GREEN COMPUTING AND ICT SUSTAINABILITY

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Abstract: - *Most commercial organizations simply cannot function effectively without substantial use of IT. Power consumption alone is therefore substantial, but ICT policies and strategies can have far broader impact than that just saving power and resources. By aligning the ICT strategy with low carbon emissions businesses can see savings on the company's bottom line as well as in some cases enhancing disaster recovery and business continuity planning. Green computing is the environmentally responsible use of computers and related resources. Such practices include the implementation of energy-efficient central processing units (CPUs), servers and peripherals as well as reduced resource consumption and proper disposal of electronic waste (e-waste). Green IT is taking on a bigger role for many reasons; this covers all areas including an increased awareness of environmental danger; concern about power bills; regulatory requirements; government procurement rules; and a sense that corporations should embrace social responsibility.*

The motivation behind this change comes from the ever-increasing business computing demand, ever growing cost of energy, rising awareness of global warming issues.

Key Words – Green computing, Data centers, green initiatives, Power consumption and sustainable computing global warming.

Introduction:

Green computing or green ICT, refers to environmentally sustainable computing or ICT. In the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems such as monitors, printers, storage devices, and networking and communications systems efficiently and effectively with minimal or no impact on the environment.

In the last few years global warming and climate change was catapulted to the front of society and became a common subject of discussion in global society. In this context, the impact of ICT on ecological sustainability usually coined as Green ICT has emerged as one of the key management

issues. Green ICT is comprised of initiatives and strategies that reduce the environmental footprint of technology. This arises from reductions in energy use and consumables, including hardware, electricity and papers. Because of these reductions, Green ICT initiatives also produce cost savings in energy use in addition to environmental benefits. ICT aims to minimize carbon footprint, minimize hazardous ICT waste, reduce energy cost, achieve corporate social responsibility (CSR) and finally comply with government regulations.

Green Computing

Green computing is the practice of using computing and ICT resources proficiently. As a human being it is our prime responsibility to protect the environment and save energy cost in today's increasingly computing requirements. Green computing or Green ICT, is the analysis and practice of environmentally sustainable computing or ICT.

Green IT can be reached through reduction of energy consumption and waste. Energy management and emissions tracking software are available. What the ICT buys – from computer equipment to paper – directly impacts how green ICT is and how green its suppliers are. If an ICT organization only purchases technologies with Energy Star, EPEAT, and other energy efficiency ratings, it can significantly reduce its energy consumption and greenhouse gas footprint, and it will help drive technology manufacturers to develop products that earn energy efficiency ratings. At the end of the chain, a green ICT function needs a waste management program.

The goals of green computing are similar to green chemistry; reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote the recyclability or biodegradability of defunct products and factory waste. Research continues into key areas such as making the use of computers as energy-efficient as possible, and designing algorithms and systems for efficiency-related computer technologies.

Green Initiatives in Information Technology

The use of ICT has exploded in several areas; improving our lives and work and offering convenience along with several other benefits. However, ICT has been contributing to environmental problems, which most people do not realize. Computer and other ICT infrastructures consume significant amount of electricity, placing a heavy burden on our electric grids and contributing to greenhouse gas emissions. Thus, Green ICT or Green Computing represents an environmentally responsible way to reduce power and environmental waste. It is about the environmental friendly use of computers and its related technologies.

