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A SURVEY ON LOWERING POWER CONSUMPTION IN CLOUD ENVIRONMENT WITH GREEN COMPUTING TECHNIQUES

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ABSTRACT

The computational power is growing rapidly today hence the need for 'Cloud computing' concept is very vital. But, in Cloud computing high performance cloud servers are used for advance computational needs. A large amount of power is consumed to execute these computational units. At the same time, harmful gases are released in the environment. Green Computing is the concept which is trying to curb these ill effects by introducing new methods that would work efficiently while consuming less energy which is environment friendly. This paper focuses on Green computing techniques, in order to achieve low power consumptions in cloud environment.

GENERAL TERMS: *Virtual Machines (VM), Cloud, Servers*

KEYWORDS: *Green Computing, Data Center, Virtualization*

1. INTRODUCTION

Cloud computing, which is considered as a giant of computing as a utility has a huge potential to bring revolution in a large part of IT industry, which complements software to make it more demanding as a service and changing the way IT hardware is thought of in terms of design and many other aspects.

Now a days developers do not require huge capital to implement their big ideas for internet services.

It happens that for a service overprovisioning is done unnecessarily which results in wasting the useful resources which ultimately leads to loss of revenue and customers too.

Moreover, big companies with huge requirements of task can get their results executed as soon as their request is received from the customer. Since using 100 servers for one hours is much cheaper overall as compared to one server for 100 hours.

This elasticity of pay per use for customer for a flexible requirement is getting hugely popular and never been done in the history of IT.

Cloud computing provides service offline and online. It means applications is accessed over the internet and through software in the datacenters.

The services is termed as Software as a Service (SaaS). The datacenter with hardware and software is refereed as a Cloud. When a Cloud is made available for all kinds of business people in a pay per use manner and to the general public, we call it a Public Cloud; the service being sold to the general public is known as Utility Computing. There are Private Cloud to service internal datacenters of a business or other organization, which is not available to general public. Hence, Cloud Computing is the summation of SaaS and Utility Computing, but not Private Clouds. People can be users or providers of SaaS, or users or providers of Utility Computing. We focus on Cloud Users and Cloud Providers.

Global warming is considered as a big concern, with high power consumption and various gas like CO2 emission.

With the ever-increasing demand and usage of cloud computing, very high power is consumed at the data centers but with a toll on environment by releasing harmful gases by these data centers.

Big cloud providers have thousands of data centers to processes user request and to run these data centers huge amount of power is used for cooling and other processes.

The power consumption is increasing slowly every year and green computing plays a big and

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helpful role to bring these issues down. Green Computing can be defined as an eco-friendly use of computers a various resources which has good effect environmentally, socially and politically with respect to effective and efficient use of energy to achieve competitive edge in terms of an energy-cost saving strategy, and reduction to carbon emission/footprints, recyclability, biodegradability, and minimal impact to the environment. Green computing represents environmentally responsible way to reduce power and environmental e-waste. Main goals of green computing are to reduce the use of toxic and hazards materials and improve the energy efficiency, recycling of factory waste. It includes the efficient use of servers and various peripherals at the same time reducing the power consumption.

1.1 Cloud computing and virtualization

Cloud computing is a cost-effective model for provisioning services, and it makes IT management easier and more responsive for the changing needs of the business. It delivers a wide range of services like Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). These services are made available on a subscription basis using pay-as-you-use model to customers, regardless of their location.

Cloud computing is a formal model for convenient, scalable and flexible network access to a shared pool of resources as per the requirement which is readily available with minimum effort or interaction with the provider.

The data centers are the backbone of cloud computing environment. The cloud services are provided from cloud data centers. A data center can be either non-virtualized or fully virtualized and either consolidated or geographically distributed. In IaaS cloud platform, service consumers give hardware and software configuration of virtual machines (VM) to be created and used to cloud platform, and perform the assignments on their custom VM. If the submitted jobs are parallelizable, the VM may require multi-core for more efficient execution. In many cases, some customers may need to execute a clustered application service which involves interprocess communication with a low-latency demand. Such services and applications will also require multi-core architecture. It is suggested that once virtual

machines are configured, created and launched onto the appropriate host, they will begin executing the jobs. The speed at which a VM processes the assignment depends on the speed of the computing resources on which the VM is launched as well as the internal scheduling policy associated with the host. Since the cloud customers and subscribers expect explicit SLA on computer resources, storage and networking infrastructure, a high-efficient scheduling and placement policy to map the incoming VM instances onto a right fit infrastructure is necessary.

