solution to Cloud

Energy Efficiency:

The most commonly used metric to determine the energy efficiency of a data center is Power Usage Effectiveness (PUE). This simple ratio is the total power entering in the data center divided by the power used by the IT equipment. Power used by the support the equipment, always referred to as overhead loading, mainly consists of cooling systems, power delivery, and other facility infrastructure like lighting.

$$\mathbf{PUE} = \frac{\boldsymbol{Total\ Facility\ Power}}{\mathbf{IT\ Equipment\ Power}}$$

There are mainly four categories of areas where cloud computing have advantages over power efficiency:

1. Diversity: Spreading computing loads across many users and time zones can improve hardware utilization.
2. Economies of Scale: Computation is large shop than small shop, as fixed costs can be spread over more servers and users.
3. Flexibility: The management of the virtual servers in cloud applications is very easier and cheaper in price than managing physical servers. It also has reliability advantage that can create savings in the data center. If you can void outages using software to route around problems, you don't need to buy two power supplies for each server.
4. Enabling Structural Change: The shifting to a cloud model enables wide broader efficiencies in a business class that can save money over the time.

VIII. Features Of Clouds Enabling Green Computing

Cloud Computing and Green computing both are today synonymous to Information Technology advancement and advancement of the society. We have several challenges and need to overcome these problems by the awareness programs and financial assistance. There are some problems that occur and disadvantages in both the computing technology methods; we need to keep in mind these methods for the healthy information society.As the occurrence of Cloud computing continues to rise, the need for power saving mechanisms within the Cloud also gets increases. This paper presents an outline framework of Green Cloud for improving and ensuring system efficiency in a data center. To demonstrate the potential of the framework, presented new energy efficient scheduling. Though in this paper, we have found out new types ways to save the vast amounts of energy while minimally impacting performance. Not only the discussed components in this paper complementing each other, they leave space for future work. Future opportunities couldexplore a scheduling

system that is both power-awareness and thermal-awareness to maximise the energy savings both from physical servers and the cooling systems used. Such a schedule should also drive the requirement for better data center designs, both in server placements within the racks and closed loop cooling systems integrated into each rack. While a various number of the Cloud techniques are discussed in this paper, there is a growing need for improvements in Cloud infrastructure, both in the academic sector and commercial sectors.

References

[1]. http://en.wikipedia.org/wiki/ Green _computing
[2]. Murugesan, San. "Harnessing green IT: Principles and practices." IT professional 10.1 (2008): 24-33.
[3]. Mishra, Sushree. "GREEN COMPUTING." Science Horizon (2013): 21.
[4]. Donnellan, Brian, Charles Sheridan, and Edward Curry. "A capability maturity framework for sustainable information and communication technology." IT professional 13.1 (2011): 33-40. [5] www.cdproject.net
[5]. Harmon, Robert R., and Nora Auseklis. "Sustainable IT services: Assessing the impact of green computing practices." Management of Engineering & Technology, 2009. PICMET 2009. Portland International Conference on. IEEE, 2009.
[6]. Chaudhary, S., Murala, D., P. and Shrivastava, V. K. (2011). Green Database. Global Journal of Business Management and Information Technology. 1(2), 105-111.
[7]. Drouant, N., Rondeau, É., Georges, J. P. and Lepage, F. (2014). Designing green network architectures using the ten commandments for a mature ecosystem.
[8]. Computer Communications, 42(2014) , 8– 46. Gholami, R., Sulaiman, A., Ramayah, and Molla, A. (2013). Senior managers' perception on green information systems (IS) adoption and environmental performance: Results from a field survey. Information & Management, 50(2013), 431–438,
[9]. Vecchiola, C., Chu, X. and Buyya, R. 2009. Aneka: A Software Platform for .NET-based Cloud Computing. In High Performance & Large Scale computing, Advances in Parallel Computing, ed. W. Gentzsch, L. Grandinetti and G. Joubert, IOS Press.
[10]. Mitchell, R. L. "Power pinch in the data center." ComputerWorld (2007).
[11]. Foley, J. "Google in Oregon: Mother Nature meets the data center." InformationWeek's Google Weblog (2007).
[12]. Zareba, A. Multifunctional and Multiscale Aspects of Green Infrastructure in Contemporary Research. Probl. Sustain. Dev. 2014, 9, 149–156.
[13]. E. S. Iyer and R. K. Kashyap, "Consumer recycling: Role of incentives, information, and social class," Journal of Consumer Behaviour, vol. 6, pp. 32-47, 2007.
[14]. A. T. Ngo, G. E. West, and P. H. Calkins, "Determinants of environmentally responsible behaviours for greenhouse gas reduction," International Journal of Consumer Studies, vol. 33, pp. 151-161, 2009.
[15]. M. D. Esfahani, A. A. Rahman, and N. H. Zakaria, "The Status Quo and the Prospect of Green IT and Green IS: A Systematic Literature Review," Journal of Soft Computing and Decision Support Systems, vol. 2, pp. 18-34, 2015.
[16]. D. C. Hambrick, "Upper echelons theory: An update," Academy of management review, vol. 32, pp. 334-343, 2007.
[17]. J. Liedtka, "Organizational value contention and managerial mindsets," Journal of Business Ethics, vol. 10, pp. 543-557, 1991.
[18]. http://www.cloudbus.org/papers/Cloud-EnvSustainability2011.pdf.