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Energy Efficient Power Management in Virtualized Data Center

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Abstract - *We know that in future Cloud computing has many scope for data storage, processing and security of data. Hence for that we establish the numerous amount of data center for data storage. For establishing the data center we require many servers for data processing. Hence the server will consume more power. So the main goal of the next generation Cloud computing is to reduce the power consumption. Cloud computing infrastructure is highly scalable as user uses this infrastructure for large amount of data storage and processing. The resource management is also an essential part for Cloud computing to define its efficiency. Using virtualization we virtually use the Cloud application on our system and in that we introduce some less power consumption technique to create efficient data storage by utilizing the power management system. As we know that by using virtualization we improvise the performance of the datacenters. By using live migration or resource scheduling we can improve the efficiency of the data center and build an efficient data center which consumes less power. Finally, we will discuss the different algorithm for the resource selection and VM migration and calculate the total power consumption. For future work we enhance the virtualization to develop the energy efficient data center.*

Key Words*: *Cloud computing, virtualization, energy efficient Data center, Power consumption, CloudSim

1. INTRODUCTION

The Information Technology has grown with the growing of the new technology for that new computing is established and that is Cloud computing. Cloud computing is nothing but to acquire the required resource from internet through the network which is termed as Cloud computing. Cloud is just representation of internet. They are two side processes. One service provider is provided the resources to the consumer or user via internet. Second one is consumer will pay for used resources. Cloud computing is just like the internet. The two main parameters are used in Cloud computing: 1) abstraction 2) virtualization. Abstraction means the detail of the implementation is hiding from the user. The administration process is hiding from the user they just use the application which is available to the internet or Cloud. Virtualization means the resources is virtually available to the user. In Cloud computing the resources which is used by the user is not residing in the computer. Cloud provides the platform to store the data, process the data and optimize the system resources.

1.1 Cloud Computing

Cloud computing is just like an internet. The Main Objective of Cloud computing is to provide resources to the consumer through an online. Some characteristic of Cloud Computing are:

Rapid Elasticity and Scalability: Easily access the system resources whenever you require resources is to scale up or down as per the user requirement.

On-Demand Self Service: Easily request the required amount of resources, storage, and hardware from Cloud service provider.

Cloud service APIs: Provide standard interface to connect the two systems.

Metered service: Based on the concept of pay and use.

Service Management Environment: The environment to maintain and manage the service level.

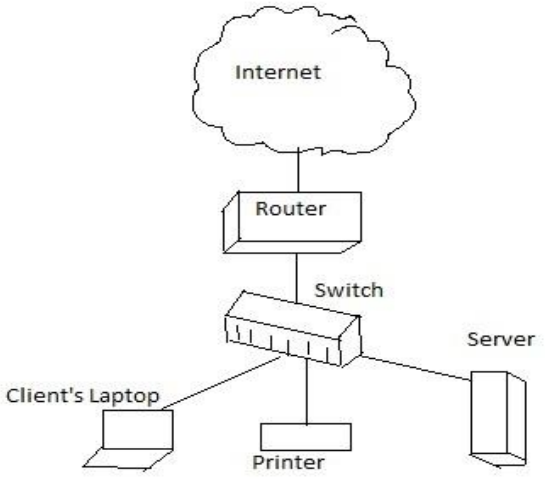

Fig-1: Cloud Computing

Advantage:

- Organization has no need to invest in the system or resources for their maintenance so it will reduce the cost.
- No need to buy the license for the Software if available on the Cloud environment.
- Provide the outsourced IT management.
- Assure the desired level of Quality of service to the customer.
- Allow to access the latest version of the software.
- Reduce the cost, if optimize the system resources.

Disadvantage:

- Cloud computing requires an always on and stable Internet connection: Cloud computing is impossible if you cannot connect to the Internet.
- Does not work well with slower-speed connections: if reliable connection is not established then it will not work properly.
- Not work properly with the printer: More problems with the printer.

1.2 Virtualization

The concept of virtualization is familiar word with the operating system. In Cloud computing environment virtualization is used by creating the virtual environment where virtual version of system is available. In virtualization, it develops a virtual machine (VM) similar to the Physical machine. The virtual machine is designed in such a way that it is used to support the function of complete operating system and the physical machine is designed in such a way that it supports the single program execution.

