Research Paper Engineering

Energy Efficient Provisioning of Virtual Machines in Cloud System using DVFS

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ABSTRACT

Cloud computing becomes emergent for the anything as a Service (XaaS) paradigm, modern user services also become available through Cloud computing. Cloud computing is driven by economies of scale. Reducing power consumption has been an essential requirement for Cloud resource providers not only to decrease operating costs, but also to improve the system reliability. A cloud system uses virtualization technology to provide cloud resources (e.g. CPU, memory) to users in form of Virtual Machines (VM). In this work, we will investigate Power-Conscious provisioning of virtual machines policy for user services. In our approach user is asking for the virtual platform to deploy his application on the Cloud system .After receiving request from the user, Resource Broker will compose the request to Data centre. We have proposed scheme to provision the virtual machine which consumes less energy so, it will increase the profit of Data centre. In case of same price of processors, node which consumes lower energy will be chosen .In all the cases user will be allocated minimum price Virtual Machine. To provision virtual machines in Cloud data centres it uses Dynamic Voltage Frequency Scaling (DVFS) scheme. We have simulated our proposed algorithm on the CloudSim Toolkit. We have compared our power-conscious virtual machine provisioning scheme with non power aware policy, and two power aware policy DVFS and SingleThreshold, and got significant improvement in terms of power consumption.t

Keywords : Cloud Computing, Virtual Machines, Energy-Efficient Computing, DVFS

I. INTRODUCTION

Rapid developments in computing and communication technologies has led to the emergence of a new computing paradigm called Cloud computing, which delivers computing services to users as utilities in a pay-as-you-go manner. Cloud providers offer various types of services, such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Service providers make use of IaaS and PaaS to deploy their services without concerns about management of physical resources. Under the Cloud computing model, users can access on-demand and pay-per-use services deployed anywhere in the world. One of the big challenges in data centers is to manage system resources in a power-efficient way. Data centers consume from 10 to 100 times more power per square foot than typical office buildings [1]. They can even consume as much electricity as a city [1]. The main part of power consumption in data centers comes from computation processing, disk storage, network, and cooling systems. Lowering the power usage of data centers becomes a challenging issue as computing applications and data are growing so quickly that increasingly larger servers and disks are needed to process them within the required time [2]. Thus, data center resources need to be managed in a power-efficient manner to drive Green Cloud computing [2].

To meet the growing demand for their services and ensure minimal costs, Cloud providers must implement power-efficient management of physical resources. Furthermore, as many applications require deadline constraints, power consumption in data centers must be minimized without violating the SLAs. Our aim is to design power-conscious policy for management of services. The main contributions are: (i) A Cloud service framework for requesting a virtual platform for use applications (ii) Power-conscious VM provisioning scheme based on Dynamic Voltage Frequency Scaling (DVFS) for cloud services.

II. Related Study

Many of recent research works have focused on reducing power consumption in cluster systems.

Chase et al. [3] have aimed at serving web-applications in homogeneous clusters according to a utility function. Gandhi et al. [4] have investigated the problem of minimizing the mean response time of web-applications on heterogeneous clusters. In this work the optimal energy allocation is determined based on a theoretical queuing model.The recently emerged Cloud computing paradigm leverages virtualization of computing resources and allows the achievement of more efficient allocation of the workload in terms of higher resource utilization and decreased power consumption [1]. Kusic et al. [5] have investigated the problem of minimizing both power consumption and SLA violations for online services in virtualized data centers using a limited look-ahead control. In addition, many studies have focused on power-aware real-time applications in clusters. Rusu et al. [7] have developed a QoS-aware power management scheme by combining cluster-wide (On/ Off) and local (DVFS) power management techniques in the context of heterogeneous clusters. The front-end manager decides which servers should be turned on or off for a given system load, while the local manager reduces power consumption using DVFS.Wang et al. [8] have proposed a threshold-based method for efficient power management of heterogeneous soft real-time clusters as well as an offline mathematical analysis for determining the threshold. Buyya et al. [9] have presented their vision, challenges, and architectural elements for energy-efficient management of Cloud computing environments with consideration of QoS expectations.

III. Dynamic voltage frequecy scaling

Dynamic voltage frequency scaling (DVFS) is accepted as a technique to reduce power and energy consumption of microprocessors [14]. Lowering only the operating frequency fclk can reduce the power consumption but the energy consumption remains the same because the computation needs more time to finish. Lowering the supply voltage Vdd can reduce a significant amount of energy because of the quadratic relation between power and Vdd as given by P= C *V2dd* f . Lowering the supply voltage and operating frequency reduces the power and energy consumption further. Figure - 1 shows the power saving achievable by using variable Vdd.

