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GREEN COMPUTING: SOME FACTS AND CHALLENGES

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Abstract

As 21st century belongs to computers, and electronic items, energy issues will get a serious alarm in coming days, as public debate on carbon emissions, global warming and climate change gets hotter. Taking into consideration the popular use of information technology industry, it has to lead a revolution of sorts by turning green in a manner no industry has ever done before. Besides the widespread sensitivity to ecological issues, such interest also stems from economic needs, since both energy costs and electrical requirements of IT industry around the world show a continuously growing trend. Such practices include the implementation of energy-efficient central processing units (CPUs), Servers and Peripherals as well as reduced resource consumption and proper disposal of electronic waste (e-waste). Green computing is the study and practice of efficient and eco-friendly computing. It is the environmentally responsible use of computers and related resources. This paper is a survey of important facts related to the field of green computing that emphasizes the importance of green computing for sustainable development.

Keywords:

Green Computing;

Virtualization;

Epeat;

RoHS;

WEEE.

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1. Introduction

Green computing is the term used to denote efficient use of resources in computing. This term generally relates to the use of computing resources in conjunction with minimizing environmental impact, maximizing economic viability and ensuring social duties. Green computing, the study and practice of efficient and eco-friendly computing resources, is now under the attention of not only environmental organizations, but also businesses from other industries. Green computing is very much related to other similar movements like reducing the use of environmentally hazardous materials like CFCs, promoting the use of recyclable materials, minimizing use of non-biodegradable components, and encouraging use of sustainable resources. Performance-wise, computer design has progressed amazingly well and surprisingly fast but looking at it from a green perspective, the work has barely begun.

Manufacturing computers means the use of lead, cadmium, mercury, and other toxics in general and laptop in particular. Normally, computers can contain 4 to 8 pounds of lead alone, it's no wonder that computers and other electronics make up two-fifths of all lead in landfills. To counter this growing pollution threat all over the world due to the growing use of electronic device in general and computers in particular there is a need to look for a green computer. The features of a green computer would be like: efficiency, manufacturing and materials, recyclability, service model, self-powering, and other trends. Green computer will be one of the major contributions which will break down the 'digital divide', that separates the information rich from the information poor.

1.1 Significance of Green Computing

In a world where business is transacted 24 hours across every possible path available, companies need to collect, store, track and analyze enormous volumes of data. Data warehouses and the expansive data centers that keeps them use up a huge amount of power, both to run servers and to cool them - approximately a 61 billion kilowatt-hours of electricity, at an estimated cost of $4.5B annually [1]. The IT industry has begun to address energy consumption in the data center through a variety of approaches including the use of more efficient cooling systems, virtualization, blade servers and storage area networks (SANs). Virtualization is a major strategy to reduce data center power consumption. In virtualization, one physical server hosts multiple

virtual servers. Virtualization enables data centers to strengthen their physical server infrastructure by hosting multiple virtual servers on a smaller number of more powerful servers, using less electricity and simplifying the data center. Besides getting much better hardware usage, virtualization reduces data center floor space, makes better use of computing power, and greatly reduces the data center's energy demands [2].

But a fundamental challenge remains. As data volumes explode, traditional, appliance-centric data warehousing approaches can only continue to throw more hardware at the problem. This can quickly negate any green gains seen through better cooling or more tightly packed servers. A combination of new database technologies expressly designed for analysis of massive quantities of data and affordable, resource-efficient, open-source software can help organizations save money and become greener. This technology is beneficial as it:-

- Reduce energy consumption of computing resources during peak operation
- Save energy during idle operation
- Use eco-friendly sources of energy
- Reduce harmful effects of computing resources
- Reduce computing wastes

2. A Brief History of Green Computing

Very first green computing movement was the launch of the Energy Star program way back in 1992. Energy Star served as a kind of voluntary label awarded to computing products that succeeded in minimizing use of energy while maximizing efficiency. Energy Star applied to products like computer monitors, television sets and temperature control devices like refrigerators, air conditioners, and similar items. One of the first results of green computing was the Sleep mode function of computer monitors which places a consumer's electronic equipment on standby mode when a pre-set period of time passes when user activity is not detected. As the concept developed, green computing began to encompass thin client solutions, energy cost accounting, virtualization practices, eWaste, etc [3][4].

San Murugesan [5] quoted that “Green IT is the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems—such as monitors, printers, storage devices, and networking and communications systems — efficiently and effectively with minimal or no impact on the environment”. Murugesan lays out the following four paths along which he believes the environmental effects of computing should be addressed:

1. Green Use: Reducing the energy consumption of computers and other information systems as well as using them in an environmentally sound manner.
2. Green Disposal: Refurbishing and reusing old computers and recycling unwanted computers and other electronic equipment.
3. Green Design: Designing energy efficient and environmentally sound components, computers, servers and cooling equipments.
4. Green Manufacturing: Manufacturing electronic components, computers and other associated sub systems with minimal impact or no impact on the environment.

Donellan et al. in their paper has argued that the 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" [6]. 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 [7].

3. Challenges of Green Computing

Computers use a major portion of barely available energy to the world. While this era has more need of computing in daily life, therefore this has become the major challenge for the field. This is one of the reasons that the focus of green computing is shifting from efficient computing to reducing the IT infrastructure and equipment associated costs. For the same purpose major IT companies are focusing in developing machines. While these issues are regularly observed by field specialists, still following areas are need to be focused and some [8]:

- It is required to control the cooling equipment and other requirements of the data centers which mainly increases the overall power of the IT equipment and is an increasing challenge.
- Equipment for heat removing also requires to be controlled as this is also a major increase in the total power consumption.
- Proper disposing and finding ways to proper recycling of the electronic items also is an issue, which needs to be resolved.
- New Optimization Techniques are needed in Performance-Energy-Temperature aware computing.

4. Five Simple Steps to Green Computing

Here are five first steps you can take toward a green computing strategy [9].

1. Develop a sustainable green computing plan. Discuss with your business leaders the elements that should be factored into such a plan, including organizational policies and checklists. Such a plan should include recycling policies, recommendations for disposal of used equipment, government guidelines and recommendations for purchasing green computer equipment. Green computing best practices and policies should cover power usage, reduction of paper consumption, as well as recommendations for new equipment and recycling old machines. Organizational policies should include communication and implementation.

2. Recycle. Discard used or unwanted electronic equipment in a convenient and environmentally responsible manner. Computers have toxin metals and pollutants that can emit harmful emissions into the environment. Never discard computers in a landfill. Recycle them instead through manufacturer programs such as HP's Planet Partners recycling service or recycling facilities in your community. Or donate still-working computers to a non-profit agency.

Recycling can also help reduce the impact that computers have on energy usage and can be carried as follows:-

(a) **An old computer:** Recycling or reusing electronics is an important environmental concern. Properly disposing of an old computer helps prevent mercury, cadmium, lead, and hazardous chemicals from leaching into our environment. Many sources will do this for a nominal fee, or

even for free. For example, both Dell and Apple accept an old machine when purchasing a new one.

(b) **Ink and toner cartridges:** Cartridges can be refilled, re-manufactured, and reused. Many manufacturers will take used cartridge, refurbish it, and refill it. Remanufactured toner and ink cartridges are considerable less than what they would cost new.

(c) **Paper:** Whenever possible, use post-consumer recycled-content paper. The cost and quality differences of recycled to virgin paper today is negligible. And remember to re-use blank sides of used paper for inkjet printing and scratch paper.

3. Make environmentally sound purchase decisions. Purchase Electronic Product Environmental Assessment Tool registered products. EPEAT is a procurement tool promoted by the nonprofit Green Electronics Council to:

•Help institutional purchasers evaluate, compare and select desktop computers, notebooks and monitors based on environmental attributes

•Provide a clear, consistent set of performance criteria for the design of products

•Recognize manufacturer efforts to reduce the environmental impact of products by reducing or eliminating environmentally sensitive materials, designing for longevity and reducing packaging materials.

4. Reduce Paper Consumption. There are many easy, obvious ways to reduce paper consumption: e-mail, electronic archiving, use the "track changes" feature in electronic documents, rather than redline corrections on paper. When you do print out documents, make sure to use both sides of the paper, recycle regularly, use smaller fonts and margins, and selectively print required pages.

5. Conserve energy. Turn off your computer when you know you won't use it for an extended period of time. Turn on power management features during shorter periods of inactivity. Power management allows monitors and computers to enter low-power states when sitting idle. By simply hitting the keyboard or moving the mouse, the computer or monitors awakens from its

low power sleep mode in seconds. Power management tactics can save energy and help protect the environment.

5. Green I.T Standards And Regulations

Green I.T standards and regulations, Epeat [10], the Energy Star 4.0 standard, and the RoHS directive [11] provide a guideline in designing green computers and IT peripherals and also classify them based on their environmental attributes. Below is given a brief overview of the various standards and regulations.

I) Epeat: This is an evaluation tool that allows the selection of electronic products based on environmental performance. Launched by the Green Electronics Council [12], the Electronic Product Environmental Assessment Tool (Epeat) assist buyers to evaluate, compare and select desktop computers, notebooks and monitors based on their environmental impact. It also helps manufacturers of electronic products to promote their products as environmentally sound. Epeat evaluates electronic products based on 23 required criteria and 28 optional criteria which are further regrouped into 8 performance categories such as reducing and eliminating environmentally sensitive materials, selecting

materials, designing for the product's end of life (such as recycling), product longevity, energy conservation, end-of-life management, corporate performance, and packaging. The registered products are identified as bronze, silver or gold by Epeat. The bronze products meet all 23 required criteria. The silver products meet in addition at least 14 optional criteria. The gold products should meet the 23 required criteria and at least 21 optional criteria additionally. All Epeat registered products have lower level of hazardous materials like cadmium, lead and mercury. These products are more energy efficient and easier to upgrade and recycle.

II) Energy Star 4.0 Standard: The new Energy Star 4.0 standard regulates energy performance of external and internal power supplies and gives power consumption specifications for idle, sleep, and standby modes for a number of different devices including PCs, desktops, and gaming consoles. Quite naturally, computers meeting the new requirements will save energy in all modes of operation. Regulations for computers in idle mode are new, as previous standards addressed

only sleep and standby modes. The new specifications require OEMs to educate users about power management [3].

III) RoHS Directive: The Restriction of Hazardous Substances in Electrical and Electronic Equipment Directive [11] aims to restrict the use of certain hazardous substances within permissible limits. It also bans selling new electrical and electronic equipment on the European Union market if it contains more than the agreed-upon levels of lead, cadmium, mercury, hexavalent chromium or flame retardants [5].

IV) W.E.E.E Law: The European Waste Electrical and Electronic Equipment Directive became law in 2003. According to this law the equipment manufacturers has the responsibility for electrical and electronic waste. Producers must take back the equipment free of charge. The intention of the directive is to decrease waste from electrical and electronic equipment and to provide incentives for designing equipment that improves environmental performance throughout the lifecycle. Producers were required to join a compliance scheme and register in every EU country. Violations are actionable and prosecutable [2].

6. Conclusion

It can be observed that green computing is the need of the hour to protect the environment. As more and more time passes the need of computers as a dependable machine increases and so does its use. This makes it all the more necessary to maintain green computing procedures throughout the life cycle of a computer from manufacturing through day-to-day operation till the end of its operating stage. According to David Wang, “Every step consumes energy and buying a new, more efficient computer may not always be the right answer”[13]. Thus, it can be safely concluded that in order to have a healthy and clean environment all stake holders must work collaboratively for a healthier and greener environment for our future generations. Green computing represents a responsible way to address the issue of global warming. By adopting green computing practices, business leaders can contribute positively to environmental stewardship— and protect the environment while also reducing energy and paper costs.

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