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DISTRIBUTIVE POWER MIGRATION AND MANAGEMENT ALGORITHM FOR CLOUD ENVIRONMENT

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ABSTRACT

In cloud computing, the resources are provided as service over the internet on demand basis. The resources such as servers, networks, storage, applications are dynamically scaled and virtualized. The demand grows gradually for each virtual machine in a cloud computing environment over time. So, it is necessary to manage the resources under each cluster to match the demand in order to maximize total returns by minimizing the power consumption cost. It can be minimized by applying minimal virtual design, live migration and variable resource management. But, the traditional way of scheduling doesn't meet our expected requirements. So we introduce the distributive power migration and management algorithm for cloud environment that uses the resources in an effective and efficient manner ensuring minimal use of power. The proposed algorithm performs computation more efficiently in a scalable cloud computing environment. The results indicate that the algorithm reduces up to 30% of the power consumption to execute services.

Keywords: Cloud, Virtual Machines, Resource Utilization, Migration, Green Computing, Power Management

1. INTRODUCTION

Cloud computing is an emerging technology, which hosts the applications and services over the internet as a service (Jin *et al*., 2010). Nowadays, customers are investing money in computing services by demand basis and "Pay-per use model" over the internet. It has become similar to the purchase of their household utilities such as gasoline, electricity which are bought on need basis. There is no suitable definition for cloud computing, we will use the definition of the National Institute of Standards and Technology-US department of Commerce (NIST) (Mell and Grance, 2011):

> "Cloud computing is a model for enabling ubiquitous, convenient, on demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction"

One major thing to know and understand is that, cloud, cluster and grid computing are not the same. There are notable differences between cluster computing, grid computing and cloud computing (Gandotra *et al*., 2011). Cluster computing is tightly coupled whereas Grid is not so. The computers in the cluster systems are placed in a single location but in cloud computing it is disseminated over the MAN (Gandotra *et al*., 2011). The **Fig. 1** is extracted from (Gandotra *et al*., 2011), which explains relationship among the above mentioned three computing.

The prominence of the cloud computing is resource sharing which leads to so many challenges, the reason is that resource utilization, safeguarding. Soon enough, ITindustry will subjugate to cloud computing, because the user applications are placed as web service over the internet, the whole user machine can be put into virtual machines that will be accessed through a terminal and that depends on the users on demand (Boss *et al*., 2007).

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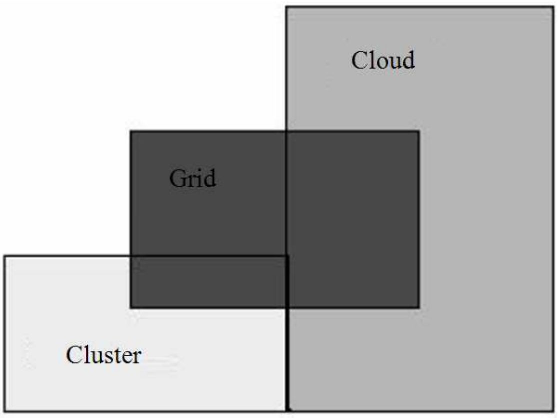

Fig. 1. Relationship between cluster, grid and cloud computing

2. STATE OF THE ART CLOUD TECHNOLOGY

The cloud computing has become an inevitable and indispensable of IT infrastructure. It is directly proportional to the amount of power utilized for its working. One of the researches states that data centers devour 0.5% of the world's total electricity usage (Forrest, 2008) and if present-day demand continues, it is anticipated to increase exponentially by 2020. Servers and their cooling units are burning up nearly 1.2 percentage of the total U.S energy utilization and it doubling up every 5 years (Wang *et al*., 2010; Von Laszewski *et al*., 2009). As a result, it is compulsory to augment the efficiency and potential sustainability of the resource utilized in the cloud computing. The following graph constructed based on various surveys reveals the danger surrounding the world, both in economics and environment point of view. **Figure 2** reveals facts about CO_2 and cost factors based on various reports.

