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Cloud Security and Energy Efficiency

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Abstract

Cloud computing is the newest distributed computing paradigm and it offers tremendous opportunities to solve large scale scientific problems. However, it presents a range of challenges that need to be addressed in order to be efficiently utilized for workflow applications. With the rapid development of Cloud computing, more and more users deposit their data and application on the cloud. Cloud computing has many characteristics, e.g. multi-user, virtualization, scalability and so on. Because of these new characteristics, usual security technologies can't make Cloud computing fully safe. Therefore, Cloud computing security becomes the present research focus. With the increasing popularity of the cloud computing model and quick proliferation of cloud infrastructures there are increasing concerns about energy consumption and ensuing impact of cloud computing as a contributor to total CO2 emissions. Due to the growing demand of cloud services, allocation of energy efficient resources (CPU, memory, storage, etc.) and resources utilization are the major challenging issues of a large cloud data center. Elasticity is undoubtedly one of the most striking characteristics of cloud computing. Especially in the area of (HPC) high performance computing, elasticity can be used to execute irregular and CPU-intensive applications.

Keywords: Workflow in cloud environment, Energy saving in cloud data center, Multiple Server Level Energy Saving Techniques, Single Server Level Energy Saving Techniques

1. INTRODUCTION TO CLOUD COMPUTING

Cloud computing is an innovative service mode. It enables users to get roughly unlimited computing power and abundant a variety of information tasks from internet. They are distributed computing, parallel computing and grid computational evolution. This type of new pattern refers the combination and expansion to the IT infrastructure, through the network to the required resources (hardware, platform, and software), virtual combination into a reliable and high performance computing platform. In cloud computing, all users' facts are stored in the cloud resources Nodes [1]. Several trends are opening up the era of Cloud Computing, which is an Internet-based expansion and use of computer technology. The ever cheaper and added powerful processors, mutually with the (SaaS) software as a service computing architecture, are transforming data centers into pools of computing service on a vast scale. The increasing network bandwidth and reliable yet flexible network connections make it even probable that users can now subscribe lofty quality services from data and software that reside solely on remote data centers. Moving facts into the cloud offers great convenience to users since they don't have to care about the complecations of direct hardware management [2].

1.1 WORKFLOW IN CLOUD ENVIRONMENT

Workflows have been commonly used to model large-scale scientific problems in areas like as bioinformatics, astronomy, and physics. Such scientific workflows have ever-growing facts and computing requirements and therefore demand a high-performance computing environment in order to be executed in a reasonable amount of time. These workflows are commonly modeled as a set of tasks interconnected by data or computing dependencies. There are two main stages when planning the execution of a workflow in a Cloud environment. The initial one is the resource provisioning phase; through this phase, the computing resources that will be used to run the tasks are elected and provisioned. In the second stage, a schedule is generated and every task is mapped onto the best-suited

resource. The choice of the resources and mapping of the tasks is done so that diverse user defined Quality of Service (QoS) requirements is met [3].

1.2 ENERGY SAVING IN CLOUD DATA CENTER

Cloud computing gives an approach for running applications in cost However, despite the several business and technical advantages of the cloud-computing form, there are increasing concerns about the rising costs (resulting from considerable power consumption) and the important impact of cloud computing as a contributor to global CO_2 emissions [4].Energy savings in the cloud data center is divided into two different categories: i) single server level; and ii) multiple server level or grid level.

A. Single Server Level Energy Saving Techniques:

Dynamic voltage frequency scaling (DVFS) based approaches for energy efficiency of a single server by restricting the use of CPU utilization well below the upper threshold value of CPU utilization. The time-out based approach kept the CPU on lower power state under no work load condition beyond a certain time-out threshold. The main limitation of this approach is that it does not switch CPU to the lower state until the time-out period has passed; hence, it will not save the energy during this time period. reduced the energy consumption of the cloud data center using DVFS. Their approach was based on DVFS that takes the task on priority basis and scheduled on minimum amount of resources. By this way, the overall utilization of the data center is increasing and resulting in lower energy consumption at the data center. The disadvantages of their work are lower priority task suffered by lower response time and there may be a chance of SLA violation.