In system, virtual machine is providing the complete environment for the multiple operating systems. The virtual machine is executing the single application on a single physical machine.

Why Virtualized?

With increased server provisioning in the datacenter, several factors play important role in the stifling growth. Increased power and cooling costs, physical space constraints, man power and interconnection complexity all contribute significantly to the cost and feasibility of continued expansion. Commodity hardware manufacturers have begun to address some of these concerns by shifting their design goals. Rather than focusing solely on raw gigahertz performance, manufacturers have enhanced the feature of CPUs and chip sets to include lower wattage CPUs, multiple cores per CPU, advanced power management, and a range of virtualization features. By employing appropriate software to enable these features, several advantages are realized:

Server Consolidation: By combining workloads from a number of physical hosts into a single host, a reduction in servers can be achieved and a corresponding decrease in interconnect hardware. Traditionally, these workloads would need to be specially crafted, partially isolated and well behaved, but with new virtualization techniques none of these requirements are necessary.

Reduction of Complexity: Infrastructure costs are massively reduced by removing the need for physical hardware, and networking. Instead of having a large number of physical computers, all networked together, consuming power and administration costs, fewer computers can be used to achieve the same goal. Administration and physical setup is less time consuming and less costly.

Isolation: Virtual machines run in sand-boxed environments. Virtual machines cannot access the resources of other virtual machines. If one virtual machine performs poorly, or crashes, it does not affect any other virtual machine.

Platform Uniformity: In a virtualized environment, a broad, heterogeneous array of hardware components is distilled into a uniform set of virtual devices presented to each guest operating system. This reduces the impact across the IT organization: from support, to documentation, to tools engineering.

Legacy Support: With traditional bare-metal operating system installations, when the hardware vendor replaces a component of a system, the operating system vendor is required to make a corresponding change to enable the new hardware (for example, an Ethernet card). In an operating system ages, the operating system vendor may no longer provide hardware enabling updates. In a virtualized operating system, the hardware remains constant for as long as the virtual environment is in place, regardless of any

changes occurring in the real hardware, including full replacement.

2. PROBLEM DEFINATION

As the internet users are increasing day by day, data storage necessity has raised the data center requirement which is growing faster so that they require more power for the maintenance. Cloud data center consumes huge amount of electrical energy henceforth resulting in the high operating cost and carbon dioxide emission in the environment. We all know that in today's world we have a very limited resource of the energy. Hence power consumption is very harmful economically and environmentally. Today size of the data center is highly increasing so the power management is very essential. The main goal of this dissertation is to minimize the power consumption in data center and to improve the performance level of the Cloud environment. The Cloud computing performance is increased when the power consumption level is reduced. So, the main purpose of this dissertation is to minimize the power consumption of datacenters and to create the energy efficient power management in Cloud environment.

3. PROPOSED WORK

Audy Al-Dulaimy, defines that power consumption is of two type static power consumption and dynamic power consumption. Static power consumption means the power consumed by the system component for example transistor and processor technology and Dynamic power consumption means the power consumed by usage of the system components for example short circuit current and switched capacitance. Anuj Prasher, have studied two technologies for reducing the power consumption 1) VM migration 2) VM placement. In VM Migration the two systems can migrates the VM using their load for efficient utilization of server and in VM placement it will replace the VM for reducing the power consumption. Virtualization technology allows one to create several VMs on physical server thereby reducing the amount of hardware in use. Various techniques for effective resource utilization have been proposed and some of which has been summarized in a tabular form below.

Table -1 Comparative analysis of Research Paper

Paper Title with reference no	Purposed technique	Goal	Limitation
Power management in virtualized data center[1]	Static and dynamic power consumption	Minimize power consump-tion	Does not consider the cost of cooling
Minimize the power consumption and improve the QoS in data center[2]	VM selection approach	To improve the QoS	Does not include the VM migration and allocation and throttling
Power saving strategies in cloud computing system[3]	Basic VM power saving technique used	To save the power	Less focus on labor cost
Power management technique for data center[4]	DVFS,VM consolidation	Improve the power efficiency	Less focus on to performance and cooling domain, balancing
Energy efficiency through virtualization [5]	virtualization	Improvise the efficiency of data center	Implementat ion will differ from experiment-al and real system

4. OPEN ISSUES

We all know that the most of the power consumption part of the Data Center is CPU and then followed by Memory. The different techniques are used to reduce the power consumption in CPU and Memory. In CPU we use High speed and most powerful processors to reduce the Power Consumption. But in Memory we have no other option to reduce the power consumptions. So the Intelligent Processor is directly proportional to the power consumption. We use

the next generation processors to reduce the power consumption. In memory we have less technique to overcome the Power consumption. In memory to increase the power efficiency we optimize the virtual network topology, thermal state and cooling system.