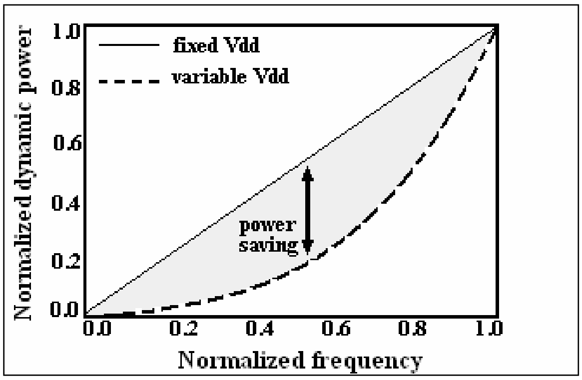

Figure .1 Power saving achievable by Using variable Vdd

When the clock frequency fclk is reduced by half, this lowers the processor's power consumption and still allows task to complete by deadline, the energy consumption remains the same. Reducing the voltage level Vdd by half reduces the power level further without any corresponding increase in execution time. As a result the energy consumption is reduced significantly, but the appropriate performance is remained . This is shown in Figure 2.

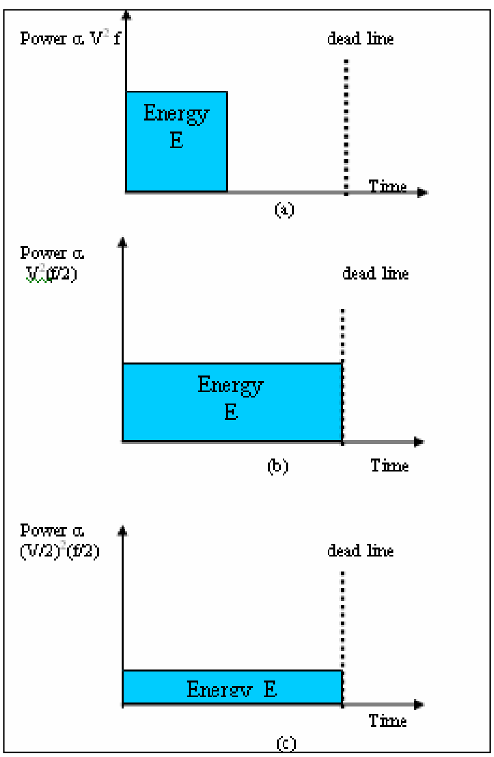

Figure.2 Energy consumption vs. power consumption

IV. Power Model

The main part of power consumption in data centers comes from computation processing, disk storage, network, and cooling systems. Our work focuses on reduction of CPU power consumption using power-conscious VM provisioning in Cloud computing environments.

The most of power consumption in CMOS circuits is composed of dynamic and static power. We only consider the dynamic power consumption, as it is the dominating factor in the total power consumption and can be managed using Dynamic Power Management Techniques (DPM). Cloud providers can increase their profit by reducing the dynamic power consumption.

Dynamic power consumption of a processor is given by equation (1).

***P= C * V²dd * f* (1)**

C= coefficient of proportionality
Vdd =Supply voltage
f =Frequency
Since the frequency is usually in proportion to the supply voltage, the dynamic power consumption of a processor is defined in equation (2).

$P = C \cdot f^3$ (2)

where C is a coefficient of proportionality.

Let us consider an application with the execution time t running at a CPU with the frequency fmax. If the processor runs at the frequency level f (0 < f <= fmax), the execution time is defined by t/ f/fmax.

Thus, the dynamic power consumption during the task execution is defined as in equation (2).

$$E = \int_0^{t/\frac{f}{fmax}} P\,dt = C.t.fmax.f^2 = \propto .t.S^2$$

where α is a coefficient and S is the relative processor speed for the frequency f (S =f/fmax). If s=1/2, t=2x (The lower the freq, the longer the time)

The DVFS scheme reduces the dynamic power consumption by decreasing the supplying voltage and frequency, which results in a slowdown of the CPU and increased execution time. We assume that each PE (Processing Element) p in a datacenter can adjust its processor frequency from fmin to fmaxp continuously. The relative processor speed S for each frequency f is defined by f/fmax, where fminp /fmaxp < S ≤ 1.

V.Frame work of VM provisioning
The steps taken by a user to execute a service are as follows.

(1) Requesting a virtual platform:
A user who wants to launch a service submits all the information about the applications to the broker.

(2) Generating a VM from set of applications:
The resource broker first analyzes the submitted applications and generates one VM request, Vi = (ui,mi, di).

(3) Requesting a Virtual Machine VM:
The broker requests a VM for VM Vi from the VM provisioner of a Cloud computing environment.

(4) Mapping physical processors:
The VM provisioner finds appropriate processing elements that meet the Vi requirements and provides the VM to the user.

(5) Executing the user applications:

The user launches and executes the applications using the provided VM.

