ENERGY EFFICIENT VIRTUAL MACHINE INTEGRATION IN CLOUD COMPUTING

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ABSTRACT

In the present study, two algorithms for VM consolidation have been developed, on the basis of three energy consuming resources namely CPU, RAM, and Bandwidth. These algorithms reduce the consumption of energy, while meeting out specified SLAs. To assess the power consumption of the developed algorithms, simulations are conducted on these algorithms using randomly generated workload datasets on CloudSim simulator. Both the developed algorithms consumed approximately one third of the energy compared to non power aware policy (NPA), while significant reduction in energy consumption is observed when compared to Dynamic Voltage and Frequency Scaling (DVFS) and other relatively newer methods of VM consolidation.

Keywords: Cloud Computing, Iaas Cloud, Network Security, Algorithm

I.INTRODUCTION

The word "Cloud computing" set milestone today, this word reflects its meaning as: seamless services to client, cost effective with low operational cost, no maintenance cost on computing infrastructure, no panic for sudden expansion of computing resources. It's a win-win situation for cloud providers, cloud service subscriber, and cloud end users. According to NIST [**1**], "Cloud computing is a model for enabling ubiquitous, convenient, on demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." Cloud grants its users a cost effective model of computing with tailor made services on a subscription based pay-per-use model. Resources are scalable according to variable load, promising uninterrupted service to its end users. Cloud service reference model is broadly classified into following types [**1**]:

1. Infrastructure as a Service (IaaS)
2. Platform as a Service (PaaS)
3. Software as a Service (SaaS)

The first layer and the foundation of this stack is IaaS layer. IaaS provides basic computing infrastructure (e.g CPU, RAM, Network, Storage) as a service. Cloud provider provides access to virtualized hardware via network to its clients. Virtualization plays a key role in creating virtualized hardware by creating an abstraction layer of hypervisor. A hypervisor is a collection of computer software, firmware or hardware that creates and runs a virtual machine [**2**], whereas a virtual machine (VM) is an emulation of a particular computer system. Virtual machines are based on the computer architecture and functions of a real or hypothetical computer and its implementations may involve specialized hardware, software, or a combination of both [**3**]. The hardware and operating system where hypervisor is installed is known as host machine, whereas the virtual resources created by the hypervisor are known as guest machine. These guest machines are created on the request of users using web browsers, or tools provided by the cloud providers, or set of commands via internet. Users can use these virtual machine instances as per their requirements, and they can install and configure the software in the same fashion as like a desktop or server at their own premises. The layer above infrastructure base is PaaS layer. It provides a scalable abstraction to deploy and develop applications. It supp orts different runtime environments and libraries that are part of core middleware functionality provided by PaaS. It hides the details of underlying infrastructure services and provides a seamless and elastic environment to a user using web based management console or using Application Programming Interfaces (APIs) and libraries. Initially the algorithms for placement of virtual machines were based on optimized performance and high Service Level Agreements (SLA) [**4**]. These algorithms were not designed for energy efficiency, reducing operational expenditure and environmental norms. Intelligent placement of virtual machines in physical servers can save a substantial amount of energy. The objectives of present work are:

• To study and review various energy saving methodologies in virtualized data centers.
• To propose algorithms based on multiple resource utilization (CPU, Memory, and Bandwidth) for optimizing the VM consolidation task.
• To maximize the energy savings and minimize SLA and VM migrations in data centers by placement of virtual machines and dynamically migrating those VMs according to the varying load.
• Simulate the proposed algorithm and analyze the computed results.

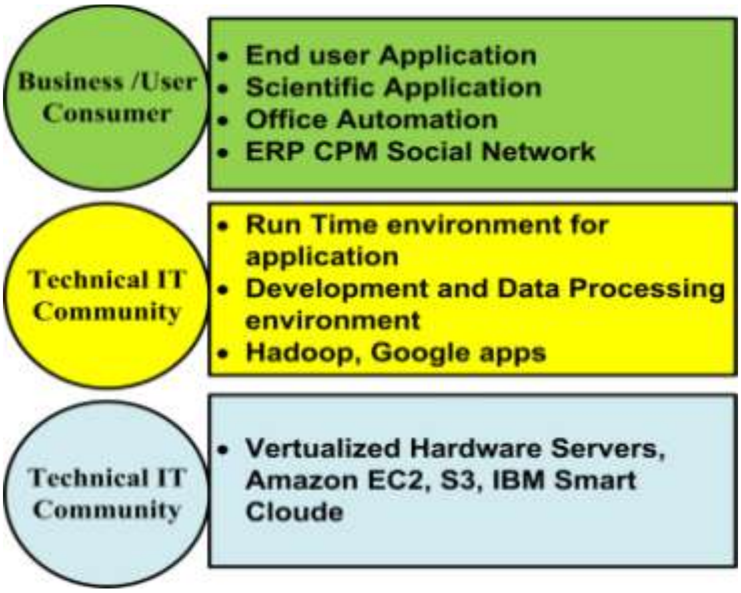


Figure 1: Cloud Reference Model [5]

II.MULTI-RESOURCE BASED VM INTEGRATION ALGORITHM

In the proposed algorithm in previous chapter, upper threshold of the host was static (fixed) in nature, and remains unchanged during entire lifetime of simulation. This static threshold may causes many un-optimized placement and consolidation decisions, *e.g* . If threshold level is set to 90% and due to workload nature any host never crossed 60% utilization mark, hence hosts will not get consolidated and optimal placement will never occur. Another case may occur if upper threshold value is very low and workload is very resource consuming, it will cause rapid VM migrations from one host to another.