B. Multiple Server Level Energy Saving Techniques

The main focus in this approach is to minimize the energy consumption of the data center by using minimum number of energy efficient PMs for the VMs allocation while switching-off unused PMs at the data center. To solve VMs allocation problem, used heuristic approaches, such as First Fit, Best Fit respectively. But heuristic approaches will not provide global optimum solution and Best Fit heuristic approach is not scalable in nature due to the long convergence time, and the other limitation of their suggested work is based on single objective function. A Modified Best Fit Decreasing (MBFD) algorithm by first sorting the VMs in the decreasing order and PMs in the increasing order on the basis of their processing capacity. After sorting of VMs and PMs, allocation of VMs on PMs is done by using First Fit Decreasing (FFD).The limitations of their work are: single objective based VMs allocation and MBFD which is not in scalable in nature when large numbers of requested VMs are arrived at the data center [5].

To consider the application perspective a few research efforts focus on the estimation of the energy consumption of applications based on their construction. For example, examine software methodologies and development tools that can be employed to enhance power efficiency of application in mobile systems. However, while highlighting contributing factors for creating energy-aware applications like as computational efficiency and context awareness energy efficiency and CO2 lessening of applications in cloud environment are not explored or capable. To this end, the Greenhouse Gas (GHG) protocol provides calculation tools and guide-lines for quantifying and managing emissions in the cloud platforms [4].

1.3 AUTOMATIC RESOURCE ELASTICITY

Elasticity is one of the strongest features that distinguish cloud computing from other approaches of distributed systems .It exploits the fact that resource allocation is a procedure that can be performed dynamically according to the demand for either the service or the user. Elasticity is an essential principle for the cloud model because it not only provides efficient resource sharing among users but also makes it feasible to have a pay-as-you-go computing style. Current state-of-the-art shows that the most common approach for elasticity is the replication of stand-alone virtual machines (VMs), when a particular threshold of a given metric or combination of metrics is reached. The load balancer maintained by the cloud provider manages the service calls (which are usually identified by a URL or IP address) and redirects demands for the most suitable replica. This mechanism was originally developed for dynamic scaling server-based applications, like as web, e-mail and databases, to handle unpredictable workloads, enabling organizations to avoid the downfalls that are involved with non-elastic provisioning (i.e., over- and under-provisioning). Thus, following this idea, cloud elasticity is also used in different areas, such as video on demand, online stores, BOINC applications, e-governance and Web services[6].

1.4 CLOUD COMPUTING SECURITY

Although cloud computing has become a mature service model, and have huge commercial, cloud computing is still facing lots of problems. In 2009, the well-known research institutions IDC liberate an IT report that cloud computing service is paving three major challenges: safety, stability and performance issue. Including the safety problem concerns the most. The results are shown in Figure 1.

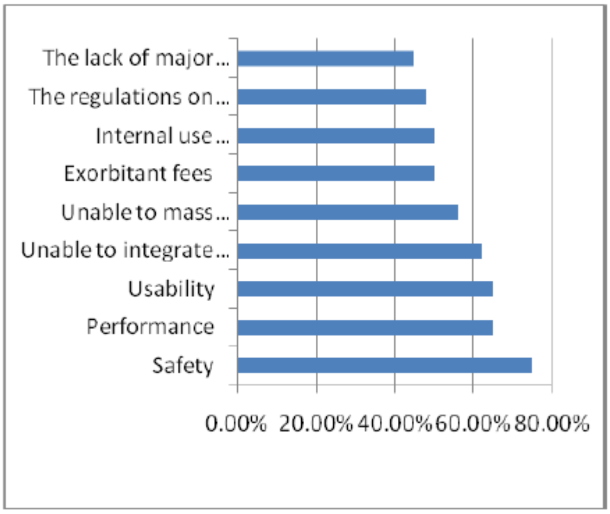

Figure1. In 2008 survey the IDC cloud computing faced problems

Three safety requirements are often considered: confidentiality, integrity, and availability for most Internet service suppliers and cloud users. In the order of SaaS, PaaS, and IaaS, the providers gradually release the responsibility of safety control to the cloud users. In summary, the SaaS model relies on the cloud provider to perform all security functions. At the other intense, the IaaS model wants the users to assume almost all security functions, but to leave accessibility in the hands of the suppliers. The PaaS model relies on the provider to maintain data integrity and availability, but burdens the user with confidentiality and privacy control [1].

