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## Going Green:-Computing For a Sustainable Future for Economy, Environment and Eco-Friendly Technology

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**Abstract:** *The idea of green computing has begun to spread in the earlier few years, gaining increasing popularity now a days. With increasing energy cost and growing environmental apprehensions, green computing is getting more and more consideration. Software and system architectures play a vital role in both computing and telecommunication systems, and they have been analyzed for performance, reliability, maintainability and security. Green computing, also named green technology is being touted as the next big eco shift, is the environmentally sustainable to use of computers with reduced resource consumption like – servers, monitors, printer, storage devices, networking and communication systems - resourcefully and efficiently with minimal but impact on the environment with proper disposal of e-waste. This is a newfangled model of designing the computer system which reflects not only the processing performance but also the energy efficiency for the viable future. More and more lately, IT vendors proclaim their electronic-waste recycling and "take back" programs, where manufacturers accept responsibility for the full lifecycle of belongings they produce. Though, Computers can have many positive aspects. They can reduce the amount of paper we consume and the pollution caused by travelling for work. Today, the internet is a powerful prospect to promote environmentally bearable choices that helps in public awareness and education. The difficulty with the environment is consumption and poor management of natural resources. Thus, we need environmentally ecological agriculture and environmentally effective business. This paper focuses on the approaches that help to implement Green Computing for creating a sustainable environment with the help of technological trends in the IT industry.*

**Keywords:** *Eco-Friendly, Green Computing, Green Technology, Recycle, Sustainable Environment.*

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### I. INTRODUCTION

Green computing, the study and practice of effectual and eco-friendly computing resources, is nowadays under the courtesy of not only environmental organizations, but also businesses from other industries. Green technology emphasizes on plummeting the environmental impact of industrial processes and innovative technologies caused by the earth are growing population. The global goal is to provide society's needs in ways that do not harm or diminish natural resources. By making entirely recyclable products, reducing pollution, offering alternative technologies in numerous fields, and forming a center of economic activity around technologies that benefit the environment. Green computing aims extend to the product's usage over its lifecycle, and the recycling, reuse, and biodegradability of obsolescent products. [1]. In this regard, Computer Virtualization is helping to make large steps in green computing technology. Nowadays, the cloud lifespan can be divided into four stages namely: designing, setup, using and disposal. Green computing in the cloud context can be attained by ensuring least or no influence on environment during each of these cloud lifecycle stages. The objective behind this is to reduce energy ingesting and expand resource performance and efficiency. Green Computing includes minimizing waste by purchasing only what you need today, sharing computers and printers, turning off your monitor and computer when they are not in use and recycling office paper waste. By developing dynamic website that allows the user to upload, add, edit and delete pictures and text on the website by minimizing the paper waste. An up to date website will reduce the requirement for catalogues and leaflets. Green computing in a Cloud can be achieved through Cloud data center design, increasing resource durability and merging common resources.

**To promote green computing concepts, the following complementary approaches are employed:**

**Green Use:** By minimizing the electricity consumption of computers and their peripheral devices it should be used in an eco-friendly manner.

**Green disposal:** Re-making an existing computer i.e. IT vendors proclaim their electronic-waste recycling and "take back" programs, where companies take responsibility for the full lifecycle of belongings they produce.

**Green design:** Effort to make an influence on environmental quality by connecting with companies, government agencies and foundations to develop inventive management, business, and regulatory processes that can improve environmental quality and product quality while enhancing economic development.

**Green manufacturing:** It grips potential economic welfares that include long-term cost savings, waste reductions and process efficiency improvements.

## **II. GREEN COMPUTING: A NEW REVOLUTION IN THE INDUSTRY FOR A CLEANER WORLD**

Green Computing refers to the:-

- ✓ Computing for a sustainable future
- ✓ The study and practice of efficient and eco-friendly computing resources i.e. servers and computer peripherals and many more.
- ✓ Reduced resource consumption and proper disposal of e-waste
- ✓ Creating fully recyclable products
- ✓ Reducing Pollution and
- ✓ By creating a center of economic activity around technologies that benefit the environment [2].

## **III. WHY GOING GREEN: - VIRTUOUS FOR THE ENVIRONMENT, VIRTUOUS FOR BOTTOM-LINE**

### ➤ **Computer energy is often wasteful**

- Instead of purchasing a new computer, try renovating an existing device.
- Shut Down the computer on when not in use i.e. CPU and fan consume lot of power.
- Always use the new technology i.e. use LCDs instead of CRTs.

