

GREEN CLOUD COMPUTING

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Abstract— while searching for information about cloud computing over the internet, I came across a computing keyword that is Green Computing. After so much of research on this term I myself tried to have the clear vision about it. This paper will help the researchers and administrators to have a clear understanding of Green Computing. In this modern era of globalization, computers play a vital role in every field, so the needs of computers increased day by day and, to full fill this need, a large amount of electricity required for manufacturing of computers functional units, such as CPU, memory, monitors and peripheral devices etc. By this a large amount of carbon content consumes in the atmosphere. These carbon contents directly or indirectly impact us and responsible for hazards on the earth. However, the growing demand of Cloud infrastructure has drastically increased the energy consumption of data centres, 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. There are many technique used by intelligent people to overcome this problem, one of that technique is Green computing. Green Computing takes responsibility of eco-friendly use of computer and their resources. In order to design such solutions, deep analysis of Cloud is required with respect to their power efficiency. Mainly, IT industries are responsible for 3% of the world's energy consumption with an increase of 20% per year. The main goal of Green computing is to increase the efficiency of the IT products during its lifecycle and endorse the recycling of useless goods and factory waste. This paper introduces some energy efficient techniques of green computing and their use in future.

Index Terms— introduction, need of green cloud, Effective steps to maintain Green Computing, Benefits of Green Cloud Computing, Recent implementations of Green Computing, Conclusion, references

1 INTRODUCTION

THIS Cloud computing is a style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet. A number of advantages of cloud computing for the enterprise have been recognized. Among these are improved TCO, reduced infrastructure costs, improved business agility, converting fixed costs to variable costs, and of course, with respect to power, acquiring IT services which can be scaled as needed, even on a temporary basis to deal with peaks in IT requirements, and which do not impose power capacity constraints. Although enterprises have been hesitant thus far to adopt cloud computing broadly as a source of IT services, there are cases where cloud computing might be advantageous, without raising the typical concerns about security, reliability, meeting SLAs, and other issues raised by cloud computing which have not yet been fully resolved. Suggests that there are four cases where the cloud should be considered by CIOs, namely, for: (1) new initiatives where budgets are very constricted; (2) business processes which have widely varying or unpredictable load patterns; (3) services provided by non-core systems which are commoditized; and (4) systems where infrastructure management and operations costs are high.

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 organizations with Green Cloud Computing we can play a considerable role in lessening the impact of your computing on the environment. Green Computing is

the emerging technology which is responsible for the manufacturing and use of computer devices by consuming less carbon.

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 cloud computing [services]. The cloud computing service model involves the provision, by 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 Centre's as a basis, cloud service providers invest in the necessary infrastructure and management. Many computers are produced from many hazardous materials like cadmium, mercury and other toxic substances. While disposing the com-

puters, it will lead to pollution and affect the environment to great extent. The impact of the toxic waste that is produced by us through throwing our old computers and peripherals lead to land pollution. This is the big challenge, how to minimize the power consumption and thereby reducing the carbon content in the atmosphere. The goal of green computing is to reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote recycle ability. Green Computing is the name attached to this movement, which represents an environmentally responsible way to reduce power and environmental e-waste. Many IT manufacturers and vendors are continuously investigating in designing energy efficient computing devices, reducing the use of dangerous materials and encouraging the recyclability of digital devices and paper. Its practice came in to being in 1992, when the Environmental Protection Agency (EPA) launched the Energy Star Program. EPA a voluntary labelling program that is designed to promote and recognize energy efficiency in monitors, climate control equipment and other technologies. Green technology comprises of the study of advanced materials to be used in everyday life and the study of new generation techniques. The main topic of concern in green technology is to reduce the environmental impact of industrial processes along with the growth in population resulting in innovative technologies. Basically, the efficient use of computers and computing is what green computing is all about. The triple bottom line is what is important when it comes to anything green and the same goes for green computing. This considers social responsibility, economic viability and the impact on the environment. The huge amount of computing manufactured worldwide has a direct impact on environment issues, and scientists are conducting numerous studies in order to reduce the negative impact of computing technology on our natural resources. A central point of research is testing and applying alternative non-hazardous materials in the products' manufacturing process. The idea is to make computers from beginning to end a green product. Green computing is the environmentally responsible and eco-friendly use of computers and their resources. In broader terms, it is also defined as the study of designing, manufacturing/engineering, using and disposing of computing devices in a way that reduces their environmental impact.

