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Green IT based Energy Efficiency Model for Data Centers to Reduce Energy Consumption & CO2 Emissions

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Abstract: Problem Statement: The advancement of Information and Communication Technologies (ICTs) based business and social practices in the last few decades has transformed many, if not most, economies into e-economy and businesses into e-businesses. For economies, ICTs are increasingly playing critical roles in transforming and generating ortunities. On the other hand, global warming and climate change coalescing with limited availability and rising cost of energy are posing serious challenges for the sustainability of the global digital (or otherwise) economy. Technology has a potential to create sustainable business and society both in grim and green economic times. Especially, the recovery from the current economic crisis is going to need and lead to more Greener and energy efficient industries. As corporations look to become more energy efficient, they are examining their operations more closely. Data centers provide capabilities of central storage, backups and networking, recovery. Data centers are found major culprits in consuming too much energy in their overall operations and generating too much CO_2. In order to handle the sheer magnitude of today's data, data centers have had to use much more power and servers have become larger, denser, hotter and significantly more costly to operate. This study determine the properties and attributes of green IT infrastructures and determines the way it will be helpful in achieving green sustainable businesses. The proposed Green IT model will be drafted using Virtualization technology for data centers to make them more energy efficient and green, hence reducing the emission of green house gases so that the overall effect on global warming can be reduced or even eliminated. Results & Conclusion: The proposed model would reveal the qualities of green IT to enhance the proper utilization of hardware and software resources available in the data center. It helps data center managers to come up with a new environment friendly and sustainable green IT strategy making environment greener and sustainable. The heart of this strategy is to reduce global warming effects by using green and energy efficient data centers.

Key words: Virtualization complements, server consolidation, environmental considerations, data centers, energy efficiency, reduce energy, environmental issues, energy efficient, environmental impact, resource allocation,

INTRODUCTION

Seldom does a day pass in which we don't hear or read about sustainability or "going green." Environmental concerns are constantly in news headlines and the impact of technology on our environment is significant. Large technology organizations such as Dell, HP, ISM, Sun, Hitachi and Fujitsu have introduced green and sustainable initiatives. "Green" is generally understood to mean "Friendly to the environment and energy efficient." Sustainable implies planning and investing in a technology infrastructure that serves the needs of today as well as the needs of tomorrow while conserving resources and saving money. Organizations are quite concerned with environmental issues, but they have also come to realize that sustainable business practices can significantly enhance the bottom line.

Data centers are changing at a rapid pace; more than any other industry in history. Yet with all the change, data center facilities and IT professionals face numerous challenges in unifying their peers to solve problems for their companies. Sometimes you may feel like you are talking different languages or living on different planets. The data centers have become an increasingly important part of most business operations in the twenty-first century. With escalating demands and rising energy prices, it is essential for the owners

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and operators of these mission critical facilities to assess and improve their performance. In contexts ranging from large-scale data centers to mobile devices, energy use is an important concern. In data centers, power consumption in U.S has doubled between 2000 and 2006 and will double again in the next five yearsn (EPA, 2006). Server power consumption not only directly affects a data center's energy costs, but also necessitates the purchase and operation of cooling equipment, which can consume one-half to one Watt for every Watt of power consumed by the computing equipment (Suzanne, 2008). As new servers are being added continuously into data centers without considering the proper utilization of already installed servers, it will cause an unwanted and unavoidable increase in the energy consumption, as well as increase in physical infrastructure like over-sizing of heating and cooling equipments. This increased consumption of energy causes an increase in the production of green house gases which are hazardous for environmental health. Hence it not only consumes space, energy, but also cost environmental stewardship (Mueen and Azizah, 2010). The continued growth of data center power consumption impacts everything from the business enterprise to the power supply companies to the environment. With more efficient energy use in data centers, power supply companies will face less demand and the possibility of excess power, which could help limit blackouts, reduce carbon dioxide output and cut other green house gases.