### ➤ **Printing Documents is often wasteful**

- Refill printer cartridges, rather than buying new ones.
- Do not print unless necessary.
- Cost Effective Solutions.

### ➤ **Pollution**

- Invention of Eco-Friendly products.
- Innovative manufacturing techniques for recycling.
- Disposal of computers peripherals and components.

### ➤ **Reducing Energy Consumption**

- Turn off computer and Monitor when not in use.
- Use Power Save mode.
- Use computer products with Energy Star Label i.e. International standard approved by the Government.
- Buy energy efficient notebook computers, instead of desktop computers.

### **3.1 APPROACHES TO GREEN COMPUTING**

The developments in technologies and apparatuses by humans have led to one major change all over the domain. People in all republics are trying to reduce their consumption of power and depleting natural resources for protecting the future of their future generations. Therefore, green computing has been adopted by all computer enthusiasts and scientists. We would discuss the major approaches that can aid in achieving green computing.

#### **Virtualization**

Computer virtualization refers to the process of running two or more logical computer systems on one set of physical hardware. By virtualization, a system administrator could combine several physical systems into virtual machines on one single, powerful system, in that way unplugging the original hardware and reducing power and cooling consumption.

#### **Switch to Eco-Friendly Power Management**

Power management is a way for your computer to use less power when it's not being used. The Advanced Configuration and Power Interface allow an operating system to directly control the power saving ideas of its underlying hardware. Power management in computer system is done by adopting following reasons:

- ✓ Extend battery life for portable and embedded systems.
- ✓ Reduce cooling requirements.
- ✓ Reduce Noise and
- ✓ Decrease operating costs for energy and cooling.

### **Switch paper systems with on-line communication systems**

- ✓ Drop the printing ratio and encourage organizations to use e-mails.
- ✓ Motivate customers and suppliers to buy products with the assistance of e-commerce, adopt on-line systems e-billing and reservations of tickets that helps in reducing the paper work.
- ✓ Setting up paper recycling process.

### **Upgrade computer's hard drive to a green drive**

Hard disk drives frequently consume less power per gigabyte than physically larger drives. Companies like Seagate are taking a pace backwards and making hard drives that consume less power. The idea behind a green hard drive is that its spindle speed is less, like 5900 rpm, but is engineered to perform virtually on parity with its faster 7200 rpm hard drives. They will be available in three variations i.e. cost, performance and capacity. These green power supplies provide computer enthusiasts in:

- ✓ The ability to enjoy stable power.
- ✓ Demanding online gaming systems.
- ✓ High end Servers and workstations work together under electric usage in check.

By adopting these tracks, resulting in low power bills and makes the future secure and improve the quality of life on earth.

### **Switch to Laptop/Tablets from a desktop**

Today, laptops and tablets are the booming gadgets in this era. These gadgets have steadily crept up to desktop computer sales in terms of number of units sold. The point is that if someone is looking to upgrade to a new system, one should might consider picking up next device in a form of laptop and tablets/ pad's due to the size factor and less in battery consumption.

### **Telecommuting- the future of work**

Advances with communications devices and with the aid of computer networking systems have made it possible for people to work from remote locations and for telecommuting to become an ever-more feasible option for many companies. With the aid of telecommuting it increased satisfaction between the two parties, reduction of greenhouse gas emissions related to travel, and increased profit margins as a result of lesser costs for workplace space, heat, lighting and many more. This technology is currently running in taking green computing initiatives [3].

### **3.2 ADVANTAGE OF GREEN COMPUTING**

**There are many advantages to this kind of computing that is good for the environment. Some of the advantages are discussed below;**

- ✓ Meeting Sustainability demand of customers and employees.
- ✓ Meeting agreement and regulatory requirements.
- ✓ Saving energy and resources that saves money.
- ✓ Reduce environment impact and carbon footprint.
- ✓ Improved operational efficiency.
- ✓ Decrease the risk existing in the laptops such as chemical known to cause disease, nerve impairment and immune reactions in human beings.
- ✓ Preserving resources i.e. less energy is essential to crop, use, and dispose of products.
- ✓ Helps in reducing energy demands and money of how we use technology which positively effects the environment, and saves our costs in the future.

### **3.3 BARRIERS IN GREEN IT**

- ✗ Initial Capital cost.
- ✗ Challenge of reengineering processes and businesses practices.
- ✗ Lack of management drive and support.
- ✗ Lack of motivation among stakeholders and
- ✗ Need and reluctance to acquire new skills.

