



## Reducing Carbon Emission Rate Using Billboard Manager (BM)

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**Abstract**— Relying on a technology that pools the resources of central servers across remote locations, and the internet, cloud computing as we know has opened up a new vista in how we look at application deployment and their uses. Cloud computing, in essence, gives the power to consumers and businesses to access their personal files, and in some cases even applications, on any compatible computer connected to the internet. Combining data storage, data and information processing, and bandwidth allows for a much more efficient computing. Data center carbon emissions have become a leading concern for service providers who offer cloud computing services. In order to control carbon emissions, it is understood that distribution of computing loads among various nodes of a distributed system can have significant impact. Load balancing, in other words, of resources utilization coupled with job response times, if done proactively can help avoid situations where some of the nodes are heavily loaded while other nodes are either lying idle or doing very little by way of productive operations. Load balancing is a continuous operation that tries to share resource demands on all processors in the system, or every node in the network, that each is burdened with approximately an equal amount resource at any given point of time. In our paper, we have proposed an electronic machine named Billboard Manager, which aims to achieve a balance of load across several virtual machines to maximize throughput. This proposed method balances the priorities of task order in the machines in a way so as to ensure that the waiting time of the tasks in the queue is at a minimum. In our study, we have compared our proposed algorithm with existing load balancing and scheduling algorithms. Results from our experiments show that our proposed algorithm compares favourably to existing ones. Our approach using the Billboard Manager clarifies that there is a marked change in average execution time and significant reduction of waiting time of queued tasks.

**Keywords**— Cloud computing, Load Balancing, Carbon emissions, Billboard Manager, Data Center.

### I. INTRODUCTION

A model for delivering information technology services in which resources are retrieved from the internet through web-based tools and applications, rather than a direct connection to a server. Data and software packages are stored in servers. However, cloud computing structure allows access to information as long as an electronic device has access to the web. This type of system allows employees to work remotely. A more formal definition of cloud computing [2] as per Gartner's: "a style of computing where massively scalable IT-enabled capabilities are delivered as a service to external customers using internet technologies". The cloud computing have five characteristics, three delivery models, and four deployment models [5]. The five key characteristics represent the first layer in the cloud environment. Architecture (see Figure1).

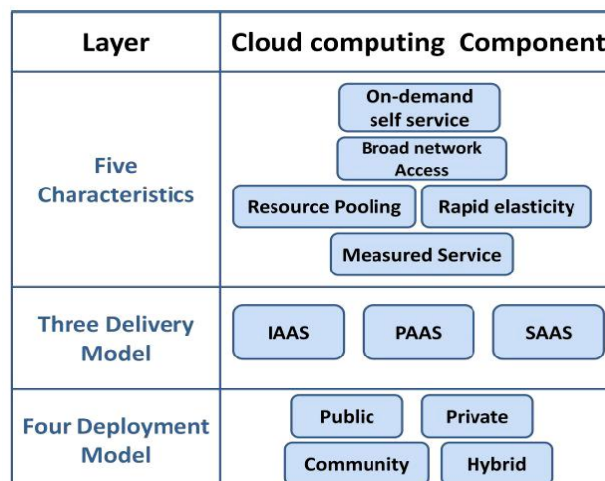


Fig 1: Cloud Environment architecture [4]

Several types of clouds are envisioned

- A. *Private Cloud*: the infrastructure is operated solely for an organization, It may be managed by the organization or a third party and may exist on or off the premises of the organization.
- B. *Community Cloud*: the infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premises or off premises.
- C. *Public Cloud* : the infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.
- D. *Hybrid Cloud* : the infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds).

Cloud computing services are broadly divided into three categories:

There are three cloud delivery models, Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) deployed as public, private, community, and hybrid clouds [7].

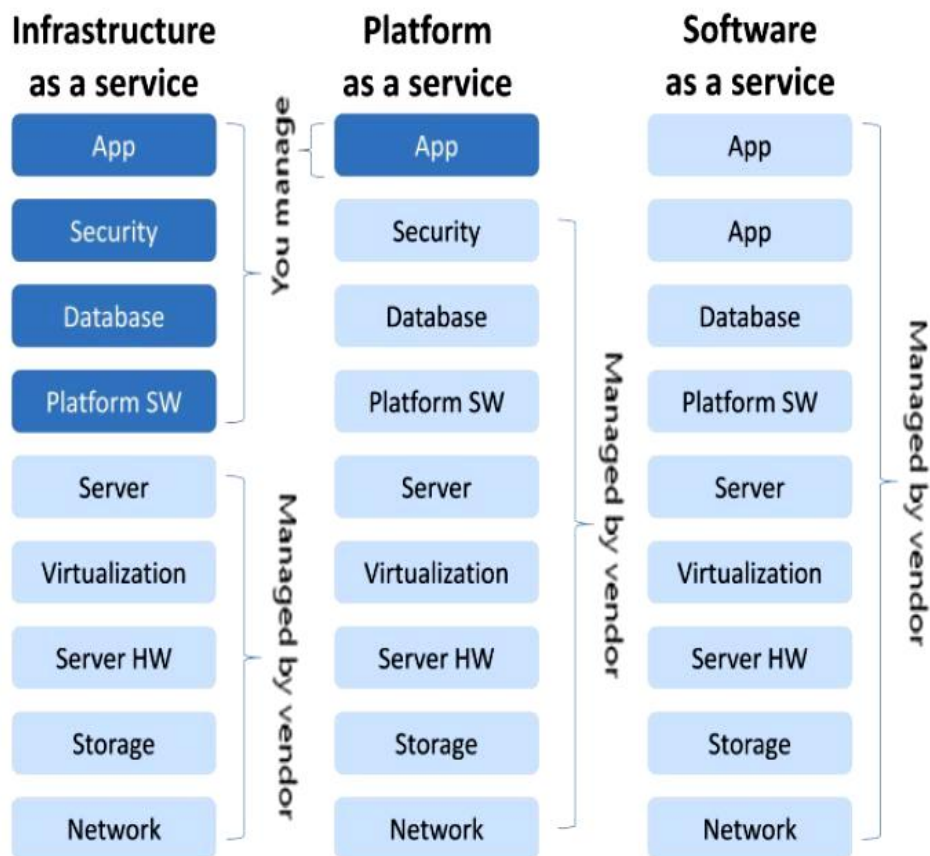


Fig 2: Cloud Delivery Model [4]

**Infrastructure as a Service (IaaS)** : This is the base layer of the cloud stack. It serves as a foundation for the other two layers, for their execution. The keyword behind this stack is Virtualization. your application will be executed on a virtual computer (instance). You have the choice of virtual computer, where you can select a configuration of CPU, memory & storage that is optimal for your application. The whole cloud infrastructure viz. servers, routers, hardware based load-balancing, firewalls, storage & other network equipments are provided by the IaaS provider. Some common examples are Amazon, GoGrid, 3 Tera, etc.

**Platform as a Service (PaaS)**: Here, a layer of software, or development environment is encapsulated & offered as a service, upon which other higher levels of service can be built. The customer has the freedom to build his own applications, which run on the provider's infrastructure. To meet manageability and scalability requirements of the applications, PaaS providers offer a predefined combination of OS and application servers. such as LAMP platform (Linux, Apache, MySql and PHP), Google's App Engine, Force.com, etc are some of the popular PaaS examples

**Software as a Service (SaaS)**: In this model, a complete application is offered to the customer, as a service on demand. A single instance of the service runs on the cloud & multiple end users are serviced. On the customers' side, there is no need for upfront investment in servers or software licenses, while for the provider, the costs are lowered, since only a single application needs to be hosted & maintained. Today SaaS is offered by companies such as Google, Sales force, Microsoft, etc.

Cloud Architecture: Cloud computing system can be divided into two sections as front end and back end [14]

