

IT for Environmental Sustainability

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Abstract: - Global warming and its increasing effects have shed light on the many global environmental issues. Our planet's fragile ecosystem is under attack on many fronts as a result of industrialization and our growing usage of Information Technology. Worldwide change is needed in order to avert this catastrophe. According to survey, the upper limit of atmospheric CO₂ is 350 pm (parts per million) which is currently 390ppm, more than the limit. This means that there is need to bring it down as soon as possible in order to avert the damages of global warming. This paper is divided in to three sections, wherein, in first section we will introduce the topic and also explain the reasons for deteriorating environmental conditions. In second section we will throw some light on the strategies adopted by IT companies for environmental sustainability, few suggestions towards green computing and finally a proposal on how the education sector can reduce its carbon footprint by using the strategies mentioned in the paper. This paper will end up by concluding the results and the future scope.

Keywords:- Greener IT, Global Warming, Environmental sustainability, Information Technology, Green Computing, Virtualization, Information Lifecycle Management De duplication, Paperless computing, Educational sector , Data Centers.

I. INTRODUCTION

Sustainability means the ability to be maintained. According to the *World Commission on Environment and Development*-“**Environmental sustainability is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.**”Why is sustainability important? With the way the human population is rising today, it is consuming essential resources at very fast rate. This is taking toll on the already dwindling environment. We cannot continue wasting precious resources because our very existence depends on them. The air we breathe, the water we drink, the soil we grow our food on, the plants , the animals, the fuels all are all getting used up at such a fast pace that it is worrying all industries, all governments, all individuals all over the world. Thus Environmental Sustainability seeks to use fewer resources or restore those that have been save our future generations so that they can foster happily in a rich environment.

II. REASONS FOR DETERIORATING ENVIRONMENTAL CONDITIONS

The environmental conditions are getting deteriorated and there are many reasons driving this phenomenon:

- 1) **Pollution** – Pollution is the contamination of physical and biological components of the earth to such an extent that the environment is not able to restore itself leading to destruction of the natural processes.

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- 2) **Deforestation**- Due to rapid industrialization forests are being cut at an alarming rate. Deforestation is done because of either want of space to set up industries or want of paper or want of wood or want of other material from the trees. Forests are not only home for animals and birds but also provide us with various natural resources and fresh air. Additionally, their roots hold onto the soil to prevent its erosion which is an important part of the water cycle. Between 1990 and 2000, the yearly loss of forests was 16 million hectares.

- 3) **Global Warming**-The release of gases such as carbon dioxide and methane into the environment, particularly from vehicles and industries, contributes to global warming by causing the average temperature around the world to rise. The current CO₂ levels are at 392.39 parts per million; the safe level is considered to be 350 parts per million. If levels continue to rise and people do not make major changes, life as we know it may end due to:

- The rise of sea levels
- Destruction of species
- Extreme weather conditions
- Economic crisis because we will be paying for the damage

III. IT FOR ENVIRONMENT SUSTAINABILITY

Information Technology (IT) has become an inseparable and important part of our life; it is deeply integrated in today's business operations. Dependence on IT; be it our daily individual life or business operations, is growing continuously and will continue to be so in the future too. Excessive use of IT results in carbon emission.

An IT emission is approx. 2% in global CO₂ which includes PCs servers, cooling, fixed and mobile technology, LAN, office telecommunication and printers. If we consider the carbon footprint contribution, the IT emission statistics show the following:

- PCs and Monitors contribute 40%
- Servers (including the cooling mechanisms) contribute 23%
- mixed telecom equipment contribute 15%
- Mobile telecom devices contribute 9%
- LAN and Office telecoms contribute 7%
- Printers contribute 6%

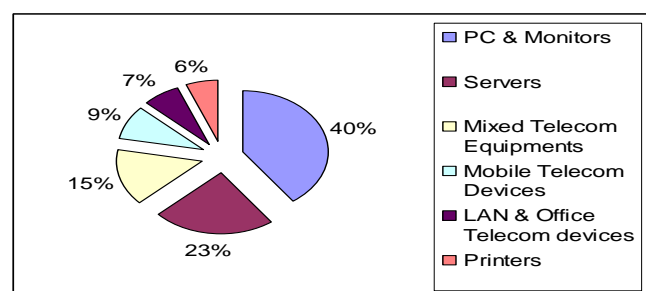


Figure 1: IT Emission

IV. STRATEGIES ADOPTED BY IT COMPANIES

No industry has taken such long strides in its development as the Information Technology industry. IT has entered every sphere of human existence. It has definitely made life easier and made possible many things unachievable before. Thus it is imperative that IT also plays its role in sustaining environmental stability and pioneers in the formation of strategies to maintain ecological balance. As discussed earlier, IT contributes to 2% of the total global carbon footprint. It can however help run business more efficiently and reduce the other 98% of the carbon footprint that the non-IT companies produce. Some of these strategies are:

