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Energy Saving by Virtual Machine Migration in Green Cloud Computing

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ABSTRACT

Nowadays the innovations have turned out to be so quick and advanced that enormous all big enterprises have to go for cloud. Cloud provides wide range of services, from high performance computing to storage. Datacenter consisting of servers, network, wires, cooling systems etc. is very important part of cloud as it carries various business information onto the servers. Cloud computing is widely used for large data centers but it causes very serious issues to environment such as heat emission, heavy consumption of energy, release of toxic gases like methane, nitrous oxide, carbon dioxide, etc. High energy consumption leads to high operational cost as well as low profit. So we required Green cloud computing, which very environment friendly and energy efficient version of the cloud computing. In this paper the major issues related to cloud computing is discussed. And the various techniques used to minimize the power consumption are also discussed.

Keywords: *Cloud computing, green cloud computing, virtualization, resource allocation, VM migration etc*

1. INTRODUCTION

The increasing demand of large processing is handled by data centers by providing sharing computations and system resources to fulfill services over the internet. Cloud is a collection of virtual computer resources and very high capacity storage devices. Various third-party service providers manage the data sharing of these remote resources among the end users. They provide access to the high speed network and resources by providing variety of cloud services. As the large number of computers are linked together via shared network to create cloud, cloud computing is also called "a network oriented computing" [1].

Various services provides by cloud:

i. Infrastructure as a service (IaaS): This provides use and pay facility to users. The system resources are shared to users by various vendors. The client can manages OS, system storages, network connection, application software etc.
ii. Software as a service (SaaS): Based on the user/client requirement, the available software on the cloud is given to that client. The clients pay for services as they use.
iii. Platform as a service (PaaS): It allows the clients to use the platform so they can store their own or personal software as well as applications on the subscribed cloud [7].

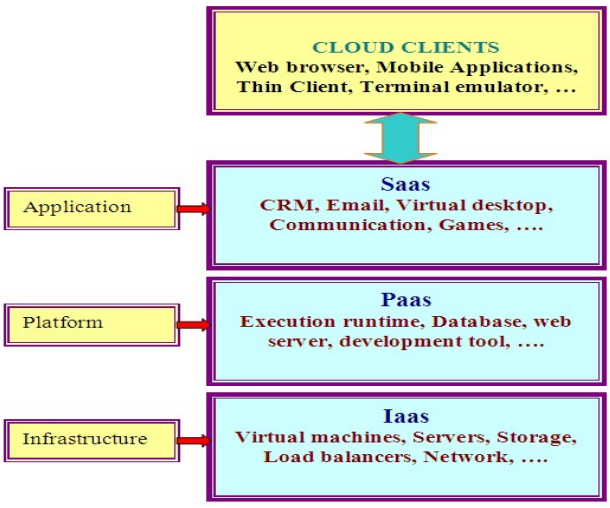

Fig 1- Cloud services [3]

2. Requirement of green cloud computing

With the expanding interest of online administrations in each territory, the need of distributed computing is

expanding quickly. With this expansion, the need of more servers increments. Along with this it also increases energy requirements. The measurement shows that an ideal server makes use of around 70% of its energy which is total waste [8].

Hence it turns out to use the energy in efficient manner. The green processing or computing utilizes the administrations of distributed cloud computing in proficient way. It uses the system resources in an eco-accommodating and proficient way. In the present pattern in IT businesses, going green has turned into a motivation for advertising and to lessen the various costs. One of the best approaches to accomplish the energy efficient model is the Virtualization.

3. Problems related to cloud computing and need of green cloud computing

With the fast going life, everyone is using computer applications and different IT services. This leads in more power consumption and ends into emission of toxic gases like carbon dioxide and into the environment. The data centers needs more power for processing and also consume power even they are idle. If the proper cooling mechanism is not used then due to heat consumption it will lead to loss of whole energy. Due to adoption of cloud computing more issues arise which leads towards the use of green cloud computing. Main considerations which are in charge of the move from cloud to green cloud are:

3.1 More power consumption

To provide high processing power, the largescale datacenter needs very large amount of energy. This energy consumes big portion of the total cost of operation [9]. According to the research done by Gartner, this energy occupied 10% of total cost which may be increased to 50% in upcoming future. Another research is also done that an idle datacenter occupies nearly 70% of its peek energy which is also very sensitive matter as it decrease the efficiency of the datacenters. As per Gartner report, an average datacenter occupies very large amount of power which is more than enough to serve nearly 25000 homes as a power source [10].

3.2 Generation of heat

It is extremely important to decrease the measure of energy required to create and manage the cloud. Large amount of power consumption generates heat which should be maintained at minimum level by applying some cooling techniques to the datacenters. Approximately 70% of produced heat is because of large scale infrastructure used to build cloud. Any failure regarding maintenance of datacenters affect the reliability of the datacenter which may break SLA between cloud vendor and customers [11].

3.3 Emission of toxic gases

The excess processing at datacenters also creates problem regarding emitting out vary toxic and harmful gases like carbon dioxide and another carbon compounds which leads to global warning. So this should be minimized to keep our environment neat and clean.