2.1 Experimental Setup and Execution

The test environment simulated in CloudSim. The algorithms performance was tested over various factors like its energy saving, proneness towards SLA violation, and number of VM migrations. This experiment was started with 110 VMs and increased up to 210 VMs with an increment scale of 10. This scenario with varying VM requests was simulated to run for 24 hours. The Following steps were carried out in simulation design and setup:

• VM instances were created by data center broker on the behalf of users request with 4 different available VM types. For the simulation, we have used standard VMs (similar to those are used in Amazon EC2 cloud) with varying single core CPU capacities and memory requirements.

• Two types of host nodes each having 2 core processor of 1860, 2660 MIPS capacity with 4 GB RAM and 1 Gbps bandwidth have been created. The power consumption of these hosts were modeled as HP ProLiant Ml110G4 and HP ProLiant Ml1 10G5 Xeon servers. In order to measure the power consumption, power model of these servers specified by Standard Performance Evaluation Corporation [**6**] were used.

• The algorithm presented is consolidating VMs with static threshold. In static threshold based policy upper threshold limit of resource utilization is determined dynamically based on workload pattern history of the resources. After the necessary setup, Simulations for proposed algorithm, including three algorithms proposed by Beloglazov et al. [**7**], DVFS (Dynamic Voltage and Frequency Scaling) and Non Power Aware VM allocation policy (NPA) were executed.

2.2 Performance Metrics

The performance metrics are total energy consumed by the hosts in entire data centers, total number of VM migrations, and SLA violation.

2.3 Simulation Results and Analysis

Graph 2-1 shows that energy consumption increases linearly with increasing VM request for all the policies under test. Whereas graph 2-2 shows that in some policies migrations increases abruptly while for dynamic threshold policy it is increasing linearly and slowly with increase in VM requests. SLA violation as depicted in graph-2-3, shows that dynamic threshold policy performed well as compared to other policies when number of VM requests were high. For low VM requests, policies Thr-Mc and Mad-mmt performed better than dynamic threshold. Based on simulation results, following conclusions can be made:

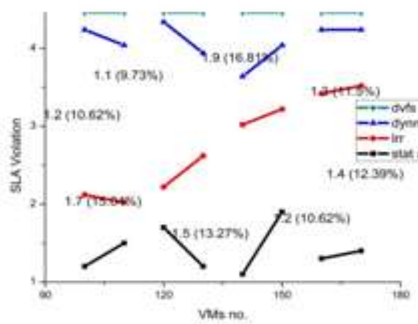
1. Simulations carried out with varying number of VM requests in data center. The proposed dynamic algorithm showed linear energy consumption pattern.

2. Dynamic threshold strategy performed well over static threshold strategy at optimal threshold *i.e.* 80% in all three parameters (Energy consumption, SLA, and VM migrations).

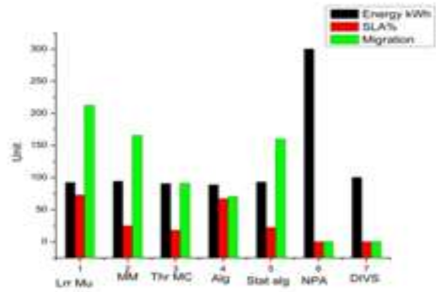
3. Dynamic VM Consolidation strategy is significantly outperformed general VM placement policies *e.g.* DVFS and NPA and other policies under test.

4. SLA violation metrics are not applicable in allocation policies DVFS and NPA therefore they never violate SLA and always give optimal QoS among all proposed policies but the Energy consumption is very high for both the policies.

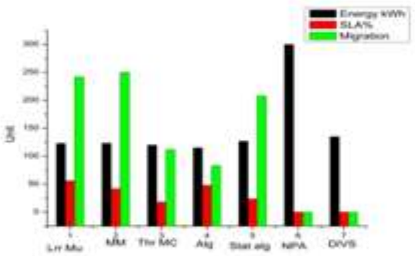
5. Proposed algorithm cannot set SLA violation limit manually, But SLA limit can be changed by adjusting parameters described in the algorithms.



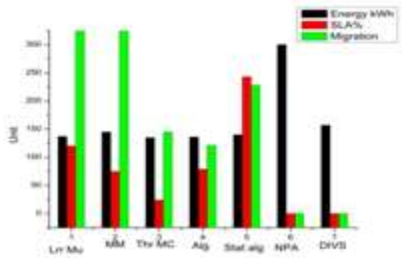
2.1 SLA Violation



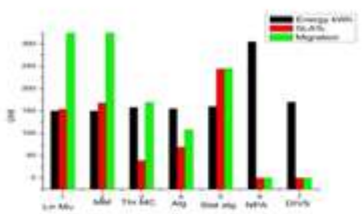
2.2 Data Center Running 100 VMs



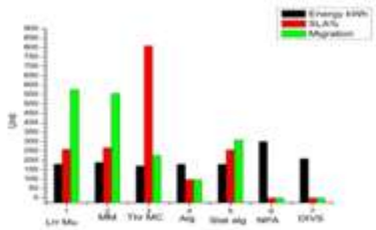
2.3 Data Center Running 130 VMs



2.4 Data Center Running 150 VMs



2.5 Data Center Running 170 VMs



2.6 Data Center Running 200 VMs

Figure 2: Simulation results and Discussions

III.CONCLUSIONS AND FUTURE WORK

This work has investigated and proposed two algorithms for dynamic VM consolidation in virtualized data centers. Proposed algorithms have improved resource utilizations of data center and reduced energy consumption, while satisfying the defined SLA requirements. With the energy saving cloud polices designed in this thesis, power savings of up to 40% is possible in comparison with default load balancing approaches. The first algorithm uses a fixed resource threshold trigger for consolidation of VMs. Static threshold method responds fast and suitable for big data centers having large number of VMs, Due to static threshold value the placement and consolidation is not properly optimized.

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