

Sustainable Green Computing and its impact on environmental issues: Past, Present and Future

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Abstract-

'Green computing', also known as environmentally responsible computing intends to perform as good as the existing traditional methods without leaving any trails on the environment. The emergence and necessity of the green computing has potentially grown in multiple folds in recent years. The motto behind utilization of this principle is to neutralize the carbon footprints. Small, medium and large scale enterprises already had shifted their focus towards green computing emphasizing the need for negative carbon emissions. In this article, we intend to discuss the significance of the green computing and its role in operational energy consumption, recycling, global warming and many other factors that are bothering the environment. The author(s) also discuss the role of techniques such as IOT and machine learning in the advancement of the green computing effectively in global markets. This article gives a detailed insight of the developments in green computing over a decade predicting its potential contributions for tackling harmful anthropogenic (human-induced) climate change which is also in alignment to the United Nations Framework Convention on Climate Change (UNFCCC) motto.

Keywords: Green computing, Environment, UNFCCC, IOT, Carbon neutrality

Introduction

In this section a brief discussion is made on colorful issues related to green computing. This is followed by a section on check of recent inquiries in the field of green computing (Saha, 2018). herbage computing should address environmental sustainability primarily by riveting on design, manufacture, use and disposal of computer and other affiliated bias in an eco-friendly way(Saha, 2018). Over the same period of time the rise in the use of computers have increased manifold. The concerted effect of the energy demanded to run these bias and the electricity needed to maintain the cooling structure for these bias have an impact on the terrain. This is refers to environmentally sustainable computing. Green Computing work for saving the terrain of computers, waiters and associated subsystems similar as a examiner, printers' storehouse bias and networking and dispatches systems. The thing of a green computing is saving the terrain (Saha, 2018), herbage computing is working for saving the terrain & Green technology focuses on reducing the environmental impact of artificial processes and advanced technologies caused by the Earth's growing population. It has taken upon itself the thing of provides society's requirements in ways that don't damage the natural coffers (Kurp, 2008). One of the first appearances of the green computing movement was the launch for the Energy star program back in 1992. Energy Star backed as a kind of voluntary label awarded to calculating products that succeeded in lessening the use of energy while maximizing productivity. Energy Star useful to products like computer observers, TV sets and temperature control bias like refrigerators, air conditioners, and analogous particulars. In 1992 the US Environmental Protection Agency Launched Energy Star, a voluntary labelling program which is designed to promote and fete energy effectiveness. In observers, climate control outfit, and other technologies. This redounded in the wide relinquishment of sleep mode among consumer electronics. The term "herbage computing" was presumably chased shortly after the Energy Star program began(Kurp, 2008).

Carbon aware green cloud architecture

Green Pall armature is one of the rearmost developments of green computing idea. The end of this unified result is to deliver both druggies and providers, high- position armature for supporting energy-effective service allocation which is grounded on pall technology. pall providers, being profit acquainted are looking for results which can lower their electricity bills without losing their request share. The thing of satisfying the demand for high- position computing services on the druggies side and saving energy on the providers side, can now be achieved by enforcing the green pall structure (Anwar, 2013). The armature for supporting energy-

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effective service allocation in green pall calculating structure. The pall services (SaaS, PaaS, IaaS) are registered in the form of public immolation in Green Offer Directory. The Green Broker has the full access to all services which are available and registered in public directory. Green Offer directory is incitement for the providers who, list their services with blinked prices and green hours. A typical pall broker parcel pall services and schedule operations Green broker's responsibility is to elect these immolations in terms of conditions of end stoner. Each request is analysed according to the price, time and service that offer the loftiest quality and least CO2 emigration. Green broker uses the up to date information about pall services and current status of energy effectiveness parameters using Carbon Emission Directory(CED) which is veritably important element of the armature. CED may include some the pivotal green criteria power dimension like Power operation Effectiveness(PUE) – which is the bit total energy consumed by the service of a data centre to the total energy consumed by IT outfit, some cooling. effectiveness pointers suchlike Water operation Effectiveness(CUE) – which is the computation of hothouse feasts(CO2, CH4) release on atmosphere by the data centre(Atrey, Jain & Iyengar, 2013, p. 96) and carbon footmark. Using data stored in CED and green offer directory broker is suitable to1857(Pazowski, 2015).