In addition, energy use has implications for reliability, density and scalability. As data centers house more servers and consume more energy, removing heat from the data center becomes increasingly difficult (Chandrakant and Patel, 2003). Since the reliability of servers and disks decreases at high temperatures, the power consumption of servers and other components limits the achievable density of data centers, which in turn limits their scalability. Furthermore, energy use in data centers is starting to prompt environmental concerns of pollution and excessive load placed on local utilities (Chandrakant and Ranganathan, 2006). These concerns are sufficiently severe that large companies are starting to build data centers near electric plants in cold-weather environments (John and Hansell, 2006). For the business enterprise, an increase in data center efficiency can save significant energy costs. However, even with the global presence of many companies, these metrics are often not applied consistently at a global level. All of these factors are increasing the public's awareness and global concerns of these current power consumption trends.

We're in the biggest data centre construction boom in history. The U.S. is spending $16 billion a year building out additional data centers, with another $6 billion on refurbishing existing ones. Experts say we should be spending $3 billion a year to build new electrical power plants to meet the supply needs of these data centres-except we're not (EPA, 2009). The Smart 2020 report published by the Climate Group and GeSI revealed that in 2002, the global data centre footprint, including equipment use and embodied carbon, was 76 MtCO2e and this is expected to more than triple by 2020-259 MtCO2e, making it the fastest-growing contributor to the ICT sector's carbon footprint, at 7 per cent per annum in relative terms. If growth continues in line with demand, the world will be using 122 million servers in 2020, up from 18 million today (Smart, 2020). With energy prices increasing worldwide the operational costs of data center continues to increase steadily. Besides the cost, availability of electrical power is becoming a critical issue for many companies whose data centers have expanded steadily.

Enterprises, governments and societies at large have a new important agenda: tackling environmental issues and adopting environmentally sound practices. Over the years, the use of IT has exploded in several areas, improving our lives and work and offering convenience along with several other benefits. We are passionate about advances in and widespread adoption of IT. However, IT has been contributing to environmental problems, which most people don't realize. Computers and other IT infrastructure consume significant amounts of electricity, placing a heavy burden on our electric grids and contributing to greenhouse gas emissions. Additionally, IT hardware poses severe environmental problems both during its production and its disposal. IT is a significant and growing part of the environmental problems we face today. We are obliged to minimize or eliminate where possible the environmental impact of IT to help create a more sustainable environment. To reduce IT's environmental problems and to create a sustainable environment, we call upon the IT sector as well as every computer user to green their IT systems, as well as the way they use these systems (Murugesan, 2008).

We are legally, ethically and socially required to green our IT products, applications, services and practices. Green IT benefits the environment by improving energy efficiency, lowering greenhouse gas emissions, using less harmful materials and encouraging reuse and recycling. Factors such as environmental legislation, the rising cost of waste disposal, corporate images and public perception give further impetus to the green IT initiative. Green IT is a hot topic today and will continue to be an important issue for several years to come. To foster 3 green IT, we should understand: What are the key environmental

impacts arising from IT? What are the major environmental IT issues that we must address? How can we make our IT infrastructure, products, services, operations, applications and practices environmentally sound? What are the regulations or standards with which we need to comply? How can IT assist businesses and society at large in their efforts to improve our environmental sustainability? This study will highlight some of these issues and then presents a holistic approach to greening IT in e businesses especially data center industry. We propose a green IT strategy for data centers and outline specific ways to minimize IT's environmental impact.