## **IV. SUSTAINABLE IT SERVICES: DRIVING ECONOMIC AND ENVIRONMENTAL BENEFITS**

Sustainable IT amenities are vital to business triumph. There is cumulative pressure to adopt sustainable business practices. Sustainable IT is almost everything an organization or a group wants to do to confirm that IT services provides superior value to attain a strong economic position in every nation. It is about supporting IT with commercial strategy to attain market-leading business, customer and societal value. The administration in all the nations has specified plans to endorse a "green

energy economy” which will possibly lead carbon emissions; increase energy costs, and embraces firms more responsible for their influence on the atmosphere.

#### **4.1 ECONOMIC MISSION: QUALITY OF LIFE**

The rudimentary nature of an economy consistently reflects the consensus of the society within which the economy functions. Economic evolution is no longer a logical mission for sustainable economies. The logical mission is, as it has continuously been, the pursuit of joy or quality of life by adopting the green computing concept. This will contribute to poverty eradication, employment opportunities, and a strong and sustainable economy. Greening the growth track of an economy depends on strategy and influential settings, level of progress, social structures and particular environmental pressure opinions. Progressive and developing countries will face different challenges and opportunities. While countrywide plans will differ, in all cases green growth approaches need to go hand-in-hand with the core pillars of action to endorse social equity.

#### **4.2 ECONOMIC BENEFITS OF GREEN INFRASTRUCTURE PRACTICES**

- **Creations of New Jobs:** Going green will have on the economy is the creation of new jobs and industries in the area of clean technology that examines mathematical and computer-based procedures and models for designing, analyzing, and measuring the cleanliness of products and processes.
- **Green infrastructure practices:** This practice helps communities save money while also providing a number of economic benefits that include reduced costs, increased energy efficiency and improving air quality.
- **Clean Energy Victory Promises:** Today, every nation invests in large-scale deployment of green energy projects that particularly emphasize in low-income groups that are hardest hit by the broken economy that helps in green energy revolution for the nation.
- **Diminish, Recycle, Reconsideration:** We need an economy that is not dependent on development and consumerism. So it's time to rethink living over-consumptive lifestyles, and turn to the principles of elegant simplicity that saves our asset and money.
- **Lowering the Prices:** Going green has become widely accepted and adapted by all the countries and businesses. More green goods and services are being sold that aids in boost the economy. Today, consumers can make green purchases that will help the country economy.

### **V. ECO-FRIENDLY APPROACH**

Technology driven growth has a dynamic role to play in the world economy and in the process of de-coupling world economic growth from ever increasing carbon dioxide emissions. In addition, organizations around the sphere recognize their responsibility to protect and endure the environment for the future generation and implementing more environmentally friendly computing. By introducing the Energy star approved by the Government can result in energy and cost savings. These power management practices can achieve in estimated annual savings of the computer peripherals devices. The greatest challenges for businesses trying to be eco-responsible are really understanding what that really means, then making changes that are sustainable over time, while adding business value.

#### **5. FACTORS DRIVING THE ADOPTION OF GREEN COMPUTING**

- ✓ The rapid growth of the Internet services like Video and music downloads, on-line gaming, social networks, e-commerce.
- ✓ Speedy growth of internet Services like 3G/4G.
- ✓ Online commencing of products instead of manual paper work.
- ✓ Increase in the server requirements has led to major increase in power density of data centers.
- ✓ Limitations on limited energy supply and access.
- ✓ Introducing cloud computing and cloud services technologies that enable applications to be used where and when needed.
- ✓ Efficient use of computer resources in a logical way to reduce energy consumption.
- ✓ Cost sustainability that includes acquisition and operating cost i.e. Choice of proper hardware and software at minimal cost.

### **VI. TECHNOLOGIES IN GREEN COMPUTING**

#### **6.1 A SUNNIER SHADE OF GREEN: CLOUD COMPUTING**

Nowadays, Cloud computing delivers the next huge thing in computing arcade. It is a collection of server delivering resources that can be accessed remotely via the Internet in real-time.

It provides a place for the users to create, store and access personal information on the cloud in an efficient way of computing technology without harm to the environment. Basically, cloud computing comprises three different models:

**1. Software as a Service (SaaS):** It refers to a browser or client application accessing an application that is running on servers hosted somewhere on the Internet.