The hosting terrain includes devoted machines for three different purposes Dis- ewers, train waiters, and cipher waiters. A Dispatcher receives service requests and chooses the cipher waiters to handle them. It also decides when to arrestment and renew cipher waiters. train waiters give all data sources, cipher waiters host the services. Dispatchers and train waiters are permanently running, whereas cipher waiters are running only if demanded. The approach presented in this paper aims at minimizing the number of running cipher waiters while offering the needed QoS to the guests. Each cipher garçon hosts a Node Manager element. The Node Manager is responsible for covering idle time and average service response time. It communicates 1 Languages similar as Web Service position Agreements(WSLA)(Binder & Suri, 2009).

Green cloud computing

The Gartner report from May 2009 defines pall conception as " a style of calculating where scalable and elastic IT capabilities are handed as a service to multiple guests using Internet technologies ", use of the eventuality of pall computing model interacts with the conception of sustainable development, understood in three confines profitable, environmental and social (Kapur & Dutta, 2021). shadows consolidate terrain, saving power, cooling, space and plutocrat. Cost savings and inflexibility of operations are among the most constantly mentioned benefits associated with a decision to borrow the pall computing result. Fixed costs related to the investment in structure(which in the traditional business model generally increases with time and the need to modernize the software) are reduced, as well as energy costs feeding the structure. Traditional costs related with the licenses, number of druggies, outfit, operation, repairs and operations are replaced for payment for functionality that's actually used by the company or other association that also gain access to the rearmost technology. This result allows to acclimate force to demand, barring incurring gratuitous costs associated with the overestimation or underestimation of client requirements. At the same time, it affects the reduction of circumstance of lost deals openings threat and cost of incorrect demand soothsaying and company's force planning (Kapur & Dutta, 2021). Some aspects of pall's ICT structure allow to identify the model as the one furnishing green benefits. The introductory features of the model allow you to specify a number of environmental benefits that can be achieved by migrating the IT coffers to the pall(Jati, 2010). These aspects may include • Dynamic provisioning and multi residency lower energy consumption and associated carbon emigrations than the traditional approach of over-provisioning. Automatic processing of calculating terrain supports stoner requirements, operating under the pall may acquire or release the coffers(cases) where it's applicable(according to the demand). Dynamic resource allocation is done automatically, therefore datacentres maintain active waiters according to current demand. With virtualization technology, which allows to connect distant coffers in one great set of coffers it's possible to release them more widely to all guests at the same time adding the position of their use. Without virtualization pall computing would now a rise. The entire pool is participated by numerous guests of a one supplier, in the way of dynamic allocation and releasing precisely defined portion of virtual coffers. position of use of the pool is commensurable to changes in demand for calculating coffers (Soomro & Sarwar, 2012). • Optimal garcon application traditionally, numerous waiters remain idle of 85-95 of the time using nearly as important power as they do when they're active. Virtualization technology enables hosting of multiple operations through one garçon. The number of active waiters is reduced and the power consumption is lower. • Energy-effective customer bias the public pall model reduces the number of energy consuming guests through small energy-effective bias(e.g. thin guests)