Having realized the threat and the constraints, modern day researchers have already started working in this area and few algorithms and methodologies have been drafted for saving the power. Though there are lot of papers and research done in the area of Cloud computing, power saving point of view is not given much focus and this motivated the authors to think of a solution for the same.

The resource administration can be achieved by the aspects of virtualization in cloud computing. In a cloud environment, hypervisors help to combine the number of unconnected physical machines into a virtualization environment, which requires less physical resources thanbefore. With a huge number of nodes connecting to cloud power consumption raise over thousand megawatts. So, it is obligatory to develop an efficient cloud computing system that curtails the power consumption.

In order to combine Green computing frame work into cloud requires a new set of protocol which carries on cloud computing development by means of data center assembly and administration. The architecture provided in this study helps us to reduce the power spent by finding a resource which is capable of being renewed and consistent energy source from the cloud environment itself.

The rest of the study is organized as follows, In chapter 2, we discuss the related state of the art work on power management technique. Followed by a proposed architecture and algorithm in chapter 3 and 4 . Chapter 5 shows various outcomes of the algorithm simulations by using CloudSim. Chapter 6 concludes the study and adds the challenges faced and future work.

3. RELATED WORKS

The following are the researches that have been done in the area of interest.

Beloglazov and Buyya (2010) explained a disseminated way out to optimize power efficiently by using their algorithms "Minimization of Migration". The placement of VM in datacenters and due to the power saves how the SLA be violated and redefine the power saving problem by considering the minimal SLA violation. They evaluated the algorithm by using CloudSim (Calheiros *et al*., 2010).

Ramesh and Krishnan (2012) has done an extensive research in the area of resource sharing for the cloud and grid computing. They proposed an algorithm for better performance with good resource utilization as well. But, power was not considered in the research.

"Managing server energy and operational costs in hosting centers" (Chen *et al*., 2005) paper focuses on control theoretic feedback technique, queue prediction and the combination of both which helps us to pattern the dynamic resource provisioning. The virtualized environment is not taken care for the consideration.

Green Cloud Framework (Younge *et al*., 2001) was described by which help us to optimize power utilization in the cloud environment and measured the fact that put multiple VM on a single host to reduce the number of live hosts that curtails the power usage. The authors also suggested that management for VM image size with respect to the green computing.

Centralized provisioning is a conventional model to monitor the performance and attributes of the each VMs and their nodes. The centralized provisioning makes the verdict largely depends on the overall usage of the resources. Administrator will access all the resources shared by the centralized system and makes the decision with the help of available facts and data to reach the desired goals.

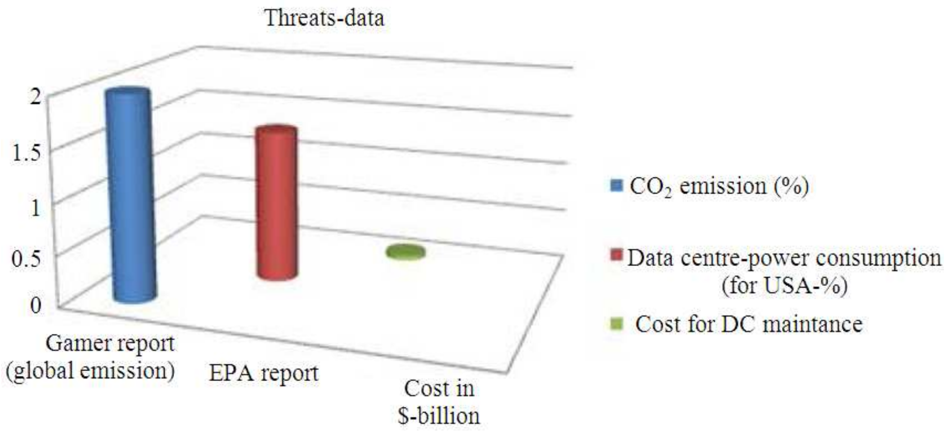

Fig. 2. Survey summary graph

This will work only the numbers of VMs are countable and becomes tougher if the nodes are getting increased.

Calheiros *et al*. (2010), authors use capacity planning technique to achieve server consolidation to reduce energy consumption in a web service server cluster environment. CPU utilization based and queue based monitoring approaches are used to estimate resource capacities required to serve future requests. This study considers server cluster (non-virtualized environment) and have used one application.

To reduce the power utilization by consolidating the server in web service cluster atmosphere by means of capacity planning approach (Tsai *et al*., 2007). Queue based and CPU utilization based approaches are used to estimate the resource needs for future purpose. The author does not consider the virtual environment for the evaluation.

Considering the omission of power related challenges in cloud technology, the need to address the same is apparent.

4. ARCHITECTURE

In this section, we present a model for VM Power Scheduler in the cloud environment. It provides efficient way to migrate the VM machines from one server to another by minimizing the power utilization which helps to reduce the operating cost of the cloud environment. This will benefit the customer in indirect way by spending lesser amount to use the cloud model.

The **Fig. 3** presents the framework of our new green cloud computing environment which have an extra scheduler called as "VM Power Scheduler" that manages the entire VMs in that cloud. This environment get the request from "n" different users, that are pooled into the request queue. The Cloud scheduler and VM Power Scheduler make sure that each and every process are placed in the particular VM in the server with the help of the distributive power migration and management algorithm for cloud environment, that minimize the power consumption.

The job of that scheduler is to collects the server details from the resource manager who holds the details of each VM running on the particular server. VM Power Scheduler closely monitors the details of VMs that arerunning on the each server and also have the details of VMs which are all in the idle state. The newly proposed scheduler gets the help from the distributive power migration and management algorithm to find the suitable server that are capable of executing the process in the particular VMs.

5. PROPOSED SOLUTION

5.1. Primary Objective

To manage or allocate the existing virtual machines to servers in such a way that minimal no of severs and in turn least amount of power is used.

5.2. Proposed Solution

- We control the Power usage by controlling the allocation of virtual machines (processes) to servers at each stage
- Every incoming VM is allocated a server by an arbitrary order defined by the user. Thus a server cannot be left alone unless its maximum capacity is reached

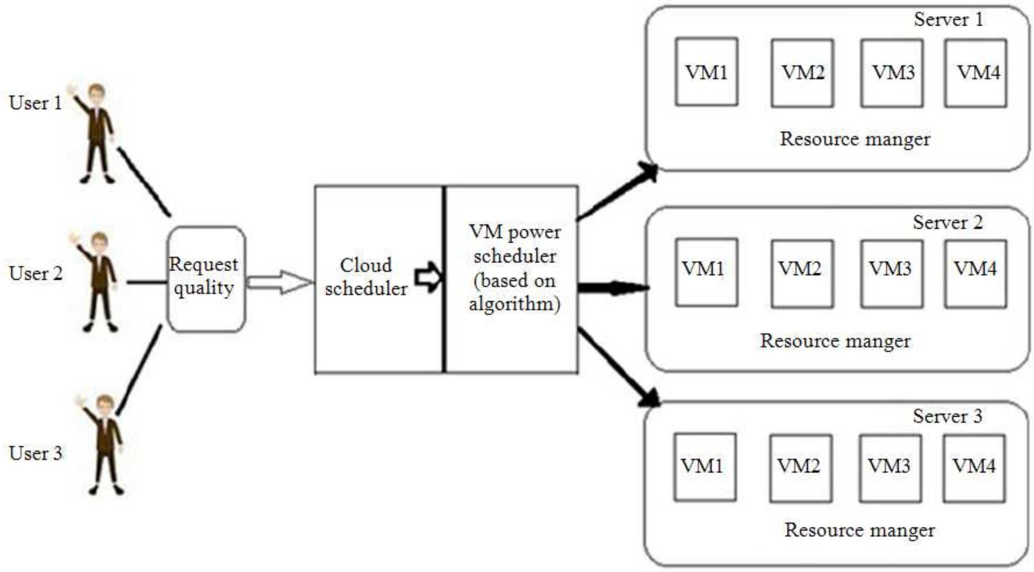

Fig. 3. Proposed architecture

- Whenever a VM is to be removed from a server the problem here is to check if the VM's in another server can be shifted to this so that the latter can be powered down
- This is accomplished at every step by retrieving all the VM's and by allocating them again manually therefore each server is filled to its maximum capacity before another server is involved
- This leaves no chance for any server to be idle or not run at maximum potency