With time ICT industry has taken many initiatives towards green ICT (Information and Communication Technologies). The remarkable green initiatives in IT are:

- **Improved Data Center Cooling Methods**: This is achieved by improving the data center-cooling configuration, eliminating considerable amount of energy leaks. IT can result in efficient data centers by following leading practices in data centre layout and rack and server arrangements. Effective approach include raised floors to improve airflow, moving cooling systems closer to servers to concentrate cold air in the right place, alternating hot and cool server passageway to improve airflow and using water-based air conditioning systems.
- **Efficient Servers usage by Virtualization**: Generally, ICT companies have been using many server farms or data centers, dedicated to a specific task. These data servers must be efficiently used. One of the mechanisms is load balancing which chooses the optimum resource among many. Also by using virtual software to perform these tasks, a single server may be used to power these virtual servers, dramatically reducing energy consumption.
- **Alternative Storage Methods**: Storage drives are another main element of data center infrastructure and, as organizations storage needs increase; more energy is used to power these hard drives. Using large capacity drives and performing data center audits to eliminate redundancies in the system can reduce it.
- **Using Thin Clients**: With thin clients, each employee has a virtual desktop that includes a mouse, keyboard and screen while all at a central location shares the remaining unit.
- **Strengthen Printer's Output Management**: Centrally located printer may be used to handle all printing tasks virtually eliminating numerous machines being left on all day sucking up energy and driving up costs.
- **Explore Alternative Sources of Energy**: The efficient resource utilization leads towards efficient methods to evolve. With time renewable and natural energy sources are being used to power data centers, such as nuclear or hydroelectric power, solar energy etc. This saves money and generates fewer CO2 emissions.
- **Energy saver initiatives**: This includes using energy saving settings and encouraging employees to turn off equipment at the end of the work day and on weekends.
- **Proper Disposal and Recycling**: This is so important because it potentially eliminates the threat of harmful toxins being released into the environment and allows for the reuse of equipment reducing the amount of waste. These initiatives exhibit the requirement of going green. Along with above-mentioned ICT initiatives every sector and area of ICT is practicing green strategy and policies because sustainable development of ICT is the future need.
- **Promoting environmental-related ICT skills and awareness**: These measures mainly include increasing awareness and knowledge

of consumers and users of the environmental impact of ICTs as well as the advantages in using ICT applications such as smart metering. They also include increasing management skills through job-related training.

- **Networks**: One objective of the Green ICT Project is to reduce energy consumption of network components by more than 30%. Technologies for optimizing router power consumption and traffic volume.
- **Data centers**: The Green ICT Project also aims at reducing the energy consumption of data centers, especially of servers and storage devices, by more than 30%. It is therefore promoting technologies like ultra-high density Hard Disk Drives (HDD) and high-efficiency cooling systems.
- **Displays**: The objective of the third research field is to reduce the power consumption of displays by 50%. Organic Light Emitting Diodes (OLED) are one of the technologies that will be promoted.

Open Research Challenges

Energy is one of the most valuable and scarce resources available to the world, a significant portion of which is now being consumed to power up computers and computing infrastructure. Basically, high-performance parallel and distributed computing system, including data centers, supercomputers, clusters, real-time systems, and grids not only consume considerable amounts of power but also require air-conditioning to keep the systems cool. The exponential growth in computing is rapidly increasing the consumption of precious natural resources such as oil and coal, strengthening the alarming danger of energy shortage. The researchers have raised these issues from time to time and the possible measures are being taken. Still there are many areas yet to be explored.

Here we present some notable areas of research in green computing:

- **New Optimization Techniques in Performance-Energy-Temperature aware Computing**: The exponential growth in computing activity and the rising concern for energy conservation have made energy efficiency in computers a technological issue of prime importance. The tradeoff between Performance-Energy-Temperature has to be made for so that the maximum benefits can be obtained. Designing techniques that are optimal with respect to performance, energy, and temperature are utmost requirement as far as green computing research challenges are concerned.
- **Information Resource Tier Optimization**: The information resource tier represents important data base management systems in the global computation world. General paradigms include databases, directories, file-systems, and flat files
- **Reduce architectural complexity**: The research area is open to reduce the number of tiers and component dependency to reduce

maximum system use. Intel‘s core 2 duo is a mechanism which uses power to run only those components which are necessary at any computation.

