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Green Computing: Eco-Friendly Computing Resources

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Abstract- Green Computing is a recent trend towards designing, building and operating computer systems to be energy efficient. While programs such as Energy Star have been around since the early1990s, recent concerns regarding global climate change and the energy crisis have led to renewed interest in Green Computing. This activity is not just limited to saving electricity, but also takes a holistic approach towards environment-friendly use of computers. Devising innovative and environment-conscious techniques for energy generation is also one of its aspects. Opportunities lie in green technology like never before in history and organizations are seeing it as a way to create new profit centers while trying to help the environmental cause. The plan towards green IT should include new electronic products and services with optimum efficiency and all possible options towards energy savings.

Keywords: Cloud Computing, Data Centers, Energy Green Computing, Power Consumptions

I. INTRODUCTION

Green computing (GC) is the study and practice of using computing resources efficiently [4]. The primary objective of such a program is to account for the triple bottom line, an expanded spectrum of values and criteria for measuring organizational (and societal) success. The goals are similar to green chemistry; reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote recyclability or biodegradability of defunct products and factory waste.

Modern IT systems rely upon a complicated mix of people, networks and hardware; as such, a green computing initiative must be systemic in nature, and address increasingly sophisticated problems. Elements of such as solution may comprise items such as end user satisfaction, management restructuring, regulatory compliance, disposal of electronic waste, telecommuting, virtualization of server resources, energy use, thin client solutions, and return on investment (ROI)

A. Need for Green Computing:

- ***a. Climate Change*:** First and foremost, conclusive research shows that CO2 and other emissions are causing global climate and environmental damage. Preserving the planet is a valid goal because it aims to preserve life. Planets like ours, that supports life, are very rare. None of the planets in our solar system, or in nearby star systems have m-class planets as we know them.
- ***b. Savings*:** Green computing can lead to serious cost savings over time. Reductions in energy costs from servers, cooling, and lighting are generating serious savings for many corporations.
- ***c. Reliability of Power*:** As energy demands in the world go up, energy supply is declining or flat. Energy efficient systems help ensure healthy power.

II. BENEFITS OF GC

As energy crisis deepens and the resources deplete, we need to seriously think about making substantial changes in our lifestyle for energy conservation. Green computing is one way of dealing with the energy crisis. It is possible to reduce carbon emissions, save energy and protect the environment as a whole with this approach.

A. The benefits of Green Clouds usage: lower costs with high profit:

One more aspect of Cloud Computing in order is how to accomplish money savings with a green role of using SaaS (Software as a Service). As it goes a step beyond IaaS by offloading applications to hosted services. With SaaS software accesses usually through a browser based client, meaning that it can be run on virtually any authorized computer, making desktop and laptop resources easily replaceable. Thus, when you also save on the support, it doubles the impact and in fact increases green role in business [6]. For one hand, using cloud computing, there is no need any more for It department structure as the employees can work remotely, travelling and moving from one place to another because they have fast access to the internet and the ability to use all the services at hand, on the other hand it reduces the consumption of fossil fuels and the harmful pollution that results from vehicle emissions as well.

Meanwhile cloud computing offers vast opportunities, as always, every debate has two sides, so there is opposite opinion of the researches considering that cloud computing is just a theory. They consider that using data centers, for example, increases the possibility to get access from any point of the world with more frequency than using infrastructure hosting providers.

Nevertheless, Cloud Computing can still do more and can be more “green”, focusing not only on energy savings but also helps in recycling e-waste, claim the others. Within Cloud Computing we can cut the e-waste production by reduction of hardware and software. In order to optimize the hardware usage, cloud computing dealing with server virtualization that consolidates all servers into a single location, in such a way replacing all hardware by online devices and resources. So, buying or renting access to datacenters we minimize the usage of hardware, at the same time reducing the e-waste. Therefore, this solution improves

both environmental and operational benefits. This activity is not just limited to saving electricity, but also takes a holistic approach towards environment-friendly use of computers. Devising innovative and environment-conscious techniques for energy generation is also one of its aspects[7].

III. ADVANTAGES OF GREEN COMPUTING

There are many innovative technologies and tools which make green computing a viable option for judicious energy usage and environmental conservation. The advantages offered by such technologies are discussed in these points [3].

A. CloudComputing:

Touted as a technology that could save substantial amount of energy, cloud computing involves replacing regular servers with the virtual ones. The different areas where cloud computing finds application include data storage, networking, operating systems, software applications. As per studies conducted by the WSP Environment & Energy, it is possible to save as much as 90% of the energy spent in a company of 100 employees. The AT&T-supported Carbon Disclosure Project reported that big US corporations can save as much as $12.3 billion (by the year 2020) if they resort to the use of cloud computing; server utilization too can be increased up to 80%.

