A Survey on Energy-aware Dynamic Virtual Machine Consolidation in Cloud Data Centers

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Abstract— Cloud computing is an emerging technology, and it allows users to pay as you need and has the high performance. Cloud computing is a heterogeneous system, and it holds a considerable amount of application data. Green Cloud is an advanced scheduling scheme to reduce energy consumption. Green Cloud Computing is the evolving need in industries and research areas. Green cloud computing is virtualized computing platform and it is a scalable use of computing resources. Cloud computing possess privacy concerns because the service provider can access the data that is on the cloud any time. It could be accidently altered or delete the information. Since the VM consolidation problem is strictly NP-hard, then proposed online optimization algorithm i.e. Ant Colony System to find a near-optimal solution based on a specified objective function. The AVVMC consolidation scheme proposes the ant colony optimization with a balanced usage of computing resources based on vector algebra. This survey contains the survey of virtual machines consolidation using different way by various authors.

Key words: Cloud computing, Green computing, VM consolidation, Service Level Agreements, Ant colony system.

I. Introduction

Cloud Computing is the delivery of computing as a service rather than providing as a product, whereby shared resources, software's, and information are provided to the computers and other devices as a utility (like electricity grid) over a network (typically the internet). The initial idea of Cloud Computing is that organizations do not manages their IT infrastructure, but have it delivered as a service by a Cloud Service Provider (CSP).Due to the fast growth of cloud computing in the Information Technology landscape, many definitions have emerged. Cloud computing is related with a new paradigm for providing different computing resources, usually are addressed from three fundamental aspects which are Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (Sass). Also, the four deployment models are private cloud, community cloud, public cloud, and hybrid cloud. There is mainly two way widely used in which the power and size can reduce that are Virtual Machine (VM) consolidation and Dynamic Server Provisioning. In proposed approach, the VMs are initially allocated PMs based on Based Fit Decreasing(BFD) algorithm. High energy consumption does not translate to high operating cost but increases higher carbon emissions. Dynamic server provisioning approaches save power by powering only a minimum amount of resources needed to satisfy the workload requirements. Therefore, additional servers are brought offline or put into a low-power mode if the workload demand decreases. The past few years, there are various attempts to reduce the energy consumption of data centers, the two widely-used techniques are Virtual Machine (VM) consolidation and dynamic server provisioning. The sharing of the PM resources among multiple VMs is handled by the Virtual Machine Monitor (VMM). The sharing of PM resources among multiple VMs is handled by the Virtual Machine Monitor (VMM). In this paper VM consolidation problem with the objective to reduce the energy consumption of data center, so present a distributed system architecture to reduce energy consumption. The AVVMC consolidation scheme proposes the ant colony optimization with a balanced usage of computing resources based on vector algebra. Moreover, the main idea of these algorithms is to set lower and upper utilization thresholds and also keep the total CPU utilization of a node between them. Achieving the desired level of Quality of Service (QoS) between cloud providers and their users.

Motivation

- High energy consumption of cloud data centers, so minimizes energy consumption.
- Most of the study in this field is done; all the study should be organized in such a way that it should have the good impact on industry practices.
- To reduce the time and computational complexity we defined an ant colony algorithm to distribute the requests in parallel format.

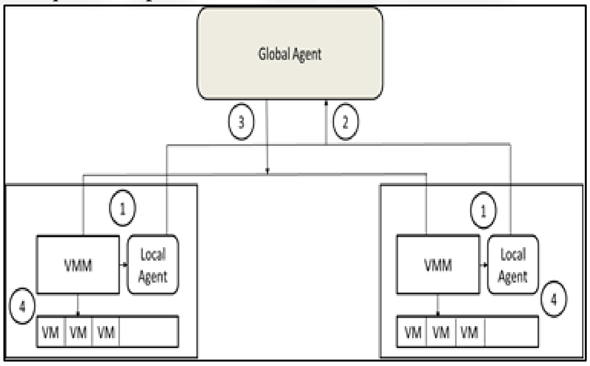

Fig. 1: The system Architecture [3]

Fig 1 shows existing system model. A cloud data center consists of n heterogeneous PMs which have different resource capacities. Each PM consists of a CPU, which is often a multi-core. The CPU performance can be defined regarding Millions of Instructions Per Second (MIPS). Also, a PM is also characterized by the amount of network I/O, memory and storage capacity. At any given time, the cloud data center usually serves many simultaneous users. Users submit their requests for provisioning of m VMs, which are allocated to the PMs. The length of each request is specified in Millions of Instructions (MI). In the existing approach, VMs are initially allocated to the PMs based on Best Fit Decreasing (BFD) algorithm, which is one of the best-known heuristics for the bin-packing problem [11]. BFD first sorts all VMs by their utilization weights in the decreasing order. Model consist of 2 agents: local and global agent: A Local Agent resides in a PM to solve PM status detection sub-problem by observing the current resource utilizations of the PM. The Global Agent acts as a supervisor and optimizes the VM placement by using the proposed ACS-VMC algorithm. The ACS-VMC algorithm, when the selected migration plan is enforced, this approach further restricts the number of active PMs by preferring VM migrations to the already active PMs [5].

