

Green Computing and Environment: A Review

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Abstract: *This paper covers all aspects of technology, computing method, energy efficiency methodology, low carbon foot print, bioinformatics science; hardware recycling and industrial polices which play an important role in environment. This study provides a brief description about Green Computing and emphasis of this review paper is on current trends in Green Computing, challenges in Green Computing and the future trends of Green Computing.*

Keywords: Carbon footprint, Cloud computing, E-Waste, Data centre, Green IT, Bio-informatics, Grid computing.

1. Introduction

Green technology refers to the environmentally responsible use of computational device. Green computing includes the implementation of energy efficiency central processing units (CPUs), software, hardware and servers. Also green technology focused to reduce resource/power consumption and improve the use of electronic waste. In the series of power saving software, power saving scheduling for parallel system plays important role to reduce power consumption and achieve better performance. Energy saving is part of green use which is one of the green computing components [1].

It is known that greenhouse gas emissions are the main cause for climate change and efforts should be done to reduce them. Emission is often measured in terms of the amount of carbon dioxide, or other GHGs (Green House Gases), emitted. If the size of a carbon footprint is known, policies' can be implemented to reduce it. Unit of carbon footprint is tons of carbon dioxide equivalents per year [2].

Reducing energy consumption by using optimized programming techniques and energy efficient algorithms in order to maximize the uptime of various battery operated devices has been an interesting research topic over the past several years. Initially the computing was performed on the basis of lesser space and quicker calculation. But in recent past years the energy consumption is one of the major driving factors for selecting the computing algorithms to attain the power efficiency and Green Computing. A lot of optimization has been made by manufacturers to minimize the energy consumption in hardware but it depends on internal algorithm efficiency too. The paper was mainly focused on energy efficiency of some standard sorting algorithms, which are not only used in various devices directly but also very often implicitly by other algorithms [3].

2. Growth in Co2 Emission

Growth of mobile users is projected to reach 6 billion by 2013, with 80% of users in the developing world where the mobile phone is their primary computing device and communication..

The electricity drawn by the Smartphone to charge such a high ampere battery is much more than the normal phones. To reduce this issue, this paper in reference 4 creates a framework by which one can assess their smart phones batteries in much sustainable way [4].

As we know that Green computing refers to the "environmentally sustainable" computing or Information Technology or in other words, Green Computing lays stress on the operation of computers and related peripherals in order to minimize the carbon footprint. The work proposes it's focused towards the advent of the Green Computing era in the 21st century and practical analysis of development of more and more energy efficient software and hardware systems that would enable green computing to be integrated into different aspects. Also, solutions have been discussed that result in support of the existing green computing approach comparing the efficacy of each in terms of energy, environmental issues and cost savings. The results of work done are provided as technological and economic evidence for the benefits of "Going Green" and to promote education in Green Computing [5].

A Green approach provides significant importance over communication network and shows how to reduce energy consumption. The paper analyzed the shortest routing mechanism because in communication networks we have to find the shortest path frequently. Finding of shortest path there are number of methods. Traveling salesman problem (TSP) is also a problem of finding a shortest path. The applications are such as planning, Flight simulation logistics, manufacture of microchips etc. [6].

Wireless Sensor Networks (WSNs) and Next Generation Networks (NGNs) are an emerging area of research from

worldwide; both types of networks have change the upcoming era of ICT. This research contribution is sketched around these two emerging networks and relates existing research works available on energy efficiency/awareness (reducing emission of green house gases, basically CO₂) with these two as well. Existing problems and solutions are highlighted in the paper [7].

Green Computing is a technique to reduce the power consumption of the computing devices. It is a current trends towards operating computer to be energy efficient, designing, building architecture. It refers to environmentally sustainable IT. Waste of energy by PCs and related resources promotes global warming. Report says that power consumption of India was 778 kWh in January 2012. Also it will be doubled by 2020. IT sector responses 10% of all power consumption. A typical desktop computer uses about 65 to 250 watts. Laptop uses about 15-60 watts. Laptop is greener than desktop computer. Power consumption is major problem of coming days. Reduce them and save the Earth and life [8].

Cloud computing initially structured to cater to the information technology sector, is now finding in other industries to optimum use of (retail, supply chain, healthcare etc.) as well. This review paper defines the importance of cloud computing in reducing the paper and power consumption of an organization and how cloud computing greener world [9].

