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EFFICIENT RESOURCE ENERGY MANAGEMENT IN DATA CENTRES USING GREEN CLOUD COMPUTING

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Abstract: The perception of cloud computing has not only reshaped the field of distributed systems but also fundamentally changed how businesses utilize computing today. Cloud computing is offering utility oriented IT services to users worldwide. It enables hosting of applications from consumer, scientific and business domains based on pay-asyou-go model. However data centres 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. The area of Green computing is also becoming increasingly important in a world with limited energy resources and an ever-rising demand for more computational power. Therefore, we need green cloud computing solutions that can not only save energy, but also reduce operational costs. In this paper, an architectural framework and principles that provides efficient green enhancements within a scalable Cloud computing architecture with resource provisioning and allocation algorithm for energy efficient management of cloud computing environments to improve energy efficiency of the data centre. Using power-aware scheduling techniques, variable resource management, live migration, and a minimal virtual machine design, overall system efficiency will be vastly improved in a data centre based Cloud with minimal performance overhead.

Keywords: Cloud Computing, Green Computing, Virtualization, Energy Efficiency, Resource Management, virtualization, Scheduling.

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INTRODUCTION

The vision of computing utilities based on a service provisioning model anticipated the massive transformation of the entire computing industry whereby computing services will be readily available on demand. Similarly, users (consumers) need to pay providers only when they access the computing services. In addition, consumers no longer need to invest heavily or encounter difficulties in building and maintaining complex IT infrastructure. This model has been referred recently as Cloud computing in which users access services based on their requirements without regard to where the services are hosted. Later it denotes the infrastructure as a "Cloud" from which businesses and users can access applications as services from anywhere in the world on demand. Hence, Cloud computing can be classified as a new paradigm for the dynamic provisioning of computing services supported by state-of-the-art data centres that usually employ Virtual Machine (VM) technologies for consolidation and environment isolation purposes.

Green Computing is defined as the study and practice of using computing resources efficiently through a methodology that combines reducing hazardous materials, maximizing energy efficiency during the product's lifetime, and recycling older technologies and defunct products. Green Computing enables companies to meet business demands for cost-effective, energy-efficient, flexible, secure & stable solutions while being environmentally responsible. Every data center transaction requires power. Efficiency, equipment disposal and recycling, and energy consumption, including power and cooling costs, have become priority for those who manage the datacenters that make businesses run.

Modern data centres, operating under the Cloud computing model are hosting a variety of applications ranging from those that run for a few seconds to those that run for longer periods of time on shared hardware platforms. The need to manage multiple applications in a data centre creates the challenge of on-demand resource provisioning and allocation in response to time-varying workloads. Normally, data centre resources are statically allocated to applications, based on peak load characteristics, in order to maintain isolation and provide performance guarantees.

ARCHITECTURE OF GREEN – CLOUD COMPUTING

People in IT industry are reassessing data center strategies to determine if energy efficiency should be added to the list of critical operating parameters.

Issues of concern include:

1. Reducing data center energy consumption, as well as power and cooling costs.
2. Security and data access are critical and must be more easily and efficiently managed.
3. Critical business processes must remain up and running in a time of power drain or surge.

These issues are leading more companies to adopt a Green Computing plan for business operations, energy efficiency and IT budget management. Green Computing is becoming recognized as a prime way to optimize the IT environment for the benefit of the corporate bottom line – as well as the preservation of the planet.

A. Cloud:

Cloud computing is becoming one of the most explosively expanding technologies in the computing industry today. It enables users to migrate their data and computation to a remote location with minimal impact on system performance.

B. Cloud Infrastructure:

In Cloud computing infrastructure, there are four main entities involved:

1. Consumers/Brokers: Cloud consumers or their brokers submit service requests from anywhere in the world to the Cloud.

2. Green Resource Allocator: Acts as the interface between the Cloud infrastructure and consumers.

3. VMs: Multiple VMs can be dynamically started and stopped on a single physical machine to meet accepted requests, hence providing maximum flexibility to configure various partitions of resources on the same physical machine to different specific requirements of service requests.

4. Physical Machines: The underlying physical computing servers provide hardware infrastructure for creating virtualized resources to meet service demands.