1.2 Data center based on green cloud computing

Now, more and more power of data centers is consumed, thus it has impacted on environments seriously. Many researchers have been seeking to find effective approaches to reduce power consumption of data centers with keeping the desired quality of service or performance

Objectives. Virtual Machine technology has many seminal features, such as reliability, flexibility and the ease of management. So it is right fit to apply in data center environments. The nature of green cloud computing is reducing energy consumption of data centers while ensuring the performance level from users' requirements. The advent of cloud computing makes large scale data centers become common in the computing industry. Since these data centers are commonly equipped with high performance infrastructures, they will consume much energy and increase CO2 emissions leading to global warming. For today's world, it has already become a serious environmental problem. In the recent data centers, the idle power wasted is one of the major causes for energy inefficiency with the servers running at a low utilization. Even at 10% of CPU utilization, the power consumed is over 50% of the peak power. During off-peak load it also leads to more energy consumption per workload. 22% of energy consumption of a single server is needed to cool it. The fact that power consumption of data centers doubled across the globe between 2000 and 2006 is shown by studying data center

Problems. Incremental US demand for data center energy between 2008 and 2010 is equal to 10 nuclear power plants. Since the existing data centers use too many computing and storage resources to execute more and more large-scale distributed applications, the power consumption Increases rapidly. In order to utilize the computing systems efficiently and to reduce their environmental and social impact, green computing is focused on by computer research organization and industry. Now, some hardware techniques can be used to solve the power problems. However, the software techniques and new architectures are more important to achieve the best results.

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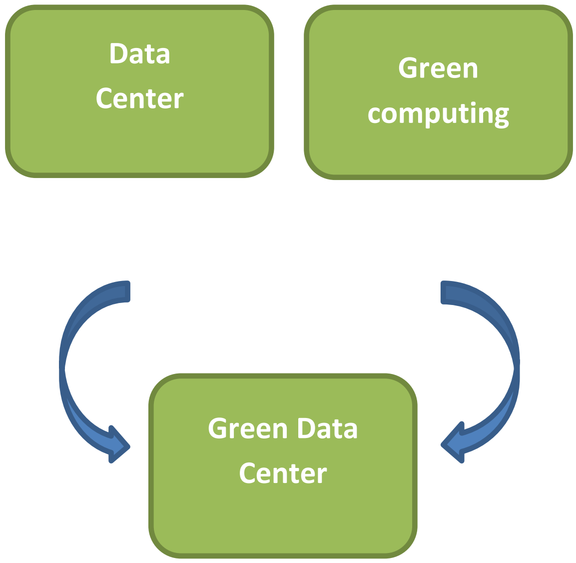

Fig 1: Green Data Center Cycle

2. GROWTH

All material In U.S. datacenters in last 15 years about 5.6 million servers were installed. Of those, 4.9 million were low-end, 663,000 were midrange, and 23,000 were high-end servers, according to a survey by Lawrence Berkeley National Labs in 2007.

By 2005, U.S. datacenters had 10.3 million servers. Of those, 9.9 million were low-end, 387,000 were midrange, and 22,200 were high-end servers.

The same study showed that it's not just the U.S. that spiked in its server growth. Around the world server demand expanded. In 2000, as shown in the following figure, there were 14.1 million servers. Of those, 12.2 million were low-end servers, 1.8 million were midrange, and 66,000 were high-end servers.

By 2005, that number had swelled to 27.3 million servers. Of those, 26 million were low-end servers, 1.2 million were mid-range servers, and 66,000 were high-end servers. To feed that growth, in the United States, the amount of power necessary was equivalent to about five 1000-megawatt power plants. Worldwide, it was the same as 14 power plants.

