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A STUDY ON GREEN COMPUTING -IT BUILDING BLOCKS

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ABSTRACT

***"Green Computing or green IT** refers to idea where the IT organizations should implement and practice environment friendly network". It is also defined as the study of designing, manufacturing, disposing computer efficiently with minimal impact on environment. The goal of it is to reduce the hazardous effect to environment by bio-degradability and maximize energy efficiency. The three building blocks to green IT include EPP, Trends in Green ICT, IT innovations and achieving efficiency. It is using the real life energy to make a computer system work which will not harm the environment. The advantage of green IT reduced carbon emission increased cooling efficiency, reduced energy costs, cost savings, financial performance, and positive publicity. Some of the steps followed in Green IT so far were measure of the server power, share power cost in internal allocating owners, server and storage virtualization, cloud computing.Research continues into key areas such as making the use of computers as energy-efficient as possible and systems for efficiency-related computer technologies*

Keywords: **Green IT, green computing, EPP, energy efficient, cost saving, Eco-kernel, OpenMp, Meter**

I.INTRODUCTION

Green computing refers to environmentally sustainable computing. It is also defined as "the study of manufacturing and designing the computers with minimal or no impact to the environment. In 1992, the energy save logo launched by the U.S Environmental protection Agency that is designed to promote and recognize energy efficiency later Swedish introduced TCO for the CRT based monitors but then it was a failure due to the usage of hazardous material while construction. Later government organizations took an initiative to follow regulations which reduces the hazardous effect due to the construction.

A. Approaches

Green computing can also develop solutions that offer benefits by aligning IT processes and practices with core principles of sustainability, which are to reduce, reuse and recycle and finding innovative ways to use IT in business processes to deliver sustainability benefits across the enterprise and beyond. Energy efficient data center design should help to better utilize a data center's space and increase performance and efficiency.

II. GREEN BUILDING BLOCKS(GBB)

Green Building blocks is the joint effort of the computer architecture and the VLSI laboratory. It provides the software backbone for fully instrumental and energy friendly clusters. GBB architecture consists Eco-Kernel, Eco- OMP, Eco-Meter, Eco-MPI. Figure (1) describes the GBB Architecture.

A. Eco-Kernel

Eco-Kernel provides an API for scaling device capacities and power modes on demand. The purpose of eco-kernel is to replace application-oblivious power management policies in the operating system, with application-specific, phase-aware policies controlled explicitly by the run time.

B. Eco-Meter

Eco-meter is a hardware monitor that collects periodic samples of device-specific event counters, from which it builds a performance, power and thermal signature of a running application. Application Signatures are partitioned into phases of computation separated by communication or synchronization events. The signatures derived by eco-meter are formulated as polynomial models, which co-relate samples of events rates and configurations of hardware resources – specifically, the allocated capacity and power mode of each resource-with performance and power consumption. Eco-Meter is used by user level runtime systems in their policy modules to predict the performance and power consumption of each phase in an application, in response to the probes that change temporarily the underlying configuration and capacity of hardware resources.

C. Eco-Open Mp

Eco-OpenMp is an energy efficient implementation of Open Mp. The Eco-OpenMp runtime uses interfaces to Eco-Meter and Eco-Kernel to implement optimization policies that improve energy efficiency while maintaining a hard lower performance bound Eco-Open Mp operates simultaneously two software knobs for controlling power efficiency, dynamic concurrency and dynamic voltage frequency scaling. By alleviating contention between threads for shared resources, such as memory bandwidth and cache space it helps in reducing the dynamic power consumption while sustaining and occasionally improving performance. Dynamic Voltage also controls power consumption both are most effective during memory-intensive phase of computation .The dynamic concurrency and voltage policies in Eco-OpenMp are based on multi linear regression models correlating performance with samples of event counters, thread count and core layout on systems with multi-core processors. The combines phase-aware dynamic concurrency and dynamic voltage optimization scheme used in Eco-Open Mp reduces execution time by 13.7%, total system power consumption by 5.9%, overall energy consumption by 18.8% and energy-delay product by 39.5% in the NAS OpenMP benchmark suite. Figure (1) describes the Eco-OpenMp percentage of energy consumption.