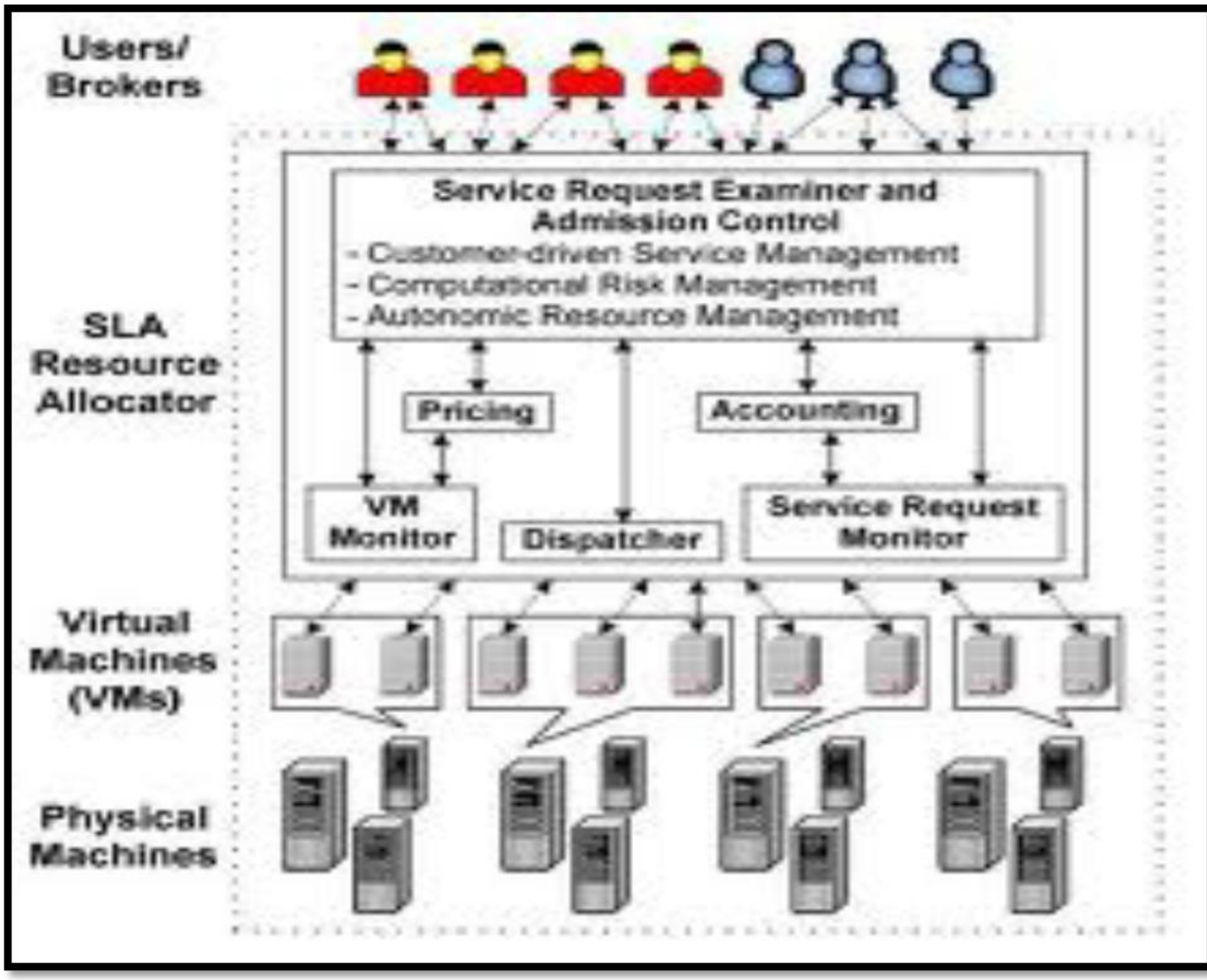

Fig 1. The high level system Architecture.

C. Green Cloud Architecture:

As discussed above, cloud computing platform as the next generation IT infrastructure enables enterprises to consolidate computing resources, reduce management, complexity and speed the response to business dynamics.

Monitoring Service monitors and collects comprehensive factors such as application workload, resource utilization and power consumption, etc.

