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Review on Green Computing: The next movement in computing

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Abstract: Now days, computer is being used by almost every person or organization in our society. But sometimes they get so lost in the excitement of using new technologies that they are not aware of its effects on the world around us. Green computing is a global effort which aims at manufacturing, implementing, using and disposing the computer systems in an efficient way to minimize its impact on the surroundings. Going green is very helpful to make our atmosphere and globe healthy. This paper aims at providing better understanding of importance of green computing in the modern world. This paper also provides a review of the literature on green computing and various preventive measures that we should follow to save our atmosphere.

Keywords: Green Computing, Green-IT, Green Technology, Environment, E-waste, Energy Efficiency, Eco-Friendly.

I. INTRODUCTION

The primary goal of adapting green computing is to facilitate the organizations to use various computer resources proficiently by maintaining and increasing its overall performance [1]. Green computing is the branch of an environmental science which enables the responsible use of computer resources, servers and its associated subsystems like display devices, various input and output devices [2]. The green-Computing, as defined in the Official Journal of the French Republic in 2009, is an eco-friendly information technology and communication technique by using which we can reduce the harmful effects of human activity on the atmosphere [3].

In today's world, with the advancement of technology, there is significant increase in the complexity and integration of of systems which causes an increase in power consumption of the system. Modern portable appliances like laptops, mobiles etc. frequently require recharging of battery because of high power consumption while using the appliances. As the demand for portable appliances increase, attention has to be focused on designing power efficient circuits. Responsible use of computer resources by adapting green computing is very helpful to save our environment because computer and its subsystem's energies are often being used carelessly.

For example by leaving the computer when it is not in use is a waste of energies because CPU and monitors still consumes the power. So there is a great need to convey the harmful effects of these energy losses to the common man to save our environment. In the next section we will look into the history and evolution of green computing.

After this section summary of literature is given and in the last section we describes various beneficial tips which not only provide profit to the organization but also reduces our carbon footprint which is very helpful for greener future.

Fig. 1. Green Computing [4]

II. HISTORY AND EVOLUTION OF GREEN COMPUTING

The interest of green computing was made evident when computing attained climax in early 90's [5].The first appearance of green computing was the launch of energy star program in 1992 by U.S Environment Protection Agency under the authority of the Clean Air Act Section 103(g) [6]. Energy star is an international standard label which is designed to encourage the development of computing products with maximum efficiency and low power usage. Energy star label is provided on computer monitors, refrigerators, television sets, air conditioners and other technologies as shown in fig 2.

Fig. 2. Energy Star Label

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After the energy star program, the term green technology was used by various USENET posts in 1992.After this other popular green technology group came into existence that is tactical incrementalists whose main objective is to reduce the costs rather than to protect the atmosphere. Apart from reducing the cost, this group also take other factors like marketing and branding [7]. Another major event in the history of green computing is Kyoto protocol introduced in 1997. It is an international agreement for united nation framework convention on climate change. Kyoto protocol enables the computer developers to determine the electricity used by the system over its lifetime to estimate the carbon dioxide release in order to reduce it by various preventive actions [8]. Figure 3 shows top 10 countries annual carbon dioxide emissions [9].

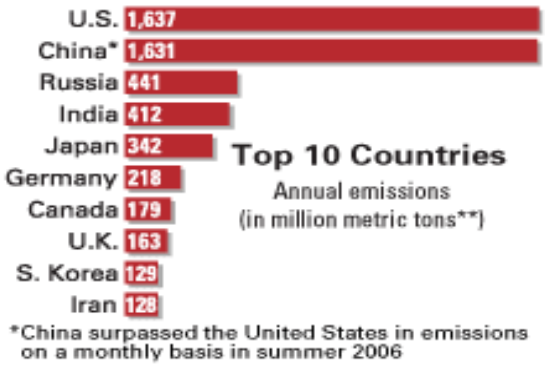

Fig. 3. Top Ten Countries
(Annual carbon dioxide emissions)

Another landmark in green computing history is the adoption of RoHS that is Restriction of hazardous substance and electrical and electronic equipment directive in February 2003 which prohibits the use of hazardous substances like lead, mercury, hexavalent chromium, cadmium, and polybrominated diphenyl in the development of electrical and electronic devices [10]. EPEAT (Electronic Product Environmental Assessment Tool) is introduced in 2005 whose main objective is to focus on various issues related to the effect of a product on environment [11]. From the above study we can say that time to time various government organizations provide variety of power and energy management programs to protect the surroundings from global warming. Many government organizations have also continued variety of standards and rules that helps in promoting green computing.

