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Green Information Technology

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Abstract - *The concept of green IT has begun to spread in the past few years, gaining increasing popularity. It is environmentally sustainable use of computers and related resources like - monitors, printer, storage devices, networking and communication systems - efficiently and effectively with minimal or no impact on the environment. This is achieved by including the implementation of energy-efficient central processing units (CPUs), Servers and Peripherals as well as reduced resource consumption and proper disposal of electronic waste (e-waste). Its goals also include reduction in the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote the recyclability or biodegradability of defunct products and factory waste. The number of computers is increasing day by day, so is the amount of electricity consumed by them which in turn is increasing the carbon content in atmosphere. This problem has been realized by people and measures are being taken which help in minimizing the power usage of computers. We use Techniques of Green IT because it reduces energy usage and translates into lower carbon dioxide emissions, stemming from a reduction in the fossil fuel used in power plants and transportation, Conserving resources means less energy is required to produce, , use, and dispose of products ,Saving energy and resources thereby saving money. It even includes changing government policy to encourage recycling and lowering energy use by individuals and businesses.*
This paper, first discuss the importance of green computing and sketch researcher's view on the next generation of IT systems for green computing. Subsequently, this paper helps to identify key issues relevant to green computing and evaluate different approaches to these problems. Finally, paper point out future directions of research and conclude the paper.

Key Words: **fossil fuel, energy efficiency, hazardous materials, carbon dioxide emissions, biodegradability,** etc….

1. INTRODUCTION

From both an individual and organizational perspective the global environmental issues we all face are here to stay for the foreseeable future. Arguably the most commonly known and widely reported environmental concern nowadays is global climate change.

For many of us in the Information Communication & Technology (ICT) Industry, the environmental spotlight is shining directly at us, as the consumption of energy derived from traditional fossil fuels becomes an international concern. It is widely cited in Information Technology (IT) circles that the ICT industry is responsible for approximately two per cent of world-wide carbon emissions.

Green computing is an effective approach to protect our environment from the hazardous material and its effects that comes from the computers and its related devices. It is an effective study of environmental science that use manufacturing, using, disposing and recycling of computer and other electronic devices.

Green computing aims to reduce the carbon footprint generated by the Information Systems Business while allowing them to save money. The green Computing, as defined in the Official Journal of the French Republic on July 12, 2009, the ESTs of information and communication for short eco-ICT, are information technology and communication which design or use can reduce the negative effects of human activity on the environment.

1.1. Problems

Chances are this isn't the first time you've heard about the need to go green as it is related to your IT Infrastructure. But even though the message is out there, not enough organizations are acting on it. Symantec Corp. released a study that revealed almost 75 percent of data center managers do, in fact, have an interest in adopting a strategic green center initiative ,but only one in seven has actually done so—Symantec, October 2007.

The reason is obvious—money. Although data center managers want to save the environment, they also want to save money. In fact, it's the old business adage that says to be successful, you have to save money and maintain performance. In other words, they're worrying about another type of green.

The truth of the matter is that, yes, adopting a green infrastructure can cost more money up front, but you can save thousands or even millions of dollars (depending on your organization's size) by making some changes.

1.2. Need to Go Green:

1.2.1. Toxins:

According to the U.S. Environmental Protection Agency (EPA), Americans throw out more than 2 million tons of consumer electronics annually, making electronic waste (also known as e-waste) one of the fastest growing components of the municipal waste stream. When these

electronics break down, they release mercury and other toxins.

E-waste is a concern for going green because of the impact of its toxicity and carcinogenicity when components are not properly disposed of. Toxic substances can include:

• Lead • Mercury • Cadmium • Polychlorinated biphenyls (PCBs)

1.2.2. Power Consumption:

On your way to work each day, you drive by a factory and see smokestacks billowing pollution into the atmosphere. You take a measure of comfort when you get to work, knowing that you work in the IT industry and aren't polluting the planet. Unfortunately, although you aren't polluting as demonstrably as that factory, your data center is taking its toll. This is also one of the main reasons for adopting green computing.

