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Green Technology: A Better Approach

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Abstract— Green computing is a very emerging topic these days, not only because of rising energy costs and potential savings, but also due to the impact on the environment. Green technology focuses on reducing the environmental impact of industrial processes and technologies caused by the Earth's growing population. It has taken upon itself the goal to provide society's needs in ways that do not damage or deplete natural resources. To address the various challenges, we design the Green - Cloud architecture and the corresponding Green Cloud exploratory system. This article suggests that tracking energy consumption at every level will become the factor of success for green architecture practitioners. It also suggests some green computing tips for a greener environment.

Keywords— Green Computing, Green Cloud Architecture, Cloud Computing.

I. INTRODUCTION

Reduction of the environmental impact and power consumption are becoming increasingly important objectives for organizations, so architecture leaders are now considering environmental resource constraints along with more traditional IT business goals.The IT industry has begun to address the problem of energy consumption in the data centre through a variety of approaches including the use of more efficient cooling systems, virtualization and storage area networks (SANs). But a fundamental challenge remains that as the data volumes explode, traditional, appliance centric data warehousing approaches can only continue to throw more hardware at the problem.

Therefore, the commitments to reduce the various environmental impacts and the power consumption will continue to be important objectives for organizations. The corporate architect must realize that the various impacts corporations make on the environment is now engrained in doing business:

• Executives are now a days allocating time, energy and money to invest in environmental initiatives.

• Governments are allocating research and regulations, and laws are being written to address the efficiency of data centres and other critical components of IT infrastructure.

• Consumer advocates, policy makers and influential industry leaders are promoting IT organizations to significantly confront the impact that computing and electronics make on the environment.

Organizations must realize that the source and amount of their energy consumption significantly contributes to greenhouse gas (GHG) emissions. Organizations can help in the following three key areas: reduced data footprint, reduced deployment resources, and reduced ongoing management and maintenance. In response to this awareness, organizations are currently using the following equation:

Reduced energy consumption = reduced greenhouse gas emissions
= reduced operational costs for the data centre and business

II. THE GREEN CLOUD ARCHITECTURE

To address the various challenges, we design the Green - Cloud architecture and the corresponding Green Cloud exploratory system. The exploratory system monitors a variety of system factors and performance measures including application workload, resource utilization and power consumption.

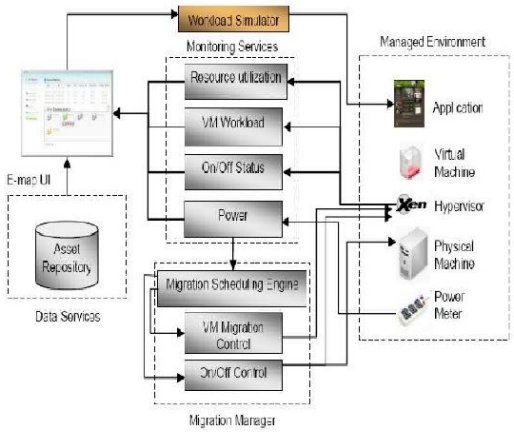

Fig 1. Green- Cloud Architecture

The system is able to dynamically adapt workload and resource utilization through VM live migration. Therefore, the Green-Cloud architecture reduces unnecessary power consumption in a cloud computing environment. Following is the description of the various components of this architecture:

1) Monitoring Service:

Monitoring Service monitors and collects comprehensive factors such as application workload, resource utilization and power consumption, etc. It serves as the global information provider. It provides on-demand reports by performing the aggregation and pruning the historical raw monitoring data to support to intelligent actions taken by Migration Manager.

2) Migration Manager:

Migration Manager triggers the live migration. It makes decision on the placement of virtual machines on physical servers based on knowledge or information provided by the Monitoring Service. The migration scheduling engine searches the optimal placement by a heuristic algorithm, and sends instructions to execute the VM migration and turn on or off a server.

3) E-Map:

E-Map is a web-based service with Flash front-end. It provides a user interface (UI) to show the real-time view of present and past system on/off status. It also shows the resource consumption, workload status, and temperature and energy consumption in the system at multiple scales, etc. E-map is connected to the Workload Simulator, which predicts the consequences after a given actions adopted by the Migration Monitor through simulation in real environment.

4) Workload Simulator:

Workload Simulator accepts user instructions to adapt workload e.g. CPU utilization, on servers, and enables the control of Migration Manager under various workloads. Then, E-Map collects the corresponding real-time measurements, and demonstrates the performance of the system to users.

5) Asset Repository:

Asset Repository is a database used to store thestatic server information, such as IP address, type, CPU configuration, memory setting, and topology of the servers.

III. PROFILING ENERGY USAGE FOR EFFICIENT CONSUMPTION

A. Developing an Energy Usage Profile for the Hardware

The energy consumption of the server is much easier to measure. Several low-cost devices are available to monitor energy consumption. The important thing is to build an overall picture of how much energy the server uses at idle and under stress. The energy usage of individual components does not need to be exact, but is important because it provides a ranking system for energy consumers within the server.

Using the EUP for the hardware, we can draw some general conclusions. Clearly, CPU usage is the most expensive resource in terms of actual cost and environmental impact. Memory usage has a minimal cost at best. Hard disk usage has minimal cost. Therefore, if we are going to attempt to optimize our infrastructure and application to minimize energy usage, the CPU should be the primary target.