5.3. PSEUDO Code

Figure 4 can be referred for understanding the flow of the algoritm:

Sn: No of servers.
Sc[sn]: Capacity of each server
Step 1: Set the no of servers (sn) and capacity of each (sc[sn])
Step 2: Incoming vm or process
Step 2.1: Check if current server to be filled has reached maximum capacity
Step 2.2: If yes move to the next server in order and check if its maximum capacity has been reached and eventually assign the vm a server slot
Step 3: VM has finished executing or is no longer needed
Step 3.1: Find in which server the vm is located and remove it
Step 3.2: Start allocating all VMs located in each server in order so as to remove server wastage
Step 4: Calculate power = (total no of server-no of servers occupied)*power consumed by one server
Step 5: Loop back to step 2 or step 3 as needed

6. RESULTS AND INFERENCE

The first phase of experimentation was done by analyzing the power consumed against the no of VM's that are running on a setup. The no of VM's tested ranged between 5 and 25 throughout which the power consumed with the algorithm in place was almost half that of the power consumed without the algorithm. **Figure 5** reveals the same.

The second phase of experimentation was done against the bandwidth of the connection used. Similar to that of the previous experimentation the power consumed by system implementing our algorithm was half that of the system without it. One can understand the impact of the proposed algorithm by referring to above graph shown in **Fig. 6**.

The third level of experimentation was done with the no of DC's requesting resources. As expected irrespective of the no of data centers requesting resources the performance remain almost the same but with our algorithm still performing better without a system that doesn't employ any strategy. The size of the storage medium or the magintude of requests orginating from each DC seems to have no visible impact on the performance. **Figure 7 and 8** stands as the support for the testing carried out.