Many IT manufacturers and vendors are continuously investing in designing energy efficient computing devices, reducing the use of dangerous materials and encouraging the recyclability of digital devices and paper. Green computing is also known as green information technology (green IT).

Green computing, or green IT, aims to attain economic viability and improve the way computing devices are used. Green IT practices include the development of environmentally sustainable production practices, energy efficient computers and improved disposal and recycling procedures. The term 'Green Computing' is the study and practices of designing IT equipment and their safe disposal efficiently and effectively with negligible or no impact on the environment. It has two factors "Green-IT" means well organized IT and "IT-for Green" means use of IT in an efficient way. First and most conclusive research on computing shows that Carbon Dioxide (Co₂) and other emissions are causing global climate and environmental

damage. Thus go green is the first and foremost need of modern age that can decrease the overall energy consumption of computation, storage and communications. The 5 core green computing technologies advocated by GCI are Green Data Centre, Virtualization, Cloud Computing, Power Optimization and Grid Computing. Company like Via Technology offer green PC's that are affordable, non-toxic and ultra-low wattage. It takes responsibility of their outdated products by offering a PC recycling service. Green computing can also develop solutions that offer benefits by "aligning all IT processes and practices with the core principles of sustainability, which are to reduce, reuse, and recycle; and finding innovative ways to use IT in business processes to deliver sustainability benefits across the enterprise and beyond".

The goals of green computing are quite similar to green chemistry which are to reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote the recyclability or biodegradability of non-operational products and factory waste.

This technology is beneficial as it:- a) Reduce energy consumption of computing resources during peak operation. b) Save energy during idle operation. c) Use eco-friendly sources of energy. d) Reduce harmful effects of computing resources. e) Reduce computing wastes.

2 NEED OF GREEN CLOUD COMPUTING

Use of computer system and IT services had made one's life easier and more comfortable. It increases the processing speed and power consumption also. This large amount of power consumption increases the emission of greenhouse gases and increases the pollution as well. Energy consumption is also increasing due to, leaving the system on even when they are not being used. Along with this a large amount of energy wasted in IT, because data centers needed lots of power and matching cooling capacity, when it is not available then it causes environmental pollution. Green computing deals with the concept of reducing energy consumption, recycling eliminate hazardous elements but it also deals with reduce in the business travel sharing the resources (cloud computing) and optimization. Insufficient power and cooling capacities can also results in loss of energy. This all become responsible for the polluted environment. It also observed that most of the data centers used old technologies based system and they don't have sufficient cooling capacities. This all leads us towards the polluted environment. The environment pollution could be because of the defects in Manufacturing techniques, packaging, disposal of computers and components. There are toxic chemicals used in the manufacturing of computers and components which can enter the food chain and water. It is observed from one source, "Information Technology energy demand is growing Twelve times faster than the overall demand for energy" and Data centers emits 150 metric tons of CO₂ per year, and the volume is increasing rapidly[xc]. In order to create standards and regulations various organizations have been formed. Some of these organizations are: 1.The Green Grid is a global pool of IT companies and professionals looking for improve energy efficiency in various data centers around the globe. Board members of the Green Grid

include AMD, EMC, Intel, APC, HP, Microsoft, Dell, IBM, and Oracle. 2. The U.S. Environmental Agency is a government agency that was created to protect human health and to safeguard the natural environment. These organizations were formed to reduce the green gas emission and other pollutants caused by the inefficient use of energy; and Make it easy for consumers to from the view of a user in an organization.

There are lots of fundamental steps that can be taken to significantly decrease the power consumption and impact on environment.

i) Energy Consumption: According to environmental protection agency around 30% to 40% of computers are kept ON during the weekends and even after office hours and around 90% of these computers remain idle. If we develop any application in green computing environment it will use optimal physical resources.

ii) E-waste recycling: Many developed countries are stronger in technology hence a huge amount of computer systems and related products are discarded every day. These products are sold out to other developing countries. In this way recycling of electronic products are achieved. Along with this, recycling of materials used in construction of computer hardware such as tin, silicon, iron, aluminum etc. and electronic items such as audio visual components, mobile phones and other handheld electronic devices contribute a lot in reducing energy efficiency. Recycling of computing equipment such as lead and mercury enables to replace equipment that otherwise would have been manufactured. The reuse of such equipment allow saving energy and reducing impact on environment, which can be due to electronic wastes [2].

iii) Virtualization: With virtualization, a system administrator could combine several physical systems into virtual machines on one single server to run multiple operating systems and make it more powerful. Energy-efficiency can be achieved with less physical equipment plugged in, which reduces power and consume less electricity. Several commercial companies and open-source projects now offer software packages to enable a transition to virtual computing.

