Cloud computing energy efficiency

Technology, Information Technology

Cloud Computing Energy Efficiency Ahmed Alghamdi Introduction Cloud computing is widely believed to be one of the most energy efficient alternatives to the conventional IT computer data storage and processing systems. A number of previous researches have sought to investigate the potential energy efficiency of cloud computing. Many experts particularly agree that cloud computing is inherently much more efficient on the premise that many of the data centers and servers currently hosting cloud services are significantly more efficient and green than the IT infrastructure that is currently used by most companies. As a result, companies have been moving their operations such as emails, word processing and spreadsheets as well as CRM to the cloud in order to server energy [5].

Generally, the concerns regarding the environmental impacts as well as the energy needs of data centers such as the cloud has been growing with the exponential increase in data centers. Consequently, the potential gains in energy efficiency by moving the software of businesses to the cloud are largely attributed to the fact that the data centers and servers currently hosting cloud services are significantly more efficient and green than the IT infrastructure that is currently used by most companies [8]. These energy savings are particularly significant for smaller companies which often tend to possess some of the most inefficient IT services.

Background

Despite the general agreement that cloud computing is currently more efficient than many of its alternatives, the implementation of cloud computing has faced a number of power and energy consumption concerns particularly with regard to the power and energy consumed by the modern cloud computing systems and data center equipment as well as the connected cooling systems [5]. The energy is mainly consumed when transporting the required data from the users to the cloud data centers and then back.

Data centers currently consume nearly 1. 4% of the entire global electrical energy with an average growth rate of 12% annually [11]. Skeptics argue that the greenhouse gas production associated with the power consumption at data centers is will double in the near future if the current popularity of cloud services continues. Moreover, the high consumption of power also often results in the release of heat which may further cause energy inefficiencies due to increased amount of energy required for removing the heat(cooling) as well as the high probability of hardware system failures [1].

Another potential cloud computing energy efficiency problem is the increasing greenhouse gas (GHG) emissions. Although supercomputers normally provide an unraveled high level of computational ability, this usually comes at the expense high power consumption used to run as well as cool the supercomputers [4]. For example, in 2007, it was reported that he cloud computing consumed approximately 623 terawatt-hours of energy and this is expected to significantly rise by the year 2020 due to the high growth of cloud computing technologies [3]. In addition, the enormous GHG emissions associated with cloud computing infrastructure has also increased the environmental concerns due to the high carbon footprint of cloud infrastructure and datacenters (DCs) which is expected to hit 1, 034 Mt by the year 2020.

However, there are a number of potential solutions to the current problems and issues associated with energy efficiency of cloud computing. For example, some researchers have proposed that the energy use in the cloud environment can be significantly reduced by adopting an approach known as Dynamic Voltage/Frequency Scaling (DVFS) that adjusts the power statues of the servers by turning the servers on and off [1, 6]. Generally, DVFS also adjust the energy consumption of CPUs according to the available workload. However, it is worth noting that the scope of their use is still limited to CPUs. Another viable solution to the problem of energy efficiency is consolidation of data centers using virtual machines in order to increase the utilization of the individual servers as well as reduce the number of active servers. This is particularly important as improved consolidation may significantly reduce the aggregate energy consumption while at the same time cryptically increases the effectiveness of power usage thereby resulting in greater energy efficiency [12].

Finally, a power modeling technique for the cooling systems in data centers has also been proposed as a potential energy optimization strategy that can significantly help solve the problem of energy efficiency in cloud computing [7]. Generally, the concerns regarding the environmental impacts as well as the energy needs of data centers such as the cloud has been growing with the exponential increase in data centers. The present research proposal seeks to critically analyze the energy efficiency of cloud computing with particular focus to the infrastructure supporting cloud computing including server and network equipment as well as the cloud management appliances and systems.

Research Questions

There are three important research questions that will guide this project namely:

i. What are the implications of various workload characteristics and system level parameters on the energy efficiency of cloud computing?

This research question is critically important because CDCs normally work with a diverse set of workloads and system parameters (CPU, storage, memory and network) [14]. This project will particularly seek to benchmark on the workloads that have close resemblance with those in the cloud computing environment as well as identify and test various parameters under different workloads.

ii. What is the performance degradation’ of a VM?

After determining the set of parameters required in modeling a VM’s behavior, it will be critically important to determine the performance degradation of a VM, particularly how a VM may interfere with other VMs as well as how is performance may be affected by such interferences. This may importantly help highlight the potential remedies and mitigation measures to address efficiency in cloud computing. The preset project will use simulation models to predict various performance degradations.

iii. How does resource provisioning impact on VM performance degradation?

Predicting and determining how different resource provisioning schemes may affect the performance of VMs is important in helping identify some of the potential solutions to the current problems and issues associated with energy efficiency of cloud computing as it assists in the understanding of how to allocate sufficient shareable physical resources to the VMs. For instance, doubling the CPU shares of a given VM may compensate for its performance degradation caused by LLC [15]. To investigate the impact of resource provisioning on VM performance degradation the present research will use resource provisioning algorithms.

Proposed Methodology

The proposed methodology to determine the energy efficiency of the cloud data systems will involve developing algorithms and simulation modeling designed to experimentally determine the energy consumption characteristics of cloud computing environments as well as establishes the potential measures and solutions that can be implemented to improve their energy efficiency. The proposed algorithms to be developed are primarily intended to be able to vary measure and ultimately model a wide range of fluctuating operational factors and workload scenarios related to cloud computing.

Generally, the various components of a computer system such as the CPU, hard disks, main memory, and other related components can easily be set to different modes or frequency in order to save power. Based on these working modes and hardware parameters, the model will compare various hardware architecture of cloud computing in order to analyze, both the hardware structure and the energy parameters of the components [13]. The first step will involve generating synthetic workloads and real workloads using common open source network simulators like OMNeT++NS2, SSFNet, NS3 or J-Sim and workload generators surge in order to simulate various load conditions in the cloud.

Next, power usage of the 4 parameters namely the CPU, storage, memory and network will be monitored to help demonstrate the potential energy consumption in a cloud computing environment. Finally, the recorded data will be analyzed using a parametric regression on MATLAB/simulink to provide analytical power consumption model profile. This will then be used to effectively determine the potential correlation between power consumption, workload properties and ultimately help highlight the potential gains in energy efficiency by moving the software of businesses to the cloud [10].

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