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SURVEY ARTICLE

Survey of the Green within Computing

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Abstract— Green within Computing is a term used to describe an innovative way on how technology and ecology converge together. Green computing ultimately focuses on ways in reducing overall environmental impacts. Around the world recent studies have shown the Sustainable IT services require the integration of green computing practices such as recycling, electronic waste removal, power consumption, virtualization, improving cooling technology, and optimization of the IT infrastructure to get together sustainability requirements. This paper will provide the literature review on problems from data centers, green computing techniques, and life cycle perspective of energy and power.

Index Terms *— Data Center; PHE; Build Smart; EPA; Renewable; ROI*

I. INTRODUCTION

Green computing is the study and practice of using computing resources efficiently. Modern IT systems rely upon a complicated mix of people, networks and hardware; as such, a green computing initiative must be systemic in nature, and address increasingly sophisticated problems. Elements of such a solution may comprise items such as end user satisfaction, management restructuring, regulatory compliance, disposal of electronic waste, telecommuting, virtualization of server resources, energy use, thin client solutions, and return on investment (ROI).

Green computing covers a vast range of methods, from energy saving techniques, to the study of materials used in our lives, it all fundamentally breaks down to finding ways to not damage or consume all of earth's natural resources. Its main purpose is to find and promote new ways of reducing pollution, discovering alternative technologies, and creating more recyclable products.

II. LITERATURE SURVEY

The idea of green computing has been around a good time, the government themselves play a role in it. For example the Environmental Protection Agency (EPA) launched the 'energy star' program in the 90s, to promote

energy efficient methods. The EPA today still plays an active role by providing not only energy effective methods, but also cost effective methods for the consumers.

In 2006 the EPA established a way to save U.S. households and businesses money; "With an eye to saving U.S. households and businesses more than $1.8 billion in energy costs over the next 5 years, today EPA announced new Energy Star specifications for computers and related equipment.

These new modifications are also expected to prevent greenhouse gas emissions equal to the annual emissions of 2.7 million cars. In upcoming days it will increase enormously. For that several techniques and methods are provided by leading journals.

III. DATA CENTERS

A Data Center is a facility housing a large number of servers and data storage. A general statistics shows that the electricity bill for a data center is close to 6 million a month with about 20 percent of the power spent on cooling the data centers. A pie chart depicting the average costs has been provided. It shows that the average amount of money spent on buying the servers amortized over a period of three years is almost equal to the cost of powering the servers. These facts show that it is necessary to effectively utilize the electricity used by the data centers.

A. Power Handle Effectiveness

The PHE is a ratio of the input power to the actual amount of power required by the servers at a Data Center. If the amount of power required to cool the system is 100 percent, then the PHE grows to 2 which is undesirable.

Power Handle Effectiveness = Total Facility Power/IT Equipment Power

If there are multiple data centers in various locations then a better way of using power infrastructure is to move the load to the data center that has a low-price period. The power generally endures a conversion from AC-DC a number of times before it reaches the server, by reducing the number of conversion the conversion loss can be avoided. Multi phase power (use of a 3 phase AC) can help provide efficient power usage.

B. Low PHE Design in Better way

1) Server and IT equipment: A survey shows that the servers consume 65% of the power. However in practice, the servers are not energy proportional and consume close to half the power even when they are in the idle state. This is attributed to various components like Disk, RAM, motherboard and network card which consume power even in the idle state. In practice it is observed that the servers are around 10-30% utilized all the time. The amount of work completed by the server for each joule of energy used is defined as the efficiency.

The servers are not efficient either. This is due to the idle CPU features like the large caches, complex architecture. If the CPU is not the bottleneck for the application then the use of a CPU with limited features can solve the problem and also make the server more efficient. The server is most well-organized when its utilization is 100%. The efficiency of a server is also linked with the software flexibility. By using Virtualization, the CPU/memory usage can be controlled. Migrating virtual machines to a subset of the physical machines and switching the other machines off also helps in efficient usage.

