RESEARCH ARTICLE

GREEN COMPUTING: AN ENERGY EFFICIENT SCHEME FOR SUSTAINABLE DEVELOPMENT OF ICT

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ABSTRACT

Green computing concept is to improve environmental condition. The main aim of green computing is to reduce poisonous materials. We systematically analyze its energy consumption which is based on types of services and obtain the conditions to facilitate green computing to save overall energy consumption in this system. Today it is the major issue to prepare such equipments by which we achieve efficient energy and to minimize of e-waste and use of non poisonous chemicals / materials in preparation of e-equipments. We can implement green computing in computer's fields as CPU servers and other peripheral devices (mobile devices). By using green computing we can reduce resources consumption and disposal of electric waste (e-waste). The other poisonous materials which are used in computer/electronics industry are also harmful for environment. In this paper, we will involve widely survey the concepts and architecture of green computing, as well as its heat and energy consumption issues. Green computing can facilitate us to safe, secure place and healthy environment all over in the world. This paper will help us to take some initiatives currently under in the field of computers/electronics industry and new ways to save vast amounts of energy which is wasted in very large scale.

INTRODUCTION

The information and communication technology (ICT) has changed the way we live, work, learn and play but at the same time, it is affecting our environment in several ways. It has created many opportunities for employment round the globe as the computer literacy becomes a prerequisite condition for sustenance in almost every public/private sectors (Mrs. Sharmila Shinde *et al.,* 2013). The computer's ability to store, retrieve and manipulate large amounts of data rapidly and cheaply has led to its wide spread use in managing many clerical, accounting and service documentation functions in organizations. But, at each stage of computer's life, from its production, throughout its use, and into its disposal, it exhibits some kind of environmental problems. Several scientists and authors have quoted their reports on ICT and its impact on the environment. Still, the debate on the effectiveness of green computing for eco-friendly and sustainable IT remains an open issue. In this paper, we report the awareness towards green computing and present the summary of key areas where IT organizations can achieve savings in terms of energy and cost. In addition, we discuss a formal approach of green computing along with its standardization and compliances and some of its challenges.

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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 (Green computing practiceof Efficient and Eco-Friendly computing Resources by parichay chakraborty, Debnath Bhattacharyya).

The goals are that is reducing the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote recyclability or biodegradability of defunct products and factory waste (Sattarova NargizaYand Sovan Bedajna International Journal of of Grid and Distributed Computing vol.2.No.3 September 2009). In recent years, companies in the computer industry have come to realize that going green is in their best interest, both in terms of public relations and reduced costs. This paper presents at several green initiatives currently under way in the computer industry, as well as issues that have been raised regarding these initiatives and presents a study about the green computing and e waste recycling process. Ultimately green computing focuses on ways in reducing overall environmental impact, its main purpose is to find and promote new ways of reducing pollution, discovering alternative technologies, and creating more recyclable products (Green Computing saves Green by Priya Rana, 2010).

Figure 1. The green computing revolution cycle

Concept of Green Computing

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. To promote green computing concepts at all possible levels, the following four complementary approaches are employed (Matti Tedre, 2009)

Green use: Minimizing the electricity consumption of computers and their peripheral devices and using them in an eco-friendly manner

Green disposal: Re-making an existing computer or appropriately disposing of, or recycling, unwanted electronic equipment

Green design: Designing energy-efficient computers, servers, printers, projectors and other digital devices

Green manufacturing: Minimizing waste during the manufacturing of computers and other subsystems to reduce the environmental impact of these activities.

Government regulatory authorities also actively work to promote green computing concepts by introducing several voluntary programs and regulations for their enforcement. Average computer users can employ the following general tactics to make their computing usage

Need for Green Computing

The following points would clear why should a company promote green, or energy efficient computing?

Climate Change: First and foremost, conclusive research shows that CO_2 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.

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.

