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Sustainable Computing and System Development Life Cycle

Mamta Santosh Nair
MATS School of Information Technology,Raipur, India
mamtanair@yahoo.com

Abstract **-This paper gives an insight of sustainable computing. The need for sustainable computing and the environmental risks associated if the practice of non green computing is followed. It also throws light on the health hazards posed by manufacturing to disposal of various hardware parts. And in the second part of paper it explains the need to change the System Development Life Cycle has been given. Various methods are devised by which we can find out energy efficiency and heat emission at every stage of development. Thus we change the conventional SDLC to Power Aware and Thermal Aware SDLC. Till now the software development process was client –specific but now it also needs to be environment-specific.**

Keywords- Green Computing, Power Aware Softwares, Optimization, e-waste.

.INTRODUCTION

Sustainable computing – once there was computing all over. The hardware and software were developed as per the requirements of the clients. The only aim was to reduce cost of the development and fulfill the needs. And the result was alarming for the environment.

That was the time when the need arose to save the environment and the term green computing came into picture.

The ill-effect on environment is due to

- the raw materials involved in the manufacturing of hardware
- energy requirement of devices and software

- heat generated due to usage of the computer systems

- last but not the least – disposal of systems known as e-waste

Manufacturing of microchip involves fabrication consisting of following steps

Process	Description
Layering	Application of a thin layer of desired material, usually silicon or aluminum
Oxidation	Changes a semi-conducting silicon layer into a insulating silicon dioxide layer
Patterning	Carving of a dense, maze-like set of furrows into a layer
Etching	Use of solvents or particle bombardment to alter the layer patterns

Fig. 1. Steps in manufacturing of microchips

And the other hardware devices along with the chips need to be dipped in solvents given further

Component	Fossil Fuels (kg)	Chemicals (kg)	Water (kg)
Computer Chips	94	7.1	310
Printed Circuit Boards	14	14	780
CRT monitors	31.5	0.49	450
LCD monitors	226	3.7	1290

Fig. 2. Amount of chemicals required for various parts of computersystem

Apart from this the manufacturing process involves soldering using lead. Many switches and batteries also make use of mercury. Both of these hazardous materials can cause serious health issues for the living beings. Secondly, the usage of computer systems requires a large amount of electricity. The systems consume energy even on standby mode. The energy requirement of softwares depends on complexity of software. More search operations, multiple sorting modules and unoptimized code makes the system power hungry. Apart from the usage of energy, the heat emitted by all electronic devices is equally affecting the environment which is one of the factors in increase in global warming. From past few years, household appliances with star ratings are available. Similarly computers and printers must follow the trend. One important aspect which gets neglected is that the cooling of all electronic devices itself is an energy consuming

process and also aids in ozone layers depletion. The data centers and servers across the world generate enormous amount of heat. Planning is being done for shifting of data centers to colder places like Siberia or underground places. This will eliminate the cooling requirement for them hence saving a lot of energy. In 1990's sleep mode in computers and printers was started so that if a system is lying idle for certain amount of time it will go to sleep mode thus saving energy and heat.

Following figure shows a picture of power consumption in watts at various stages of computer system.