Processing huge data, take hours to compute which could be less to few seconds using the new technique called as Grid computing, which reduced energy consumption of hardware. Furthermore, the paper analyzes the extent to environmental impacts the intention of enterprises to use Grid technology [10].

Bioinformatics is the calculation of biological information. Databases and information systems are used to storing, retrieving, analyzing and organize biological data. This review paper is a review on role of bioinformatics to start with green computing [11].

Technology has now come to a stage where we cannot remain ignorant about the environment, in which existence of life occurs. It has become necessary for everyone to give his/ her contribution in controlling pollution which is increasing at dangerously high level. This paper gives an overview of the causes of pollution being created by ICT sector. Various ways are also suggested to reduce carbon emission which is the main cause of pollution [12].

Green computing is a way to implement computer systems to be energy efficient. The plan moving towards energy efficiency and all possible options towards green approach [13].

Now a day atmosphere is affected negatively. Only one thing is to be added here that previously this may have been a welfare job but now it has become the need of the hour; very essential for our existence [14].

This paper covers all aspect of e-waste categorization, recyclable and recoverable. Best Available Practices, recycling, and recovery processes followed, and their environmental impact and occupational hazards. Based on the discussion, various challenges and future policies were discussed [15].

We suggested that green computing to low power consumption in wireless-communication system by using UWB (Ultra-Wideband) that provides a flexible interface to obtain ultra-low power operation in packets transmission, effective collision avoidance, and high channel utilization. UWB technology is related to spread spectrum used in WLANs. Power consumption issue is especially prominent in Green Computing. Three types of power saving approaches: power consumption at the device level, transmission level, Routing Protocol level. The technology will be given, together with a comparison between UWB and current short range wireless networking systems [16].

Involvement of the computational science in biological science is known as Bioinformatics. Biological information is a collection of biological data and warehousing, data mining, database searches, retrieving technique, analyses and interpretation, modeling and classification.

“Green computing” represents harmful environmentally responsible way to reduce energy and environmental waste. The Green Computing plays a detrimental role in 21th era. Green computing is the way of using computing resources efficiently. Which help in lower impact on the environment? The approach of green computing is algorithmic efficiency, range of equipments and technologies that helps in recognizing the areas for improvement [17].

3. Literature Survey

Table 1: Literature survey

Source	Area Covered
Green scheduling schemes for parallel system (2013)	Green Scheduling, Voltage Scaling, SVS (Static Voltage Scaling), DVS (Dynamic Voltage Scaling), AVS (Adaptive Voltage scaling).
Carbon footprint-an approach towards sustainable development (2013).	Carbon footprint, Green house gases, Emission, carbon offsetting.
Energy efficiency in sorting algorithms: green computing (2013).	Sorting Algorithms, Energy Efficiency, Joule meter, Green Computing.
Mobile computing (2013).	Handset Energy.
Implementation of green computing & future trends (2013).	Green computing; environmentally sustainable; energy efficient hardware and software systems.
Route optimization using ant colony optimization (2013).	System, Traveling Salesman Problem, Parameters, Green computing.
Wireless sensor networks (WSNS) and next generation networks (NGNS) (2013)	WSN Protocol Stack's Layer.

A study of power consumption (2013).	Power consumption in Computer, Laptop, Tablet PC.
Cloud computing for green Chhattisgarh (2013).	Cloud Computing, Library Automation, Green Libraries, Chhattisgarh.
Energy efficiency aspects of grid computing (2013).	Green IT, Distributed Computing, Grid Computing, Cloud Computing.
Role of bioinformatics (2013).	Green computing; Bioinformatics.
Green computing: implementation of green computing & future trends (2013).	Green Computing, power consumption, CO2 emission, ICT.
Green computing in steel industry (2013).	LPC,CCOE,AGS
A study of e-waste management and its challenges in India (2013).	Energy consumption, E-waste recycling, green computing, green IT.
Low power consumption in wireless-communication by using ultra-wideband (2013).	UWB, Communications, Power Efficiency, Wireless Communication, WLAN.
Role of bioinformatics in green computing (2013).	Permutation, Hazardous material, Biodegradability.

