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Technologies, Strategies And Algorithm In Green Computing – Solution To Energy Crisis

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Abstract—
A safe and non-polluted environment is the basic need of a living being. But today the situation is getting changed. Our environment is getting polluted day by day at a very high rate. The use of computing devices plays a vital role in harmfulness of environment. To reduce these harmful impacts the concept of Green Computing must be implemented. In this research paper, we includes some technologies, strategies and algorithm which are used for the implementation of green computing. The main reason is the awareness of a common user. If a common user is getting aware about the harmful impacts of use of computing devices over environment and takes some steps at own level to reduce electricity, the concept of green computing will be implemented.
Keywords— Green computing, environment, computers, hazardous, carbon dioxide (CO_2)

I. INTRODUCTION

Green computing is an emerging concept towards reducing hazardous material and to save our environment from harmful impacts of the use of computers and other electronic products. Green computing is very much related to other similar movements like reducing the use of environmentally hazardous materials. The huge amount of computing manufactured worldwide has a direct impact on environment issues, and scientists are conducting numerous studies in order to reduce the negative impact of computing technology on our natural resources. Companies are addressing e-waste by offering take-back recycling program and applying alternative nonhazardous materials in the products' manufacturing process. Taking into consideration use of information technology industry, it has to lead revolution of sorts by turning GREEN in our life.

II. LITERATURE REVIEW

A. What is Green Computing?

Green Computing is " the study and practice of designing, manufacturing, using and disposing of computers, servers, and associated subsystems – such as monitors, printers, storage devices, and networking and communication systems – efficiently and effectively with minimal or no impact on the environment."

B. Why Green Computing

Fig 1. Why Green Computing

1) *Pollution*: Manufacturing techniques, packaging and disposal of computers causes pollution in surrounding.

2) *Toxicity*: There are chemicals used in the manufacturing of computer and components while can enter the food chain and water.

3) *Climate* change: Co_2 and other emissions are causing global climate and environmental damage.

4) *Global warming*: Some pollutant gases generate a greater amount of heat. Greater power consumption and greater heat generation is due to the greater emission of green house.

5) *Power consumption*: U.S. consumes 25% of world's energy. Computer infrastructure accounts for 1.5% and growing. E-Waste is becoming a major problem.

C. *History*

In 1992, the U.S. Environmental Protection Agency launched Energy Star, a voluntary labeling program which is designed to promote and recognize energy-effiiciency in monitors, climate control equipment, and other technologies. This resulted in

the widespread adoption of sleep mode among consumer electronics. The term "green computing" was probably coined shortly after the Energy Star program began; there are several USENET posts dating back to 1992 which use the term in this manner. Concurrently, the Swedish
Organization TCO Development launched TCO Certification
program to promote low magnetic and electrical emissions from CRT-based computer displays; this program was later expanded to include criteria on energy consumption, ergonomic, and the use of hazardous materials in construction.

D. *Three phases of Green computing*

There are three long phases in the evolution of the much hyped green Computing. The first phase is known as the ecological phase, in this phase, all the activities are carried out in order to assist the ever increasing environmental problems and offer solutions for these problems. The second phase is called the environmental phase as after the environmental problems, the entire focus is shifted on the implementation of cleaner technologies. The last phase is termed as the sustainable phase which is still prevalent. This phase came into existence by the late nineties and early millennium.

E. Pathways

To comprehensively and effectively address the environmental impacts of computing/IT, we must adopt a holistic approach and make the entire IT lifecycle greener by addressing environmental sustainability along the following four complementary paths:

1) Green use: reducing the energy consumption of
computers and other information systems as well as using them in an environmentally sound manner.

2) Green disposal: refurbishing and reusing old computers and properly recycling unwanted computers and other electronic equipment

3) Green design: designing energy-efficient and environmentally sound components, computers, servers, cooling equipment, and data centers

4) Green manufacturing -manufacturing electronic components, computers, and other associated subsystems with minimal impact on the environment.

III. THEOROTICAL FRAMEWORK

A. *Designer Plan*

Designers plan to make future computer more eco-friendly across its entire lifespan, from manufacture to recycling:

1) By replacing petroleum-filled plastic with bioplastics plant-based polymers require less oil and energy to produce
than traditional plastics with a challenge to keep these bioplastic computers cool so that electronics won't melt them.