- **New high-efficiency data center design**: Bigger data centers can be made much more energy efficient than smaller data centers. Standards are emerging for measuring this, such as the concept of Power Usage Effectiveness (PUE). PUE is defined as the ratio of total facility power divided by IT equipment power. Thus, it is a measure of how much of the power being consumed by the facility is actually being used to power the IT equipment itself rather than all the other things. Therefore it will quiet be a challenge to make the bigger data centers power efficient
- **Developing Green Maturity Model**: Full equipment life cycle is the main area for green maturity model, with energy reduction as the best measure of greenness, the need of maturity models for equipments, IT organizations, computing techniques is an issue which has been addressed by some researchers but is limited to specific areas. Green maturity model for virtualization depicts that each level describes the degree of green characteristics.
- **Wireless Sensor Network for Data Center Cooling**: data center cooling is a major issue as far as power consumption is concerned. Data centers are backbone of any computing organization and must be reliable and available at every point of time. Measuring the data center effectiveness and maintaining the baseline is an issue. Wireless sensors could play a big role for managing data centers power management.
- **Green Software’s**: Recently, green software movement has become a research subject for most of the software developers companies because of need for sustainable development. Most of the research has been done on the characterization, metrics and technical answer for green software, but few have addressed green software from the business perspective. Business organizations are moving towards green software‘s and still some considerable steps need to be taken.

ORGANIZATION INVOLVED IN GREEN COMPUTING

Some of the major corporations leading the green computing initiative are the same major players in other computing venues: IBM, HP, and Dell. Other major corporations who are going green as a way to save money on power consumption include most Wall Street firms (since they use a tremendous amount of power in their data centers), banks like Wells Fargo, and Amazon.com.

- **HP** - Programs to reduce GHG and Toxic wastes in their products and supply chains.

- **DELL** - Carbon Neutral, Headquarters uses 100% Renewable energy, computer products use 25% less power.
- **INTEL** - Focus is on increasing speed while reducing energy usage in their products.
- **IBM** - Has had formal Environmental policies since 1971, and requires all employees to have environmental awareness training.
- **SUN MICROSYSTEMS** - Requires environmental management accreditation from suppliers and posts information about their energy uses and greenhouse consumption on their website.
- **MICROSOFT** - New design of Windows uses less energy. Also includes the use of virtualization technologies.
- **ADOBE SYSTEMS** - Offset all carbon emissions for their Northern California sites (42% of their total carbon emissions) and are redesigning their software packages to be more environmentally friendly

ADVANTAGES OF GREEN COMPUTING

- 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.
- Conserving resources means less energy is required to produce, use, and dispose of products.
- Saving energy and resources saves money.
- Green computing even includes changing government policy to encourage recycling and lowering energy use by individuals and businesses.
- Reduce the risk existing in the laptops such as chemical known to cause cancer, nerve damage and immune reactions in humans.

DISADVANTAGES OF GREEN COMPUTING

- Green computing could actually be quite costly.
- Given that there has been a green process that the computer will have gone through in order to make the computer in the first place; there will usually be some kind of added cost when the computer has been finished.
- Green computing takes a lot of new technology and hence, you may find that you will have to pay a premium price for your new green computer.
- A perfect example is that the greenest modern computers today are Mac books and Mac book Pros. These computers are hardly inexpensive - they're actually some of the most expensive computers in the market.

V: Conclusion

- Green computing will be the driving force of future computing. New computing innovations and applications need to fulfill the green computing requirements for the sustainable development of Information and communication technology (ICT). Every research challenge carries a future prospect for

employing efficient computing in different areas. We will further analyze these challenges for better understanding and future research.

- Through more environmentally aware usage (such as more effective power management and shut-down during periods of inactivity), and by adopting current lower power technologies, computers can already be made significantly more energy efficient. Indeed, just as we now look back and wonder why automobiles a decade or two ago used to guzzle so much petrol, in a decade's time we will no doubt be staggered that a typical desktop PC used to happily sit around drawing 100-200W of power every hour night and day, and when accomplishing no more than displaying a screensaver.

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