The conception of green computing has began to spread in the once many times, gaining adding fashionability. Besides the wide perceptivity to ecological issues, similar interest also stems from profitable requirements, since both energy costs and electrical conditions of IT assiduity around the world show a continuously growing trend. similar practices include the perpetration of energy-effective central processing units(CPUs), waiters and Peripherals as well as reduced resource consumption and proper disposal of electronic waste(e-waste). herbage computing is the study and practice of effective andeco-friendly computing. The principle behind energy effective coding is to save power by getting software to make lower use of the tackle, rather than continuing to run the same law on tackle that uses lower power. latterly, this paper helps to identify crucial issues applicable to green computing and estimate different approaches to these problems. The green computing program was introduced to the Energy star program in 1992. Energy Star applied to products like computer observers, TV sets and temperature control bias like refrigerators, air conditioners, and analogous particulars(Jindal etal., 2012). The Gartner report from May 2009 defines pall conception as " a style of calculating where

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scalable and elastic IT capabilities are handed as a service to multiple guests using Internet technologies ". The 1856 use of the eventuality of pall computing model interacts with the conception of sustainable development, understood in three confines profitable, environmental and socia(Wang & Wang, 2011)l. shadows consolidate terrain, saving power, cooling, space and plutocrat. Cost savings and inflexibility of operations are among the most constantly mentioned benefits associated with a decision to borrow the pall computing result. Fixed costs related to the investment in structure(which in the traditional business model generally increases with time and the need to modernize the software) are reduced, as well as energy costs feeding the structure. Traditional costs related with the licenses, number of druggies, outfit, operation, repairs and operations are replaced for payment for functionality that's actually used by the company or other association. that also gain access to the rearmost technology(Roy & Bag, 2009). This result allows to acclimate force to demand, barring incurring gratuitous costs associated with the overestimation or underestimation of client requirements. At the same time, it affects the reduction of circumstance of lost deals openings threat and cost of incorrect demand soothsaying and company's force planning(Anwar Mohammed etal., 2015). Some aspects of pall's ICT structure allow to identify the model as the one furnishing green benefits. The introductory features of the model allow you to specify a number of environmental benefits that can be achieved by migrating the IT coffers to the pall(Anwar, 2013).

Need for green computing

Green computing minimise the E-waste with the help of this we save the power. Understanding the ways in which power consumption impacts the greenness of any technology, and specifically calculating technology, is an essential step toward reducing this consumption and educating others (Soomro & Sarwar, 2012).

Now a days computer is the introductory need of every human. A computer made our life easier and saves alot of time and mortal sweats, but the use of computer also increase power consumption and also induce a lesser quantum of heat. Lesser power consumption and lesser heat generation means lesser emigration of green house feasts like Carbon Dioxide(CO2) that has colorful dangerous impacts on our terrain and natural coffers(Mittal & Kaur, 2013).

Challenges

According to experimenters in the history the focus was on calculating effectiveness and cost associated to IT outfit and structure services were considered low cost and available. Now structure is getting the tailback in IT surroundings and the reason for this shift is due to growing calculating requirements, energy cost and global warming. This shift is a great challenge for IT assiduity, thus now experimenters are fastening on the cooling system, power and data centre space. At one extreme it's the processing power that's important to business and on the other extreme it's the drive, challenge of terrain friendly system, and structure limitations (9). Green Computing challenges aren't only for IT outfit druggies but also for the IT outfit merchandisers.(Tiwari, 2011) Several major merchandisers have made considerable progress in this area, The HP rp5700 exceedsU.S. Energy Star4.0 norms, and has an anticipated life of at least five times, and 90 of its accoutrements are recyclable(3). Dell is speeding up its programs to reduce dangerous substances in its computers, and its new Dell OptiPlex desktops are 50 further energy-effective than analogous systems manufactured in 2005, credit goes to further energy-effective processors, new power operation features, and other affiliated factors(3). IBM is working on technology to develop cheaper and more effective solar cells plus numerous other results from IBM to support sustainable IT(Ahamad & Ravikanth, 1992). Following are the areas and practices that druggies can apply for maximizing utility and minimalizing negative consequences for terrain(Kansal & Chana, 2012). The approach of green technology disposal include refurbishing and reusing old being computing outfit and proper recycling of obsolete, unwanted or broken computers and its subsystems. Due to strength of negative goods on terrain arising from indecorous approach to disposal, this aspect of green computing is among one of the most important (Pazowski, 2015). terrain and IT wide use of computers and affiliated IT products has a veritably bad effect on the terrain. colorful environmental issues and problems due to the impact of I.T on terrain are bandied below (Fazarro & McWhorter, 2011).