**2. Platform as a Service (PaaS):** It offers base environment ready for organizing applications on cloud without hassles of managing the cloud infrastructure i.e. processing from a server hosted somewhere on the Internet.

**3. Infrastructure as a Service (IaaS):** This kind of service delivers basic components such as Servers, Network and Storage on-demand, Self-service, and Pay per use basis that are pooled and made available to handle workloads of the cloud users.

## **6.2 CLOUD VIRTUALIZATION**

Cloud computing and Virtualization are those technologies that is developed to maximize the use of computing resources while reducing the cost of those resources. Virtualization means more servers on the same hardware and cloud computing refers to measured resources i.e. pay for what the client needs. These technologies can have a major change on how business pays for its technology and handles the associated risk by:

- ✓ By eliminating the hardware associated with the IT utilities and the capital cost invested in this project are virtually eliminated.
- ✓ Operating expenditures that are readily accessible on-demand or subscription based cloud computing applications to the e-users.
- ✓ Virtualizations companies are the specialized corporations that gives benefits for the cost saving and energy saving to their clients.
- ✓ The companies can benefit more efficient operations along with improved reliability and security to their user in the cloud [4].

## **VII. LEVERAGING FEASIBLE AND SUSTAINABILITY GREEN ENVIRONMENT**

Today, Sustainable development is the future direction of our domain, our economy and the overall human consumption. Green engineering and chemistry play an essential role in making the options that will empower sustainability by developing chemicals, processes, products, and systems that are environmentally better, more energy- and resource-efficient, and often more cost-effective. It is the social responsibility of individual to give better and healthy economy to this domain. Various organizations come with the innovations in the field business, marketing with the aid of information technology to adopt a new greener approach. Much more attention is dedicated to achieve a radical development of the system that provides direction and vision to achieve sustainable development. The sustainable development is a new vision for business. Today, sustainable development holds three broad environmental objectives:

**1. Eco-efficiency:** The term 'eco-efficiency' is related to the Sustainable Development of creating more goods and services while using fewer resources and creating less waste and pollution. This can be achieved by the distribution of priced goods and services to the human desires and bring quality of life with reducing environmental influences.

**2. Eco-Equity:** This is the smartest way to finance the green building needs. As it promotes a fair distribution of environmental benefits. Equity will revolve around the ability of all groups to protect their health, safety, and economic interests from unjust environmental degradation.

**3. Eco-Effectiveness:** This approach involves the expansion method and pursues to create industrial systems that imitate healthy natural systems. The vital source of eco-effectiveness is “waste equals food.” The idea is meant in response to some of the supposed limitations of eco-efficiency which detractors claim only slow down the rate of environmental reduction and don't reverse the production of unused or non-recycled waste [5].

## **VIII. FUTURE DIRECTIONS OF GREEN COMPUTING**

Green computing in the future is going to be never-ending. As more and more businesses work towards being sustainable, the necessity for processing the data is growing in a speedy manner. Consequently, even beyond making computing hardware more green and reducing its carbon footprint, the future will find a superior need for programming to analyze proficiently all of the data needed to track the metrics in order to move onward. This entails new methods and business models to allow greater network reliability, efficiency, flexibility and transparency in every field. With the advancement of the Cloud computing, it focuses on the two rudiments of the Green IT: energy efficiency and resource efficiency. The computer designer plan to make future computer more eco-friendly across its entire life span, from manufacture to recycling. Today, governments worldwide have initiated energy-management programs, such as Energy Star for proper utilization of resources in an efficient manner than previous one and this is the good resolution in the Industry. New green materials are developing every year, and many toxic ones are already being replaced by them. The potentials of a green computer of tomorrow would be like: efficacy, recyclability, self-powering, and more energy saving.

## **IX. CONCLUSION**

Green Computing is not only a new development; it is a technology of itself i.e. moves to become friendlier and sustainable environment. Green business prospects consumers with ecologically sound products and services. Business seeking a cost effective way to responsibly recycle large amount of computers equipment. Many of the companies are taking the initiatives to take the contract to handle the recycling agreements by adopting the law and regulations. In order to use the new technology one should pay attention things like the energy star that can help to really reduce the amount of electricity used on a day to day basis. Recycled or reused instead of simply ending up in a landfill. As business carry on doing more with less, green business opportunities are certainly here for the extended tow. To keep and realm the environment, “going green” is the solitary approach to raise the business by reducing the eliminate waste. By accepting a universal approach to greening IT, it is the responsibility of the consumer to creating a more sustainable environment for the future generation.

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