Challenges of data center industry: Power outage has been mentioned as one of the most experienced and perceived risks by various types of businesses and organizations. Thus, reducing the impacts of power outage has become a key agenda in business continuity planning. Back-up or stand-by generators are among the most well known measures taken by power consumers to tackle the power outage problem (Asgary A., and Jahromi). There's no single bad guy that can be blamed for IT inefficiency. Worse, inefficiency seems to grow incrementally over time as environment becomes older and more complex. Each new application being added seems to require another server, which requires administrative time to keep running, while it consumes power, space and expensive network ports in your data center. The data center industry has a number of related problems such as:

Inconsistent measuring metrics and benchmarking: It is very greatly important for data center managers to measure the performance of their data centers regularly so that efficiency measures should be performed to make data centers energy efficient and green. But unfortunately there is no industry standard metric available acceptable worldwide to measure the performance in terms of energy efficiency and CO2 emissions. Data center managers are currently equally split between using external benchmarks, home grown tools, financial analysis and commercial asset/financial management tools, with no clear leader and metric. It is evident from different discussions that measuring IT performance is difficult.

Large number of underutilized servers: Servers are the major components responsible for performing most of the processing being performed in data centers. There number is continuously increasing as the demands from businesses grow. Due to their increased number they are the leading consumer of IT power in any data center. Data centers are plagued with thousands of the server's mostly underutilized, having utilization ratio of only 5-10% consuming huge energy and generating huge amount of green house gases (Mueen and Abdul Rahman, 2010).

Power efficiency of IT equipment: Data center comprises many types of equipment like servers, UPS, PDU's, chillers, Cracks. All of these components consume enormous amount of power to provide services to end users. Most of the data managers think that IT equipments are significant source of electrical waste. Proper efficiency measures can reduce these consumptions and help data center managers implement environment friendly and green data centers.

Establishing performance requirements and maximizing IT operations: Effective application service delivery requires a continuous understanding of end-to-end application performance requirements. In a data center environment, with rapidly changing dynamic workload and resource allocation, continuous measurement to establish performance requirements is especially vital. This understanding should start when the applications are still in development, so that IT can avoid any surprise performance problems during and immediately after production deployment. As application usage changes, continuous measurement is required to adapt workload and resource allocation and maintain service levels. When application changes are made, or new features are added, performance requirements will need to be re-established to again avoid potential disruption.

Environmental issues and problems: The growing accumulation of greenhouse gases is changing the world's climate and weather patterns, creating droughts in some countries and floods in others. It's slowly pushing global temperatures higher, posing serious problems to the world (http://egj.lib.uidaho.edu/index.php/egj/article/view/3205/3175). For instance, 2005 was the warmest year on record and the 10 warmest years have all occurred since 1980. Global data shows that storms, droughts and other weather-related disasters are growing more severe and more frequent. To stop the accumulation of greenhouse gases in the atmosphere, global emissions would have to stop growing. Electricity is a major cause of climate change, because the coal or oil that helps generate electricity also releases carbon dioxide, pollutants and sulphur into the atmosphere. These emissions can cause respiratory disease, smog, acid 4 rain and global climate change. Reducing electric power consumption is a key to reducing carbon dioxide emissions and their impact on our environment and global warming. With this in mind, let's focus on what each of us as IT professionals, members of the IT industry and IT users can do individually and collectively to create a sustainable environment. Let's

examine IT's environmental impact and consider green IT measures that we can adopt.

Proposed work:

Greening data centers: The continued rise of Internet and Web applications is driving the rapid growth of data centers. Enterprises are installing more servers or expanding their capacity. The number of server computers in data centers has increased six fold to 30 million in the last decade and each server draws far more electricity than earlier models. Aggregate electricity use for servers doubled between 2000 and 2005, most of which came from businesses installing large numbers of new servers (Pritchard, 2007). One problem with the greening of IT is that it forces organizations to buy more. Plans usually call for things like more energy efficient servers, intelligent sensors for data center cooling, server virtualization software, low power monitors and devices that turn off dormant computers (Baines, 2007). The social, financial and practical constraints involved will force businesses and IT departments to reduce energy consumption by data centers. We can improve data center efficiency by using new energy-efficient equipment, improving airflow management to reduce cooling requirements, investing in energy management software and adopting environmentally friendly designs for data centers and new measures to curb data centers energy consumption.