1.2.3. What You Use:

All your desktop PCs, servers, switches, and so forth use electricity to run. Also, a fair amount of electricity is used to cool your electronics. This not only costs you money to buy from the electrical utility, but the utility has to generate the electricity, quite often by using fossil fuels, which generate more greenhouse gas emissions.

Power usage is an especially relevant issue for operating a green information system— the more power that's used, the more money that's spent and the greater the carbon footprint. The place to start is knowing how much power is being used? However, according to research from Intel, 80 percent of businesses have never conducted an energy audit and only 29 percent of businesses are investing in energy-efficient PCs—Intel, 2006. Those companies are losing money because they don't know just what they're spending and how they can reduce those costs.

1.3. Steps to Green Computing:

As of Oct. 20, there are new performance requirements to qualify for the Energy Star rating for desktop and notebook computers, workstations, integrated computers, desktop-derived servers and game consoles. These specifications go into effect on July 20. But businesses don't have to wait until then to initiate more environmentally-friendly computing practices. Here are five first steps you can take toward a green computing strategy.

1.3.1. Develop a sustainable Green Computing Plan:

Discuss with your business leaders the elements that should be factored into such a plan, including organizational policies and checklists. Such a plan should include recycling policies, recommendations for disposal of used equipment, government guidelines and recommendations for purchasing green computer equipment. Green computing best practices and policies should cover power usage, reduction of paper consumption, as well as recommendations for new equipment and recycling old machines. Organizational policies should include communication and implementation.

1.3.2. Recycle:

Discard used or unwanted electronic equipment in a convenient and environmentally responsible manner. Computers have toxin metals and pollutants that can emit harmful emissions into the environment. Never discard computers in a landfill. Recycle them instead through manufacturer programs such as HP's Planet Partners recycling service or recycling facilities in your community. Or donate still-working computers to a non-profit agency.

1.3.3. Make environmentally sound purchase decisions:

Purchase Electronic Product Environmental Assessment Tool registered products. EPEAT is a procurement tool promoted by the nonprofit Green Electronics Council to: •Help institutional purchasers evaluate, compare and select desktop computers, notebooks and monitors based on environmental attributes •Provide a clear, consistent set of performance criteria for the design of products •Recognize manufacturer efforts to reduce the environmental impact of products by reducing or eliminating environmentally sensitive materials, designing for longevity and reducing packaging materials All EPEAT-registered products must meet minimum requirements in eight areas of environmental impact and be energy efficient to reduce emissions of climate-changing greenhouse gases. To demonstrate corporate social and environmental performance, manufacturers must offer safe end-of-life management and recycling options when products become unusable.

"Developing environmentally sound products has long been a priority for HP's design and engineering teams," says Jeri Callaway, vice president and general manager, Americas Commercial Solutions, Personal Systems Group, HP. "We're particularly proud that our business-class products already meet, and in some cases exceed, the basic EPEAT standards without any alteration to their existing design."

1.3.4. Reduce Paper Consumption:

There are many easy, obvious ways to reduce paper consumption: e-mail, electronic archiving, use the "track changes" feature in electronic documents, rather than redline corrections on paper. When you do print out documents, make sure to use both sides of the paper, recycle regularly, use smaller fonts and margins, and selectively print required pages.

1.3.5. Conserve Energy:

Turn off your computer when you know you won't use it for an extended period of time. Turn on power management features during shorter periods of inactivity. Power management allows monitors and computers to enter low-power states when sitting idle. By simply hitting the keyboard or moving the mouse, the computer or monitors awakens from its low power sleep mode in seconds. Power management tactics can save energy and help protect the environment. It's becoming more expensive to run an IT department, strictly from a power consumption standpoint. International Data Corporation (IDC) notes that ten years

ago, around 17 cents out of every dollar spent on a new server went to power and cooling. Today, it's up to 48 cents. Unless things change, that number will get as large as 78 cents or more—IDC, 2007.

The point is this: If you have less equipment, you use less electricity and you have less impact on the planet.

2. THE WAYS TO RELY LESS ON FOSSIL FUEL–BASED SOURCES OF ELECTRICITY:

2.1. Virtualization:

It is a technology that can set you free. It provides most of the business drives to make Green IT happen. No longer have you needed to be shackled to pay exorbitant electrical bills for power and servers. It allows you to condense equipment to a much smaller amount. it helps you in generating less co2 and to save your money.