LITERATURE SURVEY

Feng Zhao et al.in 2014[1] With the rapid development of Cloud computing, more and more users deposit their data and application on the cloud. But the improvement of Cloud computing is hindered by many Cloud security problem. Cloud computing has lots of characteristics, e.g. multi-user, virtualization, scalability and so on. Because of these new characteristics, customary security technologies can't make Cloud computing fully safe. Therefore, Cloud computing security becomes the present research focus and is also this paper's research direction[1].In order to solve the problem of data safety in cloud computing system by introducing entirely homomorphism encryption algorithm in the cloud computing data security a new type of data security solution to the insecurity of the cloud computing is proposed and the scenarios of this application is after this constructed This new safety solution is fully fit for the processing and retrieval of the encrypted data and efficiently leading to the large applicable prospect the security of data transmission and the storage of the cloud computing**.**

Cong Wang et al.in 2012[2] Cloud storage enables users to remotely store their data and enjoy the on-demand lofty quality cloud applications lacking the burden of local hardware and software management. Though the benefits are clear, like a service is also relinquishing users' physical possession of their outsourced data, which inevitably poses new safety risks towards the correctness of the data in cloud. In order to address this new problem and further attain a secure and dependable cloud storage service, auther propose in this paper a flexible distributed storage integrity auditing mechanism, employ the homomorphic token and distributed erasure-coded data. The proposed design permit users to audit the cloud storage with very lightweight transmission and computation cost. The auditing result not only ensures strong cloud storage correctness assurance, but also simultaneously achieves fast data error localization, i.e., the recognition of misbehaving server. Considering the cloud data are forceful in nature, the proposed design further supports secure and effective dynamic operations on outsourced data, including block modification, deletion, and append. Analysis shows the projected scheme is highly efficient and resilient against Byzantine failure, malicious facts modification attack, and even server colluding attacks.

Maria A. Rodriguez et al. in 2014[3] Cloud computing is the latest distributed computing paradigm and it gives tremendous opportunities to resolve large scale scientific problems. However, it presents diverse challenges that need to be addressed in order to be proficiently utilized for workflow applications. Though the workflow scheduling problem has been broadly studied, there are very few initiatives tailored for Cloud environments. Furthermore, the presented works fail to either rally the user's Quality of Service (QoS) requirements or to incorporate some crucial principles of Cloud computing like as the elasticity and heterogeneity of the computing resources. This paper suggests a resource provisioning and scheduling strategy for technical workflows on Infrastructure as a Service (IaaS) Clouds. Author present an algorithm based on the meta-heuristic optimization technique, Particle Swarm Optimization (PSO), which aims to diminish the largely workflow execution cost while meeting deadline constraints. Our heuristic is examined using Cloud Sim and diverse well-known scientific workflows of different sizes. The results show that our approach performs well than the current state-of-the-art algorithms.

Usman Wajid et al.in 2015[4] With the increasing popularity of the cloud computing model and rapid proliferation of cloud infrastructures there are increasing concerns about power consumption and consequent impact of cloud computing as a contributor to global CO_2 emissions. To date, slight is known about how to incorporate energy consumption and CO_2 concerns into cloud application development and deployment choice models. In this respect, this paper describes an eco-aware approach that relies on the definition, monitoring and consumption of energy and CO_2 metrics combined with the use of innovative application scheduling and runtime adaptation strategies to optimize energy consumption and CO_2 footprint of cloud applications as well as the fundamental infrastructure. The eco-aware approach involves measuring or quantifying the energy consumption and CO_2 at dissimilar levels of cloud computing, using that information to create scheduling and adaptation techniques that contribute towards dipping the energy consumption and CO_2 emissions, and finally testing and validating the developed resolution in a multi-site cloud environment with the help of challenging case study applications. The experimental and validation results show the prospective of the eco-aware approach to significantly reduce the CO_2 footprint and subsequent environmental impact of cloud applications.

