Developing Efficient Software Solution While Considering the Environment

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ABSTRACT

"Green" information technology has become a popular and trendy topic. Many companies are exploring methods, practices and policies to use green application development techniques. Energy consumption is a major cost of operating IT software in organizations and data centers. Hardware and software developers and manufacturers are beginning to include power saving options and strategies during project planning to reduce energy consumption and e-waste. While, software solutions are considered a valuable item in the IT project, there has been less research conducted to highlight their impact on the green technology movement. This paper focuses on the impact of developing green software solution on energy utilization and its benefits for the environment and organizations.

KEYWORDS

Green IT, Energy Efficiency, Energy Consumption, Software development, Database

INTRODUCTION

Recently, I got a link to The Story of Stuff by Annie Leonard, it is an amazing documentary on how stuffs are made, sold and disposed. Also, it emphasizes on the importance of being green in all aspects of life and the environmental, business and human related impacts. Climate change is likely to be the defining issue of the 21st century [3]. Green computing refers to the attempt to use computing equipment in an environmentally conscious manner, while balancing budgetary needs and usability. It is effectively a compromise solution of reduced energy and material consumption [1]. The goal of green IT is to maximize energy efficiency during the product's lifetime and promote the recyclability of IT hardware. Successful software development strongly depends on the delivery of high quality software. High quality is typically defined by quality attributes like customer satisfaction (which is mainly determined by being on budget and time), adherence to functional requirements, usability, security, stability

and many more [2]. With that in mind developers yet to spotlight on the importance of creating green software because the perception is software already green (paperless).

In this paper, I will highlight the importance of developing green software solution to businesses and what areas should be considered by software developers in order to reach that objective.

ENERGY CONSUMPTION IN MALAYSIA

It is becoming widely understood that the way in which we are behaving as a society is environmentally unsustainable, causing irreparable damage to our planet. Rising energy prices, together with government-imposed levies on carbon production, are increasingly impacting on the cost of doing business, making many current business practices economically unsustainable. It is becoming progressively more important for all businesses to act (and to be seen to act) in an environmentally responsible manner, both to fulfill their legal and moral obligations, but also to enhance the brand and to improve corporate image [8].

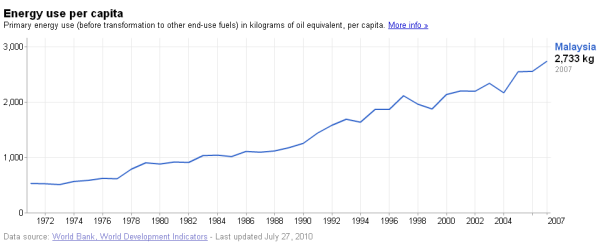


Figure 1: energy consumption in Malaysia

According to the World Bank, oil consumption has increased dramatically since 1970s due to the advancement in technology and software solutions in all forms such as IT, automobile, mobile technology and science [12]. Figure 1 presents the amount of energy usage in Malaysia since 1972 and up to 2007. In all the advancement areas, software does play an imperative part in oil and energy consumption; any implemented solution normal includes software at assist the user in implementing the technology. That solution can be a liability if it is not designed or developed in a “green” way.

GREEN BUSINESS MARKET

Businesses are contending in an increasingly green market. With the increasing drive towards centralized mega data and enterprise integration softwares alongside the huge growth in power-hungry blade technologies in some companies, and with a shift to an equally power-hungry distributed architecture in others, the IT function of business is driving an exponential increase in demand for energy, and, along with it, is having to bear the associated cost increase. The IT industry is more vulnerable than most – it has sometimes been a reckless and profligate consumer of energy. Development and improvements in technology have largely been achieved without regard to energy consumption [4].

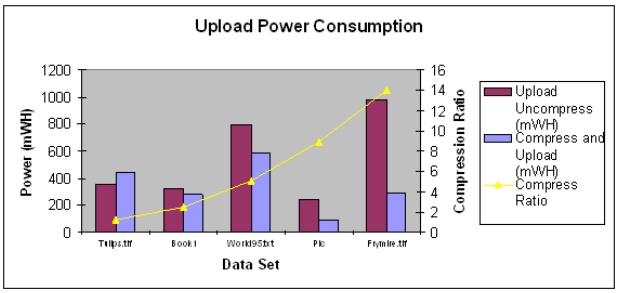
Modern IT systems provide more computing power per unit of energy (kWh) and thus reduce energy consumption per unit of computing power. Despite this, they are actually responsible for an overall increase in energy consumption and for an increase in the cost of energy as a proportion of IT costs [4]. New software in particular is devouring more and more power every year. Some software requires almost constant access to the hard drive, draining power much more rapidly than previous packages did [5].

According to Sun Microsystems engineers, a typical rack of servers installed in data centers just two years ago might have consumed a modest 2kW of power while producing 40 watts of heat per square foot. Newer, high-density racks, expected to be in use by the end of the decade, could easily consume as much as 25kW and give off as much as 500 watts of heat per square foot. The energy consumed by fans, pumps and other cooling components already accounts for some 60-70% of the total energy consumption in the data centre, and Gartner predicts that energy costs will become the second highest cost in 70% of the world's data centre's by 2009, trailing staff/personnel costs, but well ahead of the cost of the IT hardware [7].