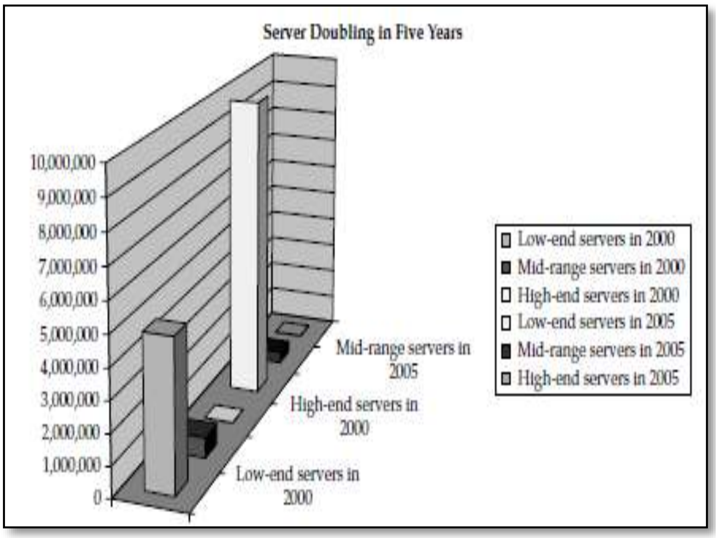

Fig 2: Graph showing High and low end servers

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Table 1: Data showing energy saving ratio

Energy-Saving Action	Savings (kW)	Savings (%)
Lower-power processors	111	10
High-efficiency power supplies	141	12
Power management features	125	11
Blade servers	8	1
Server virtualizations	156	14
Cooling best practices	24	2
Variable-speed fan drives	79	7
Supplemental cooling	200	18

White and bright colors can use up to 20 percent more power than black or dark colors.

Is the difference between a white background (74 W) and a black background (59 W) major? Well, 15 W equates to major increase in the bill.

Table 2: Data showing color and the watts used

Color	Watts used
White	74 W
Fuchsia	69 W
Yellow	69 W
Aqua	68 W
Silver	67 W
Blue	65 W
Red	65 W
Lime	63 W
Gray	62 W
Olive	61 W
Purple	61 W
Teal	61 W
Green	60 W
Maroon	60 W
Navy	60 W
Black	59 W

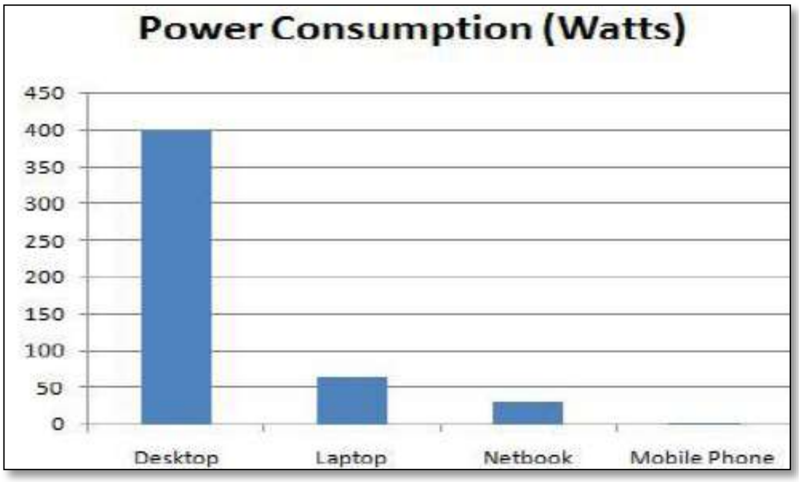

Fig 3: Graph showing power consumptions of electronics items

2.1 Other Costs

When we think and analyze about energy consumption then talking only about power meters won't be enough, instead we should have a realistic data about the complete organization and should change one area at a time to bring a big change.

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For example, Isothermal Systems Research (ISR) in Liberty Lake, Washington offers a technology called Spray Cool.

A nonconductive fluid known as Fluoinert is used by Spray Cool. The coolant is sprayed directly on a chip or processor (the procedure is called "chip-based" cooling), and then cools the chip as the coolant is converted into a gas.

Following figure shows, that gas is then taken down to a heat exchanger at the bottom of the unit, where the heat is transferred to another fluid, such as water. Because the water has been heated up, it can be used to regulate the building's temperature.

In a system with 10 racks of equipment, there is a 150-kW load just for cooling. Using the spray coolant removes a quarter of that cooling load.