III. LITERATURE REVIEW ON GREEN COMPUTING

Now days, green computing is the latest and trending topic of research not only because of rise in energy and power consumption of computers, but also due to its impact on the atmosphere. By going green we can save large amount of energy by reducing the amount of C02 emissions which helps in promoting eco-friendly environment.

Time to time various green computing researchers provides their studies about green computing which includes various key issues in green computing as well as various topics related to power and energy consumption by promoting eco-friendly computer technologies as shown in table 1. In this section we provide an overview of various studies in the field of green computing by various researchers.

TABLE I: LITERATURE REVIEW ON GREEN COMPUTING

Sr. No.	Source Article	Focused Areas
1	GREEN-IT: why developing countries should care(2011)	Various ecological issues related to computing and role played by various countries in reducing carbon releases [12].
2	Optimization of Operating Systems towards Green Computing(2011)	Focuses on green computing by optimizing operating system, Scheduling of hardware systems [13].
3	Green IT-Environment Friendly computing in ICTs(2012)	Recyclability and biodegradability of computer systems, make computer systems as energy efficient as possible [14].
4	Green Computing using Graphical Processing Units(2012)	Focuses on the role of graphical processing units in decreasing energy usage at a data centre [15].
5	Green Computing-Need of Today(2012)	Focuses on adapting green computing from commercial point of view like cost savings and business continuity planning [16].
6	A consumption-based approach to carbon emission accounting – sectoral differences and environmental benefits (2013)	Focuses on the importance of the consumption-based released accounting, carbon dioxide emission [17].
7	A Study about Green computing(2013)	Focuses on saving power consumption by various technologies, green computing in cloud environment [18].
8	A Survey on Green Computing Techniques(2014)	Role of various green technology techniques to reduce power and energy consumption in computing environment [19].
9	Protection of Environment By Green Computing(2015)	Focuses on the role of computing devices energy consumption on industries, various technologies in computing environment to meet green computing requirements

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IV. EFFORTS TO IMPLEMENT GREEN COMPUTING

We do not need to stop using computer system and power to save our environment but we have to make some effective efforts by adapting green technology to promote an eco-friendly computing environment at low cost by reducing power consumption. By adapting following tips we can go green to make our environment healthy:

1. Purchase energy star labelled products: Manufacturing of various electrical and electronics equipment with energy star labelling ensures less power consumption. Therefore we need to use monitors, air conditioners, refrigerators and other technologies with energy star label to go green.

2. Unplug the electronics appliances when not in use: Various experts says that most of the plugged in electronics gadgets uses low amount of electricity, but some other electronics devices like computer systems and television sets consumes a lot of electricity even when they are in standby mode. Therefore we need to unplug various electronics devices when they are not in use to save money and electricity [20].

3. Use flat screen monitors rather than CRT monitors: CRT monitors uses approximate 90-110 watts power whereas LCD or LED monitors uses 35-45 watts power which is very less as compare to CRT monitors. Therefore we need to use flat screen monitors like LCD or LED monitors in the place CRT monitors in order to reduce power consumption [21].

4. Use soy ink or non-petroleum-based inks for printing: Soy ink is renewable, biodegradable which is prepared from soybean oil which is better than other ink options which are prepared from various hazardous solvents [22].

5. Purchase eco-friendly printing papers: We have to buy environment friendly printing papers which are prepared from more sustainable materials like organic cotton, bamboo etc. [23].

6. Avoid using screen savers: We have to stop using screen savers for reducing power consumption. More over when we use screen saver, it also uses some amount of processor power and memory [24].

7. E-waste management: Electronic waste is responsible for various harmful effects on our environment as it includes various hazardous substances like mercury, lead, cadmium etc. So we have to stop informal disposing of electronic devices.

8. Recycling: Recycling of waste electronics recovers many valuable substances like aluminium, copper and gold etc. from the waste electronic devices. As a result of this we can control pollution and save our atmosphere [25].

Other than these steps some more useful tips for implementing green technology are like using double side printed function, using sleep mode function to save electricity, turn off all devices like printer when they are not in use, lower down the monitor brightness. By adapting these helpful tips we can reduce large amount of energy consumptions and protect our surroundings from the harmful effects of technologies.

V. CONCLUSION

This review provides an overview on importance of green computing. Green computing has gain lot of importance due to rise in power consumption and its impact on environment. Going green is very beneficial as it helps various industries to manage their E-waste in an efficient way so that the surrounding may not be effected. This paper suggested some beneficial tips that we should follow from today or even from now for greener tomorrow.

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