This survey paper include VMs consolidation, VM placement, Live migration of VM, data centers management. The survey is organized as follows. Section 2 consist of the introduction of the cloud computing and motivation for the study. In Section 3 Literature Review is given that consist of existing methodologies and conclusion of the literature review. Section 4 contains proposed system architecture. This Chapter gives the comparison of existing Green cloud system. Section5 gives Conclusion and future work.

II. RELATED WORK

Fahimeh Farahnakian, Adnan Ashraf, Tapio Pahikkala, Pasi Liljeberg, Ivan Porres, and Hannu Tenhunen[1] have proposed overall due to the ever-increasing cloud infrastructure demand, there has been a significant increase in the size and energy consumption (EC) of the cloud data centers. High energy consumption not only translates to a high operating cost but also leads to higher carbon emissions. Therefore, energy-related costs and environmental impacts of data centers have become major concerns and research communities are being challenged to find efficient energy-aware resource management strategies. Maintains the desired QoS is an essential requirement for cloud data center. The QoS requirements are formatted via Service Level Agreements (SLAs) that describe the required performance levels, such as minimum throughput and maximal response time. Beloglazov and Buyya proposed an independent workload metric called SLA Violations to evaluate the SLA delivered by a VM in an IaaS cloud. The most important optimization problems are VM consolidation is an energy-efficient placement of VMs on PMs. This problem is optimized using Ant Colony System. The proposed ACS-based VM Consolidation (ACS-VMC) approach uses artificial ants to consolidate VMs into a reduced number of active Physical Machines according to the current resource requirements. These ants work in parallel to build VM migration plans based on a specified objective function. As a plan, authors further improve the proposed system model.

Anton Beloglazov and Rajkumar Buyya[2] have proposed cloud computing has renewed the ICT industry by enabling on-request provisioning of computing resources based on a pay-as-you-go model. An organization can outsource its computational needs to the Cloud avoiding high up-front investments in a private computing infrastructure and reasonable maintenance costs or implement a private Cloud data center to improve the resource management and provisioning processes. The main limitation of data centers is high energy consumption, which has risen by 56% from 2005 to 2010, and in 2010 noted to be between 1.1% and 1.5% of the global electricity use, apart from high operating costs, this results in substantial carbon emissions, which are measured to be 2% of the global emissions. One method to improve the utilization of data center resources, which has efficient, is dynamic Consolidation of Virtual Machines (VMs). This approach explores the dynamic nature of Cloud workloads: the VMs are periodically reallocated using live migration according to their new resource demand to minimize the number of active physical servers, required to handle the workload. In this paper, specify the QoS requirements authors apply a modification of the independent workload metric proposed in their previous work. Therefore, the problem transforms into minimizing the energy consumption under QoS constraints. This problem is too complex to be treated analytically as a whole, as just the VM placement that is a part of dynamic VM consolidation is an NP-hard problem. Zhu et al. studied the dynamic VM consolidation problem and applied a heuristic of setting a static CPU utilization threshold of 85% to determine when a host is overloaded. The introduced a Markov chain model proposed a control algorithm for the problem of host overload exposure as a part of dynamic VM consolidation. The model allows a system manager to set explicitly a QoS objective regarding the OTF parameter, which is a workload independent QoS metric. One more proposed an optimal offline algorithm for the problem of host overload detection to evaluate the effectiveness of the MHOD algorithm.