2) Landfills can be controlled by making best use of the device by upgrading and repairing in time with a need to make
such processes (i.e., upgradation and repairing) easier and cheaper.

3) Avoiding the discarding will not only control e-waste out of dumps but also save energy and materials needed for a
whole new computer.

4) Power-sucking displays can be replaced with green light displays made of OLEDs, or organic light-emitting diodes.

5) Use of toxic materials like lead can be replaced by silver and copper.

6) Making recycling of computers more effective by recycling computer parts separately with a option of reuse or resale.

B. *Objectives of Green computing*

VIA Technologies, a Taiwanese company that manufactures motherboard chipsets, CPUs, and other computer hardware, introduced its initiative for "green computing" in 2001. With this green vision, the company has been focusing on clean-computing strategies, and the company is striving to educate markets on the benefits of green computing for the sake of the environment, as well as productivity and overall user experience.

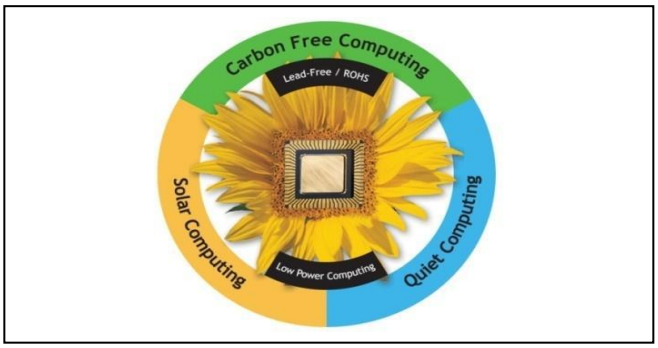

Fig 2. Objectives of Green computing

1) *Carbon-free computing:* One of the VIA Technologies' ideas is to reduce the "carbon footprint" of users. Greenhouse gases naturally blanket the Earth and are responsible for its more or less stable temperature. An increase in the concentration of the main greenhouse gases – carbon dioxide, methane, nitrous oxide, and fluorocarbons – is believed to be responsible for Earth's increasing temperature. VIA aims to offer the world's first PC

products certified carbon free, taking responsibility for the amounts of CO2 they emit. VIA promotes the use of such alternative energy sources as solar power.

2) *Solar Computing:* VIA is setting its eyes on the sun, and the company's Solar Computing initiative is a significant part of its green-computing projects. For that purpose, VIA partnered with Motech Industries, one of the largest producers of solar cells worldwide. A solar cell fit VIA's power - efficient silicon, platform, and system technologies and enable the company to develop fully solar-powered devices that are
nonpolluting, silent, and highly reliable. Solar cells require very little maintenance throughout their lifetime. Worldwide production of solar cells has increased rapidly over the last few years.

3) *Quiet computing;* A central goal of VIA's green-
Computing initiative is the development of energy-efficient platforms for low-power, small-form-factor (SFF) computing devices. These energy-efficient processors produce over four times less carbon during their operation and can be efficiently embedded in solar-powered devices. VIA isn't the only company to address environmental concerns: Intel, the world's largest semiconductor maker, revealed eco-friendly products at a recent conference in London.

C. *Approaches to Green computing*

1) *Virtualization*: Computer virtualization refers to the process of running two or more logical computer systems on one set of physical hardware. By virtualization, a system administrator could combine several physical systems into virtual machines on one single, powerful system.

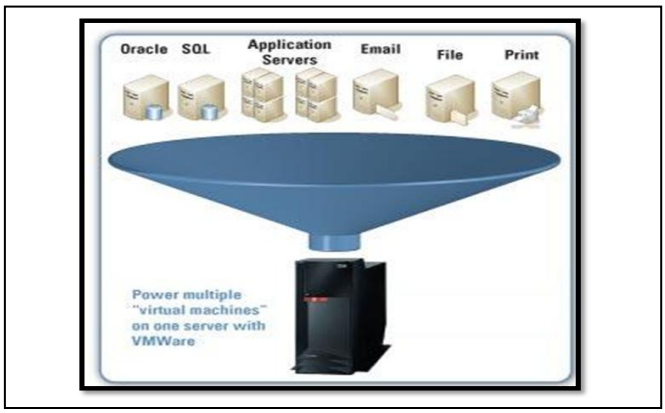

Fig 3. Virtualization

2) *Power management*: Power mangement for Computers systems are desired for many reasons particularly: Pronlonged battery life, Reduce cooling requirements, Reduce noise, Reducing operating cost and energy cooling. Lower power consumption also means lower heat dissipation.