2) Air conditioning: Chilly air is allowed to pass through the servers. On passing through the servers the cold air turns hot and this is cooled and then reused. Balancing load across the data center helps eliminating hot spots another means of cooling is to use the outside air to cool the machines. Iceland being a cold country and being a good source of geothermal energy hosts a few data centers. Microsoft conducted an experiment by placing the servers outside and using the outside air to cool the systems. The servers worked well even with temperatures in the late 90s.However the faced issues with filtering the outside air which contained leaves and other dust particles.

3) Renewables: The Main reasons behind using renewables are due to the Bad press for using many fossil fuels, electricity costs and also to reduce carbon emissions. However with renewables workload and the

available power are now changing and there is a need to match supply and demand since storage of power brings in additional overhead.

4) Common Approaches: One common approach is to make the Ensembles energy proportional. This is achieved by distributing the workload and with the decrease in utilization the components are turned off and the workload is migrated to active components. If there is an increase in the utilization of the components are turned on and the load is migrated to the newly active components. However, this method does have problems. Moving the workload might take a long time and turning on/off of the components takes a long time. It also does not work if the workload intensity changes faster than the data transfer and if the workload is not distributed.

Some of the other IT components like the switches and the routers are much inefficient when compared to the servers. They are at 100% Utilization all the time. Turning off RAM memory banks is rarely done. Mechanical disks are not energy proportional. Flash disk use no energy but they are expensive.

IV. COMPUTE TECHNIQUES FOR GREEN LIFE CYCLE

Understanding the ways in which power consumption impacts the "greenness" of any technology, and specifically computing technology, is an essential step toward reducing this consumption and educating others. This section describes the various specific techniques that can be used to reduce power consumption .Information technology can be used to make the building more green using sensors, smart software, smart appliances and smart meters.

A. Smart Buildings

A green building is one whose construction and lifetime of operation assure the healthiest possible environment while representing the most efficient and least disruptive use of land, water, energy and resources. The optimum design solution is one that effectively emulates all of the natural systems and conditions of the pre-developed site – after development is complete.

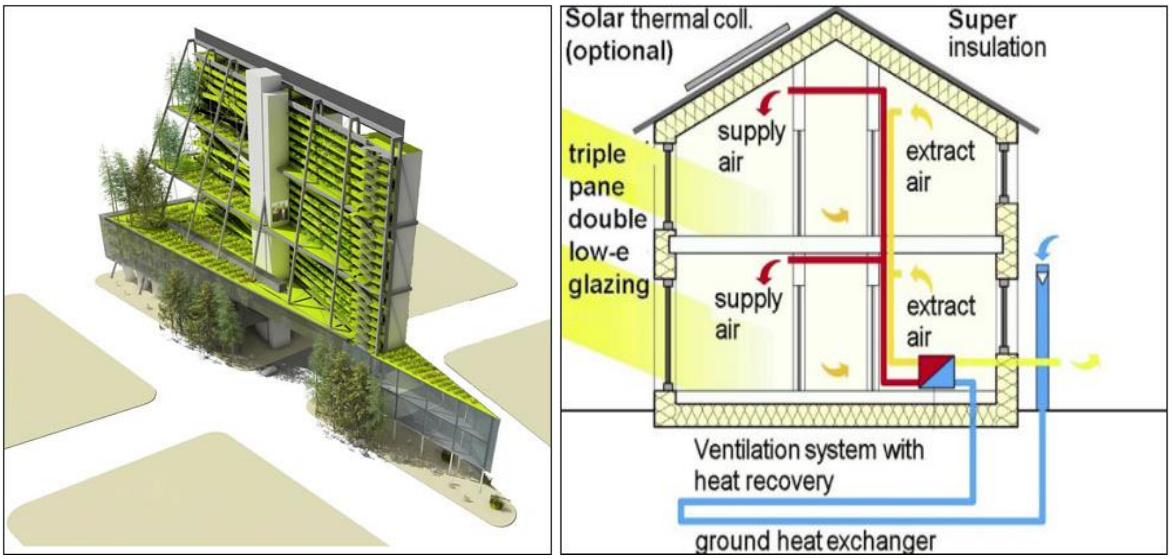

Fig. 1 Example of a Green Building (Exterior and Interior views)