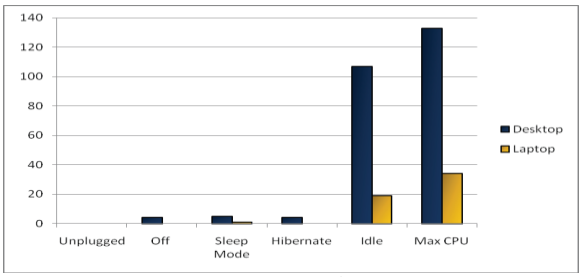

Fig. 3. Power consumption of computer system

Centralisation of processing power by having thin clients is also another solution where servers will mainly generate heat and the terminals will be used only for display. This will reduce the multiplicity of processors and emissions. Cloud Computing and virtualization are also better alternative in this regard. While using internet one should use the search engine Blackle instead of google because it has a black background and text is in white colour. All electronic devices must be switched off if not being used. As even in standby mode it consumes power, so its best to unplug it. Using an LCD monitor then CRT monitor is advisable due to difference in their power consumption. Though keeping the brightness of display screens to an optimum level is big The next big issue to green computing is e-waste disposal . Thousands of tonnes of computers and electronic devices are dumped as waste every year across the world , termed as e-waste. Disposal of this e-waste is still into primitive stage causing risky health issues as it can not be disposed in water it will cause chemical reactions between various components and water thus risking the marine life. It also cannot be burnt as harmful gas emissions will take place causing air pollution and various diseases. Landfill is another way of e-waste disposal. Instead of disposing the system, upgrading or getting it refurbished so that the old hardware can be reused is an initiative for green computing. Printouts should be taken only in emergency, for this the offices, travels, meetings agendas, reports , invitations etc. should be made paperless.

A different perspective at SDLC

As the hardware part of the system is becoming green so should be the software part. When there is so much concern and awareness about global warming due to machinery so it will be obligatory to not ignore the heat generated due to software. Time has come that we have to give energy saving rating for the software. Time has come for development of star rated software. And to achieve this we need to thoroughly look at system development life cycle with a different perspective. Along with the software development we should be considering Power Aware System Development Life Cycle. We start with the first stage of SDLC which is the analysis stage. This stage deals with collecting the system requirements from the client and preparation of feasibility study report. As a part of sustainable computing , we should also gather power requirements for the system. Following points must be analysed –

- how many computer systems will be required ?
- how much will be the consumption of power by each computer on daily, weekly and annually ?
- how much heat will be produced by each system ?
- how many cooling equipments will be needed to compensate for the heat ?
- how much will be the power consumption of the cooling equipment itself ?
- what are the energy efficient options available in various hardware parts ?
- what will be the overall effect on the global atmosphere ?

Considering the above factors energy efficiency rating can be given.

In the second stage as designing of the system takes place in terms of system design, module design and database design. In a Power Aware System Development Life Cycle, the energy consumed at each module of the system should be checked. And thermal quotient can be assigned to each module based on their CPU usage, disk head movement, printing need and time consumed to complete the module.Following figure gives power aware system chart

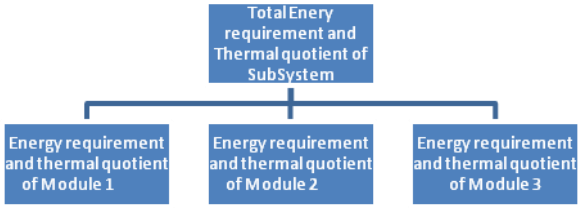

Fig 4:. Subsystem power chart

Here, more the time consumed to finish the module, more will be the thermal quotient. By optimizing code, such modules can be replaced by more efficient ones. e.g. modules with preprocessed submodules or presorted databases will reduce CPU time and disk rotation and associated head movements. Code optimization should be done in following ways –

- remove unnecessary loops
- function calls should be reduced by in-line functions
- variable sized arrays or stacks should be used
- complexity of program also plays a crucial rolemany small but simplistic programs are better than one big complex logic
-concept of Function indexing can be used

Similarly, the choice of programming language should be such where precompiled functions are ample so as to reduce the processing time. Compilation time must be compared between 2-3 languages before finalizing one.

The database design should make use of proper normalization techniques which will result in lesser redundancy and faster access. Database indexing and better sorting and searching techniques is a must. Sorting and searching algorithms should be chosen as per the system because many a times it is situation based. The next stage to this is the stage of testing the system. This stage can give exact amount of energy requirement at module level and system level. This stage is a reality check and gives a chance back to do any modifications required. At the end of this phase we can rate our software based on the previous hardware rating and tested system‘s performance. The next stage of implementation gives the real picture. We can compare the expected rating and actual rating of energy conservation. Here, we can come to know whether the software is a Green Software complying to GreenIT rules.

Further tools can be researched and developed for calculation of actual power consumption of software and ways to reduce it. The end result of which will be Green Earth .

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