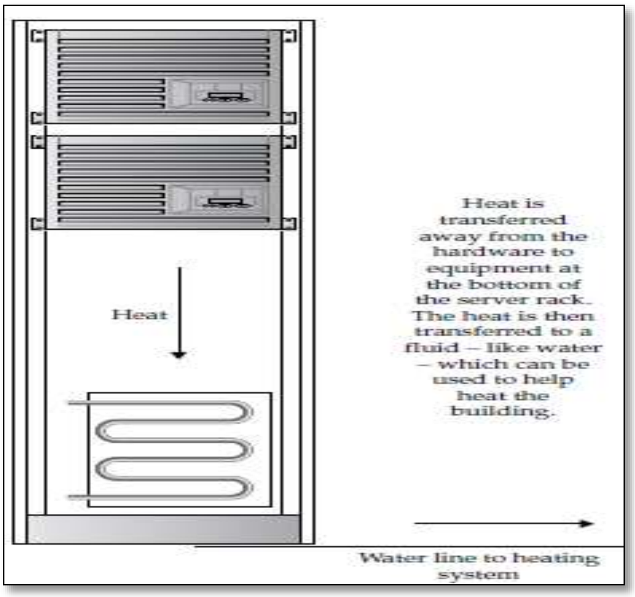

Fig 4: Cooling unit for servers

2.2 LEED Considerations

If you are concerned with LEED, good cabling practices can help propel you toward your certification goal. Buildings registered under the LEED system are awarded "credits" for reaching certain environmental goals, and are assigned a rating within the LEED system based on the following scale:

- Platinum 52–69 credits
- Gold 39–51 credits
- Silver 33–38 credits
- Certified 26–32 credits

Table 3: Leed standard for cables

Design Consideration	LEED Credit	Explanation
Using intelligent infrastructure management software	Construction Waste Management (50 percent)	Reduction of unnecessary channels due to undocumented or poorly managed movement, addition, or change work.
	Construction Waste Management (75 percent)	
	Resource Reuse (5 percent)	Identification and utilization of unused cabling channels to limit installation of new channels.
	Resource Reuse (10 percent)	
	Optimize Energy Performance	Maximization of active port usage to limit the installation of unnecessary active equipment. Identification and utilization or elimination of abandoned channels to maximize pathway space or increase air flow for energy-efficient cooling.

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CAT 7 cabling and cable sharing	Construction Waste Management (50 percent)	Cable sharing as a means to reduce the number of installed cabling channels. Future-proof performance extends the life cycle of the cabling, decreasing the frequency of cable removal/disposal and installation of additional cabling.
	Construction Waste Management (75 percent)	
	Optimize Energy Performance	Shielded construction may limit noise sufficiently to reduce active equipment power consumption through elimination of DSP.
Using trunking cable	Construction Waste Management (50 percent)	Factory termination eliminates onsite waste created by field terminations.
	Construction Waste Management (75 percent)	Efficient installation of trunk cables requires fewer contractor visits and smaller crews.
	Resource Reuse (5 percent)	Modular design of trunks allows for onsite reuse.
	Resource Reuse (10 percent)	
	Optimize Energy Performance	Well-organized channels eliminate air dams in pathways caused by poorly managed individual channels to maximize air flow for energy-efficient cooling.

3. STORAGE VIRTUALIZATION SOLUTIONS

Vendors understand the need for streamlined SAN (Storage Area Networks) solutions, and they're introducing new and ever-efficient technologies all the time. In this section, we'll take a closer look at some of the better SAN solutions out there and talk about how they can help you virtualize your storage.

3.1 Compellent Storage Center

Storage vendors are seeing the benefits of going green and reacting to market pressures to churn out smart products that balance performance, power, and consumption. One such company is Compellent. Compellent offers a number of SAN enhancements with its Compellent Storage Center 4.0. In fact, Compellent is not only concerned with providing an effective, efficient SAN, but is also taking strides to address ecological considerations through its products.

The company uses such technologies as the following:

- Automated tiered storage
- Thin provisioning
- Advanced virtualization

Compellent notes that a fully featured Storage Center SAN can save companies up to 93 percent of the power consumption and power costs of storage when compared to conventional solutions.