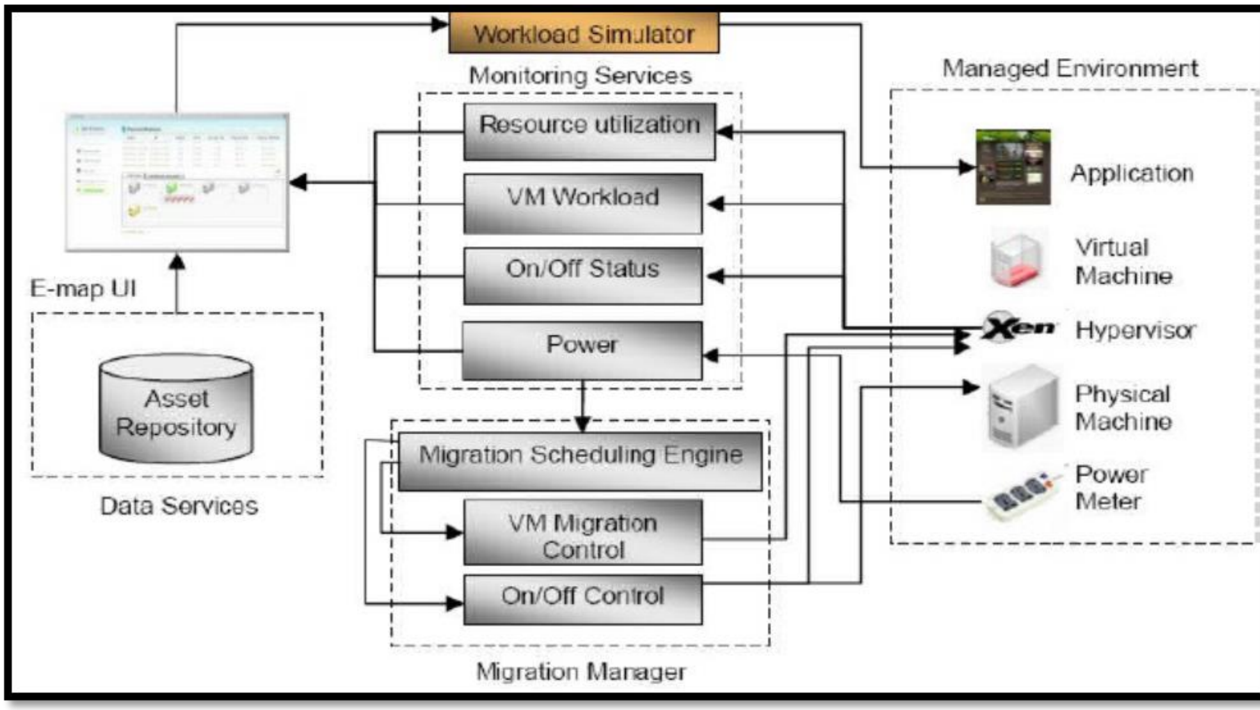

Fig 2. Green – Cloud architecture

Migration Manager, triggers live migration and makes decision on the placement of virtual machines on physical servers based on knowledge or information provided by the Monitoring Service .

Managed Environment includes virtual machines, physical machines, resources, devices, remote commands on VMs, and applications with adaptive workload, etc.

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, resource consumption, workload status, temperature and energy consumption in the system at multiple scales, from high level overview down to individual IT devices and other equipment 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.

Workload Simulator accepts user instructions to adapt workload e.g. CPU utilization, on servers, and enables the control of Migration Manager under various workloads.

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

ENERGY USAGE IN DATA CENTERS

With the growth of cloud computing, large scale data centers have become common in the computing industry, and there has been a significant increase in energy consumption at these data centers, which thus becomes a key issue to address. As most of the time a data center remains underutilized, a significant amount of energy can be conserved by migrating virtual machines (VM) running on underutilized machines to other machines and hibernating such underutilized machines. As the data center industry grows increasingly obsessed with energy efficiency, cloud computing presents a compelling opportunity to reduce data center power bills, according to a leading expert on IT power issues. Energy use is a central

issue for data centers. Power draw for data centers ranges from a few kW for a rack of servers in a closet to several tens of MW for large facilities. Some facilities have power densities more than 100 times that of a typical office building.

A. Energy Efficiency:

The most commonly used metric to determine the energy efficiency of a data center is power usage effectiveness (PUE). This simple ratio is the total power entering the data center divided by the power used by the IT equipment.

$$PUE = \frac{Total\ Facility\ Power}{IT\ Equipment\ Power}$$

Power used by support equipment, often referred to as overhead load, mainly consists of cooling systems, power delivery, and other facility infrastructure like lighting. Four areas where cloud computing have power efficiency advantages:

1. Diversity: Spreading computing loads across many users and time zones can improve hardware utilization.

2. Economies of Scale: Computation is cheaper in a large shop than small shop, as fixed costs can be spread over more servers and users.

3. Flexibility: The management of virtual servers in cloud apps is easier and cheaper than managing physical servers. It also has reliability advantage that can create savings in the data center. If you can void outages using software to route around problems, you don't need to buy two power supplies for each server.

4. Enabling Structural Change: The shift to a cloud model enables broader efficiencies in a business that can save money over time.

The concepts inspired by the notion of utility computing have recently combined with the requirements and standards and is defined as, ”A large-scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted, virtualized, dynamically scalable, managed computing power, storage, platforms, and services are delivered. On demand to external customers over the Internet As new distributed computing technologies like Clouds become increasingly popular, the dependence on power also increases. Therefore, it is Imperative to enhance the efficiency and potential sustainability of large data centers. One of the fundamental aspects of virtualization technologies employed in Cloud environments is resource consolidation and management.

CONCLUSION AND FUTURE WORK

As the prevalence of Cloud computing continues to rise, the need for power saving mechanisms within the Cloud also increases. This paper presents a Green Cloud framework for improving system efficiency in a data center. To demonstrate the potential of framework, presented new energy efficient scheduling. Though in this paper, we have found new ways to save vast amounts of energy while minimally impacting performance. Not only do the components discussed in this paper complement each other, they leave space for future work. Future opportunities could explore a scheduling system that is both power-aware and thermal-aware to maximize energy savings both from physical servers and the cooling systems used. Such a scheduler would also drive the need for better data center designs, both in server placements within racks and closed loop cooling systems integrated into each rack. While a number of the Cloud techniques are discussed in this paper, there is a growing need for improvements in Cloud infrastructure, both in the academic and commercial sectors.

In conclusion, by simply improving the efficiency of equipment, Cloud computing cannot be claimed to be Green. What is important is to make its usage more carbon efficient both from user and provider’s perspective. Cloud Providers need to reduce the electricity demand of Clouds and take major steps in using renewable energy sources rather than just looking for cost minimization.

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