2.1.1. Types of virtualizations:

i. server virtualization
ii. client(or desktop) virtualization
iii. storage virtualization

i. Server virtualization:

This type is where most of the attention is focused right now in the world of virtualization and is where most companies begin an implementation of this technology. Because each server typically serves one function (i.e., mail server, file server, Internet server, enterprise resource planning server, etc.), with each server using only a fraction of its true processing power, server virtualization breaks through the "one application, one server" barrier and facilitates the consolidation of numerous servers into one physical server. This equates to (a) less physical servers required, and (b) 70 to 80 percent or higher utilization of existing hardware as opposed to the previous 10 to 15 percent.

ii. Client virtualization:

Virtualization technology is use to separate a computer environment from the physical computer. It is considered as a "client-server" computing model because the "virtualized" desktop is stored on a centralized, or remote, server and not the physical machines being virtualized. It "virtualizes desktop computers" and these virtual desktop environments are "served" to users on the network. You interact with a virtual desktop in the same way you would use a physical desktop. Virtual desktop infrastructure (VDI) is a popular method of desktop virtualization. This type of desktop virtualization uses the server computing model, as the desktop through hard ware and software. VDI hosts the desktop environment in a VM that runs on a centralized and remote server.

iii. Storage Virtualization:

Storage virtualization is a concept in System Administration, referring to the abstraction (separation) of logical storage (virtualized partitions of stored data) from physical storage (storage devices that hold, spin, read and write magnetic or optical disks such as CD, DVD, or even a hard disk drive, etc.). This separation allows the Systems Admin increased flexibility in how they manage storage for end users.

Virtualization of storage helps achieve location independence by abstracting the physical location of the data. The virtualization system presents to the user a logical space for data storage and itself handles the process of mapping it to the actual physical location. Storage virtualization can be implemented the following three ways:
• Host based • Storage device based • Network based

Host based: Host-based virtualization occurs on a user's PC. It uses physical disks on the host system and is managed by software just above the physical device that performs metadata lookup. Most operating systems have their own form of host-based storage virtualization. In Windows it's called Logical Disk Manager and was introduced with Windows 2000.

Storage Device Based: In the past, devices such as RAID controllers provided logical and physical abstraction, but didn't provide the ability to migrate data. Just recently, new RAID controllers have made it possible to allow downstream attachment of additional storage devices.

It works through a primary storage controller that manages virtualization services and allows additional storage controllers to be added. The primary controller manages metadata services and provides pooling. It can also manage replication and migration services to other devices.

Network Based: The preceding types of storage virtualization really aren't ideal for a large organization. They can be used, of course, but the one you are most likely to use is the network-based implementation. This is a SAN connected to a network-based device. This device sits in the SAN and provides the management duties of processing I/O requests and managing the metadata.

2.2. Generate your own Power:

Many companies are striving to be completely carbon neutral. One way you can cut your electrical bill and make a move toward carbon neutrality is to generate your own power. This is typically done using solar cells or wind turbines. Also, if you generate more power than you need, you can sell it back to your electrical utility.

3. THE OTHER METHODS TO ACHIEVE GREEN COMPUTING ARE:

3.1. Server consolidation:

Server consolidation refers to the use of a physical server to accommodate one or more server applications or user instances. Server consolidation makes it possible to share a server's compute resources among multiple applications and services simultaneously. It is mainly used to reduce the number of servers required in an organization.

3.2. Data de Duplication:

Data de duplication is a specialized data compression technique for eliminating duplicate copies of repeating data. Related and somewhat synonymous terms are intelligent (data) compression and single-instance (data) storage. This technique is used to improve storage utilization and can also be applied to network data transfers to reduce the number of bytes that must be sent. In the de duplication process, unique chunks of data, or byte patterns, are

identified and stored during a process of analysis. As the analysis continues, other chunks are compared to the stored copy and whenever a match occurs, the redundant chunk is replaced with a small reference that points to the stored chunk. Given that the same byte pattern may occur dozens, hundreds, or even thousands of times (the match frequency is dependent on the chunk size), the amount of data that must be stored or transferred can be greatly reduced.

