Edge Up Green Computing in Cloud Data Centers

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Abstract: The world today is almost working on machines which are releasing hazardous gases & cloud is mainly working on the machine environment. Cloud Computing is the talk of the day and used by every person now a day. Almost all the domains are making using of this technology which on the back-end uses SAN (Storage Area Network) Technology. Through this service data, application & other resources can be accessed using internet. Cloud uses a large number of high-end machines which is resulting in the release of hazardous gases in the environment which has a negative impact on the environment around us. So, we need to look for aspects which can result in making cloud energy-efficient. In this paper, we have put forward some of the techniques which can be used to make cloud computing more energy-efficient.

Keywords: Cloud Computing, Virtualization, green computing, Recycling, Data Centres, Energy Star.

I. INTRODUCTION

The world started from an era everything such as work, storage, communication etc. was manual and finally reached to an era where all the work, communication, storage etc. is fully digital i.e. machine oriented. As we know that everything as its advantages and disadvantages, in the same way manual era and machine era as its benefits and drawbacks.

After having a look at the manual era, we conclude that the work, storage, communication etc. was time-consuming, huge, difficult to handle were as in machine era we conclude that the job, storage, communication is faster and data is easy to handle due to the use of machines. The machine which are making this possible are high-end devices which in turn are releasing hazardous gases into environment and using huge amount of power consumption, this in-turn is exhausting resources used for generating power.

II. HISTORY

Development from manual era to the cloud computing era has happened step by step with the development in the technology. The various developments are: -
1. Manual Era.
2. Wired Communication.
3. Personal Computers.
4. Computers introduced in office.
5. Wireless Communication
6. Portable Computers introduced.
7. Smart Phones.
8. Cloud Computing Era.

A. Manual Era

In the manual era, all the work was handheld be it the work in office, communication between people and physical storage. The communication between people and official work was very time-consuming and the data was very huge which needed large amount of storage space.

B. Wired Communication

After working further scientists and researchers introduced wired communication in the form of fixed lines.

C. Personal Computers

Next development in the technology was computers as it was complex to handle and costly very few people were using it.

D. Computers introduced in office

Researchers were working on the computer system to make it easy to understand and affordable for the user. Slowly these computer systems started getting used in office environment.

E. Wireless Communication

The next development in the communication was portable phone i.e. wireless communication.

F. Portable Computers introduced

By this time the existing computers were further worked on and made better and led to flatron systems and portable computer systems such as laptops.

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G. Smart Phones

Further some more developments, mobile phone and communication slowly and steadily finally leading to smart phones, which have the full functionality of working as computer systems.

H. Cloud Computing Era

With further more development in the technology we have reached to the cloud computing era in which shared resources are available to the user through internet depending on their needs.

III. CLOUD COMPUTING

Cloud Computing is the trend of the day, the most famous technology being used by almost all people on the daily basis by accessing mails, using social networking sites, etc. It is a service where resources such as hardware, applications, operating system, software, storage are being shared on demand and accessed using internet.

Figure 1: Cloud Computing

The on-demand feature of the service is making it special as the customer/user does not need to buy resources on their own just needs to have an internet enabled computer system and the working environment is available on the cloud service.

With cloud computing user get executable environment, privilege of storage and transferring their data in to distinct place with least computing power [1]. The various features of cloud computing services are as follows: -
1. Scalability
2. Quality of service
3. Customized Work-space.
4. Cost Efficient
5. User-friendly interface
6. Need based service
7. Virtualization

I. Scalability

Scalability feature of cloud offers customer the shared resources as per the need i.e. increasing and decreasing resources as and when required [1].

II. Quality of Service

The QOS (Quality of service) feature offers us much effective working space than our own data centers because of no dependency on the resources, which enables rectification of failures without informing the customer [1].

III. Customized Work-space

Due to the feature of customized work-space, the client offers specific resources according to its requirements [1].

IV. Cost Efficient

By cost efficient we mean that the user does not need to buy its own hardware, which in turn diminishes the maintenance and update cost.

V. User-Friendly Interface

Cloud service at the front-end a user-friendly interface which a user can easily understand and work on.

VI. Need Based Service

Need based specifies that when the client needs he/she can contact the cloud service provider and disconnect when the work is over [2].

VII. Virtualization

Virtualization concept used in cloud which refers to abstraction of computing resources. Using the concept virtualization on a single computing resource, can create multiple virtual resources which in turn reduces concrete hardware, power and cooling consumption.

IV. SERVICE MODELS OF CLOUD COMPUTING

The three types of services offered by cloud computing are as follows:
