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Scheduling Virtual Machines across Data Centres in accordance to availability of Renewable Sources of Energy

G Krishna Vasudeva Rao, K Premchand
Department of CSE,GITAM University
g.vasu1215@gmail.com
Department of CSE, GITAM University
premahesh9@gmail.com

Abstract— This paper presents a whole new concept or approach for Green Computing or Environment friendly computing. Model of cloud computing has enabled convenient and ubiquitous network access to a shared pool of configurable computing resources that can be quickly provisioned and released with minimal interaction with the service providers. In this paper we have developed an algorithm which will migrate virtual machines in data centres in accordance to the availability of non-conventional and renewable sources of energy i.e. wind energy, hydro power, solar power, geothermal power & etc. The proposed migration algorithm is general in nature but goes beyond conventional approach of best fit heuristic. Experimental verification shows the ability of the VMs to migrate it in accordance to the availability of different sources of renewable energy.

Keywords— cloud computing, green computing, migration, allocation, renewable sources of energy.

INTRODUCTION

Clouds and Datacenters approach for providing ubiquitous computing is falling for its own fancy. Cloud revolution induced a tremendous rise of electricity consumption, elevating data center ownership costs and increasing global carbon footprints. That is why nowadays, data centers have inherent capabilities to monitor and probe like intelligent power distribution units(PDUs) to achieve higher energy efficiency and reduced overall cost.

According to World Energy Outlook report electrical energy consumption is set to rise about 76% for next 15-16 years with data centers having a lion's share. This very study provoked us to consider reliable options and alternatives to the existing models which are not so eco-friendly. Further Gartner report states that an average Data Center consumes as much energy as 25000 households, and according to Mckinsey report, "The total energy consumption of Data Centers round the world in 2010 is 11.5 billion units and energy costs in a typical data center double every five years". We opine that due to rapid rise of cloud computing technologies will shrink the time span and rate of growth would be exponential.

Our foremost goal must be to minimize the global energy bill through energy and ecology conscious designs of data centers hardware and software, the use of photovoltaic energy, relying on renewable energy sources and more energy proficient cooling systems. Second thought must be on more modest contribution towards energy efficient green cloud-computing infrastructure by introduction of energy efficient and aware scheduling algorithms with enhanced resource management. As we know cloud data centers keeps on guzzling electrical energy especially if they turned on even if they are not in use. According to a report in Technology Review an idle server consumes approximately 70-75% of its consumption during its peak workload. This wastage of electrical power is considered as a major cause of inability of conservation of valuable power.

In this paper our major contribution is towards reduction of such wastage or excessive energy consumption using energy aware allocation and migration algorithms to maximize the number of idle servers and then putting those servers into sleep mode. Cloud Computing 2015 Vision by the leading company Intel states the need of dynamic resource handling and scheduling approaches to improve power efficiency of data centers by switching off and putting to sleep idle servers. In our work we have proposed an algorithm using classical solution of the bin packing algorithm. This algorithm aims to reduce the number of used servers and equivalently maximize the number of idle servers to put into in sleep mode. A linear integer programming algorithm is used to account workloads and service times.

The proposed concept is an electrical energy consumption aware virtual machine scheduler and can be used to enhance current infrastructure managers and schedulers such as OpenNebula and OpenStack. The power consumption parameters can be provided by energy consumption estimation tools such as joule meter. Cloud Simulator named CloudSim is used to assess the performance. Evaluation results show that migration is quite possible and has a pretty good impact on environment if

implemented successfully across the globe by global giants like Google, Facebook, Microsoft, Oracle, VMware, Apple and Salesforce as they have adequate intellectual and financial capital to take up projects like this at the global scale.