In order to make the building smart, there is a need to monitor the energy usage. The user must be able to control electricity usage by automatically turning devices on and off. The environment must be monitored. Computing for Greening comes up with means to satisfy these needs cheaply and reliably. The Building Management Systems are existing systems that monitor the energy usage. However they are not fine-grained and do not provide pervasive load control mechanisms.

B. Environment Observing

It has similar issues as energy observing. It includes monitoring weather, thermostats, doors and tracking motion. Energy usage can be implemented using recommendations via smart phones, enabling remote but

manual control, automated scheduling policies. The main aim of the computing for greening is to optimize for lower costs, lower energy usage, lower peaks and aligning consumption with renewable generation.

C. Managing Energy Usage

Programming load control switches are needed to manage the energy usage. Generally the manage involves switching a device on/off. The switching mechanism may be external or internal. An example of a wifi enabled washer and dryer has been provided. The control is provided by means of a mobile application.

D. Monitoring Energy Usage

Energy usage can be monitored at multiple levels of the wiring tree right from the electricity ingress level to the outlet level. But transferring the data in real time is an issue. This transfer can be done using Wireless networking techniques like Zigbee and Wifi or using power line networking techniques like X10, Insteon and HomePlug. It is a Challenging task to place sensors at every load since it's expensive, it may not look good and its unreliable due to the bandwidth constraints. Some Alternatives include collecting high bandwidth data at the ingress, disaggregating data into separate loads by using well placed sensors.

E. Turn off Equipment When Not in Use

Powering down equipment is the simplest, most effective and most obvious way to reduce computing power consumption. Computers have become such a standard part of daily life that many computers are left powered on around the clock, and are often done as a convenience to the user. This convenience is costly since the simple act of powering off a computing device will significantly reduce its power consumption, although it is important to note that many devices may still consume a small amount of power.

- Reduce CO2 emissions by up to 15 tons per year per system.
- Reduce electronic waste by up to 80%

Ability to turn 1 computer into 20 reduces electricity use by up to 90% as compared to traditional PC-per-workstation computing. Reducing the number of computers in use has additional earth-friendly benefits. Electronic waste is an increasing problem globally due to the quick obsolescence of electronics. This is compounded by the fact that computer waste is high in many toxic materials such as heavy metals and flame-retardant plastics, which easily leach into ground water and bio-accumulate.

F. Power Savings Modes

Management of power consumption is a standard, yet often overlooked, feature of most computers and operating systems on the market today. Typically, one changes settings that control the behavior of various software and hardware components, thereby reducing power consumption. The barrier to wider adoption is that many find power savings modes to be inconvenient as there can be a brief delay in exiting a power saving mode back to normal use. Resistance is understandable, although with careful system configuration and gradual acclimation to a different way of working, this hesitancy can be overcome. Some of the powers saving modes are listed below.

- *Hard Disk Sleep Mode*
- *Screen Savers*
- *Monitor Sleep Mode*
- *System Standby Mode*
- *Hibernate Mode*.

V. CONCLUSION

From all over the effects of green computing with its benefits, practicality, and uses are all positives. All which are great for not only the individual, but also all around the globe. By going "green" in technology we help promote an eco-friendly and cleaner environment, along with our own benefits by reducing costs, conserving energy, cutting down on waste and greenhouse gases. Green computing has definitely come a long

way, but with so many new innovations coming along in regards of preserving the environment, it is safe to say that green computing is a great development.

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