Green Computing Technologies towards the Development of ICT: A Critical Study

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Abstract

Information and Communication Technology (ICT) is the core element of any organizations green strategy. ICT is related with every aspect of our lives. It is one of the fastest growing sources of carbon dioxide emissions. This field is growing day by day and contributes a very good percentage to the total emissions. This paper describes how ICT can play a very important role in moving towards the environmental sustainability and how it is benefiting from developments in nanotechnology. We have proposed an architectural model for organizations to move towards green computing.

Keywords: Green computing, Green nanotechnology, Green cloud, ICT, Energy efficiency

I. Introduction

The technology is changing day by day and different types of electronic devices are introduced in the market. As a result of this the electronic waste is growing tremendously. Continuous product innovations and migration from analog to digital are fuelling the increase. Also these devices have energy consumption and also use hazardous metals and materials. Because of the key issues, organizations and societies have a new agenda of following environment friendly practices. One of the major challenges of 21st century is producing sustainable products in order to save energy and making the planet safe for the next generations.

The following section of the paper is organized as follows. In section 2, we briefly review the concept of green computing. Section 3 explores the role of ICT in green computing; in section 4 the focus is on cloud as a way to achieve green computing. Section 5 outlines green nanotechnology and its challenges and opportunities in ICT and section 6 concludes the paper.

II. Green Computing

Environmental or ecological problems will be the most important problems of all the living beings in future. Green is an English word used to describe a color, and it relates to the environment. In green computing, the word Green means environment and eco-system in the field of computing by maximizing energy efficiency, reducing the use of hazardous materials and promoting recyclability of products and electronic wastes. It showcases and validates greener design and cleaner production. Green computing is very popular today and going green is very important for us to have more sustaining environment. Ecological balance is conserved by avoiding depletion of natural resources. Green computing highlights the issue of making ICT infrastructures, products, services and applications environmentally sound.

III. Role of ICT in Green Computing

The main aim of green computing is reducing energy consumption, renovation, and reuse and recycling of electronic wastes, and designing and manufacturing environment friendly electronic devices. The growing concentration of the greenhouse gas is a major reason for world's climate change. This also increases the average temperature of the earth [3]. The major driving force behind the climate change is due to the human activities. The majority of the computer or electronics equipments used in ICT are made with metals like mercury and cadmium. They are very much toxic to people and the environment. For example cadmium intoxication can lead to kidney and bone damages [6]. This can be reduced to certain extent by using toxic free materials. Even though ICT plays a very important role in the emission of carbon dioxide, it also contributes towards smart energy management by sensors, power management softwares etc. It also reduces the use of energy in other activities like travelling, by using web or video conferencing for meetings.

The reasons and benefits for using green IT practices is shown in figure 1[1].

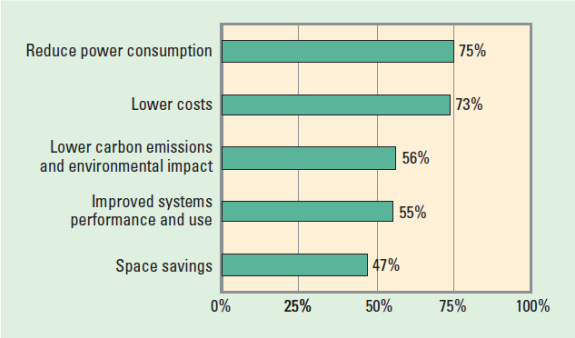


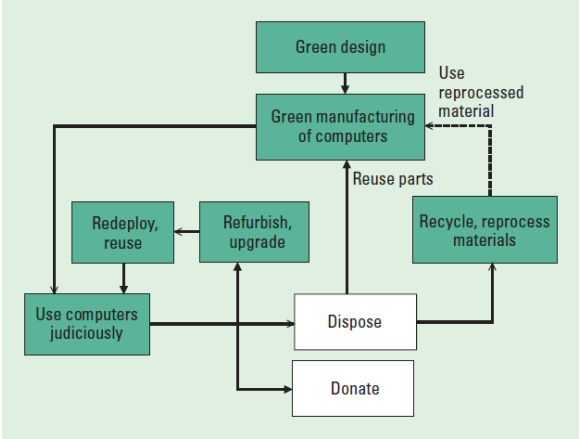
Figure 1: Reasons and benefits for following Green IT practices