SYSTEM MODEL

Our model considers cloud service providers allocating physical resource instances to host user's and applications from tenants equivalently for these paper VMs. The physical resources are seen as servers. We have assumed that applications are packed into virtual machines to be hosted by the infrastructure providers. The cloud service providers reduce power consumption and energy is saved by packing and consolidating through maximization of number of idle servers to be put into sleep mode through migration. It is shown as in the figure below.(figure 1)

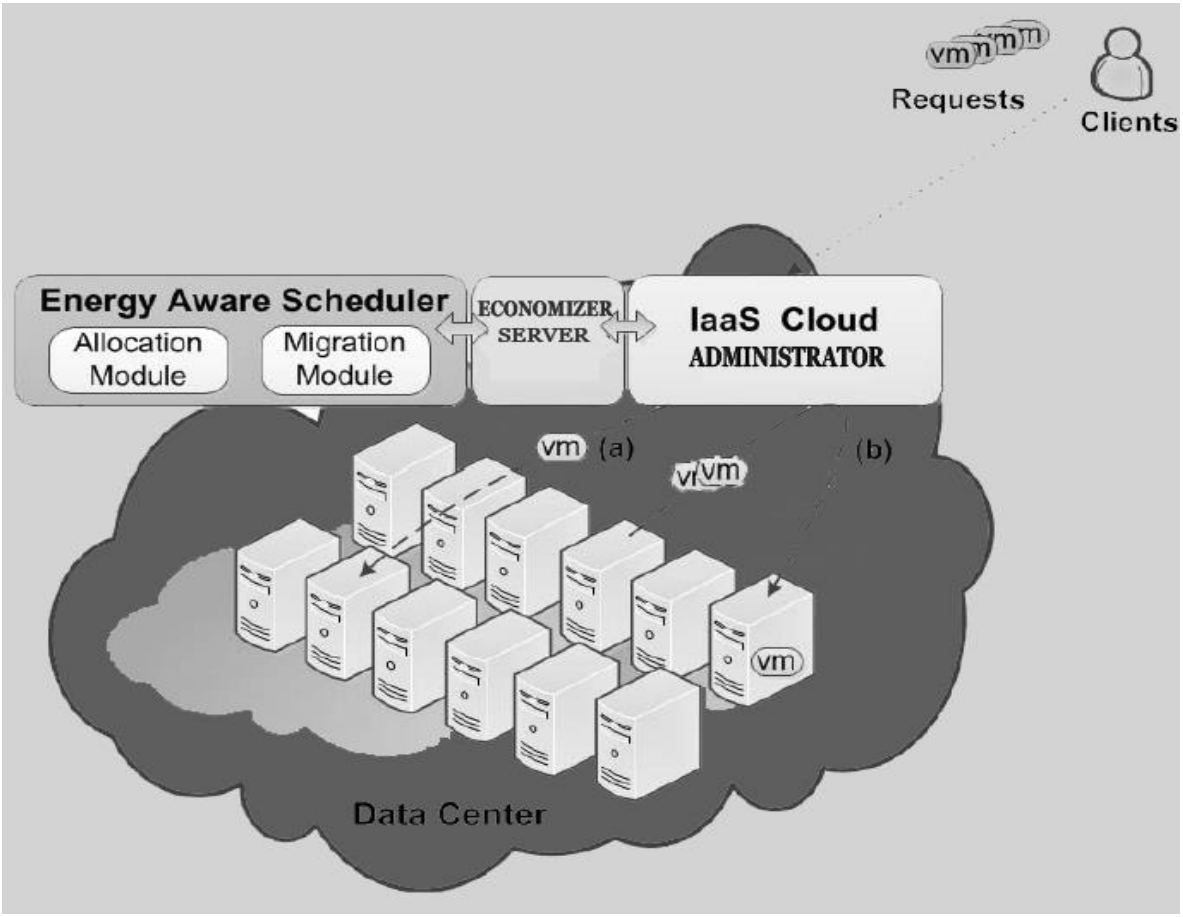

Figure 1 – The System Model

There are many companies who have made significant strides in virtualization, migration, allocation and load balancing of virtual machines in cloud scenarios. VMware corporation, Oracle, EMC & Amazon to name a few.

Products like Eucalyptus, Open Nebula, Open Stack are used to control and manage clients' requests and cloud resources(such as fetching and storing VM images) as Infrastructure as a Service(IaaS) managers.

Economizer server module is an important module between the energy-aware scheduler and cloud infrastructure administrator. It calculates how economic is to place a virtual machine into a particular datacenter.

Energy-aware VM scheduler is responsible for the energy aware VM migration and allocation in the data center. Main focus of the scheduler is on the allocation of VMs once they have requested and then migrating the respective VMs to the assigned datacenters.

RELATED WORK

There are numerous papers written by number of authors worldwide on such or similar topics to reduce the number of physical machines to switch off machines in surplus. Their approach differ from ours because of following :

a) Consolidation is achieved at the task level, rather than the virtual machine level or infrastructure as a service level, migration and allocation is also static as compared to our dynamic placement according to workload where we apply migration to reallocate Virtual Machines(VMs).[5]

b) In another address policy for dynamic virtual machine reallocations using VMs migration according to CPU performance requirements. They have also proposed a double threshold policy, is based on the idea of setting upper and lower usage threshold for hosts and keeping the total utilization of the CPU of all the VMs between these thresholds. If the CPU usage of the host machine exceeds the upper threshold, some VMs are migrated and if it fall below the lower one then all the hosted VMs should be migrated.[6]

c) Others treat the problem of consolidating VMs in a server by migrating VMs with stable and steady capacity needs. Authors have proposed an exact formulation based on a linear program described by a small number of inequalities.[7]

d) Some authors claim server consolidation(SerCon) algorithm which has minimizing the number of nodes in a data center and minimizing the migrations at the same time.[8]

e) In [9], authors presented an approach EnaCloud for dynamic live placement taking into account energy efficiency in a cloud platform. The authors proposed an energy-aware heuristic algorithm in order to save energy by minimizing the number of running servers. Another study relating to the dynamic resource allocation is presented in [10]. The authors presented a nature inspired VM consolidation algorithm inspired from an Ant Colony Optimization. This algorithm aims at reducing the number of used physical machines and thus saves energy.

These above mentioned work and research by scholars round the world compel me to take it to the next level of sophistication with a simple constructive goal "To protect Environment without hurting human progress."

PROPOSED SOLUTION

Here through this paper we want to propose a unique concept of scheduling the workload in the form of virtual machines in accordance to the availability of non-conventional sources of energy. As shown in the figure below the solar energy availability is higher at the daytime, so the workload(virtual machines) will be shifted to datacenters which are powered by solar energy and other datacenters are made idle and eventually shutdown to save power.

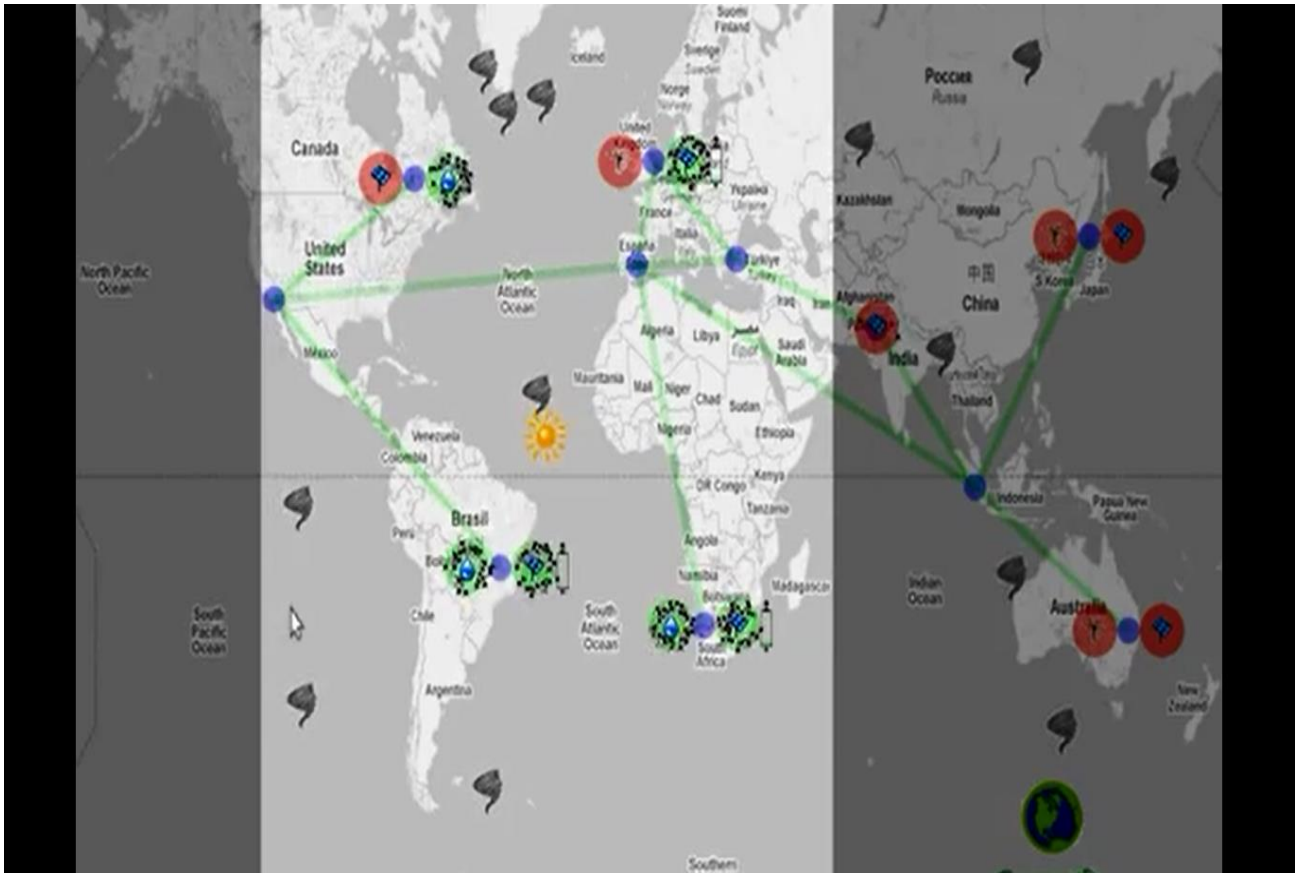

Figure 2- Showing movement of earth during Day & Night

Bin-Packing VM allocation model can be summarized by lumping the objective function with all the constraints and conditions and constraints into the following set of equations:

$$\min Z = \sum_{j=1}^{m} e_j$$

Subject to:

$$\sum_{i=1}^{n} p_i x_{ij} \leq P_{j,Max}\, e_j - P_{j,Current}\,, \quad \forall_{j=} 1,2,3 \ldots\ldots, m$$

$$\sum_{j=1}^{m} x_{ij} = 1, \forall i = 1,2,3 \ldots\ldots, n$$

$$\sum_{j=1}^{m} e_j \geq \frac{\left[\sum_{j=1}^{m} P_{j,current}\right]}{P_{j,Max}}$$

$e_j = 1$, if the server j is used

$e_j = 0$, otherwise.

$x_{ij} = 1$, if the VM_i is placed in server j

$x_{ij} = 0$, otherwise.

All the parameters, constants and variables used in this aforementioned model are listed for easy reference below:

- n is the number of requested virtual machines.
- m is the number of servers in the particular data center.
- pi represents the power consumption of virtual machine 'i'.
- xij is a bivalent variable indicating that virtual machine 'i' is assigned to a physical server 'j'.
- ej is an indication whether the physical server j is used or not.
- Pj,Max represents the maximum amount of power consumed by the physical server 'j'.
- Pj,current represents the amount of power consumed of the physical server 'j' at the current state (Pj,current = Pj,idle $+\sum_1^k P_k$ with VM_k hosted by server 'j').
- Pj,idle indicates the power consumed by the physical server j when it is idle.

CONCLUSION

In this paper VM placement problem across the cloud providers' data centers is explored. As we know that it's a NP hard problem. Algorithm which we have proposed are efficient VM migration algorithm to reduce energy consumption via consolidation. Energy savings are pretty significant depending on the system loads. It is observed and well understood that gains can be pretty significant at low loads. Although at high loads, even if the gains are much lower, still its sufficiently valuable using the algorithms proposed.

Environmental degradation will cause permanent damage to the lonely inhabitable planet in the known universe. It must be our earnest responsibility to save our mother 'Earth' from irreversible damage we may cause because of our careless overutilization or misutilisation of the resources in our hands. Currently, very little of the world's power is from renewable sources like wind, tidal and solar. We should be working on changing that by fetching electrical power directly from wind & solar farms near the data centers. We should also working with the power utility partners to find solutions that will make more renewable energy available for the datacenters. All of these initiatives will help us to get clean energy at competitive prices and the wind & solar farm owners get the money they need to finance new clean energy facilities. Together we can make the world a bit greener.

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