It is the fact that virtualization alone doesn't maximize energy and resource efficiencies. So, combined with the right skills and operational and architectural standards, automation minimizes the need of physical infrastructure which in turn maximizes the energy and resource efficiencies from server virtualization.

iv) Cloud as a Green computing: Businesses are rapidly moving from traditional system to cloud based system because of its faster scale-up/scale-down capacity, pay-per-use and access to cloud-based services without buying and managing on-premises infrastructure. The pay-per-use facility of cloud infrastructure provides energy and resource efficiencies simultaneously and promote users to consume only those resources which are required. An IT organization can achieve energy-efficiency and sustainability goals by moving the load from ordinary servers to cloud servers. But unfortunately IT industries are acquiring the 70 percent of their electricity from greenhouse gas-emitting fossil fuels, like coal and leaving a significant amount of carbon footprint. If cloud providers want to make their services as a green, they must invest in renewable energy sources. This can be achieved by generating

power from renewable sources of energy, like wind, solar. When the screen is black it consumes only 59W. Based on this theory if everyone switched from Google to Blackle, mother earth would save 750MW each year. This was a really good implementation of Green Computing.

3 EFFECTIVE STEPS TO MAINTAIN GREEN COMPUTING

1. PEOPLE MUST SWITCH OFF THEIR COMPUTER AT NIGHT SO IT RUNS ONLY EIGHT HOURS A DAY- IT WILL REDUCE ENERGY USE BY 810KWH PER YEAR AND NET A 67 PERCENT ANNUAL SAVINGS.
2. FLAT SCREEN MONITORS USE LESS ENERGY AND SUCH MONITORS ARE NOT AS HARD ON OUR EYES AS CRT'S.
3. UNPLUG THE ELECTRONIC IF NOT IN USE. A SMALL MONITOR- A 14-INCH DISPLAY USES 40 PERCENT LESS ENERGY THAN A 17 INCH ONE.
4. ENABLE SLEEP/ STAND MODE IS AN EFFECTIVE WAY TO CONSERVE BATTERY IN A LAPTOP COMPUTER.
5. POWER OFF YOUR MONITOR WHEN YOU ARE NOT USING IT INSTEAD OF USING SCREEN SAVERS. BUY VEGETABLE OR NON-PETROLEUM-BASED INKS—THEY ARE MADE FROM RENEWABLE RESOURCES REQUIRE HAZARDOUS SOLVENT.
6. RECYCLING OF ELECTRONICS WASTE IS MORE EFFECTIVE BECAUSE RECYCLING PROCESS IS MORE ENVIRONMENTALLY FRIENDLY THAN THE PROCESS OF MAKING NEW STUFF BECAUSE IT CAN REDUCE THE USE OF NEW RAW MATERIALS, LAND DEGRADATION, POLLUTION, AND ENERGY USAGE.
7. USE NETWORK PRINTER IN A BUSINESS ORGANIZATION TO SAVE THE PAPER AND ENERGY. BY USING ENERGY STAR QUALIFIED PRODUCTS HELP A LOT IN ENERGY CONSERVATION.
8. INSTEAD OF USING REGULAR MONITORS ORGANIC LED SHOULD BE USED.
9. DONATION OF OLD COMPUTERS AND OTHER PERIPHERALS REDUCES THE RATE OF GENERATION OF E-WASTE WHICH INTERNS REDUCES ENVIRONMENTAL POLLUTION.
10. USE OF COMPUTERS GREATLY REDUCES THE USE OF PAPERS, BECAUSE A HUGE AMOUNT OF DATA CAN BE STORED IN HARD DISK OF COMPUTERS AND AVOIDS THE PLACING RECORD ON PAPERS.
11. TO HAVE THE RECORD STORED IN COMPUTERS IN THE FORM OF PAPERS, PRINTERS CAN BE USED BUT TO REDUCE THE PAPER WASTE, WE SHOULD THINK 3 TO 4 TIMES BEFORE USING PRINTERS.
12. DUE TO RAPID DEVELOPMENT IN IT, THE GAMES WHICH WERE STORED IN A DISK ARE NOW AVAILABLE ON INTERNET, WHICH REDUCES THE PROBLEM OF USING DISKS AND BOXES THAT WERE REQUIRED A LOT OF RESOURCES.

