Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

Energy Efficiency in Cloud Computing

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***Abstract* : Cloud Computing is an application where various services can be used online. These services include database, storage, applications, servers etc. In Cloud Computing, the consumption of large amounts of energy is one thing which we are concerned about. Computational services are being provided to the users and a lot of heat is being generated, so cooling is also necessary. A lot of energy is being used. Because of the consumption of large amount of energy, more amount of carbon is generated and released into the environment. As carbon emission is more by the data centres, it may lead to global warming and other climatic changes which is bad for the environment. Therefore, the amount of energy consumed has to be reduced which then increases the sustainability and productivity of the system. Thus there is a need for less energy consumption.**

Key Words:-

- ◊ ***Cloud Computing***
- ◊ ***Cloud based storage***
- ◊ ***Energy Consumption***
- ◊ ***Carbon emission***
- ◊ ***Global warming***

INTRODUCTION

An application where various tools and services like data-storage, database, servers, networks etc are made available online. It is a tedious task and not preferred to store any of these on hard-disks or any other storage devices. It is always better to save them online so that even with the help of an electronic device and an active internet connection, it can be accessed anywhere. Some of the advantages of cloud computing can be mentioned as cost cutting, easy accessibility, faster performance, more secure storage of data and so on. Types of Cloud Computing:

- **Software as a Service(SAAS):** Here, various software applications are being provided to licensed users based on their requirements. Based on the features needed for the users and their demands, the price is fixed. Some of the prominent examples maybe Google-Photos, Google-Docs, Gmail, Office 365 etc.
- **Infrastructure as a Service(IAAS):** Here, facilities such as operating system, servers etc are being given to the end-users. Developers are the people who usually use this service. Some users usually buy the server space for themselves which might be costing. Instead of that, these services can be used which is far more cost efficient. The services are usually outsourced to the clients. Some of the notable examples are Windows Azure, Google App Engine etc.
- **Platform as a Service(PAAS):** Here, software framework, infrastructures are provided to the clients. These are usually used by the business that develop and manage software and web applications. Some of the important examples can be Amazon web service, Rockspace, Linode etc.

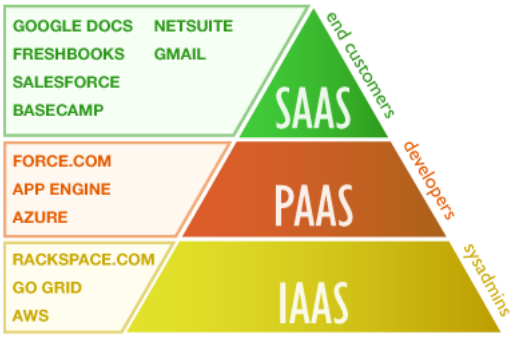

FIGURE 1. Types of Cloud Computing.

In cloud computing services, Data centres are the most prominent part which holds all the data that is being stored in the cloud. Servers, connections, air-conditions cables, computers, etc. consume a lot of energy. The amount of carbon emission is also significantly more. As carbon emission is more, one of the most important concerns would be the effect it has on the environment. As a result, it is of utmost concern that energy consumption has to be optimized. As a result, service providers started using green cloud computing Techniques. This technique helps is adopting techniques that reduce energy consumption. Instead of physical resources, natural resources are being used which is clean for the environment. Hence it increases the sustainability and performance.

MOBILE CLOUD COMPUTING

Mobile Cloud Computing can be explained where processing and storage of data happens on the cloud but mobile phone acts a display media. This can be defined as bringing the cloud computational services to mobile users and cloud computing users. Mobile network operators as well as cloud service providers are benefitted with Mobile cloud-computing.

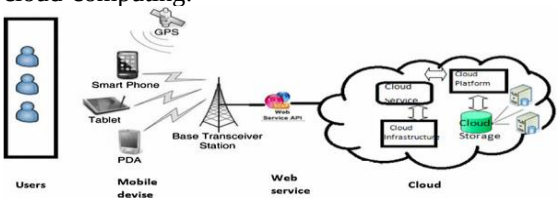

FIGURE 2. Architecture diagram of Mobile Cloud Computing.

