Research Paper

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An Adaptive Approach for VM Placement using Power and Migration Time at Cloud Data Center

Engineering

KEYWORDS : Cloud Computing ,Dynamic Reallocation, VM Placement , Network Delay,QoS.

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ABSTRACT

Cloud computing is a recent innovation, which provides various services on a usage based payment model. The rapid expansion in data centers has triggered the dramatic increase in energy used, operational cost and its effect on the environment in terms of carbon footprints. Virtualization is a promising approach to reduce this power consumption by consolidating multiple virtual servers onto a smaller number of computing resources. In this paper an efficient resource management policy for virtualized Cloud data centers is proposed. Power consumption by data-centers can be reduced by leveraging live migration of VMs and switch off idle nodes. Again dynamic reallocation incurs network propagation delay that can affect the operation cost. The objective is to optimize the power consumption as well as network delay.

1. INTRODUCTION

The concept of cloud computing was introduced in 1961 by John McCarthy. Later, the computing technologies such as Utility Computing [2] combined with established standards of Web 2.0 gave rise to cloud computing. These services are provided by sharing resources, software and other information under a usage based payment model. A Cloud is a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements established through negotiation between the service provider and consumers [1]. It has been projected that the data centers consume 0.5 percent of the world's total electricity usage [3]. If recent demand continues, it is projected to be augmented by 2020. In 2005, the total energy consumption (servers, cooling units) was projected at 1.2% of the total U.S. energy consumption, amplifying every 5 years [4]. Amazon's estimations [5] about its data centers are very clear.

2. Related Work

In this work reduction in power consumption is achieved by leveraging live migration of VM. Different heuristics are used for dynamic reallocation of VMs according to current resource requirement while ensuring reliable QoS. The objective of reallocation is to minimize the number physical serving the current work, Whereas idle nodes are switched off in order to decrease power consumption. Since dynamic reallocation of VM needs to transmit VMs from one host to another. This incurs network delay overhead which in turn increase the operation cost as physical nodes may be located geographically apart. Goal of this work is to minimize both power consumption as well as network delay ensuring reliable QoS. Doing a comprehensive study on this overall problem in the real world will be extremely difficult, so the best approach to study such a dynamic and massively distributed environment is through simulation. Even in simulation environment there are some challenges that need to be addressed.

- Optimal solution for trade-off between energy saving and performance.
- Precisely define when and which VMs and where to migrate to minimize power consumption while minimizing migration overhead and ensuring SLA.
- An efficient and scalable algorithm for resources allocation.

3. System Model

Our system model considers three main theories.

3.1 Power - Migration Time Model

Many studies [6,7] shows the power consumption by servers can be described by a linear relation between the power consumption and CPU utilization. These studies as say that an average power consumed by an idle server is 70% of power consumed by fully utilized server. So, we considered the power consumption as CPU utilization P(u) by as shown in below equation:

$$P(u) = P_{max} (0.7 + 0.3\, u)$$

where Pmax is 250 W for modern computing server and u is the CPU utilization. But, CPU utilization change with respect to time i.e. u(t). As proposed in this work, minimization of power consumption by data centers is accomplished by live migration and dynamic reallocation of VM from one host to another. Since hosts are connected through network this reallocation incurs some delay/cost to transmit VMs. if we try only to optimize power it may increase the transmission cost. So in this work we propose to integrate power and Migration Time in a single equation and optimize this value instead of optimizing power and Migration Time individually. For integrating these two dissimilar quantities we propose to use following equation (1).

Power-Migration Time = P + *w* • TMT........ (1)

P is the power required to run the VM on destination host and TMT is the total migration time required to transmit the VM from source host to destination host and *w* (<=1) is a weighting factor. Now one can optimize this value by providing the weight factor according to its requirement. The total energy consumed (E) as shown in (2):

$$E = \int_t P(u(t))\, dt \quad \text{................(2)}$$

So the total energy consumption can be measured from CPU utilization from this model.

3.2 Cost

With decrease in power consumption using live migration which results in decreasing operating cost for the data center. We consider here cost as shown in (3):

$$C_{dc} = c * E \quad \text{...................... (3)}$$

where c is the cost of 1 kW power.

3.3 SLA Violation

In cloud computing environments QoS is determined in the form of SLA (Service Level Agreement), which is determined either by minimum throughput or maximizes response time. This can differ from system to system. For our studies, we consider SLA violation as shown in (4):

$$SLA = \frac{\Sigma(requestedMIPS) - \Sigma(allocateMIPS)}{\Sigma(requestedMIPS)} \quad \text{..... (4)}$$

Therefore, in order to increase the QoS for the end-users, our prior goal is to minimize this SLA from getting violated.

4. OUR PROPOSED STRUCTURE

Here, we divide the algorithm in two parts: (1) Selection of VM and(2) Placing of VM

4.1 Selection of VM

The fixed values for the thresholds are unsuitable for an environment with dynamic and unpredictable workloads, in which different types of applications can share a physical resource. The system should be able to automatically adjust its behaviour depending on the workload patterns exhibited by the applications. Therefore, we propose a novel technique for auto-adjustment of the utilization thresholds based on a statistical analysis of the historical data collected during the lifetime of VMs. The selection of VM for migration is done to optimize the allocation. The complexity of the algorithm is proportional to the sum of the number of non over-utilized host plus the product of the number of over-utilized hosts and the number of VMs allocated to these over-utilized hosts.