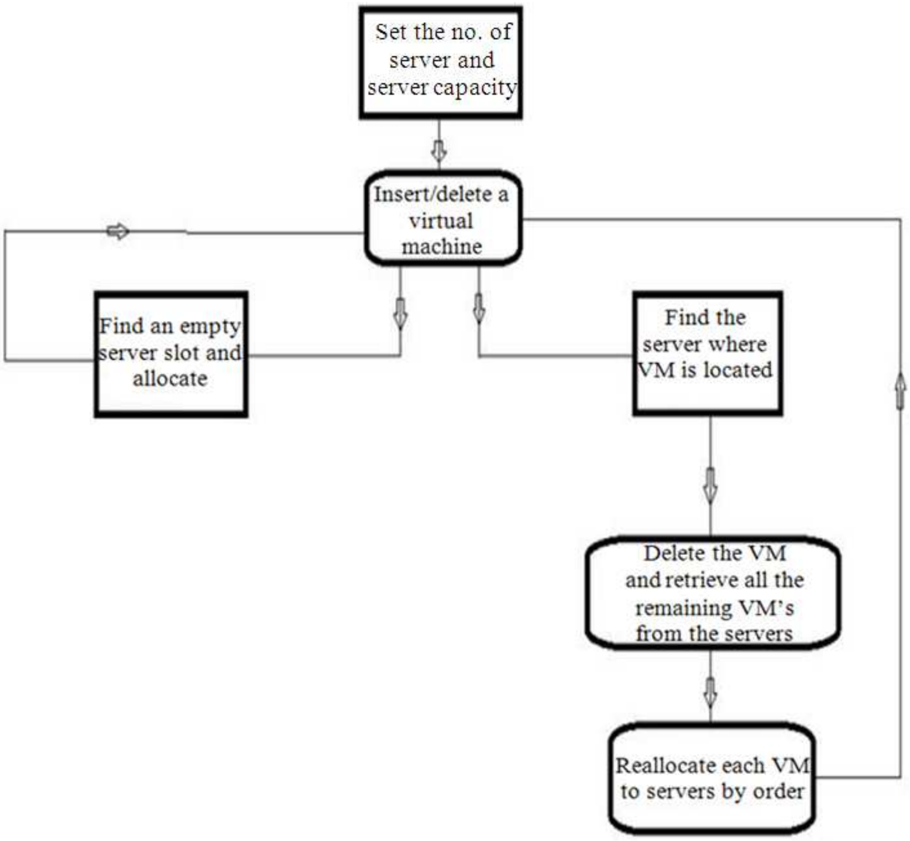

Fig. 4. Flow chart of algorithm

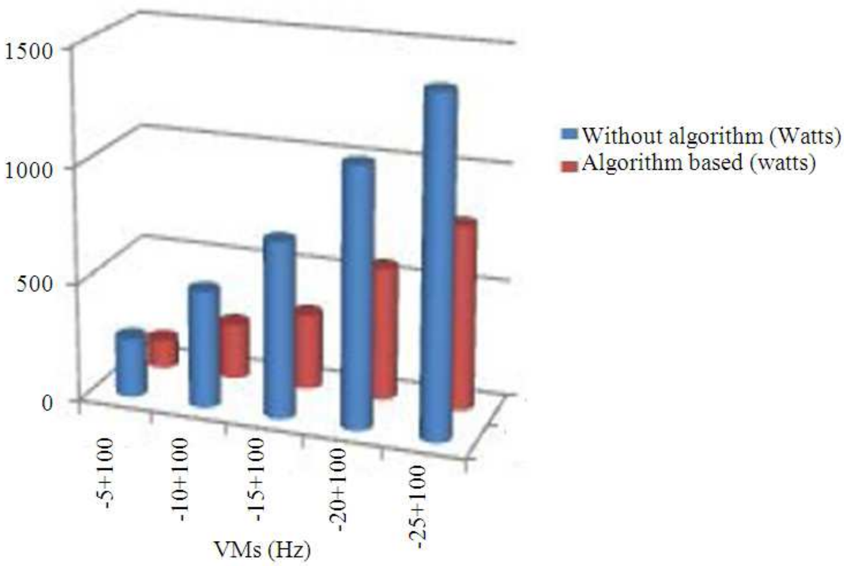

Fig. 5. Results obtained by considering no of VMs

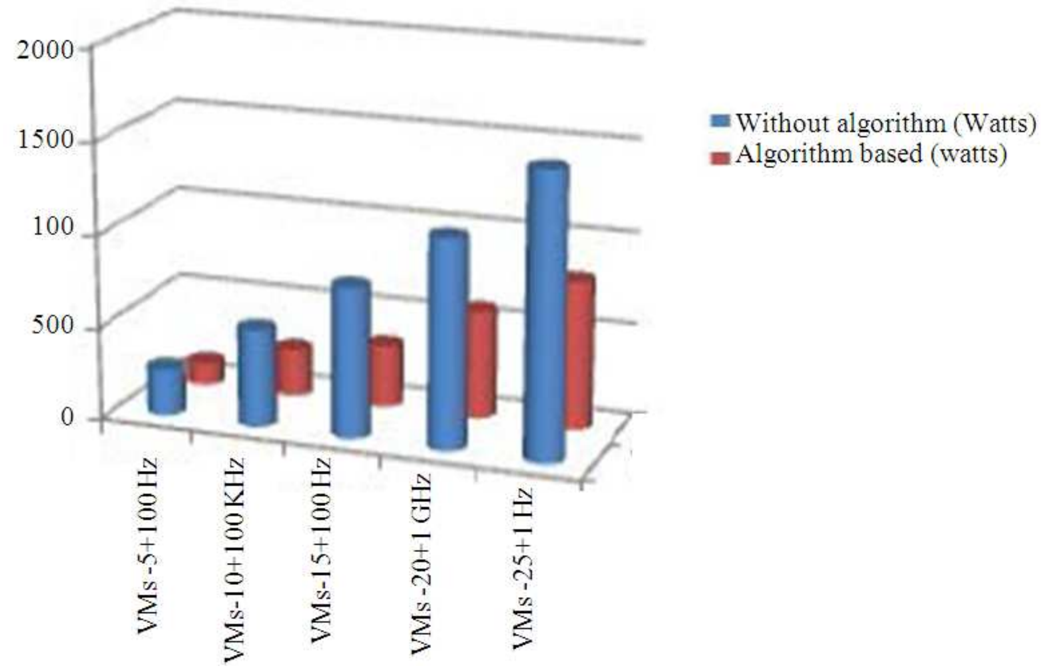

Fig. 6. Results obtained with different bandwidths for each VMs

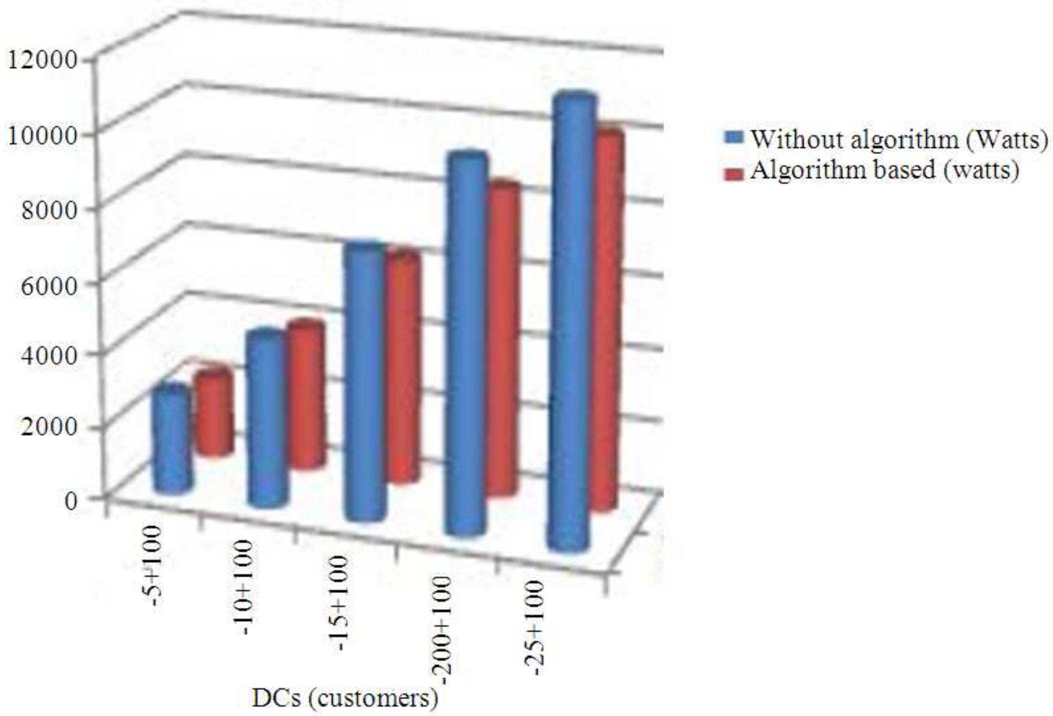

Fig. 7. No of customers with different DC Size

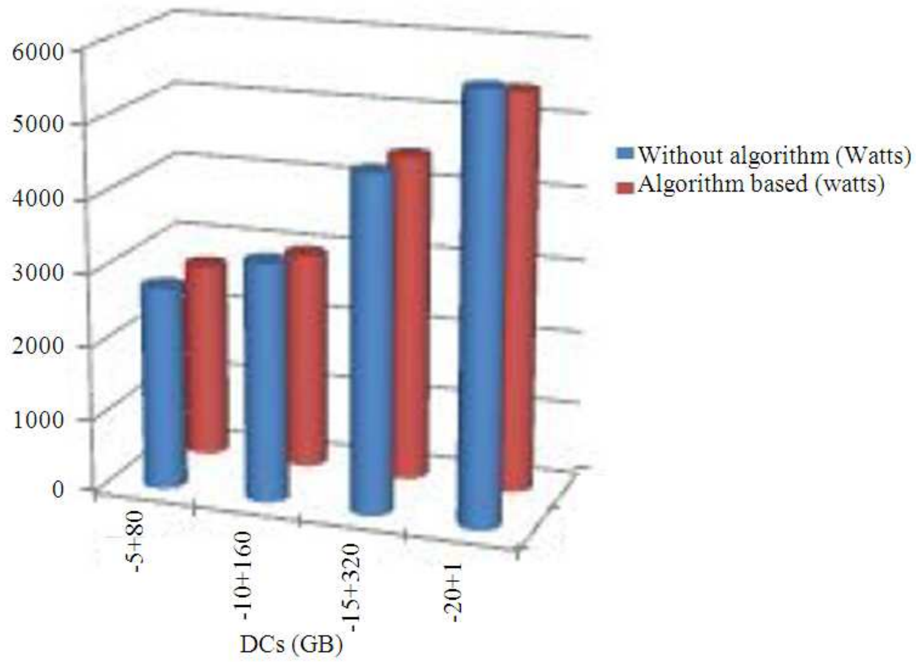

Fig. 8. Results acquired by varying storage size

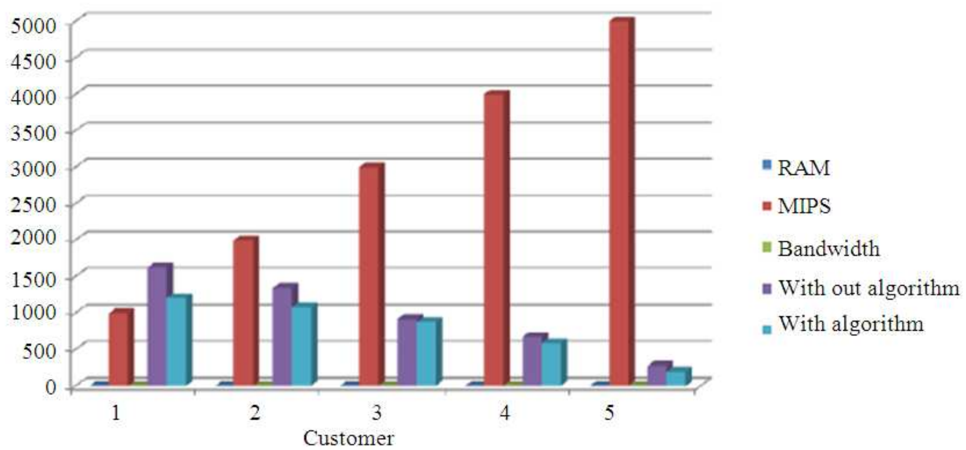

Fig. 9. Results acquired with different customer configuration

Finally all factors were considered to obtain an overall perspective about the performance of the algorithm to clearly decide the efficiency of the algorithm. As expected the performance works as well as in the case of individual case tests.

The proposed algorithm was tested on a CloudSim platform simulator. The results obtained were in accordance with that of the expected output. The above graphs demonstrate the same.

