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A novel survey on green computing

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Abstract
Green computing is receiving more and more attention to increasing energy costs and growing environmental disquiets. Green Computing is the latest movement in the IT industry towards scheming, building, and operating computer systems to be energy proficient. Green computing is environmentally sustainable to use of computers and related resources efficiently and effectively. Green computing also called green technology whose goals are to diminish the use of perilous materials, maximize energy effectiveness during the lifetime of the product, and encourage the recyclability or Biodegradability of obsolete products and waste of factories. This research paper is helpful to aware of the common man about the term green computing with the help of a survey performed.

Keywords: Energy star, Green IT, Green Marketing

1. Introduction
Green computing or green IT, refers to environmentally sustainable computing or IT. Green computing is the environmentally responsible and eco-friendly use of computers and their resources. In broader terms, it is defined as the learning of scheming, manufacturing, engineering, using and disposing of computing devices in a way that reduces their environmental blow efficiently and effectively. Green computing is "where the organizations adopt a plan of ensuring that the setup and operations of information technology produces the minimal CO2 emission and minimizes the energy consumption. Environmental Protection Agency launched Energy Star, a proscribed labeling program that is calculated to promote and be familiar with energy- efficiency in monitor, climate control equipment, and other technologies which help in green computing. This resulted in the common adoption of sleep mode among consumer electronics [1].
The goals of green computing are similar to green chemistry; lessen the use of dangerous materials, maximize energy efficiency during the product's lifetime, and encourage the recyclability or biodegradability of obsolete products and factory dissipate. Research continue into major areas such as making the use of computers as energy proficient as probable and designing algorithms and systems for efficiency-related computer technologies Different IT manufacturers and developers are continuously involved in designing computing devices which are energy proficient and lessen the cost of dangerous materials. It also encourages the reusability of different things such as papers and digital devices. When the environmental protection agency (EPA) launched the Energy Star program in 1992 then Green Computing practices were started. Green Computing is also called as green information technology (green IT). "Greening" your computing equipment is a low risk way for your business to not only help the environment but also decrease costs. It's also one of the largest upward trends in business today.
Making an appropriate decision to go green in the agency such as offices, not only improves the net profit of your trade, but also reduces the carbon footprint.
As the pledge to reduce environmental impact and power consumption are appropriate gradually more important vision for organizations, architecture selected are now proactively in view of environmental resource constraints along with more traditional IT business goals.

A. Advantages of Green Computing
a) Reduced energy usage from green computing techniques translates into lower carbon dioxide emissions, stemming from a reduction in the fossil fuel used in power plants and transportation [2].
b) Conserving resources means less energy is required to produce, use, and dispose of products.

c) Saving energy and resources saves money.
d) Green computing even includes changing government policy to encourage recycling and lowering energy use by individuals and businesses.
e) Reduce the risk existing in the laptops such as chemical known to cause cancer, nerve damage and immune reactions in humans.

B. Green Computing Approaches

Green computing can be achieved by different approaches. Some approaches illustrate as:

a) **Product longevity:** Gartner maintains that the PC manufacturing process accounts for 70% of the natural resources used in the life cycle of a PC Therefore, the biggest contribution to green computing usually is to prolong the equipment's lifetime. Another report from Gartner recommends to "Looking for product longevity, including upgradability and modularity. “For instance, manufacturing a new PC makes a far bigger ecological footprint than manufacturing a new RAM module to upgrade an existing one.

b) **Data center design:** Data center facilities are heavy consumers of energy. The U.S. Department of Energy estimates that data center facilities consume up to 100 to 200 times more energy than standard office buildings. According to the U.S. Department of Energy, Information technology (IT) systems, Environmental conditions, Air management, Cooling systems and Electrical systems are the primary areas on which to focus energy efficient data center design best practices.

c) **Software and deployment optimization:** It includes algorithmic efficiency, resource allocation, terminal servers and virtualization. The efficiency of algorithms has an impact on the amount of computer resources required for any given computing function and there are many efficiency trade-offs in writing programs. Allocating resources according to the energy can be saved. With virtualization, a system administrator could combine several physical systems into virtual machines on one single, powerful system, thereby unplugging the original hardware and reducing power and cooling consumption. Virtualization can assist in distributing work so that servers are either busy or put in a low-power sleep state. Terminal servers have also been used in green computing. When using the system, users at a terminal connect to a central server; all of the actual computing is done on the server, but the end user experiences the operating system on the terminal. These can be combined with thin clients, who use up to 1/8 the amount of energy of a normal workstation, resulting in a decrease of energy costs and consumption.