4.2 Placing Of VM

The VM placement can be seen as a bin packing problem with variable bin sizes and prices. As the bin packing problem is NP-hard, to solve it we apply a modification of the Best Fit Decreasing (BFD) algorithm that is shown to use no more than 11/9 .OPT + 1 bins (where OPT is the number of bins provided by the optimal solution) [9]. In our modification (MBFD) we sort all the VMs in the decreasing order of current CPU utilizations and allocate each VM to a host that provides the least increase of the power consumption and least Time caused by the allocation. This allows the leveraging the nodes heterogeneity by choosing the most Power efficient ones first. The pseudo-code for the algorithm is presented in Algorithm. 1. The complexity of the algorithm is n.m, where n is the number of nodes and m is the number of VMs that have to be allocated.

Algorithm1:Enhanced Modified Best Fit Decreasing (EMBFD)

Input: hostList,vmList**Output**: allocation of VMs

```
vmList.sortDecreasingUtilization()
foreach vm in vmList do
|  minPM= MAX
|  allocatedHost = NULL
|  for each host in hostList do
|  |  if host has enough resource for vm then
|  |  |  power = estimatepower(host, vm)
|  |  |  tmt=MigrationTime(desthost,srcHost)
|  |  |  PM=power+w*tmt
|  |  |  if PM < minPM then
|  |  |  |  allocatedHost = host
|  |  |  |  minPM = PM
|  if allocatedHost != NULL then
|  |  allocate vm to allocatedHost
return allocation
```

5. Experimental Results

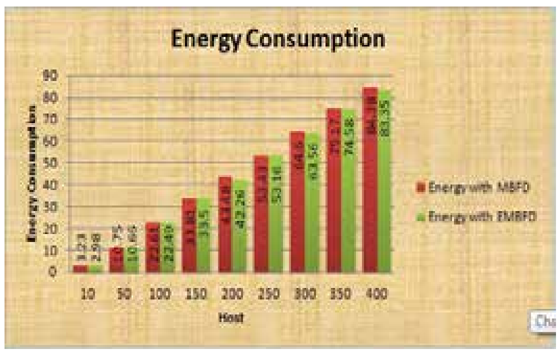
We tested our work on cloudsim toolkit [8]. In our experiment, we have worked with only one datacenter. we took up with 10 ,50,100,150,200,250,300,350,400 hosts. Each host comprises of two CPU and 4 GB RAM. The host comprises of 3560, 2660, 1860, 1460 MIPS and 1,0.5,0.75,0.25 Gbit /Second bandwidth accordingly. The host to VM ratio is 1:1.5. So for 10 hosts 15 VM, for 50 hosts 75 VM are taken. Each virtual machine comprises 1 core CPU. For our work, we have taken 8 types of VM with varying size of MIPS,RAM and bandwidth. The vm comprises of 3300, 3000,2500, 2000,1500, 1200, 1000, 500 MIPS , 870, 910, 450, 613 ,1100, 1740, 1240, 993 MB RAM and 100,200,300,50,75,150,100,100Mbit/s bandwidth.

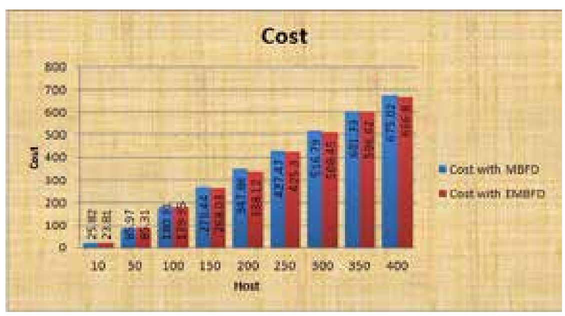
And we have taken weighting factor as 20% (0.2) Firstly, we tried to work on Cloudsim Toolkit with implementing our concept with dynamic threshold selection policy and Modified bestfit decreasing placement policy EMBFD provides efficient optimal solution for VM placement.

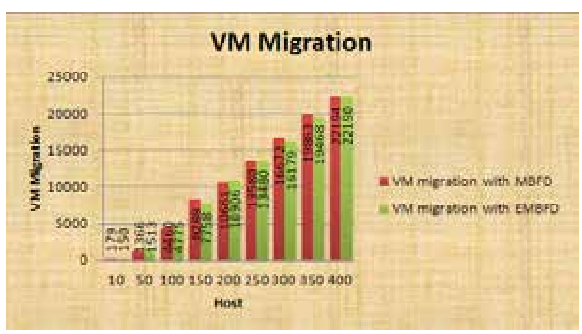
Dynamic Threshold with EMBFD				
Host	Energy	Cost	VM migration	SLA Violation%
10	2.98	23.81	150	10.00%
50	10.66	85.31	1513	9.89%
100	22.49	179.95	4775	10.00%
150	33.5	268.03	7758	9.91%
200	42.26	338.12	10906	9.92%
250	53.16	425.3	13480	9.95%
300	63.56	508.45	16179	9.97%
350	74.58	596.62	19468	9.93%
400	83.35	666.8	22190	10.02%

Table 1: Dynamic Threshold with EMBFD

As shown in the table 1, we concluded that by using network memory migration efficient policy for VM placement, energy usage can be minimized resulting into decreasing electricity bills for data centers. After the above results, we continued to look into the behavior of our algorithm enhanced VM placement policies. From this analysis, we found that number of migration bit increased but SLA violation decreased. The following graphs provides the comparision between existing and our modified energy consumption, cost, VM migration and SLA Violation.







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6. CONCLUSION

In this work an efficient resource management policy for virtualized Cloud data centers is proposed. The proposed technique reduces power consumption by data-centers by leveraging live migration of and dynamic reallocation of VMs from one host to another. Since dynamic reallocation incurs network propagation delay that can affect the operation cost, the proposed power-Migration time model takes into consideration both power required to run VM on new host and network delay overhead in transferring VM from old host to new host. The objective is to optimize the power consumption as well as network delay (with relative importance determined by weighing factors). For our future work, we would also like to investigate this technique on real cloud setup and check what will be its exact reaction on real environment

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