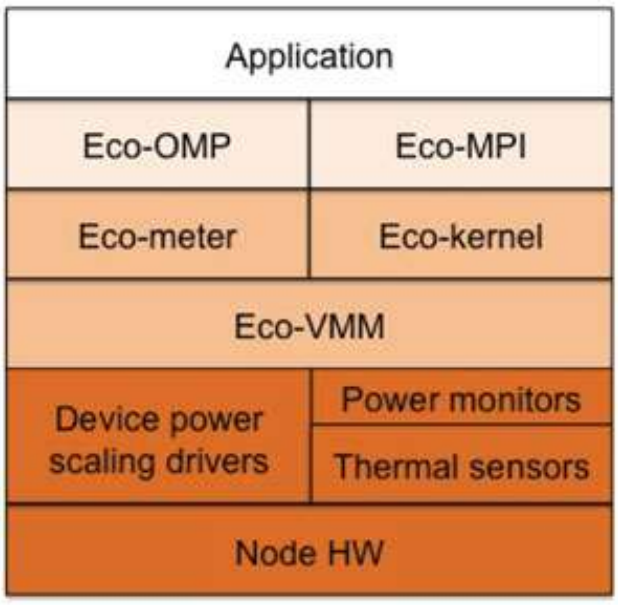
D. Eco- MPI

Eco-MPI is an energy-efficient implementation of the Message Passing Interface (MPI) communication and tasking runtime substrates. The power-efficiency optimization policy of Eco-MPI is based on a model of slack time arising during the interaction between MPI tasks in communication phases.

Eco-OpenMp	Percentage
Energy Consumption	13.7 %
System Power Consumption	5.9 %
Over all Energy Consumption	18.8 %
Energy Delay	39.5 %

Figure (1) – Eco-OpenMp Energy consuming percentage

Eco-MPI is built on top of Eco-meter and Eco-kernel and follows the phase-sensitive optimization strategy used also on Eco-OpenMP. Applications are decomposed into phases separated by communication events. Eco-MPI estimates slack time due to communication and computation load imbalance, using a novel model which calculates the rippling effects of slack on interacting tasks, both within a node and across nodes. Eco-MPI is the first software prototype to achieve real-time power reduction on clusters of up to 256 nodes, yielding up to 14% total energy savings in the Lawrence Livermore National Laboratory (LLNL) Sequoia Benchmark suite. Eco-MPI is integrated with Eco-OpenMP to implement power-aware execution of hybrid MPI-OpenMP programs.



Figure(2) GBB Architecture

III. 3 BUILDING BLOCKS

There are 3 steps necessary to develop green plan includes:

1). Creating a baseline of the environmental footprints.

2).Developing reasonable green Objectives

3) Implementing green practices with potential for significant impact.

Figure (3) shows the building blocks of green IT. With high profile figures such AI gore calling attention to the planetary crisis and global warming becoming a part of everyday conversation. the result is the raised consciousness that every behavior imapacts the world in one way or the other. The IT department is no different, and if yours is like, most others in corporate America, you're starting to field inquiries about how green your operation is .Everyone from the board of directors down to the desktop users and in some cases outside customers are starting to ask more questions about the impact their organizations has on the environment.

While concern for the most IT departments in the corporate green IT needn't be a crisis. A thoughtful big picture strategy built upon the incremental steps towards a cleaner, more energy efficient and environment friendly IT department is the key to the success.

Before one can begin to create the process of Green IT strategy it is important to have a basic understanding of how IT can impact on environment .The primary environment impact of IT is comprised of the resource and the energy required to manufacture, run and dispose of IT hardware.

A. Creating a Baseline

The first step towards creating a green IT strategy is to create a baseline of your organization's current environment from an IT perspective. For the sake of reduction and cataloging improvements and planning for future needs, a solid understanding of the current carbon footprints made by your IT house.

Figure (3) – Building Blocks of Green IT and uses

The need for creating a comprehensive baseline of the environmental impact of IT can't be understated. Understanding the current state of affairs will help in examining the elements of green IT that are within the control of the organization and those that are not. In addition, understanding the current practices will help to guide any discussion about the trade-offs and when a green objective will take priority over a cost or performance objective. Furthermore, a baseline will help in evaluation of payback on any green initiatives that are slated. Armed with this baseline of information you will be able to inform and educate others on reasonable green objectives and highlight the successes from initiatives designed to green-up IT.

Step-I – Energy Consumption Analysis

To start with the baseline, you will need to create an energy consumption analysis based on the current IT hardware : desktop, PC's, and associated monitors, laptops, servers and equipments, and networked peripherals such as scanners and printers. This inventory will be useful for the creating an estimate of the annual energy use.

One method of creating this energy consumption is to take the current IT asset inventory and create a mathematical estimate of your energy consumption using averages from organizations.

A simpler approach is to use software that manages the PC energy strategy settings at network level. In addition to the energy consumed when operating the PC, take into account the heating, cooling and ventilation requirements necessary to operate your net work, this can account for a major source of green impact.

Step-2 catalog disposal practices

The next step in creating baseline is to catalog your current hardware disposal practices. does your organization utilize a certified Pc recycler that ensures toxic and hazardous materials inside the PC monitors are disposed properly? Does your organization participate in the server manufacture disposal program where parts are reused whenever possible?

Step-3 Examine acquisition and hardware lifecycle

The final step in creating baseline is to catalog your acquisition and PC lifecycle practices. Understanding the average lifespan of your PC in your organization will help in determining how to consider the environment impact of manufacturing PC. Average lifecycle includes the refresh cycle of the organization desktop and the current life span of the servers.