5. IMPLIMENTATION DETAILS

5.1 Introduction of Cloud Sim

Recently, the Cloud computing is the most power full technology for data storage processing and reliability which present the infrastructure as a service (Iaas),platform as a service (Paas),Software as a service (Saas) also provide the private and public Cloud or hybrid Cloud for the user application based. For increasing efficient demand of IT services to evaluate the application of algorithm before implementation of Cloud product utilization of real test beds limits the experiments to the scale of the tested and makes the reproduction of results an extremely difficult undertaking, alternative approaches for testing and experimentation leverage development of new Cloud technologies. As for suitable alternative to utilize the experiment we use the CloudSim tool kit. CloudSim is one type of simulation Package which is used to simulate and execute the Cloud computing Program. It includes all the Packages and file which will provide the platform to execute the Cloud experiment. CloudSim is just like one Framework which provides the framework to simulate the Cloud scenarios.

This toolkit supports the:

- Testing of application
- Tune the system parameter before deploying.
- Provide experimental view of application with different load is applied.

Features of Cloud Sim:

- Provide the modeling and simulation view of the computing environment.
- Self contain platform.
- Provide simulation network connection with suitable environment.
- Provide reliable simulation.

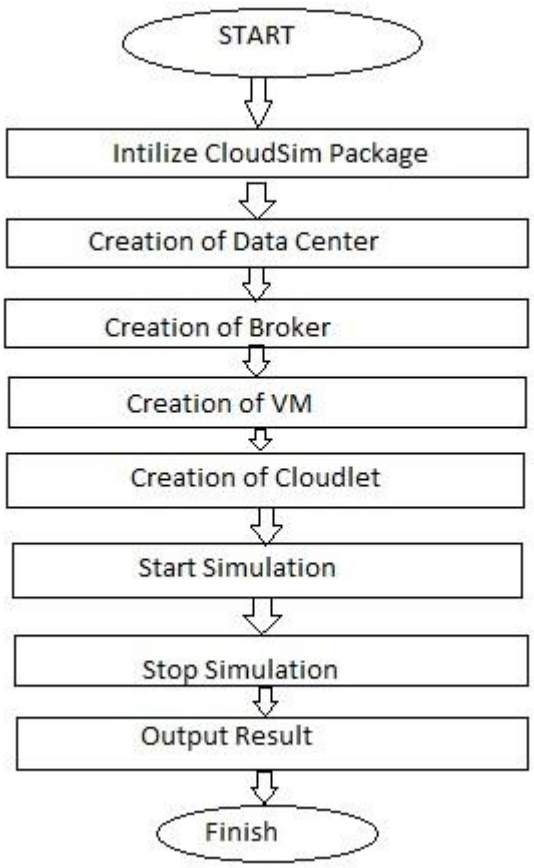

Fig-2: CloudSim Steps

6. ENERGY EFFICIENT CLOUD COMPUTING ALGORITHMS

6.1 VM Exact Allocation Algorithm:

Here Virtual machine allocation algorithm is based on the bin-packing approach. It contains some rule and equality and valid condition. In this algorithm VM is allocated according to the power consumption. The main aim of this algorithm is to minimize the server migration and total capacity of the server. The power capacity of the server is not enhanced by maximizing the power. When server is idle then switch off the server. Service load agreement will not change by this Cloud provider. So that only one VM is allocated to only one server.

