BBRC

Bioscience Biotechnology Research Communications

Special Issue Vol 13 Number (10) 2020
Print ISSN: 0974-6455
Online ISSN: 2321-4007
CODEN BBRCBA
www.bbrc.in
University Grants Commission (UGC)
New Delhi, India Approved Journal

Bioscience Biotechnology Research Communications
Special Issue Volume 13 Number (10) 2020

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On

Recent Research on Management, Sciences and Technology

An International Peer Reviewed Open Access Journal

Published By:
Society For Science and Nature
Bhopal, Post Box 78, GPO,
462001 India

Indexed by Thomson Reuters, Now
Clarivate Analytics USA

SJIF 2020=7.728
Online Content Available:
Every 3 Months at www.bbrc.in

SOCIETY
FOR SCIENCE AND NATURE
SCIENCE FOR LIFE

Registered with the Registrar of Newspapers for India under Reg. No. 498/2007
Bioscience Biotechnology Research Communications
Special Issue Volume 13 No (10) 2020

ISSN 0974-6455

Biosc.Biotech.Res.Comm. Special Issue Vol 13 No 10 (2020) Pp-56-59

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A Study on Adapting Green Techniques in Software Engineering Process to Reduce Energy Consumption.

G. B. Hema Latha[1], Yogesh Kumar Sharma[2] and Hiren Dand[3]
[1]*Research Scholar Shri. J.J.T. University Jhunjhunu, Rajasthan, India*
[2]*Professor Shri. J.J.T. University Jhunjhunu, Rajasthan, India*
[3]*Adjunct Professor Shri. J.J.T. University Jhunjhunu, Rajasthan, India*

ABSTRACT

Technology is emerging day by day and also the usage of software too in all sorts of fields along the globe. The primary concern in the world now is pollution due to natural disasters and also by the man made inventions for living modern life in society. During usage the carbon emitted from these devices will have higher impact on the overall pollution of the world .So we indeed have to find a solution to minimize the co2 emission from these devices by implementing sustainability in every activities of software development process by applying different JIT green techniques in it. In this paper the section one introduces what is need of green software engineering and its best practices, the section two introduces best practices for sustainable software and energy efficient framework of software ,the section three describes green implementation of different software process methodologies and the final section will show the improvements after implementing green techniques in life cycle.

KEY WORDS: GREEN COMPUTING, CARBON FOOTPRINT, VIRTUALIZATION, GREEN DATA CENTERS.

NINTRODUCTION

There is tremendous changes in the environment due to global warming and it became an issue to the government and private sectors as they have to abide the regulations of environmental protection schemes.so everyone is finding ways to green every activity of work performed by the organization. Also, now every individual has to take onus for healthful adaptation sustainable practices to reduce the energy consumption at home. The developers and the end users are having different perspective in case of Energy consumption of devices, the developers says that due to battery users and the end users generally think, it is due to the application programs. As more recently, economically sensible energy conservation is required.

The insight for this change comes from a) increase in awareness of global warming issues like GHS b) and increasing sense of national Energy saving security c) growing business process needs prevention of cost and energy in activities of business process d) obtaining an efficient software and hardware[2]will indirectly reduce the perverse effect in the environment.[4] For this, we need to consider a software engineering process development steps [4] in order to obtain sustainable and green software products [6]which help to minimize the negative impacts on the environment. Hence, it is possible to help and guide project managers, engineers, developers and users to better collaborate to produce efficient software applications using eco-friendly environment [8].