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ENERGY CONSUMPTION & ARCHITECTURE :

Reconfiguration, monitoring and energy efficiency mechanisms are the factors on which the architecture is dependent on. The framework used to monitor the cloud environment communicates with the Monitoring and reconfiguration modules. Energy Calculator module is used who's prediction is very much required for taking the appropriate decisions regarding energy efficiency.

Cloud service providers comprise of very large data centres. These data centres are situated in different parts of the earth. Large amount of energy is required to power and maintain these. Everyday, the amount of energy consumed is increasing.

As more energy is used, companies incur more cost. In the present days, this has become a challenge for most of the cloud computing companies. Servers are not used to their maximum capacity all the times and most of the times they are idle. So a large amount of energy is consumed on keeping these servers running. As a large amount of energy is used, CO2 emission will also be more by the data servers. Extensive data centres consists of a large number of components utilising more energy.

TECHNIQUES TO MINIMIZE ENERGY CONSUMPTION IN CLOUD

- **Dynamic Voltage and Frequency Scaling (DVFS) :** Dynamic voltage and frequency scaling (DVFS) techniques along with associated techniques such as adaptive voltage frequency scaling (AVFS), and dynamic voltage scaling (DVS) help in minimizing power consumption. The effect on active power consumption will be squared by lowering the voltage. DVFS techniques provide ways help a lot in reducing power consumption of chips on the fly by scaling down the voltage (and frequency) based on the targeted performance requirements of the application. DVFS is effective on both static power and dynamic power because it optimizes both voltage and frequency. In implementation with DVFS, the challenges are very similar to DVFS in synthesis: juggling different operating frequencies (different timing constraint files) and different operating voltages (with their assigned, different timing libraries). In more advanced Electronic device Automation tools, these different combinations are optimized in parallel, automating the process. When compared with traditional non-DVFS designs, we get a longer time to get design closure with better power benefits.

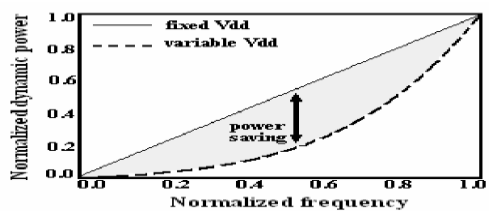

FIGURE 3. DVFS Graph

- **VIRTUAL MACHINE:** A Virtual Machine can be defined as a virtual system of computer which can execute so many functions of a computer along with running many applications and other operating systems. Virtual Machine has software that can execute programs and operating systems. It can also perform other functions such as data storage and network connection. System updates at regular intervals and constant monitoring is required for better performance. With the help of a single server, many virtual machines can be hosted and managed using a single computer. It is used for :

1. Consolidated servers: VM's can be used to set up servers which is in turn used to host other VMs'. It concentrates more resources into a single physical machine.
2. Creating testing and development environment: VM's can create isolated environments that can be actually used for testing and development of all functionalities without disturbing any other surrounding infrastructure.
3. Support DevOps: VM's can be easily used and transported between various computers and hence increasing flexibility.
4. Improve disaster recovery and business continuity: provides an extra layer of security so that data can be recovered during any fatal errors.
5. Create hybrid environment: Along with a cloud environment, A virtual machine helps with a on premises one.

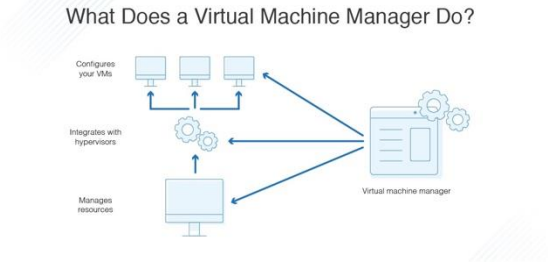

FIGURE 4. VM Manager

- **MIGRATION AND VM CONSOLIDATION:** In order to improve the usage of resources and maximize energy efficiency in cloud computing data centres, consolidation of virtual machine is needed. This uses live migration of a VM to transfer a VM among physical servers.