6.2 VM Migration Algorithms

In this algorithm VM migration is enhanced. After completing of VM, we require to place the other VM to balance the load and utilize the running server power. So that we achieve the maximum utilization limited server

capacity of power. The main aim to migrate the one server with another is that the less capacity VM server work is optimally migrated to other server and makes that server idle and utilizes the running server power. In migration Algorithm which is applied to system they have some rule which is to be followed:

- If one server migrates with another server then migration should be specific for example if server P migrates with sever Q then K server cannot migrate to server Q≠K.
- In this algorithm the server power cannot be enhanced. If server power is reached to maximum power then we cannot migrates the other load on it.
- If all load of server migrate to another server then keep it idle and switched off server. So we can save the power and maintain power of running server.
- The total time of migration is very less than the lifetime of the server running time and if the migration time is high then migration cannot be possible.
- Total no. of idle server is useful to run another server.

6.3 Energy Aware Migration Algorithm:

In this algorithm it is very essential to migrate the load optimally compare to another algorithm so we can enhance the energy level in data center.

This algorithm is list out in three steps:

1. Idle server selection:

- In this Phase we find out the server which is needed to switch off.
- Find out the server which runs below the threshold value so we need to switch off this server.
- The server is running below the threshold value migrates those load to another server so we can save the energy.

2. Target server selection:

- In this phase the idle server will find the server to place their load on it.
- So on which server the load is above the threshold value we can transfer the load on that server.
- The target server is selected as the same method to follow the allocation of works.

3. Switch on server:

- In this algorithm if server threshold value is reached on wake up threshold value then another server is switched on and migrate the extra load on nearby server.
- If running server load is reached at maximum of threshold value then the nearby server is switch on and migrate the load on to the server to balance the load.

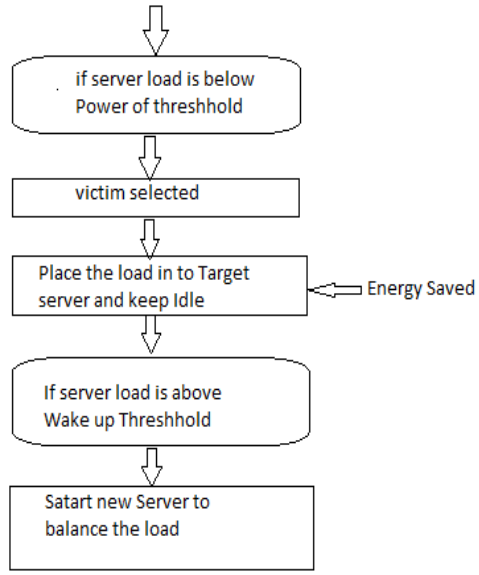

Fig: Energy aware Migration

Fig-3 Energy Aware Migration Algorithm Steps

❖ **Server Load Scenario 1:**

In this Scenario the s5 server is under "Power of Threshold (PoT) "line so Transfer the server load into s6 and turnoff the s5 so we save the power and utilize Resources of data center.

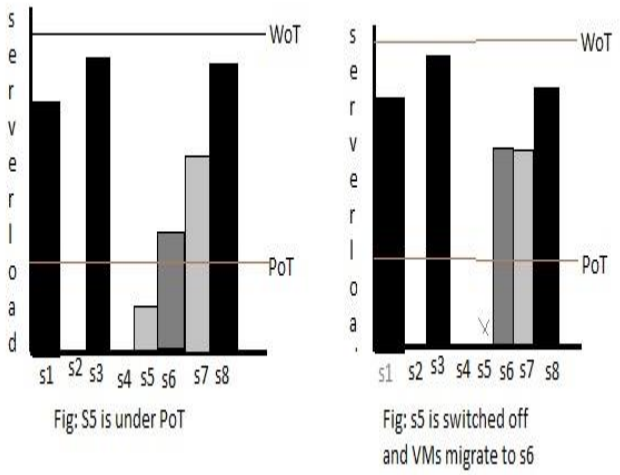

Chart-1 Server Load Scenario1

❖ **Server Load Secnario2:**

In this scenario the s5 server the server load is above the "Wake up on Threshold (WoT)" line so we turn on the new server and transfer the load on it. Here we turn on the new server s3 and migrate the load.