3) *Power supply*: If a PSU meets the certification, it will use only the power it needs at a given load. In other words, it won't use more power than it needs. It's the heart of a green PC, since it manages the power for all the other components. An industry initiative called 80 PLUS certificates PSUs that are at least 80% efficient

4) *Storage*: The most conventional route is the 3.5" desktop hard drive. The second option is to use 2.5" laptop hard drive and lowest power option is to use a solid state hard drive less than 2.5"disk.

5) *Video card*: A fast GPU may be the largest power consumer in a computer. Energy efficient display options include no video card –use a shared terminal, shared thin client, or desktop sharing software if display required.

6) *Display:* LCD monitors typically use a cold cathode fluroscent bulb to provide light for the display. LCD are up to 66% more energy efficient than CRTs, LCD are smaller in weight and also produces less heat.

7) *Material recycling;* It refers to recycling or reuse of a computer or electronic waste. It includes devices like mobile phones, hand held devices, audio-video components and substances suitable for reclamation, including lead, copper and gold.

IV. PROPOSED SYSTEM

A. Green Strategies for Compilers: Software programs are analysed at run time using energy aware compilers. The green techniques that can be applied at local, global or interprocedural level to make program energy aware are given below.

1) Cache skipping: Loops are very useful in programming and it increases performance, but causes high energy consumption due to repetition of the same thing. In this technique, compiler needs to separate the blocks that has less chance for execution.

2) Instruction clustering: The study in shows that instruction clustering can conserve energy from 26% to 47%. A compiler with special type of architecture can execute a cluster of instructions in one cycle. It will reduce the running time of program and leads to energy conservation.

3) Instruction reordering and memory addressing: Energy consumption can be reduced by changing the order of instruction in such a way to suit the power-safe mode. A method is proposed in using Gray Code and Cold Scheduling. Gray code is used to reference consecutive memory location. Using Gray code reduces the energy consumption by 36% as compared to binary representation of memory.

3) *Optimized energy cost tree:* Energy aware compilers can use energy cost database for each transaction/instruction. This database can be used in code parsing and parse tree generation algorithms. During the first run of code processing, all possible

parse trees are generated and their respective energy cost is stored in energy cost database.

4) *Loop optimization:* Loop optimization methods are
used to increase energy efficiency, which checks nested loops across dependency graph. If there is no cycle in the graph, compiler will create loop for each statement and run them in parallel using interleaved processing.

B. *Green strategies in software development:* During various stages of software development life cycle such as software analysis, design and implementation, energy can be conserved. At design level, energy can be saved by making energy efficient software structure. Programmers can use following strategies during software development.

1) Use of green compiler: Several energy aware or green compilers are available, which can be used for energy conservation. For example Green Hill compiler can be used for C and C++, can be used for C++

2) Use of readymade computer resources: There are number of readymade computer resources available as a service, for example currency converter, calculators etc. Making use of these readymade resources in program will be beneficial in terms of energy, cost and time.

3) *Using iteration:* More energy consumption happens in the case of recursion due to longer execution time. Therefore, a better approach is to use iteration and avoid recursion as much as possible in software development.

4) *Data structures and algorithms:* Using algorithms with less time complexity and energy efficient data structures in software development can be helpful for saving energy.

C. *Hardware Energy Saving Methods:* It is assumed that near threshold computing can reduce energy requirements by 10 to 100 times in future systems.

1) Dynamic Voltage and Frequency Scaling: It is used to reduce the supply voltage of a processor when the work load is too less that the processor can reduce its speed and still have a performance , that is sufficient enough to meet the system requirements. Frequency reduction makes it viable to reduce dynamic power consumption.