Green software and Software Engineering: Software: is a set of instructions or programs instructing a computer to do specific tasks as per the requirement of the user. Green software: "It's is a software made and used and

ARTICLE INFORMATION

*Corresponding Author: gb_hl@yahoo.co.in
Received 25th Sep 2020 Accepted after revision 7th Nov 2020
Print ISSN: 0974-6455 Online ISSN: 2321-4007 CODEN: BBRCBA

Thomson Reuters ISI Web of Science Clarivate Analytics USA and Crossref Indexed Journal

NAAS Journal Score 2020 (4.31) SJIF: 2020 (7.728)

Online Contents Available at: http//www.bbrc.in/

used to reduce environmental issues", provided by Murugesan in Harnessing-Green-IT Practices. Green Software: Green software to full-fill the following three high level requirements: a)The required software engineering activities of software development, maintenance, and disposal must save resources and reduce waste. b) Software execution must save resources and reduce waste. c) Software must support sustainable development.

Green sustainable –software engineering: is the skill of creating green and sustainable software in relation to the process of green software engineering. The skill of describing and making software products in a way, the positive and negative effects on sustainable developments of the Life Cycle process constantly assessed. The assessed details are maintained as records and may be utilized for a software product process optimization.

Best practices and sustainable software [02]: Can be for green implemented in all aspects of software development.

a) Defer initialization of till we need it for execution
b) Efficient data traffic to transfer data without delay
c) Decrease algorithmic complexity to keep the software with less space and time
d) Power down peripherals to reduce the energy consumption d)Efficient UI to interact the system faster
e) Efficient query to retrieve the data rapidly
f) Load balancing to distribute data and reduce overloading
g) Virtualization
h) Just-In-Time compiler to enhance execution i) Reduce transparency.

Related Study

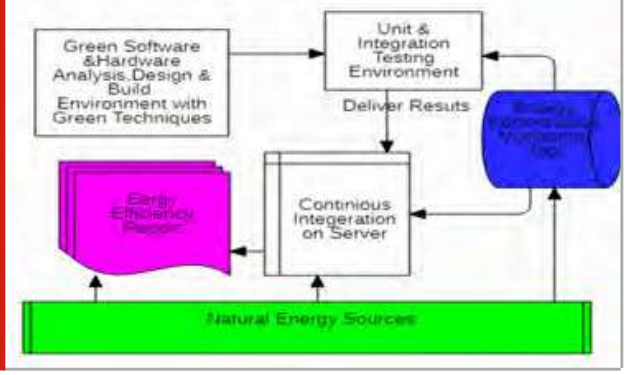
1.3.1.Gustavo Pinto, Fernando Castor,2017,In this paper[13] The major issue in preventing software developers from identifying, fixing, refactoring as well as the removal energy consumption hotspots are the insufficiency of knowledge and the non-occurrences of tools . These problems is handling both the problems. Also further they discussed about, the relationship between software and energy consumption. Energy consumption (EC) is an accumulation of power dissipation (PD) over time t, that is, EC = PD × t. Power PD is measured in watts, whereas energy EC is measured in joules. As an example, if one operation takes 20 seconds to complete and dissipates 10 watts, it consumes 100 joules of energy. Also we need to consider on the software which are in under execution, hardware platform, given context also during a given time. To understand the importance of a hardware platform, consider an application that uses the network. Any commodity smartphone nowadays supports, at least, Wi-Fi, 3G, and 4G.

1.3.2. Shantanu Ray,2013,The impact [14] of carbon emission and the necessity of sustainability in software development is mentioned. Using methods SCRUM, Extreme programming and Sprint helps in minimizing the problems related to the efficiency and flexibility .Suggested visualization of server and use natural resources for energy consumption. Monitor the energy difference through normal energy and adaptation of sustainable natural energy. They also proposed a tool OGSA-DAI-used in university of Edinburgh to enhance optimization.it is a sustainable software ,and create during better user interface.it is an innovative user interface and provided with innovative solution for data access management.

2.0.Green Design and coding in Life Cycle: Focus on creating green and sustainable software in relation to the process of it.The skill of describing and making software products in a way, the positive and negative effects on sustainable developments of the Development Life- Cycle process constantly assessed. The assessed details are maintained as records and may be utilized for a software product process optimization [2].

