Green Computing to Reduce Hazardous Impact of E-Waste

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I INTRODUCTION

"Of late, green transformation is often being talked about very vehemently. What better a way to achieve this transformation than by embracing the 'intelligent buildings' philosophy?"

Green Computing is the practice of using computing resources efficiently in order to reduce e-waste and the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote recyclability or biodegradability of defunct products and factory waste.

II DEFINITION

Green Computing is a discipline that studies, develops and promotes techniques for improving energy efficiency and reducing waste in the full life cycle of computing equipment from initial manufacture, through delivery, use, maintenance, recycling and disposal in an economically realistic way. The term Green Computing also describes Green IT that refers to the study and practice of designing, manufacturing, and using computer hardware, software, and communication systems efficiently and effectively with no or minimal impact on the environment. 'Green'l has become a popular term for describing things that are good for the environment, generally healthful and, more recently, economically sensible. Going Greenl implies reducing your energy use and pollution footprint. The technology community, specifically computer users, has popularized the term —Green Computing, that helps in the reduction of the pollution and energy footprint of computers.

In this regard, **Energy Star Program** was started by U. S. Environmental Protection Agency (EPA)

The following hazardous elements and compounds can be found in everyday e-waste:

(a) Lead in cathode ray tubes and solder
(b) Mercury in switches and housing
(c) Arsenic in older cathode ray tubes
(d) Antimony trioxide as flame retardant
(e) Polybrominated flame retardants in plastic casings, cables, and circuit boards
(f) Selenium in circuit boards as power to supply rectifier
(g) Cadmium in circuit boards and semiconductors
(h) Chromium in steel as corrosion protection

in 1992. Green computing is also known as green information technology (green IT). One of the sequels of green computing after Energy Star Program was **EPEAT or Electronic Products Environmental Assessment Tool**. EPEAT products serve to increase the efficiency and life of computing products.

'Necessity is mother of all inventions'; the need for Green Computing came from fact that the whole globe is **now** full of e-waste.

Electronic waste, e-waste, e-scrap, or waste electrical and electronic equipment ('WEEE) describes discarded electrical or electronic devices. There is a lack of consensus as to whether the term should apply to resale, reuse, and refurbishing industries, or only to product that cannot be used for its intended purpose.

E-waste contains more than 1000 different substances, many of which are toxic metals such as lead, arsenic, cadmium, hexavalent chromium and flame retardants used in the plastics. The fraction including iron, copper, aluminum, gold and other metals in e-waste is over 60%, while plastics account for about 30% and the hazardous pollutants comprise only about 2.70%.

(i) Cobalt in steel for structural strength and magnetivity

III INDIA'S CURRENT E-WASTE SCENARIO

Due to the rapid developmental activities, country like India, today, face a fast increasing load of WEEE originating from both inland and through illegal imports. E-waste is one of the fastest growing waste streams in the world due to increasing "market penetration" in developing

countries and "replacement market" in developed countries.

In India, the electronic waste management assumes greater significance not only due to the generation of our own waste but also dumping of e-waste particularly computer waste from developed countries and the amount of e-Waste generated is steadily increasing. At present Bangalore alone generates about 8000 tonnes of computer waste annually and in the absence of proper disposal, they find their way to scrap dealers. E-Parisaraa, an eco-friendly recycling unit on the outskirts of Bangalore makes full use of e-Waste. The plant which is India's first scientific e-waste recycling unit reduce pollution, landfill waste and recover valuable metals, plastics & glass from waste in an eco-friendly manner. But, this type of initiative is required more from all the parts of India. The Director of E-Parisaraa, Mr. P. Parthasarathy, developed an eco-friendly methodology for reusing, recycling and recovery of metals, glass & plastics with non-incineration methods. The hazardous materials are segregated separately and send for secure land fill for ex.: phosphor coating, LED's, mercury etc.

IV MAGNITUDE OF PROBLEM AND ENVIRONMENTAL AND HEALTH HAZARDS OF E-WASTE

A study on the effects of E-waste on human health reveals serious negative outcomes for those dismantling and handling components of discarded electronics. The study, published by the Royal Institute of Technology in Stockholm, Sweden, details that workers, some as young as six years of age, are routinely exposed to hazardous materials and inhalation of toxic gases through direct handling of discarded electronics. People affected by this health crisis are mostly in areas where there is little knowledge about the health risks and in many cases no basic health care or social protections.