Three key areas identified for improvement in achieving energy efficient data center are:

- Revising processes and metrics
- Optimizing efficiency of existing IT assets
- Revamping architecture and infrastructure

Revising processes and metrics: Changing organizational processes and measurements is a subtle but vital part of any transformation effort. Changes in processes and metrics will drive changes in behavior, which in turn will underpin all the other technology or architecture changes that a data center makes. By focusing on processes and metrics, data center managers must ensure that green does not become a "bolt-on" to the business, but rather is integrated into employees work. Process changes will extend beyond the IT organization; in fact, one of the principal goals of these activities is to foster closer collaboration among IT leadership, sourcing and vendor management and facilities or real estate functions. A policy should be drafted to revise procurement criteria to favor green suppliers, products and sustainable business practices. Benchmarking should be done for energy consumption and CO2 emissions of prospective equipment purchases using standards like Energy Star, EPEAT, Green Grid and others. Favor products with longer potential life cycles and with smaller total carbon footprint. It is also very important to emphasize on recycling programs for both consumable and durable IT assets. Performance goals should be set for teams and individuals to conform to green practices and principles. It is also necessary to implement an energy monitoring and management system to benchmark the performance of data center from time to time so that new techniques and measures should be implemented to make them green and environment friendly.

Green criteria should be built into existing performance management systems, balanced scorecards and measurement metrics, data center managers are already using to measure, incant and reward performance. Revise the employee competency or maturity model to include sustainability competencies and skills.

Optimizing efficiency of existing IT assets: A data center consists of many types of equipment and devices needed to accomplish the business needs and to provide services to the end users. These services vary depending on the different optimization priorities depending on its green IT goals, appetite for change and current infrastructures. It is pertinent here to note that data center managers must reconfigure data center equipments so that green initiatives can implemented and energy efficiency goals should be achieved. Some of the proposed initiatives are:

- Move to hot aisle/cold aisle arrangement
- Reposition and unblock air vents
- Simplify cabling systems
- Moving to overhead configuration if possible
- Group equipment with similar power and cooling requirements together in modular fashion
- Instrument equipment with temperature and power consumption sensors
- Upgrade power supplies, converters, UPS systems and CRAC systems
- Optimize data center thermals via precision cooling and other techniques
- Implement server and/or storage virtualization, tiring and consolidation
- Implement networked PC power management system
- Lengthen PC life cycle

Revamping architecture and infrastructure: Revising processes and optimizing assets will yield significant green and cost benefits for most of the data centers. Green initiatives will create an opportunity to go further and delve into revamping IT infrastructure

and architectures. Data center managers must implement thin client systems to replace desktop PC populations. Upgrade older server and storage gear with more energy-efficient models. Consolidate, relocate, or outsource data centers. Reduce energy usage with building automation systems and evaluate alternative energy technologies and suppliers. New improved infrastructures using green metrics should be adopted and implemented to save the overall cost of ownership of data centers.

Proposed green it model for data centers: This study highlights the importance of green IT for data centers and proposes a model that provides data center managers with guidelines and steps to be followed to make data centers energy efficient and green. The proposed model comprises of five optimization steps. The proposed green IT model specifies that energy consumption, underutilization, emission of green house gases, environmental concerns, global warming issues and intensive administrative labour that contribute towards data center inefficiency can be tackled by following the proposed green IT model comprising of five key element. These are:

- Baseline your environment
- Virtualize Servers
- Consolidate IT
- Improve data center efficiency
- Update IT processes