Jing Huang, Kai Wu, and Melody Moh.[3] have analyzed a Dynamic Heuristic VM Migration and Consolidation approach. They have extended the work in “Optimal online deterministic algorithms and adaptive heuristics for energy and performance efficient dynamic consolidation of VMs in cloud data centers" and proposed an efficient online heuristic for dynamic VM allocation. The energy consumption is modeled as the sum of execution energy, communication energy during VM migration, and servers switching power. Cloud computing delivers a pool of preoccupied and virtualized resources, including computing power, storage, platforms and software applications over the Internet based on users demand. Some technologies have been adopted to address energy efficiency in cloud data centers. The Dynamic Voltage and Frequency Scaling (DVFS) was used to reduce energy utilization of servers by lowering frequency and voltage of microprocessors in servers. Over-utilization is often caused by highly variable as well as violent VM consolidation. In our allocation approach, local regression method is employed to detect potentially overloaded servers, and one or more VMs are selected from each overloaded server based on minimizing the migration time. In this paper, dynamic VM migration and consolidation approaches to reduce both energy consumption and SLA violations are introduced. This method consists of comprehensive online monitoring of servers over-utilization and under-utilization, VM selection, and VM placement. This is a continuation of our efforts in cloud computing research as well as integrating cloud research into classroom teaching.

Manjot Kaur, Prabhdeep Singh: Manjot Kaur, Prabhdeep Singh[4] have presented advanced technology the total energy cost and service time for hosting and delivering the resources present in different data centers over the Internet have started all due to Cloud Computing and new model is proposed for energy–efficiency of cloud computing that helps to keep track on how many levels of degradation of atmosphere has occurred by the emissions of various greenhouse gases by different large data centers and how our computing can become eco- friendly. They have the different key challenges that arise when such energy-saving techniques are extended for use in cloud computing technologies.

A. Power Consumption Model:

1) Static Power Consumption

Static Power Consumption (SPC) is independent of the `clock rates, system status such as leakage power consumption, device usage scenario. Leakage power consumption is not taken as independent because it is related to the temperature.

2) Dynamic Power Consumption

The Dynamic Power Consumption (DPC) is created by the activity of circuits such as transistors, switches, changes value in registers and many more. It has depended upon the system scenario like usage, clock rates, and various I/O activities.

3) Energy Consumption in The Hardware

Energy is consumed by CPU utilization, different hardware components like a disc, network devices. About 60% of the energy is absorbed by them when they are in idle state. The matter of concern thus arises towards the environment.

Pradip Patel, Miren Karam, M. D. Bhavsar, M. B. Potdar presented the paper for a brief survey of Live Migration of Virtual Machines (VM) in cloud computing. Live migration is the process of moving a running virtual machine or application in various physical machines without disconnecting the client, network, memory connectivity and storage of the VMs are migrated from the original host machine to the destination. This capacity is utilized in today's enterprise environments to provide efficient online system maintenance, reconfiguration, and load balancing and fault tolerance.

B. Different categories of migration techniques:

1) Fault Tolerant Migration Techniques

This technique transfers the virtual machine from one physical server to another physical server depending on the assumption of the failure occurred, fault tolerant migration technology is to avoid performance degradation and improve the availability of physical server of any application.

2) Load Balancing Migration Techniques

The Load balancing migration method aims to distribute load across the physical servers to improve the scalability of physical servers in the cloud environment. The Load balancing aids in minimizing the resource consumption, implementation of fail-over, enhancing, scalability, avoiding bottlenecks and over provisioning of resources.

3) Energy Efficient Migration Techniques:

The power consumption of Data Center depends on the use of the servers and their cooling systems. The servers typically need up to 70 % of their maximum power consumption even at their low utilization level. Hence there is a need for migration methods that conserves the energy of servers by optimum resource utilization.

Sr. No	Paper Name	Used Services/ Methodology and Categories	Advantages	Disadvantage
1.	Using ant colony system to consolidate VMs for Green Cloud Computing [1]	1.Ant colony system 2. VM consolidation	To solve VM consolidation problem and reduce Energy consumption	VM consolidation is up to working with limited server
2.	Managing Overloaded Hosts for Dynamic Consolidation of Virtual Machines in Cloud Data Centers Under Quality of Service Constraints[2]	1. QoS metric 2. Markov chain model 3. control algorithm	Finding problem of host overload detection and approximate it for non-stationary workloads	Markov model property, which may not be true for all types of workloads
3.	Dynamic Virtual Machine Migration Algorithms Using Enhanced Energy Consumption Model for Green Cloud Data Centers [3].	1) Explicitly formulating a realistic energy consumption 2) Presenting two VM placement heuristics, Best Fit Host (BFH) and the Best Fit VM (BFV) placement methods	This Approach is useful for reducing energy consumption by consolidating VMs onto the minimum number of servers and turn idle servers into power saving modes.	This architecture uses monitoring service to provide the global information and aggregate the historical monitored data to support migration manager to make VM migration decision.
4	Energy efficient green cloud: underlying structures [4].	Power Consumption Model 1. Static Power Consumption 2. Dynamic Power Consumption 3. Energy Consumption In The Hardware	It is very useful to identify the various challenges that arise when such energy-saving techniques are extended for use in cloud computing techniques	The environmental impact and energy consumption has become a matter of contention for present and future biodiversity. The ever increasing sudden changes in the climate are posing a threat to economy and diversity.