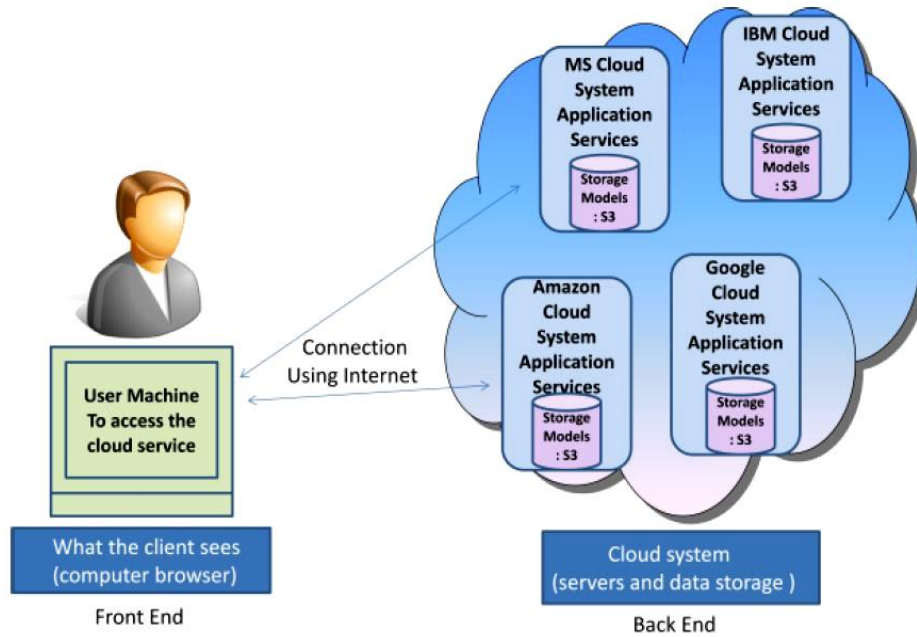


Fig3: Cloud computing system architecture [4]

They both are connected with each other through a network, usually the internet. Front end is what the client (user) sees whereas the back end is the cloud system. Front end has the client's computer and the application required to access the cloud (Browser) and the back has the cloud computing services like on-demand computing and data storage from various servers. The difference between traditional system and cloud system is represented in the next diagram. Using hypervisor [15], also called virtual machine manager (VMM), is one of many hardware virtualization techniques allowing multiple operating systems, termed guests, to run concurrently on a host computer. It is so named because it is conceptually one level higher than a supervisory program.

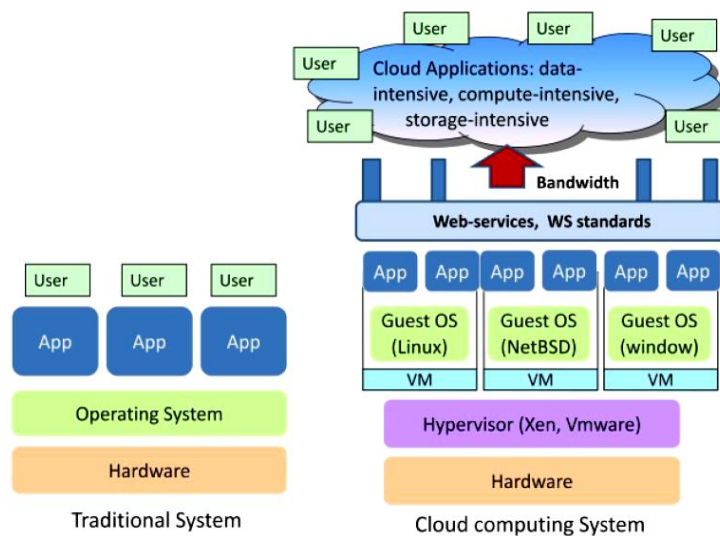


Fig 4: Compare b/w traditional system and cloud system [4]

The hypervisor [11] presents to the guest operating systems as a virtual operating platform and manages the execution of the guest operating systems. Multiple instances of a variety of operating systems may share the virtualized hardware resources. Hypervisors are very commonly installed on server hardware, with the function of running guest operating systems, that themselves act as servers.

**Virtualization:** It is a very useful concept in context of cloud systems. Virtualization means “Something which isn’t real, but gives all the facilities of a real”. It is the software implementation of a computer which will execute different programs like a real machine. Virtualization is related to cloud, because using virtualization an end user can use different services of a cloud. The remote datacenter will provide different services in a fully or partial virtualized manner [12].

Two types of virtualization are found in case of clouds as given in [13]:

- Full virtualization
- Para virtualization

**Full Virtualization:**

In case of full virtualization a complete installation of one machine is done on the another machine. It will result in a virtual machine which will have all the software that are present in the actual server.

Here the remote datacenter delivers the services in a fully virtualized manner. Full virtualization has been successful for several purposes as pointed out in [19]:

- Sharing a computer system among multiple users
- Isolating users from each other and from the control program
- Emulating hardware on another machine

**Para virtualization:**

In Para virtualization, the hardware allows multiple operating systems to run on single machine by efficient use of system resources such as memory and processor. E.g. VM ware software. Here all the services are not fully available, rather the services are provided partially Para virtualization has the following advantages as given in [13]:

**Disaster recovery:** In the event of a system failure, guest instances are moved to another hardware until the machine is repaired or replaced.

**Migration:** As the hardware can be replaced easily, hence migrating or moving the different parts of a new machine is faster and easier.