2.1: A Framework for Energy–Efficient Software: Software energy consumption plays a vital role in minimize carbon footprint. Initially, the hardware and software were tightly mingled and mostly indistinguishable. But now the hardware and software are varying, the number of software layers is constantly increasing to provide encapsulation and abstraction for software applications We can develop a green software by applying green analysis ,design, building and testing (fig:1) and perform the energy reduction from the developing stage, from the end user side as well as the customer side by collecting requirement to measuring the energy profile at every phases of the software development to enhance the software.

Figure 1: Green software Engineering Frame work



Also, Different Natural energy sources[13]should be provided to the system to reduce power consumption .There are several models and techniques available to

measure the consumption of in processor, memory, storage ,network and peripheral devices.

3.0: Reducing The Energy Through Green Software Engineering Life Cycle: To implement energy efficient software engineering process ,need to implement green activity every stages of the life cycle.

3.1.Green Requirements phase: It is initial phase of software development process analyses, trace, prioritize, and agree, and communicate to all stakeholders on functional and technical specifications. Plan for energy efficiency at all levels of software. Developers strike with issues for applying green during the development of product that due to lack of tools, guidelines, textbooks. Considering the power states of software, applying energy saving technique like computational &Idle efficiency and Data efficiency.

3.3. Sustainable Green Design coding: Design should consider hardware and software level. The coding style should be optimized and can have automatic code generators to save time in developing the process for maintaining the complete coding as clean code There is misconception that by reducing the execution time ,will reduce execution time, but it actually increases the context switching and increase the CPU execution cycles. Also can adapting energy efficient agile programming practices.

3.4 Green Testing Distribution and disposal: Perform testing with efficient test cases, Have energy profiler modules. To find the energy consumption of application unit testing level to integration level. In case of higher computation sent to the remote computer similar like mobile offloading.

Table 1. Devices chosen for power adjustments

S.no	Power Management Features Enabled systems	Number of Devices
1)	Number of desktop computers	100
2)	Number of desktop monitors	100
3)	Number of notebook computers	50
4)	Number of notebook displays	50

4.0. Applying green power management techniques in software to reduce energy consumption in the devices: A software tool called carbon calculator is used to evaluate the power consumption and co2 emission. In Table1.the total number of devices used for the power adjustment is given.

After selecting the number of devices for the experiment. We need to set parameter for the desired power management to Desktops –Monitor and computer as well as to the notebook display and the computer are shown in table2.

Table 2

Desktop Monitor	Low power sleep mode in minutes	15min
Desktop Computer	System Standby /Hibernate mode in minutes	30min
Notebook Screen	Low power sleep mode in minutes	15min
Notebook Computer	System Standby /Hibernate mode in minutes	30min

Table 3. PC usage in organization

1)	Number of hours work in day?	8 hrs
2)	How many days in a work week in your organization	5 days
3)	How many days leave in organization in an year.	22 days

Table 4. Result of energy saving.

Saving criteria	Energy (kWh)	Prevention of Co2
Desktop monitors transcended sleep mode:	16,849.2	38.9
Notebook displays transcended into sleep mode:	1,741.9	4.0
Total energy reduction from	18,591.2	42.9
Notebook computers going into sleep mode	22,328.6	51.6
Total savings from computer sleep mode	1,658.8	3.8
Total energy saved on the computer during sleep mode	23,987.4	55.4
Total saving	42,578.6	98.4

After setting the parameters in the system components in the organizations ,we need to find the amount of working hours and number of days in a week the organization is working as well as how many number of holidays in the organization, In order to find the devices used Table-3,so that it help as the find the usage of devices able 2: Power adjustments parameters. total energy saved prevention of carbon emitted can observed in Table 4.

CONCLUSION

The main challenges of the current are the global impacts of the environment are due to electronic devices. For developing the software application. This work proposes a new software model where focus is only on energy efficiency and energy consumption sustainability in every activities system. In future research can be conducted on implementing enhanced energy efficient metrics.

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