5	Live Virtual Machine Migration Techniques in Cloud Computing [5].	1) Live Virtual Machine Migration Techniques in Cloud Computing: A Survey 2) Load Balancing Migration Techniques 3) Energy Efficient Migration Techniques	The performance loss of virtual machine during migration and energy overhead for real world scenarios	The approaches concentrate on one, two or at maximum three parameters and adjust their validation environment accordingly. Hence, there is no general model for estimation of performance of migration.

III. PROPOSED SYSTEM ARCHITECTURE:

Dynamic server provisioning approaches save energy by using a reduced amount of resources needed for satisfying the workload requirements. Therefore, additional servers are switched off or put into a low power mode when the workload demand decreases.

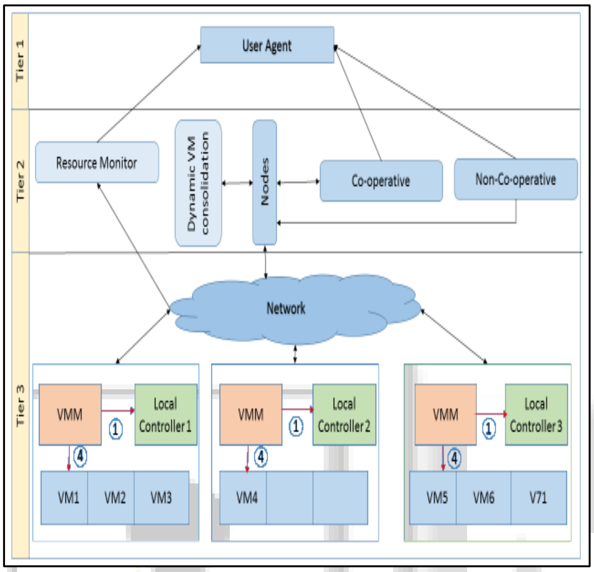

Fig. 2: Proposed system Architecture

Fig. 2 shows three tier architecture of proposed system. When user will give a task to system, the business logic layer will decide how to exactly execute the task. In this case Dynamic user consolidation will decide the nodes that are to be running on VM to execute threads of process. Dividing the task into process threads will be done by business layer, hence it will cluster those threads onto similarity of their processing nature. Resource Manager will make sure that these threads are having the required resources. All clustered processes will be executing on cloud with assigned controller. They will execute there on the cloud only. And will give combined result as asked for. Each VM on cloud holds a dynamic node for process and will be clustered on the basis of their similar functioning. This saves the energy as similar tasks are clustered together and processing in parallel way. A cloud data center consists of n heterogeneous PMs which have different resource capacities.

A. Assumption:

1) The overhead of Virtual machine migration is considered as negligible. Modeling the cost migration of VMs is another research problem and is being currently investigated.
2) Unknown types of applications running on VMs, it is not possible to build the exact model of such mixed workload.
3) The proposed ACS-VMC approach is evaluated by CloudSim simulation on real workload-treces.

IV. CONCLUSION AND FUTURE WORK

The ant colony optimization algorithm was extensively compared with the multi-objective genetic algorithm. The combined implementation of both the algorithms fetches a more optimal result. We present dynamic Virtual Machine consolidation approach called ACS-based VM Consolidation. Dynamic server provisioning approaches save energy by using a reduced amount of resources needed for satisfying the workload requirements [3]. Therefore, unnecessary servers are switched off or put into a low-power mode when the workload demand decreases. The existing algorithm, when tested with literature instances, proved to be more efficient in VM placement thereby reducing the resource wastage and reducing the power consumption of the servers.

The energy profiles we have built are an initial step toward developing energy-aware schedulers. We are now investigating the effects on energy consumption and performance of running multiple VMs with different workloads on the same machine [9]. The power models are easily extensible into power models for clouds systems, once the contribution of individual and multiple VMs are known. By devising a scheduler's architecture that minimizes the energy profile of the entire system, we plan to verify the validity of our system-level approach. It reduces the energy consumption of data centers by consolidating VMs into a reduced number of active Physical Machines while preserving Quality of Service requirements. In future work we plan clustering of multiple VMs having similar types of configuration for minimise Energy consumption of data Centers.

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