VI. Proposed algoritham
When a data center receives a VM request from a resource

broker, it returns the price of providing the VM service if it can provide VMs for that request. The broker selects the minimally priced VM among available data centers. Thus, the provisioning policy is to select the processing element with the minimum price for the sake of users.

Following shows the pseudo-code of the algorithm for provisioning a VM for a request.

For a given request for VM Vi(ui,mi, di), the data center checks the schedulability of Vi on the processing element PE_k of Q_k MIPS rate. The schedulability is guaranteed if the total summation of all the required MIPS rates including the new VM Vi is less than the processor capacity Q_k.

Algorithm: MinPower VM Provisioning (V_i)
Input :
Request for virtual machine with parameters

$V_i(ui\ ,\ mi\ ,\ di)$

Output:
Allocated Virtual Machine which consumes less power and with minimum price

1. VM := null;
2. alloc := −1;
3. energymin := MAX VALUE;
4. Price_VMmin:= MAX VALUE;
5. N := Total no of Hosts in Data Centre;
6. K := Current Host ;
7. for K from 1 to N do
8. if Required MIPS of new VM + Sum of minimum MIPS rate of VMs by dead line <= Qk) then
9. ek:= energy estimate (PEk , Vi);
10. pricek := price for the VM Vi in PEk;
11. if pricek < Price_Vmmin or (pricek = Price_Vmmin and ek<energymin) then
12. Price_VMmin := pricek;
13. energymin:=ek;
14. alloc:=k;
15. endif
16. endif
17. endfor
18. if alloc is not equal to −1 then
19. VM:=create VM (PEalloc,Vi);
20. endif
21. return VM;

The provisioning policy is to provide a lower price to users, the algorithm finds the minimally priced processor. For the same price, less energy is preferable because it produces higher profit

VII. SIMULATION AND RESULT
We have used Cloud Sim 2.0 toolkit for the simulation purpose and considered following three major scenarios for showing the result.

Scenario-1 250(Host),700(VM),800(REQUEST)
Scenario-2 500(Host),4000(VM),4000(REQUEST)
Scenario-3 1000(Host),5000(VM),6000(REQUEST)

We have worked with one datacenter. We took up with 250,500,1000 host on this datacenter which in turn is running 700,4000,5000 virtual machines on those hosts respectively.

Each node comprises of one CPU core with 10000 MB ram,100000 network bandwidth and storage space of 1TB. The host comprises of 1000, 2000, 3000 and 4000 MIPS accordingly. For each virtual machine on host MIPS Rating is 250,500,1000,1200 respectively. No of CPU core is 1,ram size if 128,bandwidth size is 100Mbits/s with VM size 2500 MB Initially the VMs are considered to be utilized by 100% of time.

We have considered same scenarios for one non power aware (NPA) policy and two power aware policies DVFS and Single Threshold(ST). And by comparison we have found that our MinPower policy gives 33.62 % better result than Non Power Aware policy. And it gives 7.43% better result then DVFS policy and 9.92 % better result than Single Threshold.

Scenario	Policy – Energy Consumption in Kwh				Improvement in %		
	NPA	DVFS	ST	MinPower	NPA	DVFS	ST
S1	22.74	10.98	12.81	8.75	14.16	2.23	4.23
S2	45.83	23.73	25.59	17.13	28.7	6.6	8.46
S3	92.01	47.46	51.06	33.99	58.02	13.47	17.07
Average Improvement Compare to MinPower Policy					33.62	7.43	9.92

Table-I Comparison Table

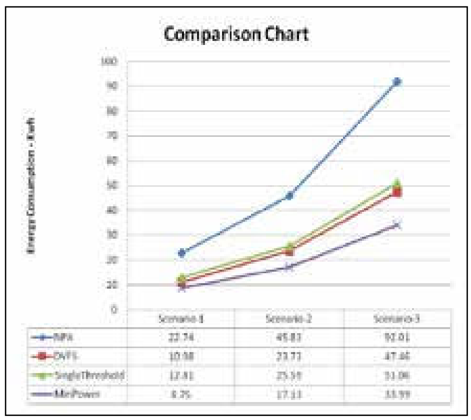

Figure-3 Comparison with other Policies

VII. Conclusion and Future Work
From our study we conclude that pproposed energy conscious VM provisioning scheme approximately gives average 33.62 % better result in terms of power consumption than Non power aware policy and gives 7.43% and 9.92% better result than DVFS and SingleThreshold respectively. Considering the lower no of hosts and Virtual machines it is giving approximately same result in terms of energy consumption.. Which profits the data centres, hence service provider at the same time user has to pay minimum in case of same energy consumption on service.

For our future work, we can consider the same algorithm with certain modifications for the soft deadline service as proposed algorithm is deadline constrained.

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