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GREEN CLOUD COMPUTING
"The NEED of the hour"

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ABSTRACT:
Cloud Computing has become a scalable services consumption and delivery platform in the field of Services Computing. The technical foundations of Cloud Computing include Service-Oriented Architecture (SOA) and Virtualizations of hardware and software. The goal of Cloud Computing is to share resources among the cloud service consumers, cloud partners, and cloud vendors in the cloud value chain. The resource sharing at various levels results in various cloud offerings such as infrastructure cloud (e.g. hardware, IT infrastructure management), software cloud (e.g. SaaS focusing on middleware as a service, or traditional CRM as a service), application cloud (e.g. Application as a Service, UML modeling tools as a service, social network as a service), and business cloud (e.g. business process as a service).

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, which has become a critical issue. 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 is not environmentally friendly. Hence, energy-efficient solutions are required to minimize the impact of Cloud computing on the environment. In order to design such solutions, deep analysis of Cloud is required with respect to their power efficiency. In this research paper I have focused on the needs of developing applications that will help to make load balances so as to facilitate effective applications design and alogorithmic approach. The efficiency of an algorithm has an impact on the resources required for a computing function and at times one may need to do trade-offs while writing programs. Cloud computing is an evolving paradigm which is enabling outsourcing of all IT needs such as storage, computation and software such as office and ERP, through large Internet. The shift toward such service-oriented computing is driven primarily by ease of management and administration process involving software upgrades and bug fixes. It also allows fast application development and testing for small IT companies that cannot afford large investments on infrastructure. Most important advantage offered by Clouds is in terms of economics of scale; that is, when thousands of users share same facility, cost per user and the server utilization. To enable such facilities, Cloud computing encompasses many technologies and concepts such as virtualization, utility computing, pay as you go, no capital investment, elasticity, scalability, provisioning on demand, and IT outsourcing.

Keywords- hardware synchronization for green computing, need for Application Development ,platform.

1. INTRODUCTION

In the Science Conclave 2013 of Indian Institute of Information Technology Allahabad,Nobel Laurete in Geography "Professor Walter J kohan",says on 10th December 2013,that " the biggest challenge for the Young Generation is Crisis Of Energy and Environmental Issues." A study by environmental campaign group Global Action Plan into **Green Cloud Computing** found that IT infrastructure accounts for 10% of the UK's annual energy consumption. This results in the same amount of CO2 emissions given off by airplanes. We should be committed to reducing CO2 footprint and by innovating the organisations with Green Cloud Computing we can play a considerable role in lessening the impact of your computing on the environment.

The increasing availability of high-speed Internet and corporate IP connections is enabling the delivery of new network-based services . While Internet-based mail services have been operating for many years, service offerings have recently expanded to include network-based storage and network-based computing. These new services are being offered both to corporate and individual end users . Services of this type have been generically called Bcloud computing[services]. The cloud computing service model involves the provision, by

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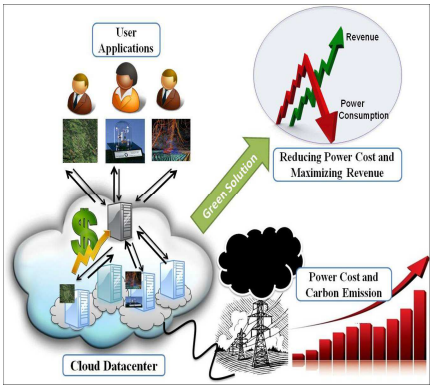
a service provider, of large pools of high performance computing resources and high-capacity storage devices that are shared among end users as required. There are many cloud service models, but generally, end users subscribing to the service have their data hosted by the service, and have computing resources allocated on demand from the pool. The service provider's offering may also extend to the software applications required by the end user. To be successful, the cloud service model also requires a high-speed network to provide connection between the end user and the service provider's infrastructure. Cloud computing potentially offers an overall financial benefit, in that end users share a large, centrally managed pool of storage and computing resources, rather than owning and managing their own systems . Often using existing data centers as a basis, cloud service providers invest in the necessary infrastructure and management.

