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A Greener Approach to Cloud Computing using Virtual Migration

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Abstract— Cloud Computing is offering utility concerned IT services to users worldwide. It enables hosting of applications from consumers, scientific and business domains. However data centers hosting cloud computing applications consume huge amounts of energy, contributing to high operational costs and carbon footprints to the environment. With energy shortages and global climate change leading our concerns these days, the power consumption of data centres has become a key issue. Therefore, we need green cloud computing solutions that can not only save energy, but also reduce operational costs. The vision for energy efficient management of cloud computing environments is presented here.

Keywords— Cloud, platform, cloud architecture, virtual machine, data centre, resource allocation

I. INTRODUCTION

Green Computing is defined as the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems – such as monitors, printers, storage devices, and networking and communications systems – efficiently and effectively with minimal or no impact on the environment. The goals of green computing are similar to green chemistry; reduce the use of hazardous materials, maximize energy efficiently during the product's lifetime, and promote the recyclability or biodegradability of defunct products and factory waste. Research continues into key areas such as making the use of computers as energy-efficient as possible, and designing algorithms and systems for efficiency-related computer technologies. There are several approaches to green computing, namely:

- Product Longevity
- Algorithmic Efficiency
- Resource Allocation

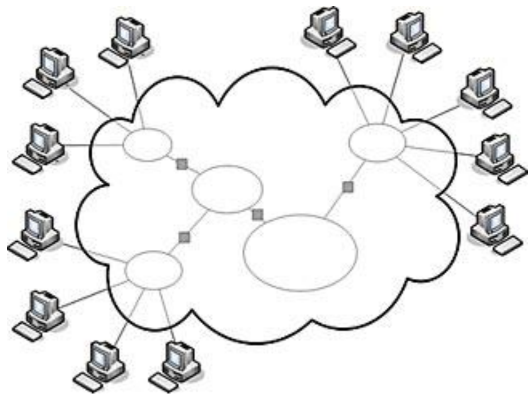

Fig 1 : Graphical Representation of Cloud Computation

II. NEED FOR GREEN CLOUD

Modern data centers, operating under the Cloud Computing model are hosting a variety of applications which are of varied duration. The need to manage multiple applications in a data center creates the challenge of on-demand resource provisioning and allocation in response to time-varying workloads. Normally, data center resources are statically allocated to applications, based on peak load characteristics, in order to maintain isolation and provide performance guarantees. Until recently, high performance was the sole concern of data centers deployments and it was satisfied without much attention to energy consumption. An average data center requires as much energy as 25,000 households. But as power availability decreases the costs are increasing thus arises the need to optimize the energy efficiency.

Data centers are not only expensive to maintain, but also unfriendly to the environment. They now drive in more carbon emissions that both Argentina and the Netherlands put together. This is due to the massive amounts of electricity required to power and cool numerous servers hosted in these data centers. Thus service providers need to adopt measures to ensure that their profit margin is not dramatically reduced due to high energy costs. Due to the increasing pressure from Governments worldwide to reduce carbon footprints a global consortium called The Green Grid is formed to promote green cloud was formed.

III. ARCHITECTURE

There are basically four main entities involved in the architecture of a Green Cloud Computing environment. They are:

A. ***Consumers/Brokers:***

They submit service requests to the Cloud. There is a difference between consumers and deployed services users as consumers may deploy applications which present varying workload.

B. ***Green Resource Allocator:***

Acts as the interface between the Cloud infrastructure and consumers. It requires the interaction of the following components to support energy-efficient resource management like Green Negotiator, Service Analyzer, Consumer Profiler, and Pricing, Energy Monitor, and Service scheduler, VM Manager, Accounting and the VMs themselves.

C. ***VMs:***

These are Virtual Machines that can be started and stopped on a single physical machine to meet accepted request, hence providing maximum flexibility to configure various partitions of the same physical machine to different specific requirements of service requests. Their state can be manipulated to save energy.

D. ***Physical Machines:***

The underlying physical computing servers provide hardware infrastructure for creating virtualized resources to meet service demands paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified.

IV. VARIOUS APPROACHES

The three experimental approaches are:

A. ***Dynamic Voltage Frequency Scaling Technique –***

It is a hardware method where the supply voltage is regulated to conserve power savings.

B. ***Resource Allocation or Virtual Machine Migration Technique –***

It uses the concept of hosting multiple Virtual Machines on a single physical machine to enable multi tasking.

C. ***Algorithmic Approaches –***

Using a neural network predictor, scheduling algorithms first estimate required dynamic workload on the servers. The unnecessary servers are turned off in order to minimize energy consumption. Also, several servers are added to help assure service-level agreement.

V. VM MIGRATION

The problem of VM allocation can be divided into two: the first part is admission of new requests for VM provisioning and placing the VMs on hosts, whereas the second part is optimization of current allocations of VMs.

Optimization of current allocation of VMs is carried out in two steps: at the first step we select VMs that need to be migrated, at the second step chosen VMs are placed on hosts using MBFD algorithm. We propose four heuristics for choosing VMs to migrate. The first heuristic, Single Frequency (SF), is based on the idea of setting upper utilization threshold for hosts and placing VMs while keeping the total utilization of CPU below this threshold. The aim is to preserve free resources tp prevent SLA violation due to consolidation in cases when utilization by VMs increases. At each time frame all VMs are reallocated using MBFD algorithm with additional condition of keeping the upper utilization threshold not violated. The new placement is achieved by live migration of VMs.

The other three heuristics are based on the idea of setting upper and lower utilization thresholds for hosts and keeping total utilization of CPU by all VMs between these thresholds. If the utilization of CPU for a host goes below the lower threshold, all VMs have to be migrated from this host has to be switched off in order to eliminate the idle power consumption. If the utilization goes over the upper threshold, some VMs have to be migrated from the host to reduce utilization in order to prevent potential SLA violation. We propose three policies for choosing VMs that have to be migrated from the host. They are:

A. ***Minimization of Migrations (MM) –***

Migrating the least number of VMs to minimize migration overhead.

B. ***Highest Potential Growth (HPG) –***

Migrating VMs that have the lowest usage of CPU relatively to the requested in order to minimize total potential increase of the utilization and SLA violation.

C. ***Random Choice (RC) –***

Choosing the necessary number of VMs by picking them according to a uniformly distributed random variable.

VI. CONCLUSION

Applying Green Computing is highly essential for the sustainable development of Cloud Computing. Of the various green methodologies required, The DVFS technology is a highly hardware oriented approach and hence less flexible. Green Scheduling algorithms based on neural predictors can lead to a 70% power savings. These policies also enable us to cut down data center energy costs, thus leading to a strong, competitive cloud computing industry. End users will also benefit from the decreased energy bills. So far, consumers haven't cared about ecological impact when buying computers, they've cared about only speed and price. But as Moore's Law marches on and computers commoditize, consumers will become pickier about being green. Devices will use less and less power while renewable energy gets more and more possible and effective. New green materials are developed every year, and many toxic ones are already being replaced by them. The greenest computer will not miraculously fall from the sky one day; it'll be the product of years of improvements. The features of a green computer of tomorrow would be like: efficiency, manufacturing &

materials, recyclability, service models, self-powering, and other trends. Green computer will be one of the major contributions which will break down the 'digital divide', the electronic gulf that separates the information rich from the information poor.

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