GREEN CLOUD COMPUTING

Green cloud computing is a term where services offered by information technology(IT) has potential environmental benefits. The term "Green" means environment friendly and "Computing" meaning the type of resource model known as cloud computing are combined. Green Cloud Computing is basically a technique where "A method where businesses and service providers follow methods for their operations and functions which are environmental friendly and reduces the carbon emission". In short, Green Cloud Computing can be defined as "The study and practise of designing,

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developing, usage of Computers, servers and other components which are environmental friendly". The main goal of green cloud computing to reduce the effect of hazardous materials used in cloud computing by designing and producing sustainable and biodegradable components. Even in the present scenario, continuous research is being done to ensure maximum energy efficiency of computers and designing systems and algorithms for better efficiency related technology.

Approaches to Green Computing:

- Virtualization
- Resource Granting
- Management of power usage
- Product durability
- Efficient Algorithms

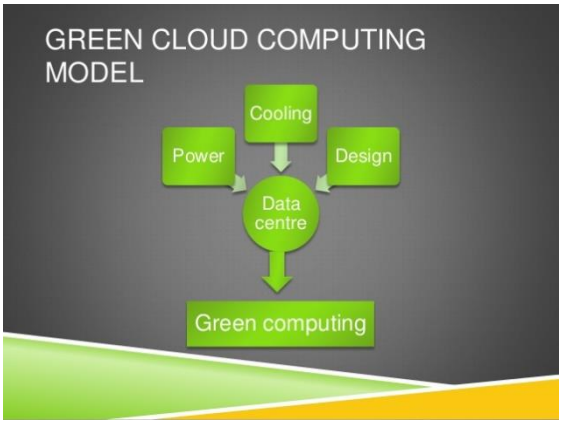

FIGURE 5. Green Cloud Computing Model

CHALLENGES OF GREEN CLOUD COMPUTING

- Proper optimisation: Proper balance has to be maintained between temperature and energy.
- Reduce structural complexity: Components need to be individually configured in order to reduce dependency on other components.
- Performance deprivation: In order to have maximum performance of the servers, more energy is required.
- Reliable power source: A reliable and efficient power source is required.
- CO2 emission: The amount of CO2 emitted by cloud servers has to be significantly reduced.
- Cooling of the data centre: A major role has been played by sensor networks in handling data centres power consumption.
- Energy efficiency: The overall energy consumption rate has been minimized using it.

DISADVANTAGES OF GREEN CLOUD COMPUTING

- **Cost of execution is more**: Small scale and Medium scale industries find it difficult to afford for the method of green cloud computing.
- **Evolving Technology**: Some latest advancements in green cloud technology will make it difficult for most of them to adopt to it.
- **Less Powered computer**s: the main aim of green cloud computing is to minimize the power being consumed, as a result the output of the computer systems might be affected.

CONCLUSION AND FUTURE WORKS

Cloud Computing is one of the most important asset for many companies. As more energy is consumed and he demand for energy is also increasing, its not only expensive but also harmful for the environment. Techniques such as Green Cloud Computing are being used now a days which is effective in reducing carbon emission and also maintain the carbon footprint of the earth, hence forming a more cleaner and safe environment. In future work, the authors will attempt to consider another sort of model, which can be incredibly powerful for breaking down specific issues in the cloud data centre including heterogeneous tasks scheduling and flaw diagnosing, and authors may take more factors into thought; for instance, not just time furthermore, power utilization yet additionally, the condition of the hosts can impact the energy of the data centre. Another promising future work heading is to attempt to utilize other biocomputing strategies to tackle a few issues in green cloud computing.

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