ENERGY CONSUMPTION AND DATA

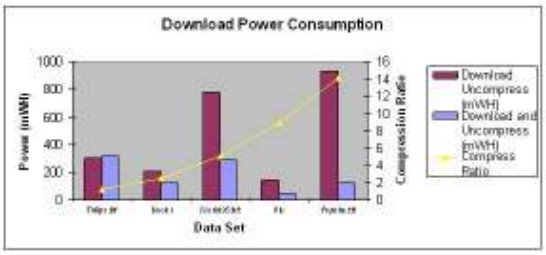
Data in software environment go through 3 levels of processing:

- Upload
- Processing
- Download



In each level, there will be a request sent to the server to handle and a response. When it comes to uploading data (or data entry), people who work exclusively in the field of data entry are likely to be quick typists, able to read off longhand or typewritten documents, and must be accurate. In programming, the wrong letter, number or symbol can throw off an entire command function of a program. For spreadsheets or for documentation that will be published or printed, typos can result in misinformation or embarrassing errors.

Therefore, the type of data that user is uploading has an impact on the processing of the server; Figure2 is an example of the processing power of an Intel server [10]. Data will be uploaded slower if the data is less compressed or organized. Furthermore, the types of data



to be uploaded can be in the range of normal worlds, files (PDF or word), audio or video files. With that in mind, type of data will affect the software performance (database environment) since the software will be handling the data upload request from the user to the server which will eventually lead to more energy utilization.

Downloading data is receiving data to a local system from a remote system, or to initiate such a data transfer. This process can be initiated via for different types of data such as audio, video, files or normal text. Nowadays, websites and softwares that offer streaming media or media displayed in-browser, such as YouTube, and which place restrictions on the ability of users to save these materials to their computers after they have been received, say that downloading is not permitted. In this context, "download" implies specifically "receive and save" instead of simply "receive". That means the processing is at the server side and requestor will not obtain the file fully on his local machine.

Therefore, the type of data requestors are downloading has a significant impact on the processing power of the server; Figure3 is an example of the processing power of an Intel server [10].

Data will be downloaded slower if the size is bigger (not compressed). Furthermore, the types of data to be downloaded can be in the range of normal worlds, files (PDF or word), audio or video files. With that in mind, type of data will affect the software performance (Database environment) since the software will be handling the download response to the user machine which will eventually lead to more energy utilization.

SOFTWARE ENERGY CONSUMPTION IN PRACTICE

For this research paper I have studied the software solution in a call centre environment for a leading airline company in Malaysia. This company is globally known in the low-cost flight services, they have flights to over 50 destinations worldwide. Also, they have other services such as hotel reservation, airport pickup, holiday packages and many more. This company has a Customer Relationship Management System (CRMS) to record users' transaction and assist with information and booking. The overall types of data transaction in the CRMS are:

1- Input user information.

2- Insert sales details.

3- Key in user reason of call (Case)

4- Search for user or Case details when required (callback process).

5- Generate various types of reports with various filtering options such as Country, date/time, gender or flight details. Such reports are:

- Users list.
- Cases list
- Sales details.

This CRMS is used for recording and retrieving their information, inserting cases and sales details, it doesn't include the booking system for flight which is handled by different booking software.

Software usage details:

- Total users (Agents) accessing the system are from 350 to 400 users between 9AM and 6PM and the number of users will go down to 5 users between 12AM and 6AM.
- Average number of calls received over the phone is 8500 per day and average number of emails is 500 per day. Customers are calling from more than 30 countries worldwide. Minimum of 80% of all calls and emails received must be inserted in the CRMS system.
- Total number of users in the database is over 1,000,000 users.
- Database and application are located at the same location as the call centre but in different floor (both in Kuala Lumpur).

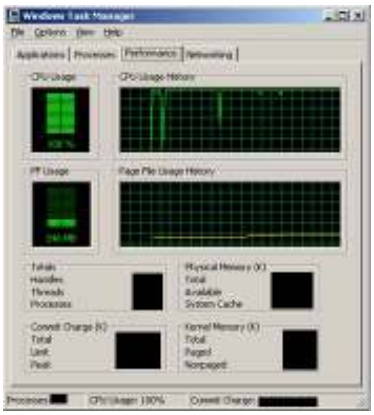
Software usage challenges:

With all stated, this Airline Company is facing an issue with their CRMS solutions. Some of the issues are as follows:

- System is slow when retrieving information.
- System timeout (Out of Memory) whenever the numbers of users increase (Between 11AM to 5PM).
- Extracting a single report takes between 15 to 20 minutes for around 10,000 records only.

Figure4 shows the task manager for that server, the CPU usage is reaching up to 100% of processing usage of resources during the peak time. That will load to consuming more energy in order to process the requests been send to the server by the users.

After viewing the environment and discussion with software developers it was indicated that the software is part of the main reason of consuming the server resources as shown in the figure since it's responsible for processing the request and response for the agents.



