A Review on: Energy Efficiency in Green Computing

[1]Pallavi Mohindru[*], [2]Amanpreet Kaur
[1]Student, [2]Assistant Professor
[1, 2] Yamuna Institute of Engineering and Technology
India

Abstract—Cloud computing is widely used nowadays to deliver on demand services over the internet. The resources present on the data centres are shared among the clients. With the rapid growth of Cloud computing, the need to have more data centres is also increasing. More will be the data centres, more will be the energy consumption and more will be the CO_2 released by these servers which is affecting the environment widely.

The objective of this paper is to study the architecture of green cloud computing, various techniques involved in limiting the energy consumption and minimising the number of migrations involved.

I. INTRODUCTION

Cloud computing is a term used for network-based environment that basically aims on sharing computations and resources in order to deliver services over internet. Cloud computing can be defined as a pool of virtualized computer resources as multiple virtual machines are hosted on the same physical server. With the help of the concept of virtualization, the cloud computing allows workloads to be managed efficiently. In clouds, users only pay for what they are using and not pay for local resources like storage or infrastructure. [11]
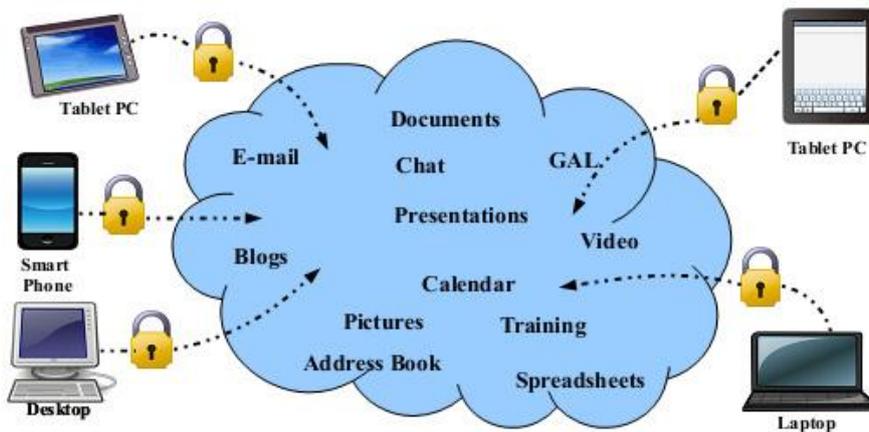

Figure 1: Cloud computing

Various services associated with Cloud computing are:
   i. Infrastructure as a service (IaaS): in this vendor's of cloud computing share their resources with clients such that clients have to pay as per use only. It allows clients to manage the operating systems, storage, applications, and network connectivity.
   ii. Software as a service (SaaS): It works upon pay-per-use costing model. In SaaS software that are available on the cloud server are provided as a services to the consumers on the basis of their requirement.
   iii. Platform as a service (PaaS):
 PaaS allows platform access for clients with the help of which they can put their own applications and soft wares on the cloud. [15]

II. CLOUD MODELS

Public cloud: A public cloud is a type of cloud model that is usually maintained by the cloud provider and is open for public use. The infrastructure of this type is provided to many clients and is generally managed by the third party. Users can simultaneously access the application equally. The users can access the features of this cloud from anywhere any time through internet. Example of a public cloud is Google, Amazon, Microsoft etc.
Privatecloud: In this type of model, the services and infrastructure are accessible to a specific customer only. It is maintained and managed by the organization and is not shared to other organization. In private cloud model, hardware and software sharing is limited due to privacy and security is given by encryption. Thus they provide the higher security, efficiency and improved reliability in cloud environment. Examples of a private cloud are IBM, Oracle, HP etc.