Table 1
The environmental impact of the processing of different electronic waste components

E-Waste Component	Process Used	Potential Environmental Hazard
Cathode ray tubes (used in TVs, computer monitors, ATM, video cameras, and more)	Breaking and removal of yoke, then dumping	Lead, barium and other heavy metals leaching into the ground water and release of toxic phosphor
Printed circuit board (image behind table - a thin plate on which chips and other electronic components are placed)	De-soldering and removal of computer chips; open burning and acid baths to remove final metals after chips are removed.	Air emissions as well as discharge into rivers of glass dust, tin, lead, brominated dioxin, beryllium cadmium, and mercury
Chips and other gold plated components	Chemical stripping using nitric and hydrochloric acid and burning of chips	Hydrocarbons, heavy metals, brominated substances discharged directly into rivers acidifying fish and flora. Tin and lead contamination of surface and groundwater. Air emissions of brominated dioxins, heavy metals and hydrocarbons
Plastics from printers, keyboards, monitors, etc.	Shredding and low temp melting to be reused	Emissions of brominated dioxins, heavy metals and hydrocarbons
Computer wires	Open burning and stripping to remove copper	Hydrocarbon ashes released into air, water and soil.

V RECYCLING OPERATIONS FOR CURRENT DISPOSAL

To handle problems caused by e-waste, environmental scientists emphasis on 3R (reduce, recycle and reuse) process as an alternative to the present e-waste management practice. For a developing society like India, reduced use of electronics equipments is not a feasible option; therefore, more emphasis is on reuse and recycling processes. Segregation of toxic substances at the root level with systematic planning can eliminate the pollution load and develop a green society. Used or unwanted electronic equipment should be discarded in a convenient and environmentally responsible manner. Computers have toxin metals and pollutants that can emit harmful emissions into the environment. Computers should never be discarded in a landfill. Computers should be recycled through manufacturer programs such as HP's Planet Partners recycling service or recycling facilities in the community. Still-working

computers may be donated to non-profit agencies. The recycling methods adopted in India include open burning of circuit boards or using acid stripes which are potentially harmful. The IP chips are reused. The parts that cannot be used are sent for open dumping to extract metals like copper. PVC-coated cables are openly burnt. Nitric acid is also used to remove Gold and Platinum. Both open burning and acid baths lead to occupational exposure to pollutants and endanger the health of nearby communities. This has been linked with various health problems like Silicosis, Respiratory irritation and pulmonary oedema.

VI METHODOLOGY USED

For this piece of work, Secondary sources of data like recent newspaper and journals, articles, authentic internet resources, etc were evaluated for the purpose of this study. Through such resources, attempt has been made to find E-waste in Indian context, which in turn helped in identifying the wide range of diverse stakeholders in the green computing. Secondary sources of data were preferred in order to accommodate the current scenario and research related to E-waste in India which are highly dispersed and diversified.

VII GREEN COMPUTING FOR CURRENT DISPOSAL

"There is no gain saying the fact that strategy minus execution or execution devoid of strategy can be counterproductive. In pursuing green goals, enterprises are enswathed with issues of good strategy-bad execution or bad strategy-good execution. This should be avoided at all costs". For the same, that is., Krishna, Balasubramanian and Mudireddy proposed an algorithm using virtualization techniques to reduce e-waste and that fulfill green computing.

The Algorithm goes like:
When more than one process is waiting for server, then server consolidation decides which process should be assigned to server services. Here, server consolidation refers to a set of rules and regulation that find out the efficient way to which process will be processed in server process. The algorithm proposed here inherits some properties of process management, which tries to minimize the server's process time.

To reduce the waiting time and to utilize the processor, the three researchers gave a new algorithm. The basic idea is to make quantum time dynamic for each process queue. For that the process should be divided in to the different queues. The number of queues should be decided at the run time. To divide the processes in the queues, the limit should be calculated first. The formulae to calculate limits are as follows:

Limit1= (H.B.T. – L.B.T.+1)/N
Limit2= (L.B.T. + Limit1)
Limit3= (L.B.T. + Limit2), where, H.B.T. = Highest burst time of the process, L.B.T. = Lowest burst time of the processes and N= No. of queue(determined at run time)

Like this the limit will be determined for each queue and according to the limit processes will be filled in the queues. Once the queue has been made, the quantum period will be decided for each process queue separately. To calculate the quantum period for each process queue the formulae is:

$$T_{(b)} = \frac{\left(\sum B(i)\right)}{N}$$

Where, B(i)= Total of processes in ith queue and N= No. of processes in ith queue
Once the quantum time has been calculated for each queue the dynamic variation of quantum period will be implemented to reduce the waiting time. The formulae to determine the dynamic variation of quantum period is:
if (Tb - Bi) < (Bi / 2) then
Tdi = Tb + (Tb - Bi)

Where, Tb = Quantum time of any process in queue
Bi= Allotted quantum period to that queue
Tdi= time quantum allotted to the ith process
Using this formula each process is allotted a dynamic quantum time and gets executed according to that.