B. Recycling:

Through this practice, we can save precious energy, time and money spent in manufacturing these electronic items. Resources used and money spent in manufacturing an electronic item from scratch are far greater than those needed for recycling it. Even in developed countries like USA, only a small percentage of discarded or used electronic items are recycled. France, which is said to be an ecology-responsible country, collects only 14% of the e-waste generated in the country. Thus, there is a great scope for recycling electronic items and thereby, preventing environmental damage. Conservation of environmental resources, electricity and money can be achieved through this simple-to-implement step.

C. TurningYourComputersOff:

The practice of switching off computers at night helps in saving a considerable amount of energy. The estimated amount of energy spent in a single year due to round-the-clock use of computer is $115-$160 (Schneider, 2008). Running your computer just 8 hours a day can help save 810 kWh energy on an annual basis. It is a myth that turning the computer off can damage it. Computers are designed for sustaining around 40,000 on/off cycles. Therefore, you need not worry about the computer even if you have to turn it off on a regular basis. The power supplied to scanners and printers should be cut off whenever these devices are not in use. This practice can also save a considerable amount of energy.

D. ImprovingAlgorithmicEfficiency:

Green computing measures can be used for improving the algorithmic efficiency of computers. An efficient algorithm makes minimum use of resources. Therefore, the productivity increases manifold. A simple computing activity like searching for information on a search engine can have an adverse impact on the environment owing to the energy consumed and CO2 emitted in the process. Thus, without improving the algorithmic efficiency, one cannot expect much in terms of energy conservation even from cloud computing.

E. ArchitecturalChanges:

Remodeling the IT architecture that is currently used should prove to be beneficial in the long term. It is not just about following a set of best practices, but also about overhauling the architecture as a whole. A strategy needs to be devised for the development of sustainable technology. This approach is not limited to changing architecture of data centers. In fact, business operations, IT facilities, communications and many other aspects of computer usage need to be taken into account. For example, one can reduce the number of systems being used and increase their efficiency. It is kind of a long-term approach in which the currently used "green" initiatives might change with time. However, the underlying idea of reducing energy consumption and causing minimum damage to the environment remains the same. Merely adding to the density of virtual servers also won't help much. In fact, increasing the rack density through virtualization would necessitate the installation of cooling systems, which again increases the cost and energy consumption. Changes in the architectural designs will increase the accessibility to sophisticated technologies that cause minimum harm to our planet's resources.

F. Technotrash:

Commonly referred to as electronic waste, techno trash refers to the toxic elements that are found inside electronic goods. Therefore, the disposal of such kind of waste has to be carried out with proper care.

IV. ACTION PLAN FOR GREEN COMPUTING

a. Using ENERGY STAR qualified products help in energy conservation.
b. The Climate Savers Computing Initiative (CSCI) catalog can be used for choosing green products.
c. Organic light-emitting diodes should be used instead of the regular monitors [3].
d. Surge protectors offer the benefit of green computing by cutting off the power supply to peripheral devices when the computer is turned off.
e. Donating your old computers and other peripherals can reduce the rate of e-waste creation. Moreover, those who cannot afford to buy a computer can benefit from such donations.
f. Through proper disposal of computers and its accessories, it is possible to reduce environmental pollution.
g. It was expected that computers would help reduce paper wastage. However, even today wastage of paper is a serious issue in industries. The easy availability of photocopiers and printers is also one of the culprits behind unchecked paper wastage [2]. Think twice before using printers. Use the device only if it is necessary.
h. The manufacturing of disks and boxes needed for video games takes up a lot of resources. Video game

manufacturers can offer their games online for download, leading to reduction in e-waste. This move can cut down on the transportation/shipping cost.

i. Use of 'Local Cooling' software can help in monitoring and thereby, bringing down the energy consumed by your computer. This 'Windows' program makes adjustments to the power options of your computer and helps minimize energy consumption.

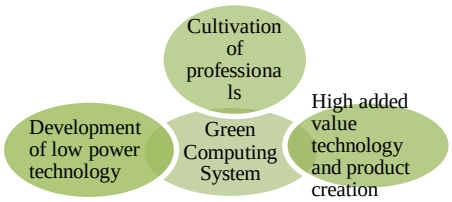

Figure 1: Green computing System

A. Ways Of Implementation:

Power management software helps the computers to sleep or hibernate when not in use. Reversible computing (which also includes quantum computing) promises to reduce power consumption by a factor of several thousand, but such systems are still very much in the laboratories. Reversible computing includes any computational process that is (at least to some close approximation) reversible, i.e., time-invertible, meaning that a time-reversed version of the process could exist within the same general dynamical framework as the original process. Reversible computing efficient use of heat could make it possible to come up with 3-D chip designs, Bennett said. This would push all of the circuitry closer together and ultimately increase performance [4].

The best way to recycle a computer, however, is to keep it and upgrade it. Further, it is important to design computers which can be powered with low power obtained from non-conventional energy sources like solar energy, pedaling a bike; turning a hand-crank etc. it is shown in Fig1.

