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Prediction Based Energy Efficient Technique for Enterprise Cloud Datacenters

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ABSTRACT**-- Cloud Data centers use huge amount of electrical energy. And electrical energy is a very useful resource for the development of the country. With the need for dynamic computing resources and pay-per-use payment for the computing resources cloud computing is gaining much attention in recent times. Many cloud architectures are available in the market. But most of them do not take care about the efficient use of energy resources. The type of task scheduling greatly affects the energy consumption of a cloud data center. According to estimation Google data centers uses electrical energy that is equivalent to the energy requirement of a small size city. This work is all about to propose a dynamic idle interval prediction scheme that can estimate future CPU idle interval lengths and thereby choose the most cost-effective sleep state to minimize power consumption at runtime. Experiments show that our proposed approach can significantly outperform other existing schemes.**

Index Terms-- **Cloud Computing, Energy efficiency, Prediction, Sleep states**

1. INTRODUCTION

As a new computing model, cloud computing brings the adjustment and transformation of the IT industry. With its growing application and popularization, cloud computing not only offers enormous opportunities, but also faces many challenges in its development process. The energy consumption in a cloud datacenter is on the rise, while the resources themselves are highly underutilized; this presents a bottleneck that restricts the improvement of cloud computing. The energy consumption in a cloud computing system consists of energy consumed by different kinds of electrical equipment; one of the highest is the energy required by IT equipment, which makes up 46% of the total energy consumption.

Compute nodes consume the most energy when executing tasks, accounting for 40% of IT equipment energy consumption. According to statistics, the resource utilization ratio of the existing datacenters is less than 30%. One reason is that cloud computing provides on demand services with incoming jobs that are stochastic, at times dense, and at other times sparse. In order to meet the requirements of tasks in time, the cloud datacenter keeps compute nodes powered on, waiting for tasks to arrive. As a result, for most of the time, compute nodes in the cloud are in an idle state, which leads to a significant waste of energy.

Moreover, cloud datacenters are usually composed of large-scale heterogeneous compute nodes, which have different hardware configurations, different compute capacity, and various power saving states. This causes the energy optimization problem to be more complex in the cloud datacenter. Cloud computing providers are under great pressure to reduce operational costs through improved energy utilization while provisioning dependable service to customers; it is therefore extremely important to understand and quantify the explicit impact of failures within a system in terms of energy costs.

2. RELATED WORK

Xu et al [1] proposed energy aware cloud application management architecture for private cloud data center. Furthermore they present a cloud application and power management model. In order to metering server energy utility efficiency and cloud applications' total energy consumption of running on a specific group of servers, they defined related measurement metrics. The objective of their approach is to reduce data center's total energy efficiency by controlling cloud applications' overall energy consumption while ensuring cloud applications' service level agreement.

Saxena et al [2] proposed an energy efficient cloud Task Scheduling architecture that is based on allotting the cloud request to the best-suited cloud server. If cloud request is assigned to the best-suited cloud server then the overall energy consumption will surely reduce because the resources are effectively and efficiently used and there is no wastage of computing resources. Different resources are also associated with a trust level that is also used in allotting resources to a cloud service request.

Chen et al [3] developed Stress Cloud, an automatic performance and energy consumption analysis tool for cloud applications in real-world cloud environments. Stress Cloud supports the modeling of realistic cloud application workloads, the automatic generation of load tests, and the profiling of system performance and energy consumption. They demonstrated the utility of Stress Cloud by analyzing the performance and energy consumption of a cloud application under a broad range of different deployment configurations.

Murwantara et al [4] dealt with applications that run in a virtualized environment such as Cloud. They presented two implementations to their idea to demonstrate the feasibility of the approach. Firstly, a method of measurement with the help of Kernel-Based Virtual Machine running on a typical laptop is presented. Secondly, in a commercial Cloud such as Elastic host, they described a method of measuring energy consumed by processes such as HTTP servers. This allowed commercial providers to identify which product consumes less energy on their platform.

Baliga et al [5] provided an analysis which considers both public and private clouds, and also includes energy consumption in switching and transmission as well as data processing and data storage. Analysis shows that energy consumption in transport and switching can be a significant percentage of total energy consumption in cloud computing. Cloud computing can enable more energy-efficient use of computing power, especially when the computing tasks are of low intensity or infrequent. However, under some circumstances cloud computing can consume more energy than conventional computing where each user performed all their computing on their own personal computer.

Satoh et al [6] developed a Cloud energy management system with sensor management functions, with an optimized VM allocation tool to minimize energy consumption at multiple data centers. Their evaluations showed more than a 30% energy savings for the servers in experimental environment. Their system can also be extended to optimize energy usage from various perspectives, such as for minimizing electricity bills or carbon emissions.

Kumar et al [7] proposed a method to reduce the energy consumption by using the Dynamic Voltage Frequency Scaling technique where the servers operate at different levels of voltage by reducing the operating frequency. They used the slack time between the tasks to sacrifice the operating frequency so that the schedule does not violate the deadline of parallel applications. They used the real world applications represented by Directed Acyclic Graphs for simulation purpose.

