



Green Computing: Issues, Challenges & Suggestions

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Abstract: At present, the computer is being used by common man or organization in our society for saving and to reduce manpower but at that time we also need to aware about its harmful impacts on our environment. Human beings are not aware of the harmful effects of it's in the excitement of using new technologies. Green computing can be defined as the study of designing, manufacturing, usage, and disposal of computing devices in a way to minimize the impact on the environment. The term green computing is used to signify the efficient usage of computing resources. The manufacturing of computing resources in huge amounts has a direct impact on the environment and researchers are performing a lot of research to minimize the negative impact of computing resources on the natural resources of the environment. The main aim of green computing is to use IT resources proficiently. The responsibility to protect the environment is increased with the increment of computing requirements in our daily life. The research paper's motive is to provide a better understanding of green computing in the modern world. This paper also includes the literature review on green computing.

Keywords: Green computing (GC), Information Technology (IT).

1. INTRODUCTION

In today's IT world, the usage of computers is increasing day by day in the form of laptops, smartphones, smartwatches, and many more which increase the consumption of electricity. This crisis has been realized by people and measures are being taken which help in minimizing the power usage of computers. This initiative can be called Green Computing (GC). So the GC can be defined as the study of designing, manufacturing, usage, and disposal of computing devices in a way to minimize the impact on the environment[1]. GC is the usage of IT resources proficiently. The main aim of GC is to reduce hazardous materials usage, maximize energy efficiency during the lifetime of products and also promote the recyclability of IT products. In the industry of IT, "Green" means the more efficient usage of computing devices with diminishing the negative impacts on the environment. GC includes the usage of computing resources in a way to minimize the usage of hazardous materials and services that comply with the environment, recycling the e-waste in a way that it does not

affect the environment. GC is minimizing the energy cost and also saving the environment[2][3].

The main goal of GC is to reduce the carbon-di-oxide emitted by the computing devices and not damage the natural resources and reduce environmental pollution. To save our environment, nowadays GC is the main need to implement[4][5].

Four approaches are implemented to promote green computing globally like[6]:

Green Use: Minimize the power consumption of computers and secondary storage devices and also these devices using eco-friendly approaches.

Green Discarding: Correctly discarding the electronic products those are not usable.

Green Design: Using energy-efficient devices.

Green Development: Minimizing the electronic waste during the production of computers and other electronic devices.

1.1 Needs of Green Computing

Today computer plays a vital role in everyone's life. The computer makes our work effortless by reducing the efforts of the human being. Usage of Computer saves human beings time and making their life easier. But computers consume a large amount of power supply and simultaneously emit a huge quantity of heat. Due to this heat energy, a large amount of CO₂ is released into the environment and CO₂ is the main source of greenhouse gas which is very harmful to the environment. CO₂ is emitted by data centers, PCs, peripherals, and networking devices. But a large amount of CO₂ is released by PCs because it contains many toxic materials. PCs are non-biodegradable and can be rarely recycled. To reduce these impacts 'Green Computing' has been implemented on various computing devices[7].

2. COMPUTER VIRTUALIZATION

Virtualization can be defined as a process that creates a virtual version of a device or resources such as server, storage

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devices, network, or even OS where the framework divides the resources into more than one execution environment. In the computer virtualization process, more than one logical system can use a single set of physical hardware platforms to run. The amount of energy needs to run and cool down the devices is largely reduced by reducing the usage of peripheral devices and also minimizes the toxic waste. So, the computer virtualization process is supportive to enhance the GC[8]. There are types of virtualization as shown in Figure1:

- **Server virtualization:** In the server virtualization process, a server is dividing into small virtual servers to increase the resources of the server. In this process, users are not able to see the server resources and the physical server is divide into multiple virtual environments which are called private servers. In this, one sever is not dedicating to a single application or task to perform. It reduces the cost because less hardware is required and also conserves space through the consolidation of several machines into one server[8].