- 1) **Reducing travel time for employees-** There are advanced teleconferencing software today like Cisco's "Telepresence" which help employees, customers, managers, buyers, vendors sitting anywhere in the world without the need to leave their workplace or home to attend the meeting. The reduced travel not only saves a lot of time and money but also help in reducing the CO₂ emissions and heating of the atmosphere which are caused from traveling in airplanes, buses, cars, bikes or trains. In just a year, Microsoft claimed to have cut over 100 million miles of air travel by following green initiatives.
Mobility solutions like VoIP, virtual LAN etc. help employees connect to the office network and hence the company resources even while on a customer site, thus giving on the spot, quick solutions.
Teleworkers and Flexitimings are the favorite words of the employees of today. Converged IP networks are not only helping workers better manage their professional and personal life by working from home but also contributing to greening of the environment.
- 2) **Smaller office spaces-** using technologies like IP Telephony, workers can use shared workspace on an as-needed basis. With IP telephony, employees can use their office number, voice mail, and features at several locations and devices. These employees also use remote access to corporate data and applications to perform their jobs on the road or from home offices. In this way, a company can provision fewer office spaces than number of employees, saving on real estate and associated energy consumption.
- 3) **Online billing and payment-** Online Billing and Payment Cuts Down on Paper Usage. Networks support online, paper-free billing, and more and more businesses are taking advantage of it. This can have a large and positive environmental impact. At Verizon, more than 84 million paper bills were suppressed in 2007, saving 1,700 tons of paper. Electronic bill payment also eliminates associated environmental costs of paper bill transportation between provider and purchaser. Vodafone itself saves more than 60 million papers a year after it has switched to paperless billing.
- 4) **Paperless office-** in today's scenario, every environmentally sensitive company is striving towards reducing the amount of paper in its day to day transactions. Each ton of paper saved, saves. -17 Trees. -240 litters of crude oil. -4210 KWH of electricity.

-26,500 litters of water.
-3 meter cube of space.

Every year, an average mid-sized Indian company transacts with papers that need 1.5 to 2 million trees. Some of the Technologies for Paperless Office are Electronic document management, Digital signatures, Work-flow, Electronic data interchange(EDI).

Electronic document management is a computer-based technique for storing and retrieving documents held in a wide variety of formats or in a number of geographic locations. EDM captures documents by scanning, converts them into editable digital formats and indexes the documents into searchable databases.

Digital signatures are created and verified using cryptography. As per IT Act 2000, a digitally encrypted document with digital signature of sender is as good as a signed paper document. One of the obstacle in the paper-processing world is waiting for a supporting document to arrive. For example, an application for advance may be received, but a medical or outstanding claims report must be ordered and received before the application can be considered. Workflow technology is the automation of a business process, during which documents are passed from one state to another for action, according to a set of rules defined by your workflow scheme.

Electronic Data Interchange is the computer-to-computer exchange of business documents. EDI helps in Data accuracy since there is no manual re-keying of data. Also all transactions are acknowledged and there is no need to mail or fax the documents. In addition to the above technologies, the very concept of E-Mailing the documents and communicating through e-mails has given a great relief to the forestry because of significant reduction in the amount of paper required and thus significant reduction in the cutting of trees.

- 5) **IT mitigating the carbon footprint created by itself-** As mentioned before, like other industries, the IT industry is also contributing towards the global CO₂ emissions and heat energy dissipations. However IT has by itself found ways to mitigate its own effects through efficient technologies and processes.

Data centers- A data center is a centralized repository, either physical or virtual, for the storage, management, and dissemination of data and information organized around a particular body of knowledge or pertaining to a particular business. Data centers store enormous amount of information and employ complex and high energy consuming infrastructure to house, search, maintain and disseminate that information. Data centers produce as much carbon in the environment as the entire airline industry. By 2012 the data centers in India itself would grow to 5.1 million square feet. Data centers consume humongous amounts of power. If all data centers are implemented efficiently, it would save the equivalent of the annual electricity consumption of 1.8 million homes.