Some of the common things to be followed to conserve energy are,

- Power Management
- Reducing harmful waste / Environment friendly waste management
- E-Waste Recycling
- Replacing electronic equipments with energy star compliant equipments
- Sensors to automatically switch off the devices when not in use.
- Power management softwares
- Virtual data storage technologies

There are several organizations providing certificates to green technology. Electronic devices with the Energy Star seal are capable of using up to 70 percent less energy because they manufactured with power management settings that adjust energy consumption [11]. EPEAT (Electronic Product Environmental Assessment Tool) is used by manufactures and consumers to evaluate the effect of products on the environment. Based on a set of environmental performance criteria, it assigns gold, silver or bronze grades to the products. It helps the manufacturer to design green computers and other devices based on their environmental attributes [7]. This way the manufactures are moving towards green computing by introducing different parameters. It showcases and validates greener design and cleaner production.

One of the key issues is handling e-waste. E-waste is the result of technology revolution. Customers are having wider option of brands and technologies. Result is the growing quantity of electronic wastes. A Take-back program to take the products back is a very good way to deal the wastes. Instead of dumping it as wastes, the manufacturer responsibility of taking it back makes a way for recycling or reusing the products. Otherwise it can be donated to charities and trusts also. Life cycle of green computer is shown in figure 2.



Fugure2: Green computer life cycle

The role ICT towards achieving green computing can be summarized as in figure 3.

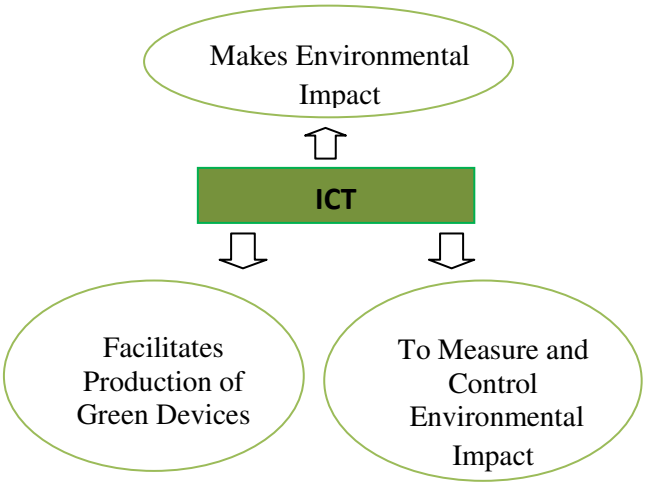


Figure 3: Green Computing: Role of ICT

ICT sector is very vast and it encompasses a continuously evolving group of technologies. In this paper we are focusing on how cloud computing and nano-technology moves towards green.

Organizations should make sure all the above said strategies while making a decision towards going green. Green computing architecture model for the organizations is shown in figure 4.

Figure 4: Green computing model: Strategic Decision Making

IV. Green Cloud

There is a high demand for computation and data storage. Today's focus is on green computing towards data centers. This section explores how ICT can be used as an infrastructure as a sevice. A substantial part of the ICT industry is currently moving beyond the user-centric phase, towards infra-centric. In this phase, technology becomes a vital infrastructure that is of critical importance to society. The infrastructure becomes an issue of the highest societal concern and social innovation a main driver for ICT development. Cloud computing reduces the number of servers required to meet the global demand. Cloud computing potentially offers financial benefit. The cloud service models are,

- Software as a service
- Storage as a service
- Processing as a service

When the client is using software as a service, the energy consumption of the client's PC is reduced, because it is same as a 'thin client' model. The processing is done by the server. In storage as a service, the users as outsourcing data storage requirements to the cloud. In processing as a service, only specific large computations are done by the cloud. This reduces the cost and power consumption. A comprehensive energy consumption analysis of cloud computing is done in [10]. Cloud computing projects should aim at development of energy efficient cloud resources while meeting the quality requirements.