2. TECHNICAL OVERVIEW

Network-based cloud computing is rapidly expanding as an alternative to conventional office-based computing. As cloud computing becomes more widespread, the energy consumption of the network and computing resources that underpin the cloud will grow. This is happening at a time when there is increasing attention being paid to the need to manage energy consumption across the entire information and communications technology (ICT) sector. While data center energy use has received much attention recently, there has been less attention paid to the energy consumption of the transmission and switching networks that are key to connecting users to the cloud. The analysis considers both public and private clouds, and includes energy consumption in switching and transmission as well as data processing and data storage. Cloud computing can enable more energy-efficient use of computing power, especially when the computing tasks are of low intensity or infrequent. However, under some circumstances cloud computing can consume more energy than conventional computing where each user performs all computing on their own personal computer (PC).
According to IDC (International Data Corporation) report, the global IT Cloud services spending is estimated to increase from $16 billion in 2008 to $42 billion in 2012, representing a compound annual growth rate (CAGR) of 27%. Attracted by this growth prospects, Web-based companies (Amazon, eBay, Salesforce.com), hardware vendors (HP, IBM, Cisco), telecom providers (AT&T, Verizon), software firms (EMC/VMware, Oracle/Sun, Microsoft) and others are all investing huge amount of capital in establishing Cloud datacenters. According to Google¨s earnings reports, the company has spent $US1.9 billion on datacenters in 2006, and $US2.4 billion in 2007



3. CLOUD COMPUTING IN INDIA

Gartner estimated that SaaS market in India was US$27 million in 2007. According to a study by Springboard Research, the Indian SaaS market would experience a CAGR (compound annual growth rate) of 77% during 2006-2010 and will reach US$165 million in 2010 (IANS 2008). According to a study by India's National Association of Software and Services Companies (NASSCOM) and Mckinsey, remote infrastructure management will be a US$15 billion industry in India by 2013. In September 2008, IBM opened a cloud center in Bangalore, which targets mid-market vendors, universities, government bodies and microfinance and telecommunications companies (Channelworld 2008). Indian universities are banking on the cloud to develop innovative research and education activities. The Indian Institute of Technology (IIT), Kanpur and other academic institutions use the cloud (MacMillan 2009; Raghu 2008).
In November 2009, Microsoft India announced commercial availability of cloud

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services such as e-mail, collaboration, conferencing and productivity starting US$2 per user per month (HT 2009). These services are mainly targeted to SMEs. India also has a number of local cloud providers (Table 2).
In July 2009, VMware opened a cloud center in Pune (eeherald.com 2009). Likewise, the U.S. Company, Parallels announced a plan to establish cloud operations in India (Desai 2009). The SaaS vendor, Salesforce.com, which started its operations in 2005, is focusing on cities such as Bangalore, Gurgaon and Mumbai and is taking measures to create cloud awareness. Salesforce.com's clients include big companies such as Bharti AXA General Insurance, eBay India, Sify Technologies, Polaris Software Labs, Lodha Group, Servion, Maytas Properties, HCL, Sasken Communication Technologies, Ocimum Biosolutions, and state owned National Research Development Corporation (NRDC) (Srikanth 2009). The Indian offshoring industry is probably the prime example of an industry that is likely to feel the impact of cloud computing. The demand for cloud related services is especially high in the offshoring industry and technology hubs such as Bangalore and Delhi (Economic Times 2009). In summary, Cloud computing, being an emerging technology also raises significant questions about its environmental sustainability.
While financial benefits of Cloud computing have been analyzed widely in the literature, the energy efficiency of Cloud computing as a whole has not been analyzed. Through the use of large shared virtualized datacenters Cloud computing can offer large energy savings. However, Cloud services can also further increase the internet traffic and its growing information database which could decrease such energy savings. Thus, this chapter explores the environmental sustainability of Cloud computing by analyzing various technologies and mechanism that support this goal. Our analysis is important for users and organization that are looking at Cloud computing as a solution for their administrative, infrastructural and management problems.
Cloud Computing and Energy Usage Model: A Typical Example
In this section, through a typical Cloud usage scenario we will analyze various elements of Clouds and their energy efficiency. Figure 5 shows an end user accessing Cloud services such as SaaS, PaaS, or IaaS over Internet. User data pass from his own device through an Internet service provider‟s router, which in turn connects to a Gateway router within a Cloud datacenter. Within datacenters, data goes through a local area network and are processed on virtual machines, hosting Cloud services, which may access storage servers. Each of these computing and network devices that are directly accessed to serve Cloud users contribute to energy consumption. In addition, within a Cloud datacenter, there are many other devices, such as cooling and electrical devicies, that consume power. These devices even though do not directly
help in providing Cloud service, are the major contributors to the power consumption of a Cloud datacenter. In the following section, we discuss in detail the energy consumption of these devices and applications.