Saving power-A well-run data center is an efficient data center. The best data centers use techniques to lessen the impact of their energy use, including the simple act of turning off unused servers. The easiest power to save is the power that isn't used. With sophisticated operating processes, servers and disk drives can be powered down

when not needed, then brought back online whenever demands require it. During low points in activity, organizations can run their servers at reduced speed, which lessens their consumption of energy. In addition, an enterprise should always choose a server with the best power supply efficiency available with the selected configuration. Data center managers can improve the efficiency of their facilities by rigorous maintenance to keep equipment operating efficiently, as well as modifying layout and configuration of equipment to reduce cooling requirements. These and many more steps will increase overall data center efficiency and help lower the carbon footprint.

Virtualization and cloud computing add to Server Capacity- Cloud computing is a hot topic of discussion today. Everybody is raving about the many technical and economical benefits that this technology is offering. Additionally, is playing a big part in ecological stability by contributing immensely to the Green Computing revolution. Cloud systems are designed to be decoupled from physical hardware, which offers the advantage of near instantaneous creation and destruction of a server (a virtual server). Companies no longer have to scale to their anticipated max load, but rather run exactly the right amount of hardware. As an example, say an Indian company runs an online business of selling fire crackers. Now the sale multiplies to three to four times in the festive season of Diwali. At that time, it may think of purchasing additional servers to meet the growing demand. These servers however are of no use for the rest of the year. Big data centers like Bombay Stock Exchange or New York Stock Exchange or retail stores like WallMart, have to be built considering their ultimate load in peak times or during prime shopping season. You just cannot purchase new servers when there is more load and remove them when there is less. Cloud computing gives you the freedom to commission or decommission the servers according to rising or falling demand of your company. Thus a lot of power is saved for the servers which are consuming electricity throughout the year sitting idle. Servers typically use only 5-15 percent of their capacity. Through virtualization, businesses can consolidate multiple IT resources, such as operating systems and software applications, on a single server, running several "virtual" servers on one device. One server can do the work of several, reducing both costs and energy usage. Businesses also can duplicate their environment—providing backup capabilities—at a fraction of the cost and environmental impact common with physical replication. And applications, whether on a virtualized machine or not, can be optimized. Bloating software, inefficient software, or even software that produces very little business value, all can be pruned, optimized and even discontinued to lighten the load on servers.

Data DeDuplication-Normally in Data centers much of the data is duplicated. For eg a presentation which tells about various products of the company may be stored by various departments in the company. Also a document detailing Company rules and regulations may be duplicated at different places in the company. In addition to that, whenever a backup of the primary storage device is taken, multiple copies of the same data get duplicated again on the

backup storage. One of the most effective storage strategy today is DeDuplication. DeDuplication basically means comparing objects and removing all non-unique objects.

V. TYPES OF DEDUPLICATION

- 1) File level
- 2) Block level
- 3) Byte level

Veritas NetBackup and Dhruva inSync are two of the many products providing DeDuplication and thus efficient storage. Thus DeDuplication can reduce the overall footprint in the data center and can store the exact amount of information in less than 1/10th of the footprint. Additionally it saves a lot of power and energy costs.

Information Lifecycle Management-It is estimated that 90% of the data stored on a disk is never or very infrequently accessed after 90 days. Till now all data was considered equal and stored on the same media for its entire life. Thus the amount of data kept on growing and accumulating thus increasing the carbon footprint and contributing to environmental hazards as well. ILM has revolutionized the way data is stored and accessed. In addition to reducing the amount of storage and increasing the efficiency of access, ILM can also contributed in a significant manner to help sustain the environmental balance by reducing the carbon footprint of the IT industry. ILM does not consider all data to be equal. As it moves through its lifecycle, data must be stored on different levels and different hardware. This means while implementing ILM, we identify the right hardware, software and processes at each stage of information's lifecycle. This means:

Right Information
At
Right Time
On
Right Storage device
At
Right Price.