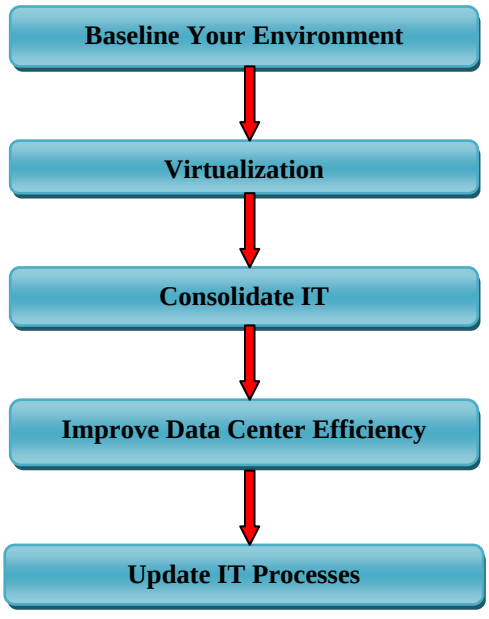

Fig. 1: Proposed green IT model for data centers

The proposed model highlights top IT improvements in data center spanned across data center energy efficiency, infrastructure consolidation, reduced administrative labor, better IT process, improved service time and reduces green house gases to reduce the effects of global warming hazardous for environmental health. These benefits may vary significantly across businesses of different types. In particular, companies with less than $1 billion in revenue said that they benefited more from physical consolidation of IT assets, whereas companies with $5 billion or more in revenue benefited the most from improving the energy efficiency of their data centers.

Baseline your environment: The first step in greening the data center is to baseline all the requirements to get the maximum value out of data center greening program. Now more than ever, energy efficiency seems to be on everyone's minds. Faced with concerns such as global warming and skyrocketing energy costs, more and more companies are considering if and how to increase efficiency. E businesses that rely on data centers must make hard decisions to accommodate growing demands without creating a negative impact on their finances or the environment. The data center baseline Study report must be based on in-depth interviews with engineers and data center managers. These professionals represent a cross-section of companies in terms of industry, size, number of servers, storage capacity, age, geography.

The baseline study provides measures to boost efficiency, as well as the incentives for making changes data center energy efficient. The growth in IT demand is among the most common obstacles to becoming more energy efficient. Data centers must contend with constant expansion in data volume, along with new and extended application requirements. The study also gets awareness about how to calculate the power load of individual IT devices. The data center baseline report also outlines helpful strategies for approaching energy efficiency in the data center. The discussion covers virtualization, air-flow management, server decommissioning, equipment upgrades, storage consolidation and optimization and use of fresh-air cooling and renewable energy sources. The report also includes tips on how to improve energy efficiency in the data center so that other data center professionals can evaluate their options and identify the most appropriate steps for their particular organizations.

IT discovery process: The process of creating the baseline of your data center starts by creating an inventory of all resources including servers, resources they require, available resources and their associated workloads, this process is called discovery process. The inventory process includes both utilized and idle

servers. It also includes information related to (Mueen and Abdul Rahman, 2010):

- Make and Model of the Processor
- Types of processors (socket, Core, Threads, Cache)
- Memory size and speed
- Network type (Number of ports, speed of each port)
- Local storage (number of disk drives, capacity, RAID)
- Operating system and their patch levels (service levels)
- Applications installed
- Running services

Inventory: It is very important for an organization to know in advance the total content of its infrastructure before implementing green IT techniques. This is the most important step in Greening IT project. There are many tools available from different vendors for performing initial analysis of an organization.

Microsoft Baseline Security Analyzer (MBSA) tool provides different information like IP addressing, Operating System, installed applications and most importantly vulnerabilities of every scanned system. After analyzing, all generated values are linked to MS Visio, which generates a complete inventory diagram of all components and also provides details about each component being analyzed. Microsoft Assessment and Planning toolkit (MAP) is another tool for the assessment of network resources. It works with windows management instrumentation (WMI), the remote registry service or with simple network management protocol to identify systems on network. VMware, the founder of X-86 virtualization, also offers different tools for the assessment of servers that could be transformed into virtual machines. VMware Guided Consolidation (VGC) a powerful tool assesses network with fewer than 100 physical servers. Since VGC is an agent less tool it doesn't add any overhead over production server's workload.