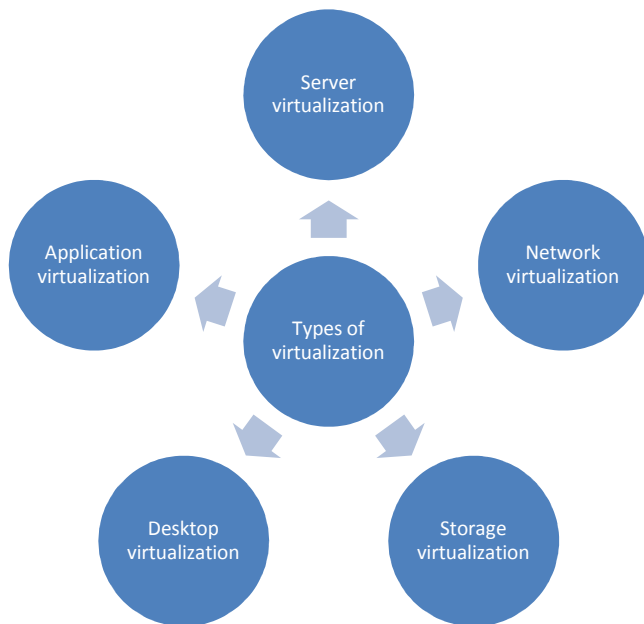


Fig. 1. Types of virtualization

- **Application virtualization:** It is a technology that encapsulates an application from the underlying host OS on which it is executed. It enables access to an application without requiring installing that application on the target device and allows the application to run independently. It is more useful for the IT administrator because install an application once on a server instead of multiple desktops and making it easier to update applications centrally.

There are two types of application virtualization. They are remote and streaming. In remote type, all the applications are run on a server. End-users using the remote display protocol to using their applications. But in streaming type components of applications are downloaded and executed on the user's local computer when required[8].

- **Network virtualization:** In network virtualization, hardware and software resources are combining in the network by splitting the existing bandwidth into independent channels. It is accomplished by installing software and services to manage the sharing of storage, computing cycles, and applications[8].
- **Storage virtualization:** In Storage virtualization, small sizes of the storage device are combined to become a single large size storage device. It helps in the expansion of storage capacity. It can be implemented with the fowling method
 1. Host-based
 2. Storage device-based and
 3. Network-based

Storage management is not an easy task and also a time-consuming process but this problem can be solved with the implementation of storage virtualization[8].

- **Desktop virtualization:** In the desktop virtualization process, the computer desktop environment is separated from the physical computer. It allows the central virtual desktop to manage by a server and run by the end-user on a thin client machine. The working of desktop virtualization is based on a client-server model. It allows users to remotely log in to access the desktop from any location[8].

3. EFFORTS TO IMPLEMENT GREEN COMPUTING

We do not need to stop using a 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 adopting the following tips we can go green to make our environment healthy[7]:

1. **Purchase energy star labeled products:** Manufacturing of various electrical and electronics equipment with energy star labeling ensures less power consumption. Therefore we need to use monitors, air conditioners, refrigerators, and other technologies with energy star labels to go green.
2. **Unplug the electronics appliances when not in use:** Various experts say that most plugged-in electronic

gadgets use a low amount of electricity, but some other electronic devices like computer systems and television sets consume a lot of electricity even when they are in standby mode. Therefore we need to unplug various electronic devices when they are not in use to save money and electricity.

3. **Use flat screen monitors rather than CRT monitors:** CRT monitors uses approximately 90-110 watts of power whereas LCD or LED monitors uses 35-45 watts of power which is very less as compared to CRT monitors. Therefore we need to use flat screen monitors like LCD or LED monitors in the place of CRT monitors to reduce power consumption.
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.
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.
6. **Avoid using screen savers:** We have to stop using screen savers for reducing power consumption. Moreover, when we use a screen saver, it also uses some amount of processor power and memory.
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 the informal disposing of electronic devices.
8. **Recycling:** Recycling of waste electronics recovers many valuable substances like aluminum, copper and gold, etc. from the waste electronic devices. As a result of this, we can control pollution and save our atmosphere.

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 a printer when they are not in use, lower down the monitor brightness. By adapting these helpful tips a large amount of energy consumptions can be reduced and protect our surroundings from the harmful effects of technologies.

4. GREEN EMERGING IT TECHNOLOGIES

The green computing paradigm was presented with a center of attraction on emerging IT technologies. In IT industries Mobile Computing, Cloud Computing, Big Data Analytics, IoT, and

Networking are identified as the emerging IT technologies which get the popularity in IT domain. Green and sustainable computing practices review the adaptation of emerging IT technologies for efficient functioning and efficient usage of computing resources in all emerging technologies shown in Figure 2, such as Big Data and Internet of Things (IoT) and many more[9][10].

