2012 International Conference on Applied Physics and Industrial Engineering

A Novel Green Cloud Computing Framework for Improving System Efficiency

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Abstract

As the prevalence of Cloud computing continues to rise, the need for power saving mechanisms within the Cloud also increases. In this paper we have presented a novel Green Cloud framework for improving system efficiency in a data center. To demonstrate the potential of our framework, we have presented new energy efficient scheduling, VM system image, and image management components that explore new ways to conserve power. Though our research presented in this paper, we have found new ways to save vast amounts of energy while minimally impacting performance.

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Keywords: System Efficiency; Cloud Computing; Green Computing

1. Introduction

The concept of the recent arouse public calculation combining requirement and standard web 2.0 [1] to create cloud calculative [2] and [3]. Cloud calculative is defined, "a massive distributed computing paradigm, is by the economies of scale, in which a pool of abstraction, virtualization dynamically, scalable and management of computing - ability, storage, platform and service demand, external customers in the Internet."

As a new kind of distributed computing technology, cloud computing become more and more popular, depend on the strength also increases. It is estimated data center use 0.5 percent of the world's total power [4], if current demand continues it is expected to quadruple by 2020. In 2005, the total energy consumption for servers and their cooling units was projected at 1.2% the total U.S.' energy consumption and doubling every 5 years [5], [6]. Most of the energy used in today's society is produced from fossil fuels harmful carbon dioxide emissions. Therefore, it is imperative to improve efficiency and sustainability of the large data centers.

Hypervisors used within a cluster of independent environment allowed consolidating the physical machine virtual environment; therefore, the physical resource needs less than ever before. Although the situation, it is often not enough. Big cloud deployment needs thousands of physical and mechanical and
megawatts of power. Therefore, it is necessary to establish an effective cloud calculative system that uses its strengths while minimizing its energy footprint.

2. Related research

In order to accurately depict the results of a study published in this article, the theme, cloud cluster computing grid, and the green calculation are reviewed.

2.1. Clouds

Cloud calculative has become the most explosive to expand the technology in the computer industry today. This allows the user to their data and calculating migrated to remote areas with minimal impact on system performance [7]. Usually this provided a lot of advantage, otherwise cannot achieve. These benefits include:

- Scalable - cloud is aimed at providing more computing power as any users want to place. But in practice, the foundation is not unlimited potential resources, the clouds will alleviate developers rely on any specific hardware.
- Quality of Service (QoS) - a cloud would very high quality than is usually impossible. This is due to the lack of specific hardware and so on any physical machine failure without the user can reduce the knowledge.
- Specialized Environment - In a cloud, the user can use the customization tools and services to meet their needs. It can use the latest toolkit, library, or support in new infrastructure heritage code.
- Cost Effective - Users found only hardware requirements for each project. This greatly reduces the risk of institutions may build an extensible system. Since provides more flexibility is paying subscribers only needed infrastructure needed to maintain growth of service.
- Simplified Interface - Whether to use a specific application, a set of tools or network service, providing a potentially large computing resources and clouds in relaxed manner [8], [9].

Host Resource

![Virtual Machine Abstraction](image_url)
2.2 Green Computing

Over the past few years, has increased research and development of large computing resources efficiently. The super computer performance over 3,000 times has doubled in the past 15 ~ 20 years, with increasing 300 per watt per square foot fold performance only 65 times turn at the same time. The lagging Moore's law, in a period of time has created the history of computing needs more effective management and consolidated data center. This can be seen in figure 2.

![Graph 2: Performance increases much faster than performance per watt](image)

Figure 2. Performance increases much faster than performance per watt. One technique being explored is the use of Dynamic

![Graph 3: Possible energy to performance trade-off](image)

Figure 3. Possible energy to performance trade-off. Here you can see a 18% reduction in frequency contributes to only a 5% performance loss.

A power - aware cluster support multiple power and expression way and frequency processor can turn up or down. This allows for an efficient scheduling system minimum power consumption system, at the same time trying to maximize performance.
3. Green cloud framework

The frame is used to define efficiency of resource management and green computing technology can be applied to cloud systems.

Figure 4. Green Cloud Framework. Shaded items represent topics discussed in this paper.

. Figure 4 shows a comprehensive framework for green cloud maximum per watt of clouds. The framework generalizes the main area of the VM scheduling, VM image, and advanced management data center.

First, we can expand on the function of the virtual machine in the clouds. This is usually either by optimizing the power equipment itself, or the server data of temperature in the center. Due to the inherent flexibility and universality in half - even the boat data center, we can use the ability to move, improve the management efficiency and the virtual machine.

4. Virtual machine scheduling & management

The super computer cluster scheduling algorithm was designed to arrange individual work rather than some of the concepts of the virtual machine can be transformed into the clouds. In many service oriented architecture, new scientific cloud boat was created to get some work done. This idea is similar, in a professional sand boxing environment.