B. Green Objectives

Second step in GBB is to focus on the green objective of your organization. Objective will be the result of cost-reduction, regulatory/legislative requirements and social responsibility promises made by the organization. The objective of going green is fraught with many trade-offs along the way meaning sometimes what seem like the green solution may not really be green at all. The best way to minimize the impact on the environment from a personal computer therefore is to extend its useful life as much as possible. Understanding the business driver behind an objective will help to ensure the decisions made to meet objective are as green as possible.

The following IT practices are green and will support your overall green IT Strategy:

PC Power Management

The single greatest opportunity for reducing energy consumption in the most organization is to implement network level PC power Management solution. Historically most of the organizations have kept the desktop PC's on 24/7 and set operating systems power management to monitor off/standby both of which consumes almost as much as power as fully powered idle machine. Desktop managers needed access to networked PC's for general maintenance and urgent security updates. Inconsistence between the operating systems and the software applications or network security issues made waking machines from a lower point setting such as sleep/hibernate. Conservative estimates put wasted energy consumption of unused computers at the third of overall consumption. The simplest way to increase energy efficiency is to use a network based solution to implement power setting policies that reflect user behavior and turn the machine to sleep or hibernate when not in use.

Extend the useful life of IT hardware

Another opportunity to reduce the impact of their IT hardware over environment is to extend the life of their IT hardware. That is presenting the present IT hardware is to replace them with an equipment more energy efficient. The making of a PC hardware is equal in making the mid-sized car. The lifespan of a car is about 10years whereas the lifespan of PC used in IT organization is 3years. By extending the lifespan of PC in organization can significantly reduce the environmental footprint of the PC

Another way to reduce the impact is to delay the refresh cycle of the PC. So that it will have less impact on the environment.

To that end when PC's are at the end of the lifecycle, participating in the PC recycling program that focus on the reselling of the machines extend useful of PC over 6000 users. These programs require a little more than that of the IT department than by shipping them to manufacturers.

Truly green recycling programs

Ensuring proper disposal of the IT hardware is another green tactic. More than 1000 chemicals are used in production which are toxic and hazardous to health. Reviewing the current recyclable and disposal program to ensure that all recyclable parts are returned to the manufacturer and that equipment bound for disposal is not sent to countries with less stringent regulation is another strategy that has significant impact and is easy to implement.

Considering green in acquisition

Beginning to understand the energy efficiency of new acquisition is another green strategy that is easy for IT to implement. The IT companies should change their hardware with new energy efficient PC regularly but it is not been done due to cost and hence leading to environmental impact. Catrina McAllister of AEA said "There is no correlation between the cost of PC and Energy Efficiency".

Figure (4) shows the green IT life cycle which will be continued while designing a hardware or any green IT products. Every phase in the green life cycle has to be given importance. Maintenance phase needs more effort.

Figure (4) – Green IT cycle

IV. EPP

Environmentally **P**referable **P**roducts is the abbreviation of EPP. It is said that Buying computers, peripherals, copiers, and related electronics that are *energy efficient* as it often costs more to power a computer over its useful life-cycle than it costs to buy it free of hazardous materials because, even today, too many pieces of electronic equipment that contain hazardous materials end up in landfills and taint local water supplies *repairable* and made of modular components that can easily be swapped out when they fail so you don't have to replace whole systems until they reach the end of their useful life *highly recyclable* and designed to be easily disassembled and recycled *returnable* to the manufacturer under an end-of-life program who will then see that the component is *refurbished or recycled*.

V. CURRENT AND FUTURE WORK

GBB is extended in four directions. The first is virtualization of the power, thermal and performance instrumentation infrastructure, followed by the derivation of appropriate metrics that would apportion resources to applications in order to improve energy efficiency under performance constraints. The second direction is the implementation of cluster-level static and dynamic task aggregation. Static task aggregation amounts to clustering application tasks in fewer nodes than the number of nodes apportioned to applications at submission time. Dynamic task aggregation amounts to dynamic clustering of tasks after application submission and is enabled through virtual machine migration mechanisms. The third direction is the integration of multi-device scaling capabilities in GBB, in particular DRAM and disk scaling, in a unified modeling and policy framework. This research will enable GBB to target data-intensive workloads dominated by I/O and memory traffic. The fourth direction is the development of a GBB runtime for the Map Reduce programming model, targeting large-scale data processing tasks on compute clouds.

VI. CONCLUSION

Recognizing going green is a process and often involves in trade-offs is important in creating a green strategy .The creating of IT environmental baseline will assist in examining where your organization is at as well as where it is going. Creating an objective that reflects in the both green desire and business will ensure the strategies put in place are truly green. By implementing all of the strategies presented here will make your organization grow in an environment friendly way.

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Charts using MS PowerPoint and Word