As we all know hothouse feasts are having a ruinous and long lasting dangerous effect on our atmosphere and terrain. The growing accumulation of hothouse feasts is changing the world's climate and rainfall patterns in an intimidating way. Accumulation of hothouse feasts in the atmosphere is sluggishly adding global temperature. Global data shows that storms, famines, and other rainfall-related disasters are growing more severe and being more constantly than ever ahead. Electricity is a major cause of climate change, because the thermal power shops that help induce electricity also releases huge quantum of carbon dioxide and numerous other dangerous patches into the atmosphere. These emigrations beget serious respiratory conditions, gauze, acid rain and global climate change. Reducing electric power consumption and producing electricity in furthereco-friendly way is a key to reduce carbon dioxide emigrations and their impact on our terrain and global warming(Agarwal, 2014). More importantly rainfall geste to a large extent has come changeable. The ocean- position is also adding alarmingly because due to global warming the arctic glaciers are melting as noway ahead. Leaders of all countries are veritably much upset and keen to stop the accumulation of hothouse feasts in the atmosphere. They're of the opinion that global emigrations of hothouse feasts would have to stop growing to check the imminence of hothouse effect(Dinote etal., 2020).

Hazardous Iimplication of Technical Development

on terrain IT affects our terrain in different ways. Each stage of a computer's life, starting from its product, throughout its use, and into its disposal, environmental problems. Manufacturing computers and their colorful electronic andnon-electronic factors consumes electricity, raw accoutrements, dangerous chemicals and water and generates dangerous waste. All these directly or laterally increase carbon dioxide emigrations and impact the terrain(Panda, 2013). The total electrical energy consumption by waiters, computers, observers, data communication outfit, and cooling systems for data centers is also adding at a veritably fast rate(Sanjeevi etal., 2018). These increase in energy consumption results in increased hothouse gas emigrations. Each particular computer(PC) in use generates about a ton of carbon dioxide every time. Computer factors contain lot of poisonous accoutrements. As further and further people are using computers, decreasingly consumers are discarding a large number of old computers, observers, and other electronic outfit many times after purchase, and utmost of this ends up in tips, contaminating the earth and polluting water due to the presence of colorful poisonous accoutrements in the electronic factors(Wang & Wang, 2011). The increased number of computers and their use, along with their frequent reserves, make the environmental impact of IT a major concern for all of us(Agarwal, 2014). Accordingly, there's adding pressure on all stake holders the IT assiduity, businesses, and individualities to make IT environmentally friendly throughout its lifecycle, from birth to death to revitalization. It's our collaborative responsibility to guard our terrain for our unborn generation.

Measures Driven By G.C to Safeguard Environment

Here, is some basis for green computing which shows how designers plan to make future computer more eco-friendly across its entire life span, from manufacture to recycling Energy-intensive work of computer system can be abated by making manufacturing process more energy effective. To make a green computing process more effectively we have to upgrade the mechanism. Sidestepping the discarding will not only control e-waste out of dumps but also save energy and materials required for a whole new computer Organic light emitting diode and OLED are used instead of using power sucking display. some of the toxic material are used to make a computing product but we have to switch for the good environmental material like lead and copper.

Application of Potential usages of Green computing

Now a day, one of the popular green computing groups is politic proliferation lists. This group applies & uses green computing doctrines substantially to save up on costs rather than save the terrain. This movement arose substantially from profitable sentiments rather than political pressure. Strategic Leaders take into account the social and environmental impacts of new and arising technologies. Away from minimizing costs, this particular movement also takes into account other factors similar as marketing and branding. Unlike the position held by politic proliferation lists, strategic leaders fete the need to catch some being programs or structural makeup of the association. This can be seen in recent sweats to make IT labor force directly responsible for managing, minimizing and icing effective energy expenditures.