VIII RECOMMENDATIONS FOR ACTION AND REDUCTION OF E-WASTE

Current trend of "***replace-rather-than-repair***" mentality is polluting the planet with electronic waste. Green Computing is towards efficient utilization of resources. Energy is considered as the main resource, therefore, the emphasis is to reduce the energy utilization and increase the performance of Computing. There are several areas where researchers are putting lots of efforts to achieve desired results. Following are the major methods and technologies which helps in green IT:-

(a) E-Waste Recycling- Over 133,000 PCs are discarded by U.S. homes and businesses every day and less than 10 percent of all electronics are currently recycled, this is based on the study by US Researchers. Majority of countries around the world require electronic companies to finance and manage recycling programs for their products especially under-developed Countries. Green Computing must take the product life cycle into consideration; from production to operation to recycling. E-Waste is a manageable piece of the waste stream and recycling e-Waste is easy to adopt. Recycling computing equipment such as lead and mercury enables to replace equipment that otherwise would have been manufactured. The reuse of such equipments allows saving energy and reducing impact on environment, which can be due to electronic wastes.

(b) Telework and Telepresence- Telework and Telepresence, two of the least understood elements in Green IT, are rapidly being included in the public and private sectors as a means of reducing e-waste and saving energy. Teleworking has been actively used by the private sector companies like IBM, Microsoft, Sun Microsystems, Bank of America, Procter and Gamble, and Cisco for decades. It is claimed that considerable amounts of energy is saved and e-waste avoided with employees working at their homes. As fewer hardware resources like PCs, printers, copiers and various other equipments have to be installed at the work premises, the e-waste is reduced. Though it is difficult to measure the effects of Telework, the benefits of Telepresence can be more easily estimated as the cost of travelling is reduced. With more and more companies using these elements the effective reduction in e-waste will be quite substantial. Perhaps the least understood element in Green IT measurements is the contribution of Telework to energy savings. A recent UK study found that the typical teleworker generates a third more CO_2 over a year than an office worker. Telework is generally regarded as both a productivity enhancer and a differentiator in recruiting employees, although the private sector has been more actively using it than the public sector. Companies like IBM, Microsoft, Sun Microsystems, Bank of America, Procter and Gamble, and Cisco have been teleworking for decades and have also claimed significant additional savings in real estate; that is, releasing buildings and offices because the work is being done at home or client site. Nearly half of IBM"s workforce of over 300000 teleworks. While teleworks" benefits are not easy to document, the business case for telepresence, the use of technology to hold meetings and other work sessions normally requiring travel is easier.

(c) Cloud Computing- Scaling is one of the key concepts in cloud computing. It provides scaling of design, scale of use, and even reverse scaling of cost per unit. The common technology provides an average of 140 servers per administrator, but with scaling many cloud providers can now provide as many as 1000 or more servers per administrator. It is evident that scaling can reduce a huge amount of e-waste with server to administrator ratios improving by up to sevenfold. Many companies today are migrating towards cloud computing for data storage and resource virtualization. This also helps in reducing e-waste drastically as many companies depend on the existing cloud service provider's servers and data centers instead of installing its own servers. Cloud computing is both a metaphor and an indicator of the significance of Green IT. Every time an organization shifts a workload of storage or processing to the cloud they are reducing their overall electricity usage, since the massive new data centers used for cloud services are all striving, like the Yahoo and Capgemini facilities mentioned above, to reduce power usage drastically. Major reductions in cost are achieved in the cloud, too.

(d) Virtualization- Virtualization is a set of techniques that leads to efficient server management through higher utilization and reduction in energy expenses. Through the use of intelligent virtual machine allocation, improved data center automation and resource reclamation of underutilized CPUs, virtualization can reduce e-waste. In the past, individual servers, sometimes thousands of them in one data center, were using only 5 to 15% capacity, waiting for work, so to speak. But over a million servers had been virtualized by 2008 and, by one estimate, the combination of virtualization of servers and storage plus improving air flow could alone reduce data center operating costs by half.

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