Categorize server resources: After creating server inventory information, the next step is to categorize the servers and their associated resources and workloads into resource pools. This process is performed to avoid any technical political, security, privacy and regulatory concern between servers, which prevent them from sharing resources. Once analysis is performed, we can categorize each server roles into groups. Server roles are categorized into following service types:

- Network infrastructure servers
- Identity Management servers
- Terminal servers
- File and print servers
- Application servers
- Dedicated web servers
- Collaboration servers
- Web servers
- Database servers

Categorizing application resources: After categorizing servers into different resource pools, applications will also be categorized as:

- Commercial versus in-house
- Custom applications
- Legacy versus updated applications
- Infrastructure applications
- Support to business applications
- Line of business applications
- Mission critical applications

Utilization data: Aggregate utilization data helps initially to target particular servers and storage devices as candidates for consolidation. But it doesn't tell the whole story, since many servers are busy for short periods of time on a periodic basis. In that case system management tools should be used to collect trends for the entire cycle of systems with applications s that run on a weekly, monthly, or quarterly basis. Some capacity or consolidation planning tools can simplify this task by superimposing historic data for multiple systems to simplify analysis.

Performance modeling and consolidation planning: To optimize the consolidation scenarios, consider using performance modeling and consolidation planning tools to analyze different consolidation and virtualization scenarios. Different consolidation strategies can be y between dissimilar systems or those that will compete for resources at the same time.

Virtualization:

Server virtualization: Virtualization promises to dramatically change how data centers operate by breaking the bond between physical servers and the resource shares granted to customers. Virtualization can be used to "slice" a single physical host into one or more Virtual Machines (VMs) that share its resources. This can be useful in a hosting environment where customers or applications do not need the full power of a single server. In such a case, virtualization provides an easy way to isolate and partition server resources. The abstraction layer between the VM and its physical host also allows for greater control over resource management. The CPU and memory allocated to a virtual machine can be dynamically adjusted and live migration techniques allow VMs to be transparently

moved between physical hosts without impacting any running applications.

In order to minimize the overall network traffic in a multiserver system, the number of users served by each server (and hence the group size) should remain constant. As the underlying traffic fluctuates, a split and merge scheme is implemented in a physical server to achieve load balancing (R. Sukumar and V. Vasudevan, 2009). Server virtualization has become popular in data centers since it provides an easy mechanism to cleanly partition physical resources, allowing multiple applications to run in isolation on a single server. It categorizes volume servers into different resource pools depending on the workloads they perform and then server consolidation is applied. This technique decouples software's from hardware and splits multi processor servers into more independent virtual hosts for better utilization of the hardware resources, allowing services to be distributed one per processor. In server consolidation many small physical servers are replaced by one large physical server to increase the utilization of expensive hardware resources, reducing the consumption of energy and emission of CO2 (Mueen and Abdul Rahman, 2010). Server virtualization complements overall IT consolidation projects by allowing firms to share capacity across multiple underutilized systems and shrink the hardware footprint of applications that cannot be completely eliminated.

Use virtualization to improve service levels: Data center managers should focus on reducing hardware and operational costs with virtual servers, yet overlook significant improvements to disaster recovery and faster time to market for applications. By offering improved service levels for virtualized servers, we can accelerate internal customers' migration to virtual infrastructure, while improving overall satisfaction with IT services.

Physical to virtual live migration: This is the most critical, time-consuming and painful operation when performed manually, since it includes cloning existing operating system and restoring it on an identical machine, but at the same time changing the whole underlying hardware, which can lead to driver reinstallation or possibly the dreadful blue screen of death.

To avoid these ambiguities, virtualization vendors started to offer different Physical To Virtual (P2V) migration utilities. This utility software speeds up the movement of operation and solves on the fly driver incompatibilities, by removing physical hardware dependencies from server operating systems and allowing them to be moved and recovered. Instead of having to perform scheduled hardware maintenance at some obscure hour over the weekend, server administrators can now live migrate a VM to another physical resource and perform physical server hardware maintenance in the middle of the business day. Virtuozzo for Windows 3.5.1 SWsoft itself introduced a Physical To Virtual (P2V) migration tool called VZP2V. This tool can remotely install P2V knowing machine administrative username and password.