VI. PHASES OF ILM

- 1) Assessment
 - 2) Socialization
 - 3) Classification
 - 4) Automation
 - 5) Review
 - 6) Destruction
- 1) **Assessment**- People who handle storage find out what data is residing on what storage devices in their company.
 - 2) **Socialization**- Data utilization and costs benefit analysis is done for all type of data.
 - 3) **Classification**- According to the facts and figures collected in the previous level, data is classified according to its criticality and priority at that point in time.
 - 4) **Automation**- We find out which data has to be stored in what storage level and form policies to migrate data to the proper storage class over time. This process is then automated.

- 5) **Review**- We keep monitoring the storage environment continuously to know where excess capacity, duplicate files or aged files exist.
- 6) **Destruction**- Unnecessary files are migrated out of the storage system completely or transferred to cheaper media and delivered to off site storage.

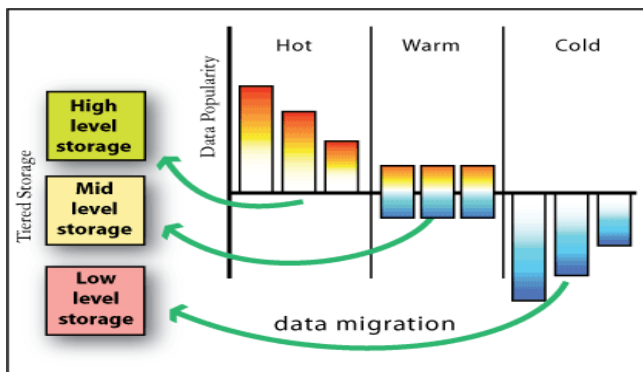


Figure 2: Information Lifecycle Management

ILM products like StorageTek from Symantec organize data into separate tiers according to specified policies and automate data migration from one tier to another based on those criteria. New data is stored on faster and more expensive storage media. Less critical data is stored on cheaper and slower media. However, a path management application also runs to retrieve any stored data.

VII. SUGGESTIONS

Smart particles- smart particles are small semiconductor nano particles which are actually electromechanical sensors. They form ad hoc networks and are capable of detecting light, temperature and radiations. They are basically small computers connected to several sensors and a radio transmitter. Data gathered by the mote are passed on to the radio link for transmission from mote to mote until data reaches the transmission node. They use the power of IT for Environmental protection and Habitat monitoring. They can be spread around an area where they can monitor things like pollution in the area or behavior of organisms in their natural habitat. This information is then used for various environmental sustainability measures.

VIII. PROPOSAL -GREEN IT FOR EDUCATIONAL SECTOR

Education is an important component of life because it equips us with all that is needed to make our life beautiful. All the country spends huge amount on education from primary to higher education either directly or indirectly. Earlier many technologies were expensive and unavailable for common use, which are now becoming free to everyone and anyone with an Internet and web browser. Students are already using these services whether it is music sharing, movie sharing, social sharing, software sharing etc. Our education system should take advantage of this same trend, which will both enrich our student's technology enabled education, and importantly, reduce the budget impact in academic institutions. University management should identify and leverage emerging technologies that are cost-effective, and strive for the broadest feasible and equitable access to technology for students and staff. One of the emerging technologies is cloud computing. By adopting

cloud computing, many educational institutes can reduce its operational cost. In universities the usage of resources varies depending on the academic calendar. Demand for resources is more during assignments and year-end time as compared to mid. The research projects and other research oriented activities are active throughout the year. In my opinion the usage of the strategies mentioned in the paper can help academia by:

- Reducing cost and providing flexibility and accessibility.
- Utilize on-demand computing and storage to host, scale, and manage applications and services for entire organization or individual departments within it, globally or locally.
- Provide on-demand scalability, and reduced time to market for educational applications.
- Provide collaboration and online communication between students and staff. It means Quick & Effective Communication with Anytime Anywhere Access.
- Provide wide-range of course materials and academic support tools to instructors, teachers, professors, and other educators and university staff.
- Reduce maintenance cost.
- Help teachers & students in organizing their classroom presentations and schedules.
- Save on notebooks, papers, printing etc.