Features of Clouds enabling Green computing
Even though there is a great concern in the community that Cloud computing can result in higher energy usage by the datacenters, the Cloud computing has a green lining. There are several technologies and concepts employed by Cloud providers to achieve better utilization and efficiency than traditional computing. Therefore, comparatively lower carbon emission is expected in Cloud computing due to highly energy efficient infrastructure and reduction in the IT infrastructure itself by multi-tenancy. The key driver technology for energy efficient Clouds is "Virtualization," which allows significant improvement in energy efficiency of Cloud providers by leveraging the economies of scale associated with large number of organizations sharing the same infrastructure. Virtualization is the process of presenting a logical grouping or subset of computing resources so that they can be accessed in ways that give benefits over the original configuration . By consolidation of underutilized servers in the form of multiple virtual machines sharing same physical server at higher utilization, companies can gain high savings in the form of space, management, and energy. According to Accenture Report , there are following four key factors that have enabled the Cloud computing to lower energy usage and carbon emissions from ICT. Due to these Cloud features, organizations can reduce carbon emissions by atleast 30% per user by moving their applications to the Cloud. These savings are driven by the high efficiency of large scale Cloud data centers

Towards Energy Efficiency of Cloud computing: State-of-the-Art
1- Applications
SaaS model has changed the way applications and software are distributed and used. More and more companies are switching to SaaS Clouds to minimize their IT cost. Thus, it has become very important to address the energy efficiency at application level itself. However, this layer has received very little attraction since many applications are already on use and most of the new applications are mostly upgraded version of or developed using previously implemented tools

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2 -Cloud Software Stack: Virtualization and Provisioning
In the Cloud stack, most works in the literature address the challenges at the IaaS provider level where research focus is on scheduling and resource management to reduce the amount of active

resources executing the workload of user applications. The consolidation of VMs, VM migration, scheduling, demand projection, heat management and temperature-aware allocation, and load balancing are used as basic techniques for minimizing power consumption.

3- Datacenter level: Cooling, Hardware, Network, and Storage
The rising energy costs, cost savings and a desire to get more out of existing investments are making today's Cloud providers to adopt best practices to make datacenters operation green. To build energy efficient datacenter, several best practices has been proposed to improve efficiency of each device from electrical systems to processor level.

4 -Monitoring/Metering
It is said that you cannot improve what you do not measure. It is essential to construct power models that allow the system to know the energy consumed by a particular device, and how it can be reduced. To measure the unified efficiency of a datacenter and improve its' performance per-watt, the Green Grid has proposed two specific metrics known as the Power Usage Effectiveness (PUE) and Datacenter Infrastructure Efficiency (DciE) .

- PUE = Total Facility Power/IT Equipment Power
- DciE = 1/PUE = IT Equipment Power/Total Facility Power x 100%

5- Network Infrastructure
At network level, the energy efficiency is achieved either at the node level (i.e. network interface card) or at the infrastructure level (i.e. switches and routers). The energy efficiency issues in networking is usually referred to as "green networking", which relates to embedding energy-awareness in the design, in the devices and in the protocols of networks.

4. GREEN CLOUD ARCHITECTURE

From the above study of current efforts in making Cloud computing energy efficient, it shows that even though researchers have made various components of Cloud efficient in terms of power and performance, still they lack a unified picture. Most of efforts for sustainability of Cloud computing have missed the network contribution. If the file sizes are quite large, network will become a major contributor to energy consumption; thus it will be greener to run application locally than in Clouds. Furthermore, many work focused on just particular component of Cloud computing while neglecting effect of other, which may not result in overall energy efficiency. For example, VM consolidation may reduce number of active servers but it will put excessive load on few servers where heat distribution can become a major issue. Some other works just focus on redistribution of workload to support energy efficient cooling without considering the effect of virtualization. In addition, Cloud providers, being profit oriented, are looking for solutions which can reduce the power consumption and thus, carbon emission without hurting their market. Therefore, we provide a unified solution to enable Green Cloud computing. We propose a Green Cloud framework, which takes into account these goals of provider while curbing the energy consumption of Clouds. The high level view of the green Cloud architecture is given in Figure . The goal of this architecture is to make Cloud green from both user and provider's perspective.