**Capacity management:** In a virtualized environment, it is easier and faster to add more hard drive capacity and processing power. As the system parts or hardware can be moved or replaced or repaired easily, capacity management is simple and easier.

**Cloud Components**

A Cloud system consists of 3 major components such as clients, datacenter, and distributed servers. Each element has a definite purpose and plays a specific role [12].

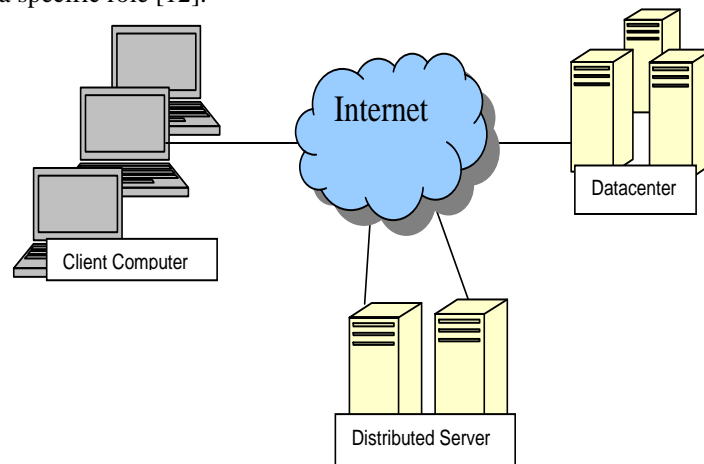


Fig 5: Three Components make up a cloud computing solution

**Clients:** End users interact with the clients to manage information related to the cloud. Clients generally fall into three categories:

**Mobile:** Windows Mobile Smart phone, smart phones, like a Blackberry, or an iPhone.

**Thin:** They don't do any computation work. They only display the information. Servers do all the works for them. Thin clients don't have any internal memory.

**Thick:** These use different browsers like IE or Mozilla Firefox or Google Chrome to connect to the Internet cloud.

Now-a-days thin clients are more popular as compared to other clients because of their low price, security, low consumption of power, less noise, easily replaceable and repairable etc.

**Data center:** Data center is nothing but a collection of servers hosting different applications. A end user connects to the data center to subscribe different applications. A data center may exist at a large distance from the clients. Now-a-days a concept called virtualization is used to install software that allows multiple instances of virtual server applications.

**Distributed Servers:** Distributed servers are the parts of a cloud which are present throughout the Internet hosting different applications. But while using the application from the cloud, the user will feel that he is using this application from its own machine.

**Load balancing:** Load balancing is the process of searching overloaded node and transferring the extra load of the overloaded node to other nodes which are under loaded, for improving resource utilization and decreasing server response time of the jobs.

Depending on system state, load balancing algorithms divided into two types as static and dynamic. A load balancing algorithm which is dynamic in nature, does not consider previous state or behaviour of the system, that is, it depends on the present behaviour of the system. Depending on who initiated the process, load balancing algorithms can be divided into three types as sender Initiated, receiver Initiated and symmetric. The important things to consider while developing such algorithm are : estimation of load, comparison of load, stability of different system, performance of system, interaction between the nodes, nature of work to be transferred, selecting of nodes and many other ones. This load considered can be in terms of CPU load, amount of memory used, delay or Network load.[5].



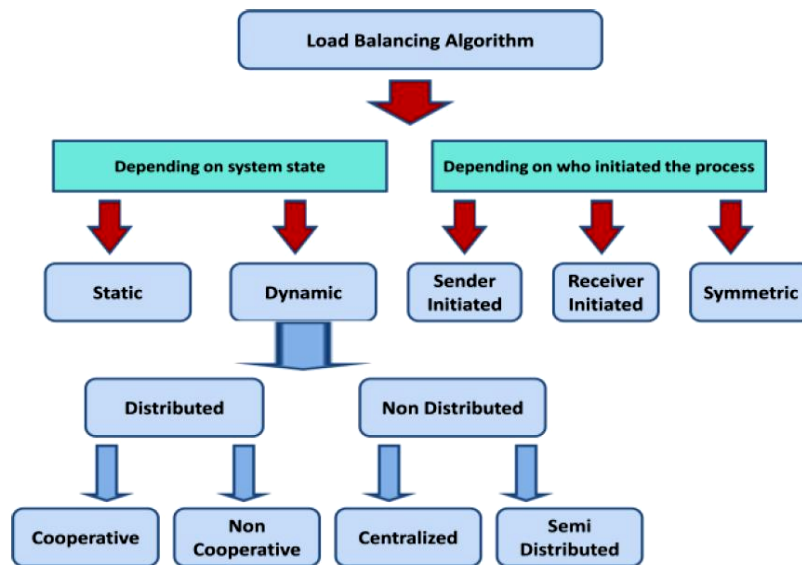


Fig 6: Classification of load balancing algorithms [4]