Neeraj Kumar Sharma et al. in 2016[5] Due to the growing demand of cloud services, allocation of energy efficient resources (CPU, memory, storage, etc.) and resources utilization are the major challenging issues of a large cloud data center. In this paper, we propose an Euclidean distance based multi-objective resources allocation in the form of virtual machines (VMs) and designed the VM migration policy at the data center. Further the allocation of VMs to Physical Machines (PMs) is carried out by our proposed hybrid approach of Genetic Algorithm (GA) and Particle Swarm Optimization (PSO) referred to as HGAPSO. The proposed HGAPSO based resources allocation and VM migration not only saves the energy consumption and minimizes the wastage of resources but also avoids SLA violation at the cloud data center. To check the performance of the proposed HGAPSO algorithm and VM migration technique in the form of energy consumption, resources utilization and SLA violation, we performed the extended amount of experiment in both heterogeneous and homogeneous data center environments. To check the performance of proposed HGAPSO with VM migration, author compared proposed work with branch and bound based exact algorithm. The experimental results show the superiority of HGAPSO and VM migration technique over exact algorithm in terms of energy efficiency, optimal resources utilization, and SLA violation.

Rodrigo da Rosa Righi et al. in 2015[6] Elasticity is undoubtedly one of the most striking characteristics of cloud computing. Especially in the field of high performance computing (HPC), elasticity can be used to execute irregular and CPU-intensive applications. Moreever, the on the fly increase/decrease in resources is more widespread in Web systems, which have their own IaaS-level stress balancer. Considering the HPC area, current approaches usually focus on batch jobs or assumptions like as previous knowledge of application phases, source code rewriting or the stop-reconfigure-and-go approach for elasticity. In this context, this article suggests Auto Elastic, a PaaS-level elasticity model for HPC in the cloud. Its differential approach contains of providing elasticity for high performance applications without user intervention or source code modification. The technical contributions of Auto Elastic are twofold: (i) an Aging-based approach to resource allocation and de allocation actions to avoid unnecessary VM (virtual machine) reconfigurations (thrashing) and (ii) a synchronism in creating and terminating VMs in such a way that the application does not need to wait for completing these procedures. The prototype assessment using OpenNebula middleware showed performance gains of up to 26% in the execution time of an application with the Auto Elastic manager. Moreover, we obtained low intrusiveness for Auto Elastic when reconfigurations do not occur.

Yuanpeng Xie et al.in 2014[7] Cloud computing is an Internet-based computing pattern through which shared resources are provided to devices on demand. It’s an emerging but promising paradigm to combining mobile devices into cloud computing, and the integration performs in the cloud based hierarchical multi-user data-shared environment. With integrating into cloud computing, security issues such as data confidentiality and user authority may arise in the mobile cloud computing system, and it is concerned as the main constraints to the developments of mobile cloud computing. In order to provide safe and secure operation, a hierarchical access control method using customized hierarchical attribute-based encryption (M-HABE) and a modified three-layer structure is proposed in this paper. In a specific mobile cloud computing model, enormous data which may be from all kinds of mobile devices, such as smart phones, functioned phones and PDAs and so on can be controlled and monitored by the system, and the data can be sensitive to unauthorized third party and constraint to legal users as well. The novel scheme mainly focuses on the data processing, storing and accessing, which is designed to ensure the users with legal authorities to get corresponding classified data and to restrict illegal users and unauthorized legal users get access to the data, which makes it extremely suitable for the mobile cloud computing paradigms.