Hybrid cloud: It is an integrated cloud service that utilizes both private and public clouds features to perform various functions or operations within the same organization. That is the reason it is called hybrid cloud. As Public cloud services are more cost effective than private clouds. Therefore, an organization can increase their efficiencies by using public cloud services for all non-responsive operations, only using features of a private cloud where they require it. [14]
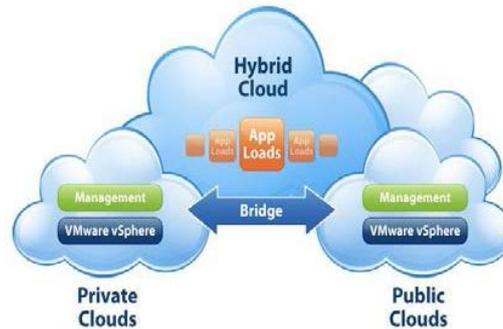

Figure 2: Cloud models

III.   NEED OF GREEN COMPUTING

With the increasing demand of online services in every area, the need of cloud computing is increasing rapidly. With this increase in demand, the need of more servers increases. Thus with more need of the servers, more will be the energy consumption. It is figured out that even an ideal server consumes 70% of the energy.

Thus it becomes very important to use the energy in an efficient way.

The term green computing is used to use the services of cloud computing in efficient way. It refers to the art of utilizing computing resources in an eco-friendly and efficient manner.

In the current trend in IT industries, ―going green has become an agenda for public relations and to reduce costs. One of the way to achieve the energy efficient model is the of Virtualization.

IV.   VIRTUALIZATION

Virtualization is a term that is used for a technology to create cloud computing platform. It is generally referred to the strength of cloud computing. It refers to the use of hardware and software virtually without knowing the need of resources available originally. The virtualized environment is known as the virtual machine (VM). It lets one to run multiple virtual machines on a single server (physical machine), where each virtual machine shares the resources of single physical server across multiple environments. Different virtual machines can run on different operating systems and various applications on the same physical computer. Thus with this virtualization key technology, effective and eco-friendly   utilization of resources are more desirable feature of cloud computing. As many virtual machines can run on a single host machine with a help of concept of hypervisor, it helps in saving power, that shows the way to achieve green computing. [14]
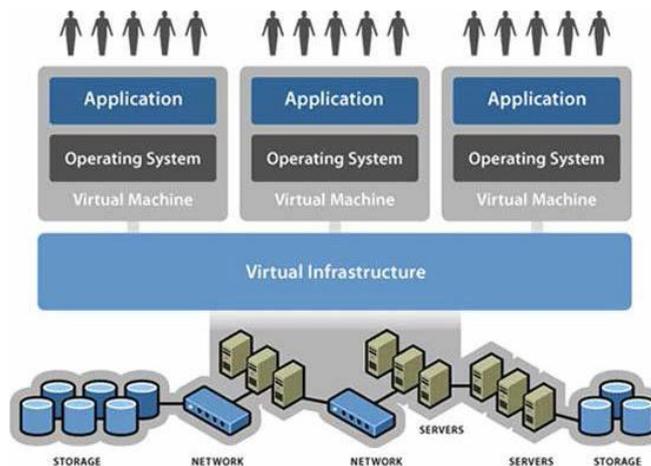

Figure 3: Virtualization

V.   GREEN COMPUTING SOLUTION

- **Minimizing consumption of paper**

There are many ways of limit the consumption of paper. With the use of computers being more popular than any other thing today all the major jobs can be done on the accumulator. Various modes of communications like e-mail, free-messaging, other social networking sites have brought communication to your doorstep. Less will be the use of paper, more will be the way to achieve "Go green" concept.

- **Purchase products that are environmentally green and sound**

Purchase the products that are labelled to be green and safe for one as well as the environment. These products will help to reduce the degradation caused by CO2 emitted by various energy consuming devices.

- **Recycle and Reuse**

One should discard used or unwanted electronic equipment in a convenient and environment friendly manner. Computers have various toxin metals and pollutants that emit harmful emissions into the environment so one should never discard computers in a landfill. Recycle them instead with the use of manufacturer programs such as recycling facilities in your community. One can even donate still-working computers to a non-profit agency.