Proper load balancing can help in utilizing the available resources optimally, thereby minimizing the resource consumption. It also helps in implementing fail-over, enabling scalability, avoiding bottlenecks and over-provisioning, reducing response time etc. Apart from the above-mentioned factors, load balancing is also required to achieve Green computing in clouds which can be done with the help of the following two factors:

*Reducing Energy Consumption:* Load balancing helps in avoiding overheating by balancing the workload across all the nodes of a cloud, hence reducing the amount of energy consumed.

*Reducing Carbon Emission:* Energy consumption and carbon emission go hand in hand. The more the energy consumed, higher is the carbon footprint. As the energy consumption is reduced with the help of Load balancing, so is the carbon emission helping in achieving Green computing [3].

However, the explosion of cloud computing networks and the growing demand drastically increases the energy consumption of data centers, which has become a critical issue and a major concern for both industry and society [9]. This increase in energy consumption not only increases energy cost but also increases carbon-emission. High energy cost results in reducing cloud providers' profit margin and high carbon emission is not good for the environment [10].

Hence, energy-efficient solutions that can address the high energy consumption, both from the perspective of the cloud provider and the environment are required. This is a dire need of cloud computing to achieve Green computing. This whole scenario is depicted in Fig. 4. Load balancing can be one such energy-saving solution in cloud computing environment.

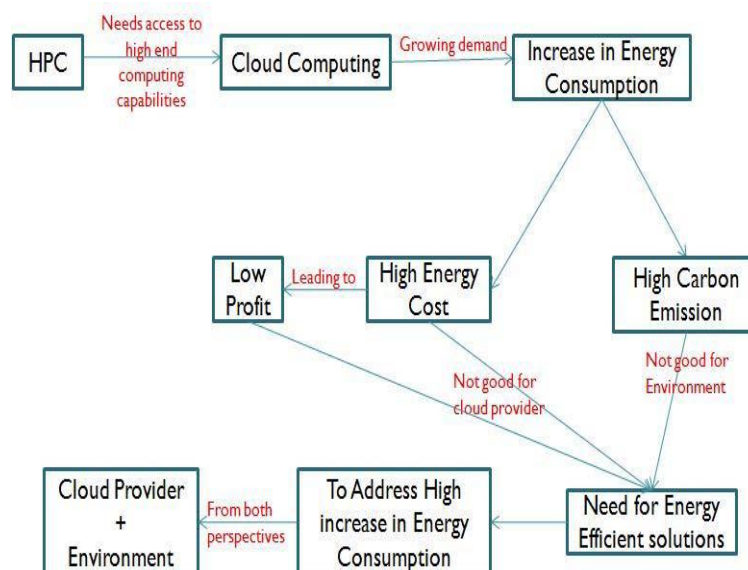


Fig. 7: Green Computing in Clouds[3]

In rest of the paper is organized as follows, In section II we discuss the related research works, In section III we introduce load distribution with a minimum time can reduce the power consumption as well as reduce the carbon emission rate, in section IV we introduce our main proposed algorithm. Section V contains flowchart, Section VI contain simulation setup.

## II. RELATED WORKS

Most works improve the energy efficiency of Clouds by addressing the issue within a particular data center and not from the usage of Clouds as a whole. They focus on scheduling and resource management within a single data center to reduce the amount of active resources executing the workload [22]. The consolidation of Virtual Machines (VMs), VM migration, scheduling, demand projection, heat management, temperature aware allocation, and load balancing are used as basic techniques for minimizing energy consumption. Virtualization plays an important role in these techniques due to its several benefits such as consolidation, live migration and performance isolation. Some works also propose frameworks to enable the energy efficiency of Clouds from user and provider perspectives. From the provider perspective, Green Cloud architecture [23] aims to reduce virtualized data center energy consumption by supporting optimized VM migration and VM placement. Similar work is presented by Lefevre et al. [24] who propose Green Open Cloud (GOC). GOC is designed for next generation Cloud data center that supports facilities like advance reservation. GOC aggregates the workload by negotiating with users so that idle servers can be switch-on longer. The authors in the paper [16] explore the concept of cloud computing, its advantages and disadvantages and describes several existing cloud computing platforms and discuss the results of quantitative experiments carried out using PlanetLab, a cloud computing platform as well. A two-phase scheduling algorithm under a three-level cloud computing network is a scheduling algorithm combines OLB (Opportunistic Load Balancing) and LBMM (Load Balance Min-Min) scheduling algorithms that can utilize more better executing efficiency and maintain the load balancing of system[25]. In [17] the authors propose to find the best EFFICIENT cloud resource by Co-operative Power aware Scheduled Load Balancing solution to the Cloud load balancing problem. The authors designed the algorithm using the inherent efficiency of the centralized approach, energy efficient and the fault-tolerant nature of the distributed environment like Cloud