Reliability of Power: As energy demands in the world go up, energy supply is declining or flat. An energy efficient system helps ensure healthy power.

Computing: Computing Power Consumption has Reached a Critical Point: Data centers have run out of usable power and cooling due to high densities (Raghavendra *et al.,* 2008).

Basis of Green Computing

Here is some basis for green computing which shows how designers plan to make future computer more eco-friendly across its entire life span, from manufacture to recycling:

- 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.
- Landfills can be controlled by making best use of the device by upgrading and repairing in time with a need to make such processes (i.e., up gradation and repairing) easier and cheaper.
- Avoiding the discarding will not only control e-waste out of dumps but also save energy and materials needed for a whole new computer.
- Power-sucking displays can be replaced with green light displays made of OLEDs, or organic light-emitting diodes.
- Use of toxic materials like lead can be replaced by silver and copper.
- Making recycling of computers (which is expensive and time consuming at present) more effective by recycling computer parts separately with a option of reuse or resale.
- 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.

Green Revolution

IT vendors also are applying green standards to their own operations. The reasons are:

- New revenue opportunities
- Fear of a customer backlash
- Desire to act like good corporate citizens

The awareness programme may include the following major issues

- Green computing minimizes the energy consumption of the organization i.e. minimizes the power bill.

- Use of non-toxic material in the equipments makes the worker safe from health problem and occupational hazards.
- It saves the resource of the country as a whole.
- In the long term these green equipment will be less costly without any hidden cost of waste and enhanced resource consumption without any detrimental effect of accuracy, performance and longevity.

Developing a Green Machine

Activating the power management features on our computer saves energy and money while helping the environment. Our computer's SLEEP and HIBERNATE settings are two of the most effective ways for us to make your computer more environmentally friendly. We can activate these functions manually or through our operating system's pre-set power management settings (http://www.wisegeek.com/what-is-green-computing.htm, ?).

Sleep Mode: Sleep or standby mode conserves energy by cutting off power to display, hard drive, and peripherals. After a pre-set period of inactivity, the computer switches to a low power state. When we move your mouse or press any computer key, you exit sleep mode and the computer takes you back to its previous operating state. Sleep mode is an especially effective way to conserve battery power in a laptop computer. However, if the computer loses power for any reason while in sleep mode, we may lose unsaved work (Ruth, 2009).

Hibernate Mode: Hibernate mode saves energy and protects our work by copying system data to a reserved area on our hard drive and then completely turning off the computer. It also reduces wear and tear on our components. When we turn power back on, the files and the documents appear on our desktop just as we left them. Be sure to set our system to automatically go into hibernate mode any time battery power reaches a critically low level.

Green computing strategies:

- Green computing reduce the amount of pollutants in the atmosphere
- It shrinks the paper industry burden
- It saves power consumption and reduce co2
- created from computer
- Promote the use of renewable resources
- Promote the alternative energy source as solar system

Formal Approaches to Green Computing

Green management: Green management measures such as certified environmental management systems (EMS) or tools like life cycle assessment activities are considered to improve corporate environmental performance directly by mandating companies to introduce environmental goals and management structures as well as programs to achieve them. Green management definitely related to the environmental policy establishment, which will enhance the corporate environment performance through application of green technology activities.