Moment all manufactures companies are trying to establish similar data center which are cheap and use low energy/ power. In America in the year of 1992 a program was introduced named as energy star program. Its main end was given awarded to those calculating products which use minimal energy and give maximum effectiveness in its working. In Energy star program were included similar product as computer examiner, TV sets, refrigerator, air exertion and other electronics bias. Product standards are checked by using EPEAT . All product which are registered are better to cover mortal health and these item can be fluently upgraded and reclaimed. These products have reduced the chance of lead, mercury and cadmium. These products are more effective in energy and reduce the environmental impact. IBM also has also contributed these issues. IBM has helped the guests to buy the products according to green computing. According to the exploration of the IBM in 1990, He saved4.6 billion KWh of electricity and also prevented3 million metric tones of CO2 emigration(Nwankwo etal., 2020). During this times, attention in ' Green Computing ' has moved exploration into energy- saving ways for home computers to enterprise systems(Meena, 2016). customer and Garçon machines Saving energy or reduction of carbon vestiges is one of the aspects of Green Computing. Current Trends of Green Computing are towards effective application of coffers. Energy is considered as the main resource and the carbon vestiges are considered the major vestments to terrain(Binder & Suri, 2009)

Energy consumption

Association are realizing that the source and amount of their energy consumption significantly contributes to Greenhouse Gas(GhG) emigration. In response to this finding, association are presently using the following equation Reduced energy consumption = Reduced hothouse gas emigration = Reduced functional costs for the data center. It means espousing smaller and further energy effective systems. while refactoring operation surroundings to make optimal use of physical coffers is the stylish architectural model. According to Environmental Protection Agency in around 30 to 40 of particular computers are kept' ON' after office hours and during the weekend and indeed around 90 of those computers are idle(Pazowski, 2015).

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E-waste recycling

E-waste recycling predicated on the Gartner estimations over,000 PCs are discardedbyU.S. homes and businesses every day and lower than 10 percent of all electronics are presently reclaimed. maturity of countries around the world bear electronic companies to finance and manage recycling programs for their products especially under- developed Countries. E-Waste is a manageable piece of the waste aqueduct and recyclinge- Waste is easy to adopt(Soomro & Sarwar, 2012) VIA Technologies, a Taiwanese company that manufactures motherboard chipsets, CPUs, and other computer tackle, introduced its action for" green computing" in 2001(Suri, 2014). With this green vision, the company has been fastening on power effectiveness throughout the design and manufacturing process of its products.(Jindal etal., 2012).

Carbon-free computing One of the VIA Technologies'ideas is to reduce the" carbon footmark" of druggies — the quantum of hothouse feasts produced, measured in units of carbon dioxide(CO2). hothouse feasts naturally blanket the Earth and are responsible for its more or less stable temperature. An increase in the attention of the main hothouse feasts — carbon dioxide, methane, nitrous oxide, and fluorocarbons is believed to be responsible for Earth's adding temperature(Jindal etal., 2012). Lead-Free and RoHS computing In February 2003, the European Union espoused the Restriction of Hazardous Substances Directive(RoHS). The legislation restricts the use of six dangerous accoutrements in the manufacture of colorful types of electronic and electrical outfit. The directive is nearly linked with the Waste Electrical and Electronic Equipment Directive(WEEE), which sets collection, recycling, and recovery targets for electrical goods and is part of a legislative action that aims to reduce the huge quantities of poisonouse-waste.(Pazowski, 2015)

Approaches to green computing

The field of green computing as" the study and practice of designing, manufacturing, using, and disposing of computers, waitpersons, and associated subsystems analogous as spectators, printers, storage bias, and networking and dispatches systems — efficiently and effectively with minimum or no impact on the terrain.(Lo & Qian, 2010) Murugesan lays out four paths along which he believes the environmental goods of computing should be addressed Green use, green disposal, green design, and green manufacturing(Sanjeevietal., 2018). modern IT systems calculate upon a complicated mix of people, networks and attack; as analogous, a green computing action must cover all of these areas as well. A result may also need to address end user satisfaction, operation restructuring, nonsupervisory compliance, and return on investment(ROI). There are also considerable fiscal provocations for companies to take control of their own power consumption;" of the power operation tools available, one of the most important may still be simple, plain, common sense"(Ahamad & Ravikanth, 1992).