PALB [18], maintains the state of all compute nodes, and based on utilization percentages, decides the number of compute nodes that should be operating. It presents a load balancing approach to IaaS cloud architectures based on power as per local cloud computing architectures and it provides adequate availability to compute node resources while decreasing the overall power consumed by the local cloud. Companies and institutions emphasize on cloud computing service and its application for the storage and analysis of very-large images, which has been implemented using multiple distributed and collaborative agents. A distinctive goal of this work is that data operations are adapted for working in a distributed mode by using different sub-images that can be stored and processed separately by different agents in the system, facilitating processing very-large images in a parallel manner [19]. In clouds, load balancing, as a method, is applied across different data centers to ensure the network availability by minimizing use of computer hardware, software failures and mitigating recourse limitations, where the availability of cloud systems is one of the main concerns of cloud computing [20]. In [21] the authors analyze the performance of cloud computing services for scientific computing workloads and quantify the presence in real scientific computing workloads of Many-Task Computing (MTC) users that, of users who employ loosely coupled applications comprises many tasks to achieve their scientific goals. They also perform an empirical evaluation of the performance of four commercial cloud computing services.

## III. PROPOSED WORK

In our proposed method we used the billboard manager (BM) [11], is an electronic machine from which we get any information like capacity, and shortest node distance and any kinds of information about the nodes. So load distribution with a minimum time can reduce the power consumption as well as reduce the carbon emission rate. It is not a cost effective solution but it helps us to reduce carbon emission that is good for our environment.