Edouard Outin et al.in 2015[8] Due to high electricity expenditure in the Cloud datacenters, providers aim at maximizing energy efficiency through VM consolidation, precise resource allocation or adjusting VM usage. More generally, the provider attempts to optimize resource consumption. However, while minimizing expenses, the Cloud operator still needs to conform to SLA constraints negotiated with customers (like as latency, downtime, affinity, placement, response time or duplication). Accordingly, optimizing a Cloud configuration is a multi-objective problem. As a nontrivial multi-objective optimization problem, there does not exist a single solution that concurrently optimizes each objective. There exists a (possibly infinite) number of Pair to optimal solutions. Evolutionary algorithms are popular approaches for generating Pareto optimal solutions to a multi-objective optimization problem. Most of these solutions use a fitness function to assess the quality of the candidates. However, regarding the power consumption estimation, the fitness function can be approximative and guide to some imprecisions compared to the real observed data. This paper presents a system that uses a genetic algorithm to optimize Cloud power consumption and machine learning techniques to improve the fitness function regarding a real distributed cluster of server. Authors have carried out experiments on the Open Stack platform to validate our solution. This experimentation shows that the machine learning generates an accurate solution.

Dan Gonzales et al.in 2015[9] The vulnerability of (CCSs) Cloud Computing Systems to Advanced Persistent Threats (APTs) is a significant concern to government and industry. Author present a cloud architecture reference model that incorporates a wide range of safety controls and best practices, and a cloud safety assessment model – Cloud-Trust – that estimates high level security metrics to quantify the extent of confidentiality and integrity offered by a CCS or cloud service provider (CSP). Cloud-Trust is used to assess the safety level of four multi-tenant IaaS cloud architectures equipped with alternative cloud security controls and to show the possibility of CCS penetration (high value data compromise) is high if a minimal set of security controls are implemented. CCS penetration possibility drops substantially if a cloud defense in depth security architecture is adopted that protects (VM) virtual machine images at rest, strengthens CSP and cloud tenant system administrator access controls, and which implies other network security controls to minimize cloud network surveillance and discovery of live VMs.

Michael Pantazoglou et al.in 2015[10] Author present a decentralized approach towards scalable and energy-effective management of virtual machine (VM) instances that are provisioned by large, enterprise clouds. In our technique, the computation resources of the data center are effectively organized into a hypercube structure. The hypercube impeccably scales up and down as resources are either added or removed in response to changes in the number of provisioned VM instances. Devoid of supervision from any central components, each compute node operates autonomously and manages its own workload by implying a set of distributed load balancing rules and algorithms. On one hand, underutilized nodes effort to shift their workload to their hypercube neighbors and switch off. On the other, over utilized nodes attempt to transfer a subset of their VM instances so as to reduce their power consumption and protect degradation of their own resources, which in turn may lead to SLA violations. In both cases, the compute nodes in this approach do not overload their counterparts in order to improve their own energy footprint. An evaluation and comparative study of the projected approach provides evidence of its merits in terms of elasticity, energy efficiency, and scalability, as well as of its viability in the presence of elevated workload rates.

Table 1. Different energy efficient methods

Methodology	Limitations
Adjusting operating frequency of the CPU using DVFS.	Deals with single server not cluster level.
Energy saving adaptive computing using DVFS in grid environment.	During no work load condition the CPU still consumes the power.
Load prediction using historical data, deals with dynamic power saving.	Accurate load prediction from previous data is not possible, SLA violation with reference to user's response time.
Energy efficient resources allocation and migration with both static and dynamic power saving.	Energy calculation in non-heterogeneous environment, during VM migration SLA violation may occur.
Multi queue job scheduling, saves dynamic power.	Not dealing with static power.

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CONCLUSION

In the wake of increasing popularity of cloud computing, achieving energy efficiency has been highlighted as one of the key challenges in this area. In this respect, an approach that brings together a set of innovations such as eco-metrics, eco-aware scheduling, eco-aware monitoring and eco-aware adaptation mechanisms to not only quantify the environmental impact but also to deliver significantly reductions in CO2 emissions of cloud applications. Using power simulator at runtime in a MAPE-K loop to self-optimize a Cloud infrastructure to maximize power efficiency and performance while maintaining expected and reliable behavior. a fully decentralized approach for managing the workload of large, enterprise cloud data centers comprises a hypercube overlay for the organization of the data center's compute nodes, and a set of distributed load balancing algorithms, which rely on live VM migration to shift workload between nodes, with the dual goal to i) minimize the active resources of the data center, and thereby its energy consumption, and ii) avoid overloading of compute nodes.

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