2) *Sleep mode:* Energy can be saved, if the system is put into sleep mode, after finishing the execution.

3) *Power management techniques at the OS level:* Many power management techniques control the amount of parallelism dynamically. FDT (Feedback driven threading) is a framework that dynamically controls the number of threads using run time information.. Both these techniques can reduce execution time and power consumption up to 70%.

4) *Energy Efficient Algorithms:* The aim of these algorithms to reduce energy consumption without compromising on performance.

V. TECHNOLOGIES THAT DEFINITELY SOLVE ENERGY CRISIS

A. *Enhanced Geothermal System*: The overall objective of Enhanced Geothermal Systems (EGS) is to harness the heat naturally generated by the Earth to produce electricity.

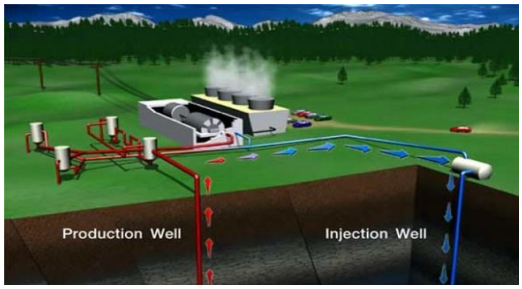

Fig 4. Enhanced Geothermal System

EGS is a base-load resource, which gives it the ability to produce power 24 hours a day. It is also help in the overall reduction of CO2 emissions.

B. Nanosolar: Solar energy has always been one of the best renewable energy sources as it doesn't release noxious gasses into the atmosphere, and once installed requires little maintenance. Nanosolar managed to reduce production costs from $3 per watt to 30 cents per watt during the manufacturing of their Power Sheet cells. The company has ambitious plans to mass produce cost efficient solar energy at their plant in San Jose, which is expected to produce 430 megawatts per year.

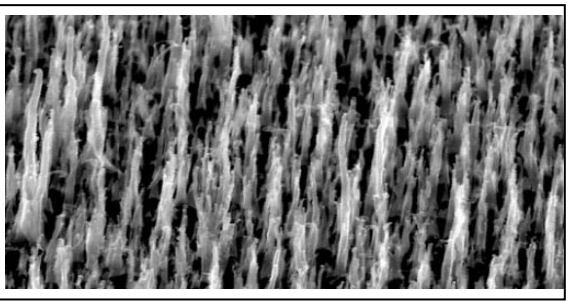

Fig 5. Nanosolar

C. Orbiting Solar Arrays: This technology still in the discovery. In theory an array of solar panels would be constructed outside of the Earth's atmosphere and placed into orbit. These panels would then beam the solar power back down to a receptor where it could be converted into electricity. The main attraction of

this technology is the ability to tap into an unimaginably huge energy source several orders of magnitude beyond all other known sources combined.

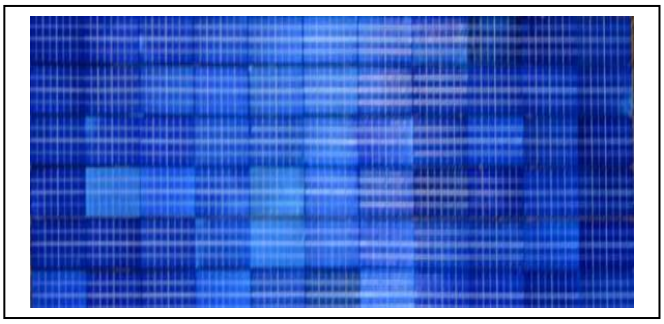

Fig 6. Orbiting Solar Array

D. Smart building: A green building is one whose construction and lifetime of operation assure the healthiest possible environment while representing the most efficient and least disruptive use of land, water, energy and resources. The optimum design solution is one that effectively emulates all of the natural systems and conditions of the pre-developed site – after development is complete

Fig 7. Smart building

E. *Smart Grids*: According to a report from the International Energy Agency, between 2003 and 2030 more that $16 trillion will have been spent worldwide on designing, developing and installing smart grids. The primary objective of smart grids is to overcome the endemic problems common to current electrical grid systems. Smart grids will make the distribution and consumption of energy more efficient and cost-effective.