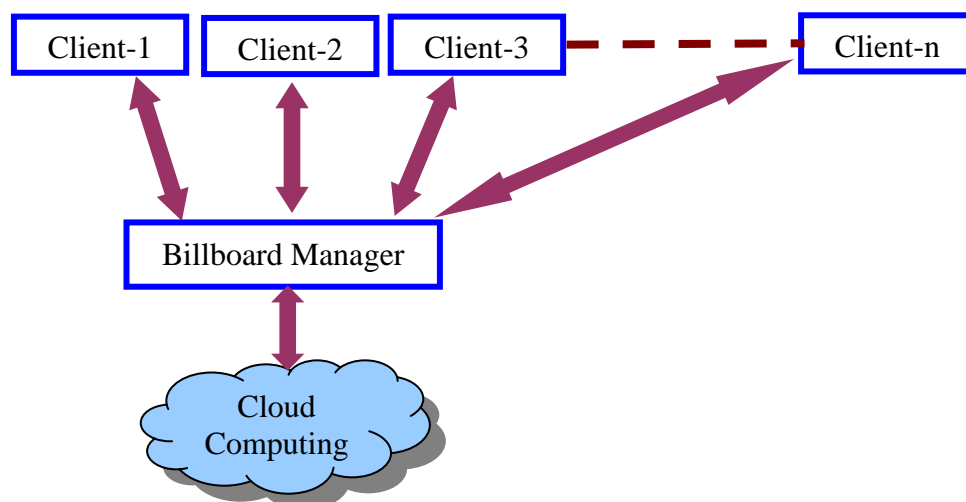


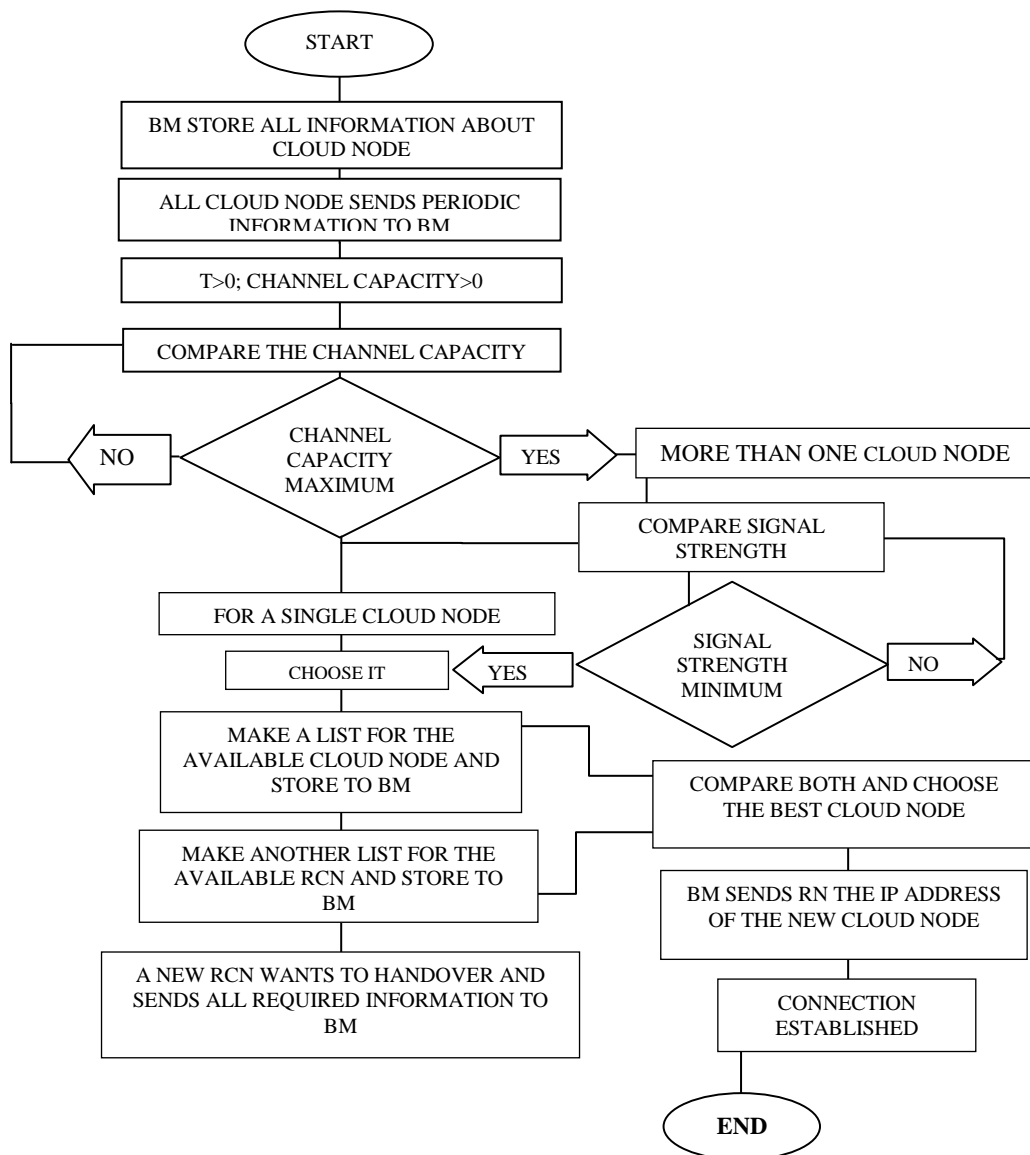
Fig 8: Cloud with intermediate node

## IV. ALGORITHM

- 1) BM stores all information about Cloud Nodes like capacity, IP address, and shortest node distance and any kinds of information about the nodes..
- 2) All Cloud nodes sends periodic information to BM.

- a) Channel capacity
- b) Storage space
- Both of the information varies time to time and also area to area.
- 3) Now for  $t=0$ , compare channel capacity if the channel capacity  $>0$   
Continue;  
Else stop
- 4) Compare channel capacity, choose the maximum one.
- 5) If the channel capacity of the two Cloud nodes to handover is same,
- 6) Compare the signal strength. Choose the lowest signal strength of same channel capacity.  
Else go back to 4
- 7) Repeat 4-6 every time while choosing a new cloud node to handover.
- 8) Make a list of the available cloud node and store it to BM
- 9) Now, If a new Remote cloud node RCN wants to handover, signal strength decreases under a certain level i.e. threshold level, it sends a Handover Request to BM via its current cloud node containing
  - a) IP address of the current cloud node .
  - b) IP address of the adjacent satellite, If RCN/RCN1 is connected to CN/RCN2 through more than one Data Center by ISLs.
  - c) IP address of RCN
  - d) Position of RCN
  - e) The direction of the RCN
- 10) Now BM again makes a list of available RCNs.
- 11) Now comparing the first list and second list it chooses the best cloud node to handover.
- 12) Once the cloud node is selected, BM sends RCN and IP address to the new cloud node.
- 13) Now the connection is established.