Table 2: Green computing issue and challenges

TOPIC	ISSUE	CHALLENGES
Green computing (Eco Friendly environment) using green technology, parallel system.	Green Scheduling, Voltage Scaling, Static Voltage Scaling, Dynamic Voltage Scaling, Adaptive Voltage scaling.	DVS widely used in various research, but it is not helpful in thermal heat reduction of systems. AVS is useful for both power reduction of processing element as well thermal heat reduction of systems. But not frequently used in parallel system [18].
Calculation of Carbon footprint (GHG emission, Individuals, nations or organization's carbon).	Carbon footprint, Green house gases, Emission, carbon offsetting.	Awareness about GHG emission and Commitment can go a long way in keeping our environment clean [19].
Reducing energy consumption by using optimized programming techniques and energy efficient algorithms	Sorting Algorithms, Energy Efficiency, Joule meter, Green Computing.	Optimized quick sort requires least time as well as consume least energy in comparison to other sorting algorithms, also the energy consumption depends not only on the sorting algorithms but also on the data types of the elements being sorted. The integer type data requires less energy than that of double type data [20].
Reducing electricity (energy) consumption on smart phone.	Handset Energy	Increasing integration of advanced functionality, mobile device energy consumption is rapidly increasing. Various challenges remain in the areas of energy and huge advances have been made in low power design and power management techniques in area of mobile revolution. [21].

Green computing using energy efficient software and hardware system.	Energy efficient hardware and software systems.	New challenges occurred will include how to best way for reduces energy from the hardware to the software. How to optimize computational on hardware, we reduced any large algorithm towards its energy-optimal conditions, approaching the low energy per computation limits [22].
Green approach by using shortest path algorithms (Methods Traveling salesman problem.	System, Traveling Salesman Problem, Parameters.	Ant Colony Algorithm has great impact on algorithm performances. Good parameter combination will increase the overall route optimization performance [23].
Contribution of Wireless Sensor Networks (WSNs) and Next Generation Networks (NGNs).	WSN Protocol Stack's Layer.	New finding in the area of power consumption of next generation networks by analyzing the components within a network. [24].
Green computing technique: An analysis of power consumption on desktop pc, laptops and Tablet PC.	Power consumption in Computer, Laptop, Tablet PC.	Challenging work done so far is that it's give some of question to optimize power except decreasing performance [25].
Cloud computing a greener approach.	Cloud Computing, Library Automation, Green Libraries.	Data centers consume huge amounts of power, high computing costs and reduced high amount of carbon to the environment. Reducing power consumption and carbon emissions is open challenges for the future research work [26].
Grid computing: Grid technology as a means to reduce energy consumption.	Green IT, Distributed Computing, Grid computing, Cloud Computing, Green Grid.	Grid computing systems require standard security functions and certain constraint which are user access Control, integrity, privacy, authentication and no repetition [27].
Review on role of bioinformatics to start with green computing.	Green computing; Bioinformatics.	Bioinformatics is an area, concerned about the calculation of biological data and analysis of data sets, and retrieval and processing of data, which is greater complex work [28].
Formation of traditional computing to green computing.	CO2 mission, ICT, power consumption	There are various thing such as managing data center, server power consumption and calculation complexity is to be handling for the hardware and software as well [29].
Implementation of green computing	CO2 emission, energy efficiency.	Introducing more energy efficient policies, future eye work, to get drastic result today. [30]

Green computing steel industry.	LPC, Last Pay Certificate, Customer Centre of Expertise (CCOE) by SAP Active Global Support (AGS)	Applying highest Safety standards, CO2 breakthrough programmed innovative steel solutions in such a manner that it meets greener [31].
E-waste replacing and recovery process.	E-waste recycling, power consumption,	Focused toward awareness to citizen and organization sectors are the main important tasks now that work greener environment [32].
Reduce power consumption by using UWB (Ultra-Wideband technology).	UWB, Communications, Power Efficiency, Wireless Communication, WLAN.	Energy uses, combined technique in such a way to save overall energy and increase the lifetime of the network is a challenge [33].
Bioinformatics in green computing	Permutation, Hazardous material and biodegradability.	Various methods are becomes critical in bioinformatics due to changes and large amount of data sets for processing and analyzing [34].

4. Conclusion

By this review we conclude that industrial evolutions and adapted technologies have various effects on environment. But we should bring a change that will take us towards a greener tomorrow.

5. Future Work

After achieving milestone in IT sector, there is a need to efficiently use resources without affecting environment. IT sector covers many of things for achieving green computing such as hardware equipment recycling, cloud computing, reduction of paper usage, low power management, green manufacturing etc. Work may be taken up in any one of these areas.

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