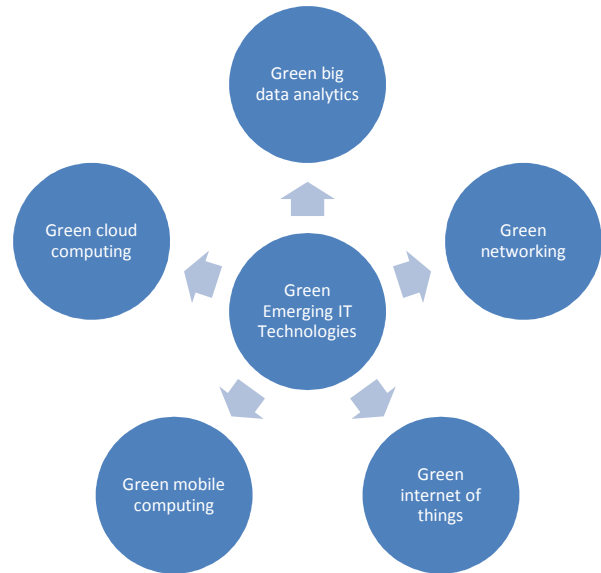


Fig. 2. Green Emerging Technologies[9]

5. ISSUES AND HURDLES IN IMPLEMENTING GREEN COMPUTING

The increase in usage of electronic devices such as laptops, mobiles, smartwatches, and many more increase the consumption of electricity. This crisis can be minimizing by reducing the power usage by electronic devices by green computing. But a number of issues and hurdles are facing during the implementation of green computing. Some issues are explained here such as[11][12]:

- Manufacturers are preparing devices that are more efficient and accurate but they use more energy and evolve very toxic, dangerous gases and chemicals.
- Some chemicals like Lead, Mercury, Cadmium, and other toxic chemicals are used by several electronic companies in the manufacturing of commuters.
- By surveying America energy consumed by the data center in the USA and all over the world will be doubled in the next few years.
- Green computing could be quite costly. Some green computers may be considerably low-powered also.
- The rapid technology change.
- Implementation cost for installing, training, updating, and technology support.

6. CHALLENGES

According to past researchers, the main focus was on efficient computing, cost associated with IT equipment and infrastructure services were considered low cost and availability. With growing computing needs, the cost of energy and global warming is becoming the bottleneck in IT environments and this shift is a big challenge to the IT industry. According to researchers, the few prominent challenges of Green Computing are as follows[13][14][15]:

- Equipment power density / Power and capacity of cooling.
- Growing of energy cost and requirements for Data Centers.
- Equipment Life cycle management.
- Disposal of Electronic Wastes.

7. SUGGESTIONS

- This part explains some suggestion to implement green computing in the IT domain[14]:
- When electronic devices are not in use turn off the devices.
- If the computer is not used frequently then acquire a small system with minimum peripherals devices.
- Always purchase a PC with Energy star and also observe the consumption of power.
- Always shutdown the computer instantly after usage. Don't use the standby mode because standby mode is consuming around 10 watts of power.
- Unplug the peripheral devices like a printer; music system scanner and modem are not used.
- The hard copy of the document uses less as much as possible. Evaluate and modify documents on the screen and use print preview. Minimize the number of hard copies. Instead of printing, save information to disks.
- If you use a laser printer, don't turn your printer on until you are ready to print. Although minimize the use of laser printer. Instead of it using the ink ink-jet printer consumes 80-90 percent less energy.
- Instead of using a bright-colored display, choose a dark background screen display that consumes less power.
- UPS of computer doesn't keep always switched on. It can be done when the PC is using because when the user using the PC for sometime daily that's enough for charging the battery. With this practice, the battery is preventing from overcharging and also reduces the consumption of electricity.

8. CONCLUSION

In the coming years, lots of research work need to be done in the domain of GC and research can be concentrated around making data centers and cloud computing more energy efficient. GC has gained a lot of importance due to the rise in power consumption and its impact on the environment. Going green is very beneficial as it helps various industries to manage their E-waste efficiently so that the surrounding may not be affected. This paper suggested some beneficial tips that we should follow from today or even from now for a greener tomorrow.

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