4.1. Power-aware VM Scheduling

At present, there are two types of competition, the green scheduling system super power aware - and - know scheduling. Our goal is not always save energy use server, but in order to reduce the energy required to operate the cooling system data center. In power - aware scheduling [9], work plan in such a way that the total power of the server nodes. The biggest operating costs at one point cloud data center is in the server running. So, we focus on power - aware scheduling problem is discussed in this paper.
Figure 5 powers aware - the motives behind the VM scheduling. The graphics files to our recent studies of energy consumption in the processor verses. In this paper, with the number of consumer curve, will not increase energy use processor. When using only processing power, this change in electricity costs are the core of another treatment more than 20 watts. To meet this need we propose Algorithm 1, a new greedy-based algorithm to minimize power consumption.

Algorithm 1 Power based scheduling of VMs

FOR $i = 1$ TO $i \leq |pool|$ DO

$pe_i = \text{num cores in } paol_i$

END FOR

WHILE (true)

FOR $i = 1$ TO $i \leq |pool|$ DO

$vm = queue_i$

FOR $i = 1$ TO $i \leq |pool|$ DO

IF $pe_j \geq 1$ THEN

IF check capacity $vm$ on $pe_j$ THEN

schedule $vm$ on $pe_j$

$pe_j - 1$

END IF

END FOR

END WHILE
4.2. VM Management

Another key aspect is a green cloud image management framework virtual machine. Through the use of virtual reality technology in the cloud and many new technologies become possible. In a physical machine can dynamically idle during the close, to save energy and to restart low load conditions. The concept is similar to the grid system, although use Glide condor. In dynamic added - condor, and remove machine form resource. The concept of the machine will be closed without electricity without influence, during the peak load all the machines will run.

This is a process of dynamic allocation and deal locating physical machine is free to our scheduling system algorithm (1). A scheduling algorithm implementation, it will leave the number of machines, potential idle for a long period of time, to create the best condition for the VM system. This machine can close, as shown in figure 6.

5. Service oriented virtual machine image

Although the virtual machine scheduling and management in a private cloud is very important, one must realize their environment is actually in reserve. Examples include the VM than they need to support various types of hardware and software, and different user tasks. Although this is ideal for a desktop environment, it is waste of time and energy in a server with solutions. A procedure provides the same hardware and virtualization of each VM is each specific tasks of the design. In essence, we hope in the VM action in OS, not as a light packaging equipment support some specific tasks or service, but the refined, rather than the whole desktop/application package. In order to achieve this goal, we must focus on two area size and boots, VM image.

Another method is to reduce the time sequence to cooperate boots in a more efficient way. Many elves and applications of general situation often outfit, in a lightweight VM examples, don't need, can be removed. This includes the independence of the server application window manager and x 11 window system. It will also remove system disk footprint save valuable disk space in distributed file system and network flow.
6. Power consumption analysis

In order to verify our frame, it is important in a practical feasibility study of the virtual machine cluster environment. This section will discuss the implementation of our scheduling algorithm used in OpenNebula project, multinucleated clustering evaluation and establish a new image of VM light.

6.1. Scheduling Analysis

OpenNebula is an open source distributed virtual horse - China's manager in a dynamic configures virtual machine resource pool. The core components of the OpenNebula accept user interface, and will OpenNebula through calculation of the virtual machine in the cluster nodes.

This OpenNebula scheduling is an independent components, provides the policy of virtual machine. We choose OpenNebula project, because this compartmental - can design for it allows us to integrate our custom scheduling algorithm. The default scheduling provides scheduling strategy, and on the basis of resource allocation level for calculating the virtual machine.

6.2. VM Image Analysis

In order to evaluate the performance of our VM image design, we must create a prototype. Two paths can be used to build such a virtual memory system. The first method in the bottom of the basic Linux kernel is based on the minimum feature. This requires a new distribution. Although this may be "clean" mode, it needs a large r&d team, so not for this project. Another choice is top-down method, including joint distribution and eliminates some components, lighter and faster sub - larger. This line is more practical, because do not need to keep reinventing the wheel and options, such as a package management system, large-scale distribution of maintenance.

A customized Linux image was created, the possibility that the rapid and lightweight the VM system operation. From Ubuntu Linux versions 0.904 jaunty and all unnecessary bag was removed, including gnome window manager and. Through the elimination of this large package, this system is the image by 4 GB 636Mb only. To Many other bags, library and guide level can start from the process. In the final stage, the image is a minimum installing Linux with bare necessity components only. The rest is a synaptic package management system, so if any tools or library is a process to their system installation. Although this package management system and take some space, it is worth to provide increased malleability. Lots of kernel module is also removed FM 2.6.28-11 kernel accelerate probe and the plugin initialize kernel process of as much as possible.

7. Conclusion and future work

Not only the parts are discussed, they leave complementary space for future work. Future opportunities can explore dispatching system, thermal power aware - aware -, maximum saving energy from physical server and cooling systems. This would also drive the scheduling strategy to better data center, in the design of the server in closed-loop cooled shelves system integration to each frame. We believe that Green computing will be one of the fundamental components of the next generation of Cloud computing technologies.

References