d) **Power management:** The Advanced Configuration and Power Interface (ACPI), an open industry standard, allows an operating system to directly control the power-saving aspects of its underlying hardware. This allows a system to automatically turn off components such as monitors and hard drives after set periods of inactivity. In addition, a system may hibernate, when most components (including the CPU and the system RAM) are turned off. ACPI is a successor to an earlier Intel- Microsoft standard called Advanced Power Management, which allows a computer's BIOS to control power management functions. Some programs allow the user to manually adjust the voltages supplied to the CPU, which reduces both the amount of heat produced and electricity consumed. This process is called undervolting. Some CPUs can automatically undervolt the processor, depending on the workload; this technology is called "Speed Step" on Intel processors.

e) **Materials recycling:** Recycling computing equipment can keep harmful materials such as lead, mercury, and hexavalent chromium out of landfills, and can also replace equipment that otherwise would need to be manufactured, saving further energy and emissions.

f) **Telecommuting:** Teleconferencing and telepresence technologies are often implemented in green computing initiatives. The advantages are many; increased worker satisfaction, reduction of greenhouse gas emissions related to travel, and increased profit margins as a result of lower overhead costs for office space, heat, lighting, etc.

g) **Telecommunication network devices energy indices:** The energy consumption of information and communication technologies (ICTs) is today significant even when compared with other industries. Recently some study tried to identify the key energy indices that allow a relevant comparison between different devices (network elements). This analysis was focus on how to optimize device and network consumption for carrier telecommunication by itself. The target was to allow an immediate perception of the relationship between the network technology and the environmental impact.

C. Green Computing Techniques to Manage Power in Computing System

These techniques can be classified at different levels:
1. Hardware and Firmware Level
2. Operating System Level
3. Virtualization Level
4. Data Center Level

Hardware and Firmware level techniques are applied at the manufacturing time of a machine. These techniques contain all the optimization methods that are applied at the time of designing at the logic, circuit, architectural and system levels. Operating System level techniques include methods which take care about programs at operator level.
Virtualization level techniques used the concept of Virtual Machines (VMs) to manage power. In this number of VMs are created on a physical server, so that reduce the amount of hardware in use and improve the utilization of resources.
Data Center level techniques are applied at data centers and include methods which are used to manage workload across physical nodes in data centers in this paper we are focusing on data center level techniques for managing power in computing system.

D. Data Center Level Techniques

Data Centers are those which contain a computer system

and its associated system such as telecommunication and data storage systems. It also requires backup power supply, some cooling system and security system. A green data center has an efficient management of the system and associated system less power consumed environment. Data center level approaches based on workload consolidation across physical nodes in data centers. The workload can be represented by incoming requests for online servers or web applications, or virtual machines. The goal is to allocate request/virtual machines to the minimal amount of physical resources and turn off or put in sleep state the idle resources. The problem of the allocation is twofold: firstly, it is necessary to allocate new requests; secondly, the performance of existing applications / VMs should be continuously monitored and if required the allocation should be adapted to achieve the best possible power-performance trade-off regarding to specified QoS. Data Center Level approaches further divided into two parts-

Non-Virtualized Systems: Non-virtualized systems are those in which single operating system owns all hardware resources.

Virtualized Systems: Virtualized systems are those in which multiple operating systems share hardware resources. We further survey on virtualized systems for managing power in data centers.

2. Related work

Liang-The Lee *et al.* [4] presented dynamic resource management with energy saving mechanism and gives a method of dynamic voltage scaling for dynamic adjustment of resources by inspecting CPU utilization in cloud

Computing environment. In this method the voltage of the idle or light loaded computer is reduced and heavy loaded works is migrated to those machines which are lighter loading.

Energy-aware resource management for a HPC data center is critical. Takouna, I. *et al.* [5] presented power-aware multicore scheduling and Find Host for Vm to select which host has minimum increasing power consumption to assign a VM.