For instance, the company observes that a typical 20TB storage system configured with RAID 10 and utilized at 50 percent might require 274 enterprise-class disk drives. Using 10,000 rpm 146GB drives could consume 6020 watts per year (52,740 kWh). If the company pays $0.10 per kWh to power those drives, it would cost US$26,370 over the drives' 5-year lifespan.

However, a Compellent SAN with its proprietary technologies—thin provisioning, advanced virtualization, and automated tiered storage—might require just 14 of the same enterprise-class disk drives configured at RAID 10, and seven 7200 rpm 750GB SATA storage disks, configured at RAID 5.

This configuration would consume just 429 watts—or 3758 kWh—for a total cost of just US$1879 over the drives' 5-year lifespan [6].

3.2 Incipient

Another SAN management platform is offered by Incipient. Incipient's solution is two enterprise-class software products managed by a common administrative console called Incipient Storage Administrator (iSA). The two products are Incipient Automated Data Migration (iADM) software and Incipient Network Storage Platform (iNSP) software. Incipient Automated Data Migration (iADM) Software iADM is targeted at customers who need to move their data with very little planning. Data migration includes:

- Datacenter moves
- Storage array refreshes
- Application tiering
- Storage resource balancing

iADM boasts an intelligent automation of end-to-end migration processes, and it supports heterogeneous SAN environments as well as various storage vendors (including 3PAR, EMC, IBM, and Sun).

Further, the software can run on off-the-shelf servers and is designed to automate end-to-end workflow and provisioning tasks that occur with migration projects. iADM also allows you to perform datacenter moves with reduced downtime, as well as to perform all tasks from a single console.

Incipient Network Storage Platform (iNSP) Software

The iNSP platform is targeted at customers who have ongoing data mobility needs, but can't have any downtime. iNSP combines storage virtualization tools with powerful management tools, which allows customers to move data across the SAN with no downtime.

iNSP is located on a director-class SAN switch and provides a suite of network-based storage services that can be deployed SAN-wide or across heterogeneous storage arrays.

These services provide:

- Nondisruptive data migration
- Network volume management
- Storage provisioning
- Point-in-time copy

4. SAVINGS

So how much can you save by virtualizing your servers and storage? Let's consider the fictional software giant CompuGlobalMegaWare, which has decided to make the switch and is going to virtualize and consolidate its servers and storage. It will be reducing the amount of physical servers it has from 1000 down to 72—a 14:1 reduction. The company is also going to reduce its 1000TB of storage spread across 13,700 hard drives down to 1050 drives, or a 13:1 reduction. Let's take a closer look.

Server Savings

In terms of storage, an average, run-of-the-mill server will cost US$9052 per year in costs.

Those costs include:

- US$4000 for purchase, support, and maintenance costs. This amount is amortized over 3 years.
- US$1100 for storage and networking costs.
- US$333 for server provisioning and life cycle replacement costs, which consume 20 hours per server. That also assumes a 10 percent server growth. If your environment is growing especially fast, expect this amount to be higher.
- US$2720 in ongoing administration.
- US$589 in power and cooling costs.
- US$310 for datacenter space costs.

5. GREEN COMPUTING TECHNIQUES TO MANAGE POWER IN COMPUTING SYSTEM

These techniques can be classified at different levels:

1) Hardware and Firmware Level
2) Operating System Level
3) Virtualization Level
4) Data Center Level

Hardware and Firmware level techniques are applied at the manufacturing time of a machine. These techniques contain all the optimization methods that are applied at the time of designing at the logic, circuit, architectural and system levels.

In technique working at operating system level, it includes various methods which works at operator level.

Virtualization level techniques used the concept of Virtual Machines (VMs) to manage power. In this number of VMs are created on a physical server, so that reduce the amount of hardware in use and improve the utilization of resources.

The technique working at Data center level is applied at data centers which has various methods to manage workload across various nodes in the data centers [6].

6. CONCLUSION

After analyzing many techniques for managing power and energy in computing system, different approaches has been surveyed for data center to manage efficiency of energy using virtualization. The work presents in this paper indicate the ever increasing interest of researchers in the area of green computing. Many green computing methods for energy efficiency are proposed by researchers however, green computing technology needs to be further researched because of high power consumption in data centers. This is the conclusion of power management techniques in a virtualized environment by analyzing the existing work [7], [8].

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