Discussion

In 1992 the US Environmental Protection Agency was proposed Energy Star. This redounded in the wide relinquishment of sleep mode among consumer electronics. The term" Green calculating" was presumably chased shortly after the Energy Star program began. Green calculating minimises the E-waste with the help of this we save the power (Childs et al., 2008). A computer made our life easier and saves a lot of time and mortal sweats, but the use of computer also increases power consumption and also induce a lesser quantum of heat on our terrain. Green calculating challenges aren't only for IT outfit's druggies but also for the IT merchandisers. Hewlett-Packard lately unveiled what it calls" the greenest computer ever" (Suri, 2014). The HP rp5700 exceedsU.S. Energy Star4.0 norms, and has an anticipated life of at least five times. As further and further people are using computers, decreasingly consumers are discarding a large number of old computers, observers, and other electronic outfit many times after purchase. utmost of this ends up in tips, contaminating the earth and polluting water due to presence of colorful poisonous accoutrements. One of the popular green computing groups is politic proliferation lists. This group applies and uses green computing doctrines substantially to save up on costs rather than save the terrain. In America in 1992 introduced a energy star program which awarded computing products which use minimal energy and give maximum effectiveness (Journaa & Kadry, 2012). IBM has helped the guests to buy the products according to green computing. According to the exploration of the IBM in 1990, He saved4.6 billion KWh of electricity and also averted 3 million metric tons of CO2 emigration. lower than 10 percent of all electronics are presently reclaimed. maturity of countries around the world bear electronic companies to finance and manage recycling programs, herbage computing is the study and practice of using computers efficiently and effectively with minimum or no impact on the terrain. ultramodern IT systems calculate upon a complicated blend of people, networks and tackle. A result may also need to address end stoner satisfaction, operation restructuring, nonsupervisory compliance, and return on investment. The 1856 use of the eventuality of pall computing interacts with the conception of sustainable development, understood in three confines profitable, environmental and social. Over,000 PCs are discarded byU.S. homes and businesses every day and lower than 10 percent of all electronics are presently reclaimed. maturity of countries around the world bear electronic companies to finance and manage recycling programs. herbage computing must take the product life cycle into consideration; from product to operation to recycling. E-waste is a manageable piece of the waste sluice and recyclinge-Waste is easy to borrow(Syzdykbayeva, 2009). Strategic Leaders take into account the social and environmental impacts of new and arising technologies. This can be seen in recent sweats to make IT labor force directly responsible for managing, minimizing and icing effective energy expenditures.

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Conclusion

VIA is a part of carbon free Computing Initiative, Mainly this means creating fully recyclable products and reducing pollution. There is a growing awareness among business leaders that greening their IT practices offers the double-winl of reducing costs while demonstrating a positive environmental commitment. Smart healthcare plays important role in human life and various research projects are running on it. It consists of diverse ingredients like wireless communication technology, cloud computing, edge computing, medical sensors, artificial intelligence (AI), and IoT. SThese chapters introduce with respect to the multiple challenges like privacy, security and low-power operation faced while incorporating IoT with healthcare sector. Manufacturers of IT equipment are required to adhere to a variety of environmental laws and regulations as a result of global warming. This review paper intends to discuss the study on present trends in green computing, problems with green computing, and potential green computing trends in the future. The purpose of this article is to make this green mission successful through green computing and various preventive measures that we should follow to save our atmosphere.

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