Fig 8. Smart Grids

F. *Carbon Capture & Storage:* Carbon Capture & Storage (CCS), also known as Carbon Sequestration, could account for almost a third of the CO2 reductions needed by 2050, according to the International Energy Authority. The carbon emissions from this plant are said to be 90% less than traditional facilities.

Fig 9. Co_2 emission

VI. TASK CONSOLIDATION ALGORITHM

Task consolidation is the process of allocating tasks to resources without violating time constraints aiming to maximize resource utilization. Two energy-conscious task consolidation algorithms given here:

1) ECTC (Energy Consolidation and Task Consolidation): The value $f_{i,j}$ of a task t_j on a resource r_i obtained using the cost function of ECTC is defined as:

$$f_{i,j} = [(p\Delta \times u_j + pmin) \times r_0\Delta - \Delta (p\Delta \times u_j + pmin) r_1 + (p\Delta \times u_j) \times r_2\Delta] \quad (1)$$

Where in "(1)", $p\Delta$ is the difference between pmax and pmin, u_j is the utilization rate of t_j and t_0, t_1, t_2 are total processing time of t_j.

2) MaxUtil (Maximum Utilization);. The first and obvious advantage is energy consumption is reduced. And, the second number of active resources since it tends to intensify the utilization benefit is that MaxUtil's cost function implicitly decreases the small number of resources compared with ECTC's cost function.

Input: A task tj and a set R of r cloud resources
Output: A task-resource match
1. Let r* = Ø
2. for Vr_i € R do
3. Compute the cost function value $f_{i,j}$ of t_j on r_i
4. if $f_{i,j} > t_j$ then
5. Let r* = r_i
6. Let $t_j = f_{i,j}$
7. end if
8. end for
9. Assign t_j to r*

Fig 10. Task Consolidation Algorithm

The value $f_{i,j}$ of a task t_j on a resource r_i using the cost function of MaxUtil is defined as

$$f_{i,j} = \frac{\sum_{j=1}^{\tau 0} U_i}{\tau 0} \qquad (2)$$

VI. ANALYSIS

By having a look at the condition of our environment, today people are becoming more and more conscious and socially responsible. By using the products which are environmentally safe, it not only helps in improving the current status but will also help our future generation to survive. Apart from making the surroundings worth living, it will help us to conserve the scarce resources. During analysis it is seen that using above technologies, strategies and algorithm, Green computing becomes successful to provide following advantages:

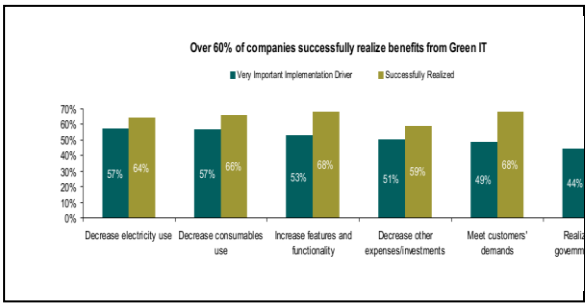

Fig 11. Over 60% of companies and user successfully benefits from Green computing

1) Meeting Sustainability demand of customers and employees.
2) Meeting agreement and regulatory requirements.
3) Saving energy and resources that saves money.
4) Reduce environment impact and carbon footprint.
5) Improved operational efficiency.
6) Decrease the risk existing in the laptops such as chemical known to cause disease, nerve impairment and immune reactions in human beings.
7) Preserving resources i.e. less energy is essential to crop, use, and dispose of products.
8) Helps in reducing energy demands and money of how we use technology which positively effects the environment, and saves our costs in the future.

VII. CONCLUSION

Green Computing is not only a new development; it is a technology of itself i.e. moves to become friendlier and sustainable environment. Many of the companies are taking the initiatives to take the contract to handle the recycling agreements by adopting the law and regulations. In order to use the new technology one should pay attention things like the energy star that can help to really reduce the amount of electricity used on a day to day basis. To keep and realm the environment, "going green" is the solitary approach to raise the business by reducing the eliminate waste. By accepting a universal approach to greening IT, it is the responsibility of the consumer to creating a more sustainable environment for the future generation.

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