- **Conservation of energy**

Since all electronic gadgets consume lots of energy, proper techniques should be followed to consume more of the energy. The best practices should be followed in order to limit the use of energy in an eco-friendly way.

- **Green Procurement and Asset Management**

This category refers to purchasing those computing equipment that are more energy efficient and environmentally friendly. It includes programs to extend the life of equipment, recycle and engagement with the suppliers that demonstrate a commitment to reduce hazardous materials in their manufacturing, packaging practice and factory waste management. [5]

VI. RELATED WORK

The various approaches used for green computing as given below.

- **Hypervisor technology**

Cloud computing is one of today's most exciting technologies as it can reduce the cost and complexity of applications. Along with that it is flexible and scalable. Actually, Virtualization technique has many security issues and limited security capabilities that must be addressed before cloud technology is affected by them. They proposed new security architecture in a hypervisor-based virtualization technology in order to secure the cloud environment. [11]

- **Integrated Green Cloud Computing Architecture**

In order to reduce save energy, reduce operation cost and to maintain eco-friendly environment, they proposedan Integrated Green Cloud Architecture (IGCA) that comprises of a client oriented Green Cloud Middleware to assist managers in better overseeing and configuring their overall access to cloud services in the greenest or most energy-efficient way. Decision is made, whether to use local machine processing, public or private clouds, is decided smartly by the middleware using predefined system specifications such as equipment specifications, service level agreement (SLA), job description and Quality of service (QoS) and provided by the IT department. [12]

- **LookAhead control**

By dynamically provisioning virtual machines, maintaining the workload, and turning servers on and off when required, data centre operators can maintain the required quality-of-service (QoS) along with higher server utilization and energy efficiency. They proposed a dynamic resource provisioning framework that can work in virtualized server environments where the provisioning problem is solved using a lookahead control scheme. The proposed approach is for the switching costs incurred while working with virtual machines and also covers the corresponding risk in the optimization problem. QoS is still maintained with approach in order to provide best services to customer. [16]

- **A Live Migration of Virtual Machine Based on the Dynamic Threshold at Cloud Data Centres**

Cloud computing has changed the whole picture of computing that is used now a days in every field. Virtualization is the key technology that is used in cloud computing. With this technique one can divide one physical machine into the multiple virtual machines. Live migration of virtual machine is one of the most important features of the virtualization. By the proper technique of virtual machine migration administrator can move the virtual machine from one physical machine to another physical machine. Migration is mainly used for the load balancing fault tolerance, hot spot management and resource consolidation. They proposed a technique that can also be used to minimize the energy consumption of data centres and also use a lower and upper level threshold to limit the number of migration involved. [17]

VII. COMPARISON BETWEEN VARIOUS TECHNIQUES

Paper title	Proposed techniques	Virtualization	Advantages	Limitations
Secure Virtualization for Cloud Environment Using	Hypervisor	Yes	Provides more security	Limited memory, need license for paid version

Hypervisor-based Technology[1]				
Integrated Green Cloud Computing Architecture[2]	Middle ware Integrated Green Cloud Architecture (IGCA)	Yes	minimum energy consumption ,provide a client oriented green cloud middleware allowing the job/operation manager to define the job of each department, maintains QOS	Overhead cost of middleware.
Power and Performance Management of Virtualized Computing Environments Via Look ahead Control [3]	look ahead control scheme	Yes	Minimize energy consumption	QoS varies in some cases
A Live Migration of Virtual Machine Based on the Dynamic Threshold at Cloud Data Centres. [4]	Migration technique	Yes	Minimize the number of migration as well as the energy consumption.	Costly, sometimes packets are missed during migration

VIII. CONCLUSIONS

With the study of related work, it concludes that it is very important to build in some techniques to use the cloud computing in an eco-friendly way. Live migration technique on threshold can control the number of migrations needed and the energy consumption but it is sometimes costly to be used everywhere and affects the Qos. Also with the help of middle ware Integrated Green Cloud Architecture, we can control the energy consumption but again it will add the extra cost of middle ware in the cloud computer architecture.

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