Proper management to increase utilization ratio: Server consolidation increases the utilization ratio of underutilized volume servers from 10% to 50% or even more by proper management of workloads to be virtualized to increase the productivity of data center and reduces the total cost of ownership. There is always a room for improvement, however, as many data centers leave a substantial amount of headroom on their virtual server hosts. Today, some data centers are consolidation the load of 5-10 Virtual Machines (VMs) on single server, while more experienced organizations are putting 25-30 VMs on a single server. Many administrators are reluctant to run servers at maximum capacity because they are concerned about the possibility of performance problems that could affect multiple applications simultaneously. In order to get to higher levels of hardware utilization, it is important to improve the administrators' visibility into the performance and availability of the virtual infrastructure with management tools designed for virtual servers. Active power management software can be used to help power your server infrastructure up and down depending on the demand for applications. This is particularly useful in virtual environments where live migration is used to consolidate VMs onto as few physical servers as necessary to maintain service levels, shutting down the rest.

Consolidate IT: The best way to reduce hardware, software, labour and facilities costs is to unplug unneeded infrastructures. But it's a complex task that requires a lot of legwork and detailed information on your assets to do it right. You need to assess data center from all aspects and then categorize it into measurable units so that, consolidation can be applied and then benchmarking can be set properly to reduce the consumption of energy and emission of green house gases. IT consolidation involves the consolidation of servers, storage devices, applications running, operating systems.

Focus on reducing operational Cost: Virtualization increases the capability of already installed equipments by increasing their utilization ration and thus reduces the overall operational costs. Many data center managers tend measure the consolidation success rate by the percentage reduction in their IT budget, while it is important to note that consolidation success rates

should be measured from percentage reduction in operational costs. Virtualization complements IT consolidation but cannot replace it. Even after virtualizing, you'll still be paying for the maintenance of the same number of application instances, even if they use less equipment to run. As a result, companies frequently struggle to reduce operational costs on the basis of virtualization alone.

Consolidate storage into networked pools: Direct-attached storage is usually blamed for data centers low storage utilization. However, networked storage can also suffer because of over-provisioning and isolated Storage Area Networks (SANs). You may already be paying for intelligent arrays with virtualization, thin provisioning, or deduplications features waiting to be turned on.

Improve data center efficiency: Considering the power consumption in data centers, the main problem is the minimization of the peak power required to feed a completely utilized system. In contrast, the energy consumption is defined by the average power consumption over a period of time. Therefore, the actual energy consumption by a data center does not affect the cost of the infrastructure. On the other hand, it is reflected in the electricity cost consumed by the system during the period of operation, which is the main component of a data center's operating costs. Furthermore, in most data centers 50% of consumed energy never reaches the computing resources: it is consumed by the cooling facilities or dissipated in conversions within the UPS and PDU systems. With the current tendency of continuously growing energy consumption and costs associated with it, the point when operating costs exceed the cost of computing resources themselves in few years can be reached soon. Therefore, it is crucial to develop and apply energy-efficient resource management strategies in data centers. Upgrades data center power and cooling infrastructures so that energy efficiency can be achieved. There are many opportunities to reclaim capacity (and reduce electrical costs) in data center by making both small and large adjustments. Improving data center efficiency is especially important for large data centers.

Reduce overall electricity consumption: Reducing data center electricity bill is usually the most tangible and easiest-to-calculate green IT goal. By implementing the proposed model will optimize and improved the overall energy performance of data center either on an absolute basis (usage is lower in the future than the present) or a relative basis (usage is lower in the future versus a "do-nothing" trend line projected from current levels).