New Internet Protocol-enabled networks now allow for network integration along the entire supply chain – from generation, transmission, to end-use and metering – and create the opportunity for Intelligent Utility Networks (IUN) which applies sensors and other technologies to sense and respond in real-time to changes throughout the supply chain. The IP-enabled network connects all parts of the utility grid equipment, control systems, applications, and employees. It also enables automatic data collection and storage from across the utility based on a common information model and service-oriented architecture (SOA), which enables a flexible use of information technology. This in turn allows utilities to continuously analyze data so that they can better manage assets and operations.

Electronics giants are about to roll out eco-friendly range of computers (like desktops and laptops) that aim at reducing the e-waste in the environment. Besides desktops and laptops, other electronic hardware products should also be strictly adhering to the restricted use of hazardous substances. In other words, they should be free of hazardous materials such as brominates flame retardants, PVCs and heavy metals such as lead, cadmium and mercury, which are commonly used in computer manufacturing. Reliability about the use of green materials in computer is perhaps the biggest single challenge facing the electronics industry. Lead-tin solder in use today is very malleable making it an ideal shock absorber. So far, more brittle replacement solders have yet to show the same reliability in arduous real-world applications [3].

B. Real-World Applications:

a. Energy-intensive manufacturing of computer parts can be minimized by making manufacturing process more energy efficient by replacing petroleum filled plastic with bioplastics—plant-based polymers— require less oil and energy to produce than traditional plastics with a challenge to keep these bioplastic computers cool so that electronics won't melt them.
b. Power-sucking displays can be replaced with green light displays made of OLEDs, or organic light-emitting diodes.
c. Use of toxic materials like lead can be replaced by silver and copper.
d. Making recycling of computers (which is expensive and time consuming at present) more effective by recycling computer parts separately with an option of reuse or resale.
e. Future computers could knock 10 percent off their energy use just by replacing hard drives with solid-state, or flash, memory, which has no watt-hungry moving parts.
f. Buy and use a low power desktop or a laptop computer (40-90 watts) rather a higher power desktop (e.g. 300 watts).
g. The maximum power supply (up to 1kW in some modern gaming PCs) is not as important as the normal operating power, but note that power supply efficiency generally peaks at about 50-75% load.
h. Idle state represents 69 to 97% of total annual energy use, even if power management is enabled.
i. Computer power supplies are generally about 70–75% efficient; to produce 75 W of DC output they require 100 W of AC input and dissipate the remaining 25 W in heat.
j. Higher-quality power supplies can be over 80% efficient; higher energy efficiency uses less power directly, and requires less power to cool as well.
k. Thin clients can use only 4 to 8 watts of power at the desktop as the processing is done by a server.
l. For desktops, buy a low power central processing unit (CPU). This reduces both power consumption and cooling requirements.
m. Buy hardware from manufacturers that have a hardware recycling scheme, and recycle your old computer equipment rather than sending it to landfill.
n. Turn your computer and monitor off when you are not using it.
o. Enable hibernation using the power management settings. Standby does not save as much power.
p. Use server virtualization to aggregate multiple under-utilized servers onto more energy efficient server infrastructure.
q. Use blade servers instead of rack or standalone servers to reduce power consumption.
r. Specify low energy consumption level in Request for Tender documents.
s. Measure your data centre power usage.

t. Use server and/or web-based applications where possible to extend desktop service life and reduce desktop software maintenance.
u. Establish policies governing the acquisition, usage and disposal of computer hardware to minimize energy consumption and environmental impact.

V. FUTURE OF GREEN COMPUTING

Technology is ever-changing and expanding and so any device which is new today will become obsolete tomorrow. Thanks to the advancements happening in the area of information technology, new computers enter the market and soon remain nothing more than a piece of junk [1]. This is precisely why a new area of computing has emerged, which is popularly known as Green Computing. A Canadian company, Userful Inc. (www.userful.com) has come up with a solution that turns 1 computer into 10 - Discover Station. Quickly becoming the standard for green computing worldwide, Discover Station leverages the unused computing power of modern PC's to create an environmentally efficient alternative to traditional desktop computing. Multiple users can work on a single computer by simply attaching up to 10 monitors, mice and keyboards [5]. This makes it possible to reduce CO2 emissions by up to 15 tons per year per system and reduce electronic waste by up to 80%. Useful has recently stated that in the last year their software has saved over 13,250* tons of CO2 emissions, the equivalent of taking 2,300 cars off the road. The technology encourages people to use computers as well as accessories that are environmentally-friendly and that cause little or no harm to the environment during their usage or when they are disposed off.

VI. CONCLUSION

Many governments worldwide have initiated energy-management programs, such as Energy Star, an international standard for energy-efficient electronic equipment that was created by the United States Environmental Protection Agency in 1992 and has now been adopted by several other countries. Energy Star [1] reduces the amount of energy consumed by a product by automatically switching it into "sleep" mode when not in use or reducing the amount of power used by a product when in "standby" mode. Surprisingly, standby "leaking," the electricity consumed by appliances when they are switched off, can represent as much as 12 percent of a typical household's electricity consumption.

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