3.3 Going paperless:

According to research done by the Environmental Paper Network, the paper industry is the fourth largest contributor to greenhouse gas emissions in the United States. The same study found that an emission of 1.6 million tons of greenhouse gases could be prevented by cutting paper use in offices by just 10%. This mass consumption of paper is extremely wasteful, as well as detrimental to the environment in the long run.

The technology to reduce paper usage is readily available to all offices. A number of benefits are achieved by going paperless:

- Reduce business cost associated with paper, printers, copiers, fax machines, ink and toner cartridges
- Eliminate filing cabinets and reduce office space
- Conduct business in a mobile environment resulting in faster responses to customers
- Increase efficiency of your staff by removing the time spent searching for and sending documents
- Present a professional image to your customers with mobile computing solutions
- Create faster business work flow by eliminating the time wasted on getting paper signatures on contracts and forms that need to be hand delivered
- Secure backup of all documents
- Real time updates and delivery of documents

3.4. Recycling:

Audiovisual components, televisions, VCRs, stereo equipment, mobile phones, other handheld devices, and computer components contain valuable elements and substances suitable for reclamation, including lead, copper, and gold.

One of the major challenges is recycling the printed circuit boards from the electronic wastes. The circuit boards contain such precious metals as gold, silver, platinum, etc. and such base metals as copper, iron, aluminum, etc. One way e-waste is processed is by melting circuit boards, burning cable sheathing to recover copper wire and open-pit acid leaching for separating metals of value. Conventional method employed is mechanical shredding and separation but the recycling efficiency is low. Alternative methods such as cryogenic decomposition have been studied for printed circuit board recycling, and some other methods are still under investigation.

As properly disposing of or reusing electronics can help prevent health problems, reduce greenhouse-gas emissions and create jobs, there have been calls to reform "the methodology for e-waste disposal and re-use in developing countries" with reuse and refurbishing offering a more environmentally friendly and socially conscious alternative to down cycling processes.

3.5. Reduce Cooling Costs:

Cooling costs are reduces by using economizers, on demand cooling and dynamic smart cooling.

3.6. Greening Information Systems:

- Initial improvement calculations are done by selecting metrics and tracking the process.
- A change in the business process is done by interacting with the customers, paper reduction and being a part of green supply chain.
- Technology infrastructure is improved by reducing PC's and servers, by sharing services, reducing hardware costs and cooling more efficiently.

4. FINDING YOUR CARBON FOOT PRINT:

The term carbon footprint is thrown around a lot in green circles. Although we have a general idea of its meaning—one's impact on the planet—there's no standard definition. In some cases, it might refer just to carbon dioxide output; in other cases it means greenhouse gas emissions. In other organizations, carbon footprint might mean that everything is tallied—sourcing materials, manufacturing, distribution, use, disposal, and so forth.

When computing your company's carbon footprint, you need to decide how complete and honest you want to be. Measuring your carbon footprint necessitates gathering a lot of information. Let's consider your company carbon footprint as it relates to greenhouse gases.

You need to track such areas as

• Facilities • Operations • Transportation • Travel
• Purchases

5. GLOBAL INITIATIVES:

5.1. United Nations:

At the highest level of global governance is United Nations. Seeing the e-waste is a international concern, it has stepped forward and implemented its Solving the E-waste Problem (StEP) program.

i. Basel Action Network:

It is a worldwide organization focused on working with human rights and environmental impact of e-waste. It also works to ban waste trade and promote green, toxic-free design of consumer products.

ii. Basel Convention:

It is an international treaty to reduce the transportation of hazardous waste between the nations, especially from developed to less developed countries. Further, the convention deals with minimizing the amount and toxicity of generated wastes.