IX. IMPLEMENTATION

The number of computers and servers are increasing day by day in the educational sector in order to meet the demands of today's generation. Our institutes and universities need more than just extraordinary teachers and innovative educational programs to overcome today's challenges. They need more efficient and cost-effective systems to permit the teachers, administrators and even parents to focus more of their time and energies on these exciting initiatives. Every year, the number of students seeking admissions in universities is increasing at a very fast pace. With the same speed are increasing requirements related to storage space and technology upgrades. How far can we cope up with all these demands and keep on spending millions and millions on these? Following are some activities performed by institutes and universities where implementing cloud computing would not only increase the efficiency of the overall process but also prove to be cost effective:

Admissions: With increasing usage of internet, universities are focusing on making the entire admission process online with manual intervention only in case of verification of final documentation. This is likely to put significant load on university servers as more and more students would try to download admission forms. There may also be a need for significant storage space so that all relevant documentation uploaded by students (scanned academic proofs) can be managed. At this stage, using cloud computing would be a good option as universities will be able to hire storage space, computational efficiencies at an affordable cost instead of investing into hardware resources. The money saved can be used for the betterment of the overall education system. Also Information Lifecycle Management can be used through which, data of the older students could be kept at a comparatively low end storage device and the current admission data to be kept in a high end storage device with better accessing technologies. This would make the storage more cost effective. Online purchase and submission of the

admission form definitely saves a lot of paper. This is in addition to reducing the travel time needed for students living in far flung areas to come to the university campus for the purchase or submission of the form. Even if any interview is to be conducted, various teleconferencing tools like 'Telepresence' can be used.

Research projects/Class Assignments/Presentations: these are an important ingredient of good institutes and universities. Cloud computing provides vast collection of resources for research projects, class assignments and presentations at affordable costs. SaaS and Cloud Computing meet the escalating needs of faculty, students, researchers as well as Parents. A very good example of this is Google Apps that has become pervasive at both secondary school and college levels. A growing generation of Google Apps users, often prodded by a new generation of young teachers, is becoming exposed to the power of these online collaboration tools. These tools change the way teachers and students interact. Social networking tools like Twitter and Facebook, which have been seen as needless distractions in many schools, are now increasingly being used as educational tools by savvy teachers who recognize their information dissemination and collaborative powers. LinkedIn is also a powerful media of technical exchange. Using mobility solutions like VoIP and VPN faculty and students can get access to the institute resources sitting anywhere, anytime, improving their efficiency in addition to reducing travel, thus reducing their carbon footprint.

Examination: Before any examination takes place, Hall ticket/admit card are generated. My idea is to use biometric system for examination hall entry. If authenticity is required, then online authentication can be done by using digital signatures and hall ticket can be generated.

X. RESULT GENERATION

Result announcement days are ones when the university servers experience significant load as students are eager to check their scorecards. Institutes also print copies of marksheets to be put up at various location in the campus and for their records. In order to reduce the paper work or load on servers, our idea is to send results on students' mobile number. This will not only shed the load of servers but also reduce the cost of result generation.

XI. OTHER STRATEGIES FOR EDUCATIONAL SECTOR

Use Laptops than Desktops: LCD monitors use an average 50% to 70% less energy than CRT monitors.

PC Power Management: Use software that centrally control power management of desktops

Collaborative tools: Use of communication tools like Video Conferencing, Voice of IP, TelePresence, Instant messaging can considerably reduce carbon footprint. It also helps in idea sharing in research projects, presentations and class assignments

Server consolidation: Consolidating the servers and usage of multi core server also helps in reducing the carbon footprints.

Cooling technology: Usage of sensors for optimum cooling also helps

XII. CONCLUSION

These initiatives are not only attacking a serious social issue facing our country today, but also cultivating a new generation of environmentally sensitive user for the future. Greener data centers are vital both to meet business demands and reduce environmental impact. They provide the computing capacity for larger sustainability initiatives such as online collaboration, while also offering key opportunities for savings in both costs and carbon emissions. In our experience, all 'Green IT' initiatives should be focused on delivering a benefit aligned to one or more of the following three principles: **Reduce, Reuse, Recycle**. These principles can be used to assess each IT transformation initiative in terms of its ability to support the organization's environmental agenda and objectives. The success of these initiatives will not only help to improve the quality of our education system but also other sectors - IT or non IT, but also cement the movement of the software and technology industry to new horizons of green computing.

XIII. FUTURE SCOPE

Here we suggest "Green Maturity Model" which every organization should frame in order to assess the organization growth and its contribution towards environment. This GMM would integrate the existing practices with new innovation for the greening of each and every task performed by the company be it deployment, delivery, marketing, production, development etc.

According to us, all new products designed by IT companies should be energy efficient and eco-friendly.

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