Figure 5 demonstrates the power consumption based on the no of VM's running, as we can see with our algorithm in place the power consumption is reduced by almost one-fourth of the value without the algorithm. Also factoring in the effect of bandwidth the results seem almost similar at a lower levels but as its increased the need for the algorithm is clearly seen with the apparent difference in the amount of power consumed (**Fig. 6**).

Again one cannot forget the impact of the no of data servers on the power consumed; with the algorithm in effect we see a small decrease in power consumption a reduction nonetheless (**Fig. 7 and 8**).

Finally factoring in all the parameters to make sure the other results are not exclusive of each other we can clearly the difference brought about by the algorithm. In cases portrayed in **Fig. 9** the performance of algorithm justifies the need for its presence.

7. CONCLUSION

There were a number of challenges faced by the authors during this research. The major challenge was to create a dynamic algorithm for the expected power management requirements. Maintaining the Quality of service was another major challenge faced. Care has been taken to make sure that the algorithm does not fail in case of addition or removal of machines from the cloud network. The algorithm reduces the power spent on the data centers for cloud thereby reducing the CO_2 emission and global warming created because of it, can be reduced to a very decent extent. The algorithm is not just static in nature; it is dynamic enough to support scaling and improved QoS. This algorithm can be further adapted to any network, not just cloud. We have used simulators to test and support our findings. But, the real test would be to take this up in the real time setup where, the behavior should be tested.

8. ACKNOWLEDGEMENT

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