3.4 Security

If any technology is scalable enough then only it is useful else it will break at some point as it cannot fulfill users' incrementing demands. Along with scalability it also provides integrity and security. Cloud computing require resource management through proper connection/network channel between the users. Using virtual machine concept, multiple users of same machine can share network. This requires highly secure channel otherwise it will affect the integrity of the data being transmitted on that channel.

Due to above and many more other factors, the present cloud concept should be modified. So Green computing is a solution with which we can create environment-friendly as well as energy efficient computing system.

4. Green computing

The term "Green figuring" implies practicing environmental safety with computer frameworks. This mainly focuses on creating various peripherals, processors and servers of the datacenters energy efficient by using minimum system resources and doing optimum e-waste management. So design, development, usage and waste management of the entire physical component etc. are very environment-friendly and highly efficient with green computing [6].

It attempts to minimize the power consumption and carbon dioxide emission. So we can say that green computing aims to create whole computer system

with different software services at very low cost and low power consumption to maintain eco-friendly environment.

5. Strategies and solutions to reduce energy usage : Making cloud more green

To make the distributed cloud computing more ecology friendly the examinations have been done on principally three methodologies. The approaches that are applied to the datacenters are [12]:

5.1 Dynamic Voltage Frequency Scaling (DVFS)

Every last electronic circuit works on their clock signal. By adjusting this clock frequency we can manage the input voltage of the circuit but it considers the characteristics of the hardware. It cannot handle the dynamic nature of requirement so power saving will be less compared to other techniques. Another reason of being less popular is that it is only applied to CPU, not applied to another component of the system. To reduce the total power consumption the idle servers can switched to sleep mode.

5.2 Algorithms

It is practically proved that an idle datacenter occupies nearly 70% of its peek energy. The prediction using neural network and green scheduling algorithms identifies the approximate dynamic workload of the server. So we can shut down the unoccupied servers to minimize the total energy usage. To fulfill the SLA sometimes some extra servers need to be added. So the green algorithms should be capable enough to minimize cost, power consumption and should be environment-friendly by ensuring quality of services.

5.3 Dynamic resource allocation

Various virtual machines can be handling by physical machine upon which different applications can be run. In cloud, for load balancing these virtual machines are transferred to another host with lower load. This can happen because of dynamic nature of user requirements or non-availability of system resources. While transferring/migrating the virtual machine (VM) the care should be taken that it won't lead to more power consumption. So VMs are migrated among the processing nodes which are power efficient. This method is discussed in detail latter.

6. Proposed approach

The datacenters located at different location has unique carbon footprint rate according to various energy resources. Following equation gives carbon footprint for particular cloud with d datacenters which consists of c clusters having total n hosts and time period is [0,t] :

$$CF = \sum_{t=1}^{T} \sum_{i=1}^{d} (PUE(i) \times \sum_{i=1}^{c} (cf(j) \times k=1hPvmi,j,k,t \times ht)) \quad (1)$$

Here,
CF = carbon footprint of the cloud
PUE = power usage effectiveness and PUE is the ratio of total power consumption to that by IT devices.
ht = holding time for virtual machine (*vm*)[4].

When there is a requirement for any resource it is forwarded to host having enough RAM, CPU, processing elements as well as storage. This procedure can be done in two simple steps:

Step-1:
Broker of the cloud maintains the repository of datacenters containing details about carbon footprint rate. Receiving upon any request the broker will transferred it to proper host having minimum rate after visiting the repository.

The algorithm to allocate VM to the carbon efficient datacenter is given bellow:

1. Request for VM
2. Retrieve information about datacenters from repository
3. Retrieve all available hosts in the cloud
4. Make a list of hosts fulfilling VM requirement
5. Select most efficient host and allocate the host to VM

Step-2:

The actual migration takes place in second step. Depending upon the present state of the host, it is migrated to such host having underutilization of workload. When a certain host crosses upper

threshold value of CPU utilization, some VMs are migrated to another host and if host goes underutilization then all VMs are migrated to another host leaving underutilized host in sleep mode. The minimization of VM migration approach [5] helps to select minimum number of VM to be transferred.

The selection of VM is carried out based on following formula:

$$R = \begin{cases} \left\{ \begin{matrix} S|S \in P(Vj), Uj - \\ \sum_{v \in S} Ua(v) < Tu \end{matrix} \right\}, & if\ Uj > Tu; \\ Vj, & if\ Uj < Tl; \\ \emptyset, & otherwise \end{cases} \quad (2)$$

Where

Tu = upper threshold of utilization

Tl = lower threshold of utilization

Vj = VMs at j^{th} host

Uj = CPU utilization of j^{th} host

Ua (v) = CPU utilization of VM v

Ur (v) = CPU capacity requested for VM v

The modified best fit decreasing (MBFD) algorithm makes the list of all VMs by sorting them based on their CPU usage in descending order. This algorithm makes mapping between the hosts and VMs such that it reduces the power consumption. The selected VMs which are required to migrate are placed by using MBFD algorithm [5].

7. Conclusion

In this paper basics of cloud computing, its current problems and how it can be eliminated by introducing the concept of green cloud computing is discussed. The proposed technique for allocation of resources and migration of VM in datacenters reviews the carbon emission rate of the datacenters. So far a minimal work is done to minimized power consumption keeping system efficient, reliable, secure etc. and more attempts are required in this critical issue as it affects the environment so our life too.

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