**V. FLOWCHART**



## VI. SIMULATION:

This work has been simulated ,X-axis represents the process and the Y-axis represents carbon emission .

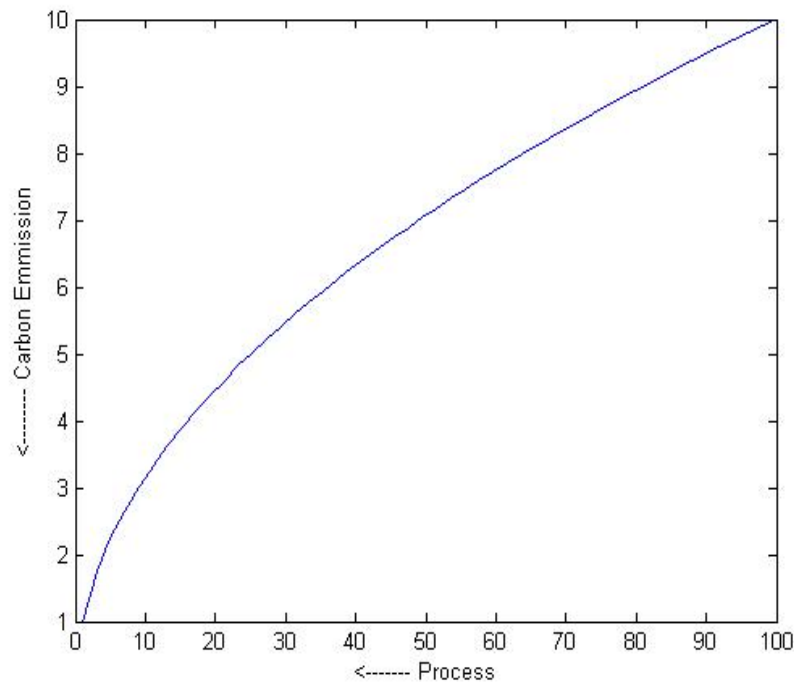


Fig 9: Simulation

The above graph illustrates the rate of decline in carbon emissions over a range of process runs. It is interesting to note that the rate of decline of carbon emissions at around the 50-process mark beginning from 100, is gradual when compared to the sharper rate of reduction in carbon emissions beginning from 50 and tending towards zero.

## VII. CONCLUSION

While the impact of cloud computing and its inherent strengths cannot be denied, the Achilles heel, so to speak, have been the issues which revolve around load balancing, virtual machine consolidation and energy management. Although various techniques and research journals have extensively, and in almost all the cases quite successfully, addressed these issues, the lacunae of cloud computing insofar as carbon emission control is concerned remains a proverbial “thorn in the flesh” threat. With the boom of internet and proliferation of network connectivity across villages, towns, cities and megalopolises, the glaring impact of carbon emissions on our atmosphere cannot be ignored. We can so much as circumvent this issue for so long and to our own peril. To insure the future of our generations to follow, we need to focus on how best to minimize, through load balancing, the rate of carbon emissions at the very least, and reverse the carbon emissions, if at all possible, in the best case scenario. In this paper, we have tried to understand, within a defined set of situations, a simulated test case that could possibly be a harbinger for future development in reducing and, possibly sometime in future, halting the rate of carbon emissions given a running number of processes required to significantly augment the reach and efficacy of cloud computing the way we know it today. The Billboard Manager demonstrates, in simulation runs, its ability to reduce carbon emissions with declining number of process runs. This is important as it is seen that the algorithm employed is not only capable in reducing the extent of carbon emissions, but is able to curtail the rate of emissions at a faster rate in direct proportion to the reduction of number of processes employed. The algorithm employs load-balancing procedures to achieve the results evident in the simulated exercise.

The Billboard Manager actively rationalizes information like capacities involved, the shortest node distance and other vital statistics involving the nodes themselves to function the way it has been designed to do. The effect of this cannot be ignored as this is pivotal in engineering further models as it saves resources and, thereby, protects our environment and atmosphere.

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