The server has a finite amount of memory available to satisfy the needs of the application running on it to store and process their data as well as to accommodate the code and internal state of the application itself. Memory is provided by the system in different forms (e.g., RAM, disk, virtual) and there are a number of limits associated with these due to the software and hardware characteristics of the computer [11]. Code efficiency in handing the user transactions plays an important role in

data transaction. So in order to handle memory consumption effectively, actions must be taken to improve server performance by modificing the software solution.

DEVELOPING GREEN SOFTWARE SOLUTION

Software energy consumption is affected by hardware specification and vacant resources in the processor and memory. In order to become a green solution, developers have to consider (internal and external) development process in order to achieve the ultimate goal. Some of the things developers need to consider and they are:

- **Programming language and Database selection**

There are countless programming languages and database applications available in the market, some of them are open source such as PHP and Mysql while others are property products such as ASP.NET and Microsoft SQL Server. Hence, some of these applications consume more memory and hardware capacity due to its size and capability such as Oracle while others are lightweight performance such as PostgreSQL. Therefore, developers must understand the purpose of the end software and choose the best platform that is cost effective, meet the desired goals and meet green objective.

- **Development server**

To be a green developer, the fastest machine should not be used as an acceptable performance benchmarking system (development server). Instead, developers should consider an older machine with less memory, slower CPU and smaller hard drive. If it can run on that machine with acceptable performance, your contribution to the rapid replacement of hardware is significantly less. By doing so, the application will function on the sample level of energy consumption as in the new server and there will be no performance issues in the future.

- **End user device**

End user device is a PC or mobile device that users utilize to access the software application. While most machines having 2 or 4GB of memory these days, developers often forget that there are hundreds of millions of PCs out there with just 256MB of memory (or less!). End user with low memory (RAM) send a request to the server toward retrieving data, the request will take time to be completed due to the minimum resources available on the end user PC, therefore, developers should consider the possibility of minimum resources and make the code lightweight and reduce processing time.

- **Additional components**

Software engineers intended to reuse existing codes or install plunging (external codes) in order to solve some

issues or enhance the system. As a result, developers intend to build libraries of code and recycle the libraries as much as possible. This is generally green; however, some 3rd party components which is thousands of times larger than the portions we actually want to use. As a result, we create a product that requires ten times or a hundred times more disk space and memory than if the product was developed completely in-house. Of course, developing completely in-house could mean additional cost must be included such as man power and software cost, however, this solution will minimize future costs of energy.

- **Include Environmental Costs in Cost Analysis.**

These days the data center electricity alone that a server uses in a given year can cost as much or more than the server itself, not to mention rack costs, cooling costs, bandwidth costs, software costs and the environmental impact of all the materials and manufacturing processes that goes into creating the server itself.

CONCLUSION

The aim of this paper is to highlight the importance of developing a green software solution that can reduce the energy consumption and improve software performance. Developers and researchers yet to spotlight on the importance of creating green software because the perception is software already green (paperless). While energy consumption is a priority in this green-aware society, software engineers need to take part in the green movement so they can contribute to the cause.

FUTURE RESEARCH

Further research should be given in green software development area to highlight additional reasons and solutions for this challenge. Future search topics that can be researched are:

- Server setting and Energy Consumption.
- Effective LAN infrastructure for optimized software solution.
- Green Database design: implementing efficient entirety relationship
- Paperless environment and the green movement: issues and challenges.

REFERENCES

[1] Greening Your Computing Technology, the Near and Far Perspectives, Dan Herrick Colorado State University Engineering Network Services Fort Collins, CO.

[2] Software Quality Development and Assurancein RUP, MSF and XP - A Comparative Study Wolfgang Zuser Vienna University of Technology.

[3] Second International Workshop on Software Research and Climate Change, Steve Easterbrook, University of Toronto, Toronto, Canada

[4] 'Green IT' the next burning issue for business, Richard Lanyon-Hogg ITS UKISA:

Chief Technology Officer, IBM.

[5] Greening Your Computing Technology, the Near and Far Perspectives Dan Herrick ,Colorado State University, Engineering Network ,Services Fort Collins, CO

[6] Green Applications: Software Applications that Optimize Energy Usage, Hoi Chan, Jeffrey O. Kephart, IBM T.J Watson Research Center, 19 Skyline Drive

[7] Green: A Framework for Supporting Energy Conscious, Programming using Controlled Approximation Woongki Baek Computer Systems Laboratory, Stanford University

[8] It's Not Easy Being Green: Understanding Home Computer Power Management, Marshini Chetty*, A.J. Bernheim Brush†, Brian R. Meyers† and Paul Johns, Georgia Institute of Technology 85 5th Street NW Atlanta, GA, 30332 USA.

[9] Green Tracker: A Tool for Estimating the Energy Consumption of Software, Nadine, Amsel Donald Bren School of Information and Computer Sciences University of California, Irvine 6210 Donald Bren Hall

[10] Data Transfer over Wireless LAN Power Consumption Analysis, Jun De Vega and Rajshree Chabukswar, intel online articles, February 24, 2009

[11] Math support. Product Support 1107 - Avoiding Out of Memory Errors.

[12] World bank development program report 2010.