Gao et al [8] adopted the latter modeling approach, which provided more opportunities for energy and performance optimizations, thus enabling the CSP to meet user deadlines at lower operation costs. However, these optimizations require additional supporting efforts e.g., resource provisioning, virtual machine placement, and task scheduling, which are addressed in a holistic manner in the proposed framework. In the envisioned cloud environment, users can construct their own services and applications based on the available set of virtual machines, but are relieved from the burden of resource provisioning and task scheduling. The CSP will then exploit data parallelism in user workloads to create an energy and deadline-aware cloud platform.

Hosseinimotlagh et al [9] proposed a VM scheduling algorithm based on the unsurpassed utilization level to come up with optimal energy consumption while meeting a given QoS. The proposed algorithm aims to regulate execution speeds of VMs on a host with a result that the host works at its optimal energy level. In fact, a host is scheduled to run its allocated tasks faster to reach the optimum level of utilization instead of migrating its tasks to other hosts. They also proposed several task scheduling policies to adjust execution speeds for real-time tasks in each VM.

Dharwar et al [10] summarized the state-of-the-art in power-management technology on server hardware and described how these raw features can be abstracted into a set of energy policies. Then they explained how these policies or energy-profiles can be used to run cloud data center energy efficiently. Further, they also highlighted some of the challenges involved in running cloud infrastructures in the emerging markets optimally despite some unique energy constraints.

3. PROPOSED WORK

Data centers consume a large and growing amount of energy. Much of the energy consumed is wasted when servers operate at very low utilization levels. Generally, server machines consume roughly the same amount of energy whether lightly or highly utilized. A key technology to reduce energy waste in data centers is virtualization. With virtualization, multiple physical machines can be consolidated into one machine when the offered load to the data center is low. This enables unused machines to be powered-down and energy consumption is then reduced. Previous work suggests that even for large data centers, power management is most effective at the rack or cluster level.

A key challenge is to develop a policy to consolidate machines such that the performance criteria specified by a Service Level Agreement (SLA) can still be met. Thus, the trade-off is one of energy consumption versus response time. For this proposed work, a simulation model is built which consist of a server cluster and then experimented with policies to power-up and power-down machines assuming that virtualization is used to allow such consolidation to occur. The SLA for the system is the server cluster must maintain an SLA based on measured response time. Figure 1 depicts the proposed system architecture.

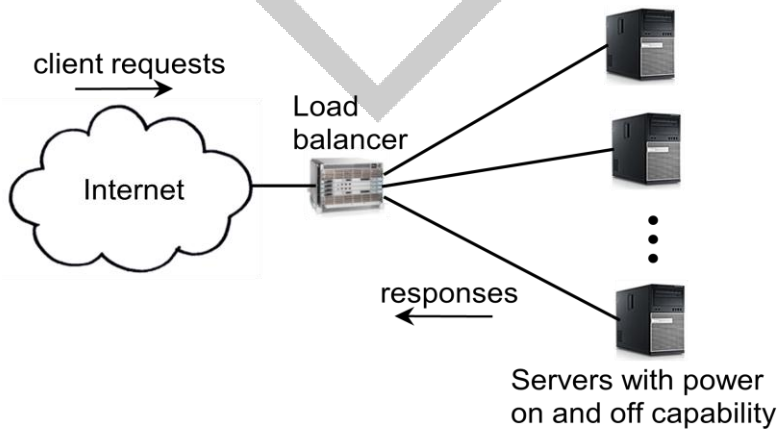

Fig 1: Proposed system architecture

4. PERFORMANCE EVALUATION

The simulation performance of the developed technique and algorithm are compared with the legacy techniques and the real time traces are used instead of analytical models. As shown in figure 2 the end results states that the existing system model is capable of achieving considerable energy savings and higher utilization that are very close to the optimal case when compared to other techniques and algorithms.

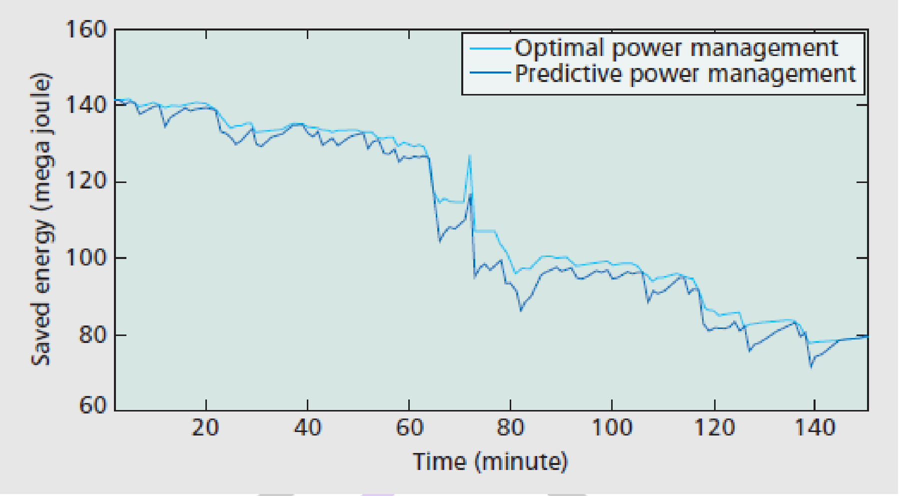

Fig 2: Energy savings

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