V. Green Nanotechnologies

Nanotechnology is a key player in ICT research and development. Green nanotechnology research is towards producing sustainable products. It focuses on finding different ways to make the nanotechnology products less toxic throughout the lifecycle. It is a new technology having different methods to make environment friendly product and waste management. In this section we explore how green nanotechnology helps us to achieve go green concept in ICT. The application of nanotechnology in ICT includes design and development of chemical sensors, smart electronic materials, nanoscale robots, medical devices, logic elements, computer chips, memory storage devices etc [5].

Electronic devices needed for ICT should be made eco-friendly by the green nanotechnology. A non-silicon memory technology for data storage, development of new concepts and architecture for computing and increasing use of photonics to reduce energy dependency etc are the new emerging technologies in this field to move towards green computing [5]. Use of proper nano-materials is used for less power consumption. Nanotechnology has been identified as the main enabler of thermo electric efficiency improvement. Thermo electric devices have less impact

on environment and contribute to carbon dioxide emission reduction [8].

Nanotechnology made a mark in semiconductor industry. OLED (Organic Light Emitting Diode) and FED (Field Emission Display) are the two nanotechnology enabled display devices. The main components of these devices are made up of organic compounds [5]. A nanotechnology material called 'Graphene' is being researched by Samsung to conduct electricity across flexible transparent touch screens based on a carbon sheet. Nanotechnology-based data storage mainly comprises of MRAM (Magneto-resistive Random Access Memory), FERAM (Ferro-Electric RAM), RRAM (Resistive RAM) and NRAM (Nanotube RAM). MRAM has the advantage of wider temperature operation bandwidth [8].

Conclusion

Green computing is an important concept to save planet from growing concentration of green gas emissions. Everyone has realized the necessity of environmental friendly resources. We can reduce the environmental impact using the green computing devices for ICT. The various approaches of the green IT are virtualization, power management, material recycling and telecommuting. Energy efficient resource management system for virtualized cloud data centers that reduces operational costs and how ICT is benefiting from that is also discussed in this paper. There have been continuous improvements in the energy efficiency of equipment as new generations of technology come on line. The study reveals that ICT plays a very important role in making the environment sustainable.

References

[1] San Murugesan , "Harnessing Green It: Principles and Practices", IEEE Computer Society, 2008.

[2] Richard Hodges, "Green Tech New: Go Green in ICT", White Paper,

[3]http://www.eia.gov/oiaf/1605/ggccebro/chapter1.html

[4] Dragan S. Markovica,, Dejan Zivkovic, Dragan Cvetkovic, Ranko Popovic,"Impact of nanotechnology advances in ICT on sustainability and energy efficiency", Elsevier-2012

[5] "Challenges and opportunities to green nanotechnologies", Green nanotechnology,Issue 1. April 2009

[6] Johannes Godt, Franziska Scheidig, Christian Grosse-Siestrup" The toxicity of cadmium and resulting hazards for human health", Journal of Occupational Medicine and Toxicologgy. 2006.

[7] http://www.epeat.net/

[8] Sachdeva GS. "Good things come in NANO packages", 2010

[9] Newton,"Is Cloud Computing Green Computing?", Proquest , Dec-2010

[10] Jayant Baliga, Robert W. A. Ayre, Kerry Hinton, Rodney S. Tucker, "Green Cloud Computing: Balancing Energy in Processing, Storage, and Transport", 2011 IEEE

[11] Praveen Tripathi, "Green computing as a manadatory revolution for proper end-og-life", Journal of Information and Operations management", Issue1,2012