Improve utilization of IT equipment: This is a related measure of IT efficiency, aimed at reducing not only electric power usage and spending but also future capital outlays on IT servers, storage and other gear. Higher utilization means managing the same IT workload on fewer servers, which in turn means less need for power, cooling and space and fewer new servers to buy going forward.

Prevent hot and cold air mixing: When hot exhaust air mixes with cold air, it increases the intake temperature of equipments installed in the data center. This means that it is necessary to set the temperatures even lower, to accept the intake temperatures. It is necessary to isolate the exhaust air with a hot aisle containment system or ceiling to reduce the load on cooling system and increase the power density of racks. Because it is relatively inexpensive, compared with new 10 infrastructures, facilities upgrades to prevent hot/cold air mixing were one of the top choices among the data centers. Before overhauling anything, start small improvements like eliminating under-floor obstructions to airflow, plugging cable cut outs and installing blanking panels in racks can improve the amount of air delivered to racks.

Improve data center airflow: Without any new equipment or procedures, the IT team can improve circulation in the data center by moving boxes, unblocking air vents and generally tidying up. This can quickly translate into a lower power draw for the CRAC and related air handling equipment

Refresh power and cooling infrastructure: Older, uninterruptable power supplies and power distribution units may have older, less efficient transformers that are responsible for a sizable portion of the wasted electricity in data center. It is important for data centers to replace these older systems with newer, more efficient. Most data center infrastructures are network oriented allowing collecting usage statistics from a variety of energy management software's.

Update it processes: Consolidation and virtualization helps to optimize hardware and software investments, reduce the number of systems being managed and free up or close some underutilized volume servers. However, IT processes remain unchanged and probably a major source of IT inefficiency. Many data centers are implementing more formalized IT processes, while others suffer from IT processes that have too many steps and depends on manual labor to get them done. Therefore it now becomes obvious for

data center managers to revise their IT processes to achieve green data centers.

Establish critical IT processes and upgrade management software: The focus should be on those processes that are most critical to running reliable and efficient IT services. In particular, problem management and incident management issues in data center followed by financial management and configuration management issues. IT processes ensures more reliable services, but with added records and data formalized processes don't get better efficiency because of the added overhead. The efficiency can be achieved by upgrading the system management tools that integrate with service desk software and provide more task-level automation to free up administrators' time.

CONCLUSION

Green IT is constantly becoming more relevant and many organizations are working towards reducing the carbon footprint of their data centers. This reduction in carbon footprint is achieved by reducing the data centers power consumption, which in turn results in savings for the organization. Many new techniques have been used to achieve this reduction in power. One of them is virtualization. it helps to consolidate multiple servers onto a few physical machines, which increases their utilization and decreases their power consumption.

This study presents perhaps an inaugural academic attempt to understand Green IT. However, as green issues continue to entice global debate, IT is expected to play a crucial role in both greening its operations and services and supporting a business's overall environmental sustainability objectives. Most CIOs and IT mangers are facing two conflicting demands. On the one hand, the growth of digital business has led to increasing demands for data centres. On the other hand, the rising cost of energy, its cleanliness and its availability are limiting the supply of energy to those data centres. This requires IT to turn to Green IT solutions. In this study we identified five concerns of Green IT economical, environmental, strategic, technological and social. These concerns are not mutually exclusive and they can underline the key motivation for building Green IT. We have also identified different dimensions of greening data centers by implementing green initiatives in terms of IT infrastructure efficiency, green technologies; support tools and supplanting tools.

The proposed green IT based model relates to implementing green business practice in general. However in this study, Green IT is conceptualised as a measure of data centers IT preparedness to be environmentally responsible and competitive. The five dimensions that make up the model can be combined in a variety of 11permutations to separate organisations that are successful in building Green IT from those that are less successful. Separately, the five attributes represents barriers to Green IT success. It encompasses as a solution for implementing green data centers. The proposed solution is mainly based on virtualization technology to overcome the issues and challenges of data centers like energy efficiency and CO2 emissions to reduce the effects of global warming.

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