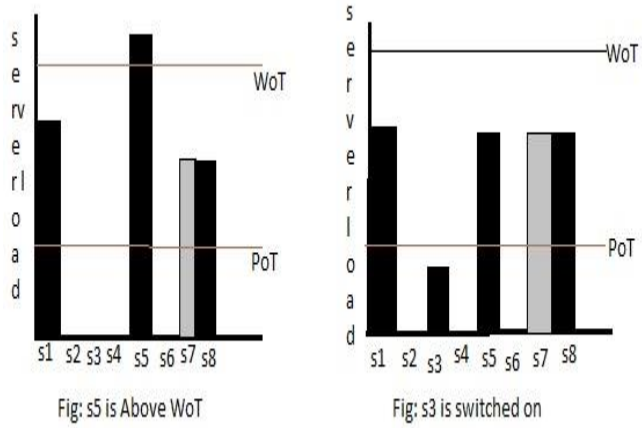

Chart-2: Server Load Secnario2

6.4 DVFS (Dynamic Voltage /Frequency scaling):

DVFS (Dynamic Voltage /Frequency scaling) is widely used because in this algorithm the clock frequency is dynamically adjusted according to the use of processor so the frequency is varying according to the voltage. If we reduce the voltage according to our work then the clock frequency is dynamically adjusted. DVFS is widely useful in memory bound workload. The total power consumption of CMOS (Complementary Metal Oxide Semiconductor) is:

$$C=Cstatic+CFV_2$$

Here, C capacitance of transistor gate

F operating frequency

V supply voltage

If capacitance of the circuit is calculated using clocked frequency then we can reduce the voltage and also we can reduce the frequency so we can save the power. The main disadvantage of DVFS is that if we reduce the voltage then also our circuit performance is reduced so that the DVFS is directly connected to the performance of the Data center. For this disadvantage we have to be very efficiently applying this algorithm in our data center. The main aim of this algorithm is to minimize the power consumption and to increase the energy efficiency. In today's world we operate the CPU at any speed using DVFS so we save the power at operating running speed of CPU.

6.5 Server consolidation:

Due to the inaccurate and incorrect use of server resources the server utilization is not efficient hence for that a server consolidations approach is applied. In server consolidation the VM which has very low level load residing on different server are consolidate into single server for better resource utilization and energy saving. So that which server has the low level load gets transferred the load into single server then turn off the server for power saving.

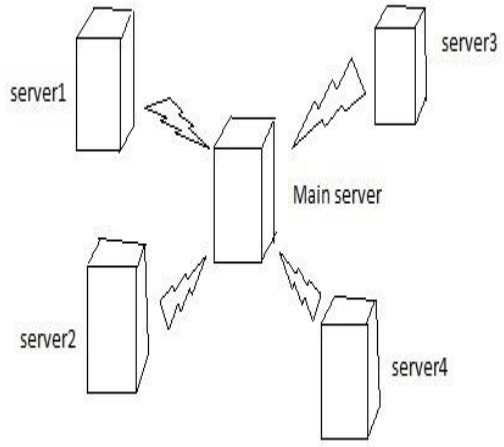

Fig-4: Server Consolidation

The main Disadvantage of the server consolidation is security and cost. In consolidation, the resource management is most important facts. The main reason of consolidation is in our system where we have many

underutilized resources which consume more power. So we consolidate this resource into single package based work so we can save the power and energy.

Table-2: Comparative study of Algorithm

Algorithm	Approach used	Energy saved	Feature consider
VM Allocation	Bin Packing	90% more than direct allocation	Minimum power consumption
VM Migration	Extended Bin Packing	95% more than first fit allocation	Balance the load optimally
Energy aware Algorithm	First fit Algorithm	95% more than best fit algorithm	Increase efficiency of live migration
DVFS	Dynamic allocation	More than all algorithm	Dynamically adjust the load and save the power
Server consolidation	Sorting	More than round robin method	Minimize the active server

7. CONCLUSIONS

By studying the research work we analyze that the cloud data centers consumes huge amount of power so to overcome this problem we introduce many other technique for the power management. To improve the efficiency of the cloud data center not only one technique is sufficient we have to apply all the techniques which is efficient for the cloud data center. VM migration technique is used when the server is under or over utilizes the resources. Energy aware algorithm is used when we know the number of resource is available and which type of service is given to the customer. As we know the hardware resources is used for the reduction of power consumption then also we introduce some software side algorithm for better power management.

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