5.2. North America:

North America is home to two countries The United States and Canada that seem to be struggling with implementing e-waste programmes.

i. **The United States:**

Although the country, as a whole, doesn't have any broad e-waste regulations many states have taken it upon themselves to protect their environments. Some of them are :

1. National Computer Recycling Act
2. Electronic Wastes Recycling Act
3. Cell Phone Take Back And Recycling
4. Rechargeable Battery Take Back And Recycling

ii. **Canada:**

Canada is managing e-waste in a way similar to the European Unions Waste Electrical and Electronic Equipment (WEEE) directive. The goal is to reduce the amount of electronic waste going into the general household waste stream.

5.3. Australia:

It follows a program called the Byteback program which is a fusion of government and industry aimed toward managing e-waste. With this program, consumers can bring up to 10 computers to be recycled at no charge to them.

5.4. Europe:

The European Union leads the world with its e-waste management WEEE and its ROHS directives.

i. **WEEE Directive:**

The Waste Electrical and Electronic Equipment Directive sets collection, recycling, and recovery goals for used electronic equipment.

ii. **ROHS:**

It restricts the use of 6 hazardous materials in manufacturing of certain type of electronic equipment.

5.5. Asia:

i. **Japan:**

Japanese have made great strides in managing their own e-waste problem.

ii. **China:**

The Chinese regulation is generally referred to as China RoHS. It is similar to the European Union's RoHS.

iii. **Korea:**

In April 2007, Korea adopted its act for recycling of Electrical and Electronic Equipment and Automobiles also known as Korea RoHS.

6. FINDINGS:

1. If we think computers are non-polluting and consume very little energy we need to think again. It is estimated that out of $250 billion per year spent on powering computers worldwide only about 15% of that power is spent computing- the rest is wasted idling. Thus, energy saved on computer hardware and computing will equate tonnes of carbon emissions saved per year.
2. The plan towards green IT should include new electronic products and services with optimum efficiency and all possible options towards energy savings.
3. Power supplies are notoriously bad, generally as little as 7% efficient. And since everything in a computer runs off the power supply, nothing can be efficient without a good power supply. Recent inventions of power supply are helping fix this by running at 80% efficiency or better
4. Mobile phones are better than computers – green computing. They have faster processors, more ram, faster wireless Internet connectivity and larger memories. Mobile Phones consume very low power
5. Purchase LCD's monitors which consume less energy than CRT's screen and LCD's is also not harmful for the eyes.

7. FUTURE:

Green computing in the future is going to be limitless. As more and more businesses work towards being sustainable the need for processing the data grows expeditiously. So even beyond making computing hardware more green and reducing its carbon footprint, the future will find a larger need for programming to analyze efficiently all of the data needed to track the metrics in order to move forward. Data that, as the video below from Chris Pyke, states only "unpacks the plaque" referring to the award for Leed Technology in building. The more data in his "hydrant" of information needs to have a means of being measured and analyzed on a regular and consistent basis to allow not only upper management, but market, industries, and governments the means to make more informed decisions. Green computing is invaluable in managing the reporting of sustainable project tracking in order to find common problems that are occurring and solutions to these issues.

The next wave is Nano data being created from mobile sensors and controls. Nano data is about individuals and individual companies to give us insight into how we use equipment. This allows us to figure out ways to do what we want to do, when we want to do it and using the least amount of resources to achieve it. Since 1941 computer technology has grown at a doubling rate every 1 1/2 years on energy efficiency and it was thought that we had possibly another 3 decades before we had reached the maximum growth potential based on a 3 atom transistor. Researchers at Purdue and the University of New South Wales have just created in the last few weeks a reliable one atom transistor, which has now extended the capacity for this trend well into the future. According to Jon Koomey, "the best way to predict the future is to create it", and we are at the verge of innovation that knows no bounds except those that we put on ourselves.

Whether it be software that is strictly analyzing the data looking for new metrics to measure the progress, new software for engineers to use to develop new processes, or software for architects to use when designing new Leed or more sustainable buildings and plants. The capabilities and needs are ever changing and help us not only feel good about our decisions but help to leave a better world for our children.

8. CONCLUSIONS:

This research paper shows the importance of Green computing. We should understand the need of Green computing and as shown in research paper necessary steps should be taken for healthy environment. If not then we of us will suffer from air pollution, water pollution, soil pollution etc. So with a little sense of understanding the importance and need of Green computing we should take the steps from today or even from now.

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