4 BENEFITS OF GREEN CLOUD COMPUTING

- Reduced Cost
- Automatic Updates
- Green Benefits of Cloud computing
- Remote Access
- Disaster Relief
- Self-service provisioning
- Scalability
- Reliability and fault-tolerance
- Ease of Use
- Skills and Proficiency
- Response Time
- Increased Storage
- Mobility

5 RECENT IMPLEMENTATIONS OF GREEN COMPUTING

i. Blackle: Blackle is a search-engine site powered by Google Search. Blackle came into being based on the concept that when a computer screen is white, presenting an empty word or the Google home, and your computer consumes 74W. When the screen is black it consumes only 59W. Based on this theory if everyone switched from Google to Blackle, mother earth would save 750MW each year. This was a really good implementation of Green Computing. The principle behind Blackle is based on the fact that the display of different colors consumes different amounts of energy on computer monitors.

ii. Fit-PC: a tiny PC that draws only 5w: Fit-PC is the size of a paperback and absolutely silent, yet fit enough to run Windows XP or Linux. Fit-PC is designed to fit where a standard PC is too bulky, noisy and power hungry. If you ever wished for a PC to be compact, quiet and green then fit- PC is the perfect fit for you. Fit-PC draws only 5 Watts, consuming in a day less power than a traditional PC consumes in 1 hour. You can leave fit-PC to work 24/7 without making a dent in your electric bill.

iii. Zonbu Computer: The Zonbu is a new, very energy efficient PC. The Zonbu consumes just one third of the power of a typical light bulb. The device runs the Linux operating system using a 1.2 gigahertz processor and 512 Meg of RAM. It also contains no moving parts, and does even contain a fan. You can get one for as little as US\$99, but it does require you to sign up for a two-year subscription.

iv. Sunray thin client: Sun Microsystems is reporting increased customer interest in its Sun Ray, a thin desktop client, as electricity prices climb, according to Subodh Bapat, vice president and chief engineer in the Eco Responsibility office at Sun. Thin clients like the Sun Ray consume far less electricity than conventional desktops, he said. A Sun Ray on a desktop consumes 4 to 8 watts of power, because most of the heavy computation is performed by a server. Sun says Sunrays are particularly well suited for cost-sensitive environments such as call centers, education, healthcare, service providers, and finance. PCs have more powerful processors as well as hard drives, something thin clients don't have. Thus, traditional PCs invariably consume a substantially

larger amount of power. In the United States, desktops need to consume 50 watts or less in idle mode to qualify for new stringent Energy Star certification.

v. The Asus Eee PC and other ultra-portables: The "ultraportable" class of personal computers is characterized by a small size, fairly low power CPU, compact screen, low cost and innovations such as using flash memory for storage rather than hard drives with spinning platters. These factors combine to enable them to run more efficiently and use less power than a standard form factor laptop. The Asus Eee PC is one example of an ultraportable. It is the size of a paperback, weighs less than a kilogram, has built-in Wi-Fi and uses flash memory instead of a hard drive. It runs Linux too

6 CONCLUSION

In this paper it is analyzed that the main motive of Green Computing is the low amount of power consumption to save time and money. There some IT industries those are working on this concept. In this paper we have also focused on some technologies and techniques to make the Green Computing successful. So Green Computing is the emerging technology which is more over like aid and need to sustain the eco-friendly environment. To make the computer society completely green, one should do the following things. When computer components are not in our use then the components must be donated to those people who may not have those components. Instead of discarding computers, upgrade their parts in order to make them new. As some components used to build the motherboard of computer are very expensive and toxic then recycling of these components is a better option. Different wallpapers consumes a large amount of energy so instead of setting different wallpapers, set Blackle as home page. Because blackle is a website powered by google custom search whose screen is predominantly black and fonts are of gray color. This arrangement consumes very less energy. So, Go green is a concept which is used in few organizations but if everyone use its components then it could be beneficial for everyone. The benefits of green computing are clear. As the number of PCs approaches 2 Billion by 2015, the potential savings related to energy use, CO2 emissions and e-waste are undeniable. Hence proper implementation of Green computing will be helping hand in terms to save energy and remove the pollution.

Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions. Authors are strongly encouraged not to call out multiple figures or tables in the conclusion—these should be referenced in the body of the paper.

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