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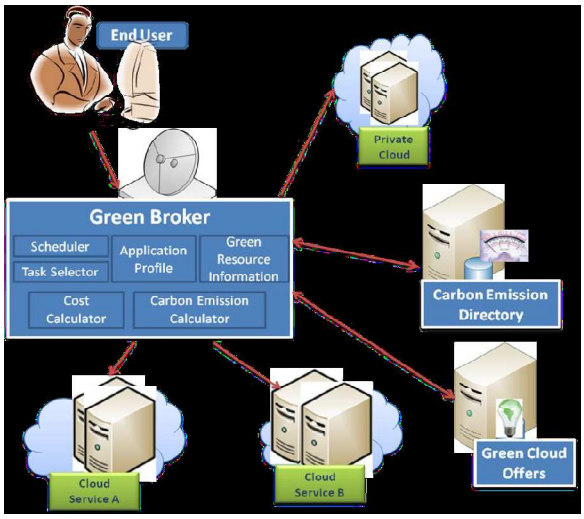

Need to Develop optimized Algorithms

Use efficient algorithms. For example, use fast search algorithms such as hashed or indexed search algorithms instead of slow linear search algorithms. Cost optimization can be achieved by using algorithms to route the data to data center where electricity is cheaper. In case data center is facing warm weather, traffic could be routed away to cut energy usage, allowing the servers to shut down and avoid using the air conditioning. We have seen above how different measures such as cloud data center design, increasing resource longevity, resource consolidation and optimization help achieve green computing in the cloud context. There is scope for further reducing the carbon footprint in the Cloud. Research is being done in areas such as optimization of data center hardware and software, improving power supply chain and data center cooling technologies.

5. CONCLUSIONS AND FUTURE DIRECTIONS

Cloud computing business potential and contribution to already aggravating carbon emission from ICT, has lead to a series of discussion whether Cloud computing is really green. It is forecasted that the environmental footprint from data centers will triple between 2002 and 2020, which is currently 7.8 billion tons of CO2 per year. There are reports on Green IT analysis of Clouds and datacenters that show that Cloud computing is "Green", while others show that it will lead to alarming increase in Carbon emission. Thus, we should analyze the benefits offered by Cloud computing by studying its fundamental definitions and benefits, the services it offers to end users, and its deployment model. Then, we should focus our discussion to the components of Clouds that contribute to carbon emission and the features of Clouds that make it "Green". We also discussed several research efforts and technologies that increase the energy efficiency of various aspects of Clouds. For this study, we identified several unexplored areas that can help in maximizing the energy efficiency of Clouds from a holistic perspective. After analyzing the shortcoming of previous solutions, we proposed a Green Cloud Framework and presented some results for its validation. Even though our Green Cloud framework embeds various features to make Cloud computing much more Green, there are still many technological solutions are required to make it a reality:

- First efforts are required in designing software at various levels (OS, compiler, algorithm and application) that facilitates system wide energy efficiency.
- To enable the green Cloud datacenters, the Cloud providers need to understand and measure existing datacenter power and cooling designs, power consumptions of servers and their cooling requirements, and equipment resource utilization to achieve maximum efficiency.
- For designing the holistic solutions in the scheduling and resource provisioning of applications within the datacenter, all the factors such as cooling, network, memory, and CPU should be considered.

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- Last but not the least, the responsibility also goes to both providers and customers to make sure that emerging technologies do not bring irreversible changes which can bring threat to the health of human society.

CONCLUSION

In conclusion, by simply improving the efficiency of equipment, Cloud computing cannot be claimed to be Green. What is important is to make its usage more carbon efficient both from user and provider‟s perspective. Cloud Providers need to reduce the electricity demand of Clouds and take major steps in using renewable energy sources rather than just looking for cost minimization.

Our broad conclusion is that the energy consumption of cloud computing needs to be considered as an integrated supply chain logistics problem, in which processing, storage, and transport are all considered together. Using this approach, we have shown that cloud computing can enable more energy-efficient use of computing power, especially when the users' predominant computing tasks are of low intensity or infrequent. However, under some circumstances, cloud computing can consume more energy than conventional computing where each user performs all computing on their own PC. Even with energy-saving techniques such as server virtualization and advanced cooling systems, cloud computing is not always the greenest computing technology.

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