B. Developing an Energy Usage Profile for the Application

We want to know how much power a single application uses and, while we cannot get to the exact number, we can get pretty close. The first step is building an EUP for the hardware. The idle consumption can be used to calculate a baseline cost for the application. Once an application-level EUP has been created, specific areas of the application can be targeted for improvement.

Tools such as Visual Studio 2008 Profiler can be used to determine precise CPU usage for specific components of the application. These tracking statistics can then be used to attack the high cost portions of the application. In other words, find the most expensive operations and optimize them to reduce CPU usage. The ultimate goal is to lower resource usage to the point where multiple applications can be hosted on the same set of servers. Server sharing can reduce the energy footprint of all the applications involved.

C. Developing an Energy Usage Profile for the Operating System

Application-based optimizations are not the only way to save energy, optimizing the operating system is just as important. The base hardware EUP also provides us with an idle operating system EUP. We know that a significant amount of energy is wasted on the system idle process. This wasted energy can be reclaimed through operating system virtualization. Virtualization allows the host machine to run at approximately 80 percent of peak processor utilization with fractionally increased power requirements.

Each physical server replaced with a virtual equivalent represents a significant savings, both in upfront costs as well as with respect to the environment. This optimization includes minimizing disk and network utilization, at the same time reducing the memory footprint. These optimizations reduce the amount of work done by the guest operating system as well as by the host.

D. Developing an External Energy Usage Profile

The impact of your application goes beyond CPU cycles and megabytes. The way end users interact with the application has a very real cost and impact. The actions taken within your application that are external to your design are measured in the External EUP. Following are examples of actions that should be tracked in an External EUP:

• Printing: Are the users likely to print the information? If so, how many ways are there to optimize screen layout so as to minimize the likelihood of printing?

• Information Retrieval: Are statements, invoices, or other materials mailed to the users? Are there ways to present that information within the system?

• Updates: Do users need to leave their systems on to receive updates? If so, is there a way for the application to update itself while being used?

• E-mailing: Purging bad email addresses eliminates the energy wasted.

IV. GREEN COMPUTING TIPS

A. Green Computing in Mobile Phones

Mobile phones are better than computers as today they are used for almost all computer related activities such as surfing the Internet, chat, gaming, social networking, downloading, desktop computing including documents, spreadsheets or presentation making or just watching your photos and videos. Today‘s mobile phones have faster processors, more ram, faster wireless Internet connectivity and larger memories. Also mobile phones consume very low power and yet provide almost all functionalities of a computer they contribute to a greener environment.

B. Green Computing in Computers

Our ecological balance depends a lot on energy consumption. So all computer users (both casual and professionals) are now looking to adopt Eco-friendly ways for making this planet a better place to live. Computer users can reduce negative impact of computing on global energyresources by using thefollowing tips:

1) Always Switch-Off Your PC When Not In Use

Never forget to turn-off your computer overnightor whenever your work is over. This is perhaps the most useful and logical way to save energyand easily contribute in creating a green planet.

2) Vampire Power

Many computers or monitors, even when you switch them off, can consume power from the spike strip they are connected to. Therefore always remember to turn off the power of the strips, or other connectors which you are using and thereby contribute in creating a green planet by doing this.

3) Avoid Screensavers

Never believe that screen-savers can save power or can keep your monitors in good health. They originally consume more powerthan monitors that are allowed to get dimmed out when not working.

C. E-Waste Management

E-waste is one of the fastest growing waste streams in the world. It includes items such as televisions (TV), computers, Liquid Crystal Display (LCD), plasma panels, printing-scanning devices, mobile phones, etc. At present, Indians use about 14 million PCs, 16 million mobile phones and 80 million televisions. So, there is a pressing need to address e-waste management particularly in developing countries like ours. Here is an effective method for e-waste management:

1) Recycling

Environmental scientists emphasize on 3R (reduce, recycle and reuse) process as an alternative to the present e-waste management practice. For a developing society like ours, reduced use of electronics equipment being not a feasible option, we, therefore, have to emphasize on reuse and recycling processes. The impact of recent legislation such as the Waste Electrical and Electronic Equipment Directive (WEEE) and the "Restriction of the use of certain Hazardous Substances in electrical and electronic equipment" directive (RoHS), and of current and future methods for treatment, recycling and disposal of this waste would ultimately lead to a green development and eco-friendly society.

V. CONCLUSION

As 21st century belongs to computers, gizmos and electronic items, energy issues will get a serious ring in the coming days. The public debate on carbon emissions, global warming and climate change is getting hotter. If we think computers are non-polluting and consume very little energy then we need to rethink. This is because it is estimated that out of $250 billion per year spent on powering computers worldwide only about 15% of that power is spent computing- the rest is wasted idling. Thus, energy saved on computer hardware and computing will equate tons of carbon emissions saved per year. Taking into consideration the popular use of information technology industry, it has to lead a revolution of sorts by turning green in a manner no industry has ever done before. Opportunities lie in green technology like never before in history and organizations are seeing it as a way to create new profit centres while trying to help the environmental cause.

Hence in this paper, we have seen how Green technology focuses on reducing the various environmental impact of industrial processes and innovative technologies caused by the Earth’s growing population. Also we have designed the

Green - Cloud architecture and the corresponding Green Cloud exploratory system that reduces unnecessary power consumption in a cloud computing environment. We have also seen a few green computing tips for a greener environment.

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