The Find Host for Vm, however, is similar to the PABFD's [6] except that they concern memory usage in a period of estimated runtime for estimating host energy. The work also presented a method to select optimal operating frequency for a (DVFS-enabled) host and configure the number of virtual cores for VMs. Nguyen Quang-Hung *et al.* also presented EPOBF's Find Host For Vm which is different from the previous works in a way that the EPOBF's Find Host For Vm chooses which host has the highest value of ratio of total maximum of MIPS (in all cores) to the host's maximum value of power consumption [7].

There is another way to reduce power consumption. Chia-Tien Dan Lo *et al.* [9] presented algorithmic approach to reduce power consumption. They told about Fine-Grained Green Computing and Coarse-Grained Green Computing. Fine-grained green computing refers to running a program efficiently and effectively via a subtle power control on each Computing resources as CPU, memory, registers, peripherals, clock management, and power supply while coarse grained green computing in which the program's execution is in a full power mode disregarding to whether the program is using a memory banks or I/O peripherals.

FeiFei Chen *et al.* [10] presented a new energy consumption model and associated analysis tool for Cloud computing environments. They measure energy consumption in Cloud environments based on different runtime tasks. Empirical analysis of the correlation of energy consumption and Cloud data and computational tasks, as well as system performance, will be investigated based on energy consumption model and analysis tool.

George Perreas *et al.* [11] proposed a centralized monitoring entity that attempts to reduce power consumption in Internet Data Centers (IDCs) by employing live Virtual Machine (VM) migrations between blade servers. To perform live VM migrations, usage statistics collected by servers are evaluated and the servers that may be offloaded are selected. VMs that belong to the servers that may be offloaded are scattered to other active servers provided that the user-perceived performance is sustained. Overall, jobs submitted by users should be consolidated to as few servers as possible and the servers that host no job can be put in stand-by or hibernate mode, thus achieving an overall power reduction. Data center management authorities may take advantage of such a monitoring entity in order to decrease energy consumption attributed to computing, storage and networking elements of data centers.

3. Tactics of green computing

1. **3.1 Virtualization**

Computer virtualization refers to the generalization of computer resources, such as the procedure of running two or more rational computer systems on one set of objective hardware. IBM mainframe operating systems of the 1960s, originated the concept but was commercialized for computers compatible withx86 only in the 1990s. A system administrator could unite numerous physical systems into virtual equipment on one single, influential system, thus unplugging the original hardware and dropping power and cooling expenditure with virtualization

2. **3.2 Materials Recycling**

Those computer systems can be re purposed that have outlived their meticulous purpose, or are donated to various non-profit organizations and charities. Though, different charities have lately imposed least amount system requirements for donated equipment. As well parts from out- of-date systems may be salvaged and used again through certain trade outlets and municipal or classified recycling centers [12].

3. **3.3 Conserve Energy**

We can conserve energy by turning off the computer when we know that we won't use it for longer time period. The Advanced Configuration and Power Interface (ACPI), an open industry standard, allows an operating system to directly control the power saving aspects of its fundamental hardware. This allows a system to routinely turn off components such as monitors and hard drives after set periods of idleness. In addition, a system may hibernate, where most components (including the CPU and the system RAM) are curved off. ACPI is a heir to an earlier Intel-Microsoft standard called Advanced Power Management, which allows a computer's BIOS to manage power management functions [12].

4. **3.4 Green Data Center**

Computer center or Data centers has a computer system and its related system such as telecommunication system data

storage system. It needs power supply for backup, some cooling system and security system. A
green data center is a data center which has a efficient management of the system and associated system less power consumed environment [12].

3.4.1 Practical condition of data centers are as follows: Provide a substantial protected position for server [13]. It is require to maintaining full time network connectivity in data center.

3.4.2 Characteristics of data centers are that the Design must be:
Simple
Scalable
Modular
Flexible

4. Conclusion and future scope

In this paper, we have surveyed different approaches used for data center to manage efficiency of energy using virtualization. The work presents in this paper indicate the ever increasing interest of researchers in the area of green computing. Many green computing methods for energy efficiency are proposed by researchers however, green computing technology needs to be further researched because of high power consumption in data centers.
The future work in green computing can be research in IT industry that how the IT industry can use green computing by use of green products and green marketing. How IT industries can use only green products to develop new computer system's so that the products does not produce harmful effects to the environment.

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