Green Purchasing: Green purchasing is the purchase of environmentally friendly products and services, "Green" products or Services utilize fewer resources, are designed to last longer and minimize their impact on the environment from cradle to grave. In addition, "green" products and services have less of an impact on human health and may have higher safety standards. Green procurement steams from pollution prevention principles and activities. Also known as green or environmental purchasing, green procurement compares price, technology, quality and the environmental impact of the product, service or contract. Green procurement policies are applicable to all organizations, regardless of size ("GREEN COMPUTING SAVES GREEN" 2010. http://bipublication. com")
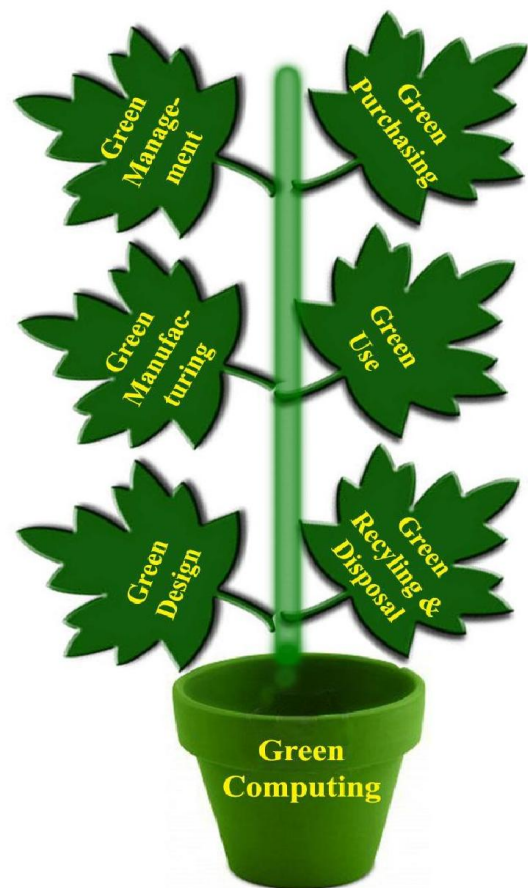

Figure 2. Formal approaches to green computing

Green manufacturing: The term green manufacturing can be looked at in two ways: the manufacturing of "green" products, particularly those used in renewable energy systems and clean technology equipment of all kinds, and the "greening" of manufacturing reducing pollution and waste by minimizing natural resource use, recycling and reusing what was considered waste, and reducing emissions ("Benefits-of-green-computing"2011.http://greencomputingisgood.blogspot.in/ htm").

Green design: green design, is an approach to building that minimizes harmful effects on human health and the environment. The "green" architect or designer attempts to

safeguard air, water, and earth by choosing eco-friendly building materials and construction practices.

Green architecture may have many of these characteristics (Zhu *et al*., 2012). Ventilation systems designed for efficient heating and cooling Energy-efficient lighting and appliances, Water-saving plumbing fixtures, Landscapes planned to maximize passive solar energy, Alternate power sources such as solar power or wind power, Non-synthetic, non-toxic materials, Locally-obtained woods and stone, Adaptive reuse of older buildings, Use of recycled architectural salvage, Efficient use of space while most green buildings do not have all of these features, the highest goal of green architecture is to be fully sustainable (Green Computing, 2013).

Green recycling and Disposal: Green Recycling is a successful and effective environmental solution in waste management. In this process change waste materials into new products to prevent waste of potentially useful materials, reduce the consumption of fresh raw materials, reduce energy usage, reduce air pollution (from incineration) and water pollution by reducing the need for "conventional" waste disposal, and lower greenhouse gas emissions as compared to plastic production.

Figure 3. Green recycling and Disposal

Recycling is a key component of modern waste reduction and is the third component of the "Reduce, Reuse and Recycle" waste hierarchy.

Conclusion

Modern computing poses not only technology problems, but it has to facing major environmental challenges in term of its high power consumption. With increase in IT infrastructure, it is clear point that effective green computing policy must be formulated to minimize its environmental effects. Green computing techniques and issues which were discussed in this paper help us to reduce power consumption and heat which is evolved during processing.

Power consumption in computer can be managed such as the sleep mode, hibernate mode, standby mode are very effective in it because computers may be automatically go into low power states,, when a computer is in an idle state without human interest or interfere. By going "green" in technology we help promote an eco- friendly and cleaner environment, along with our own benefits by reducing costs, conserving energy, cutting down on waste. Green computing has definitely come a long way, but with so many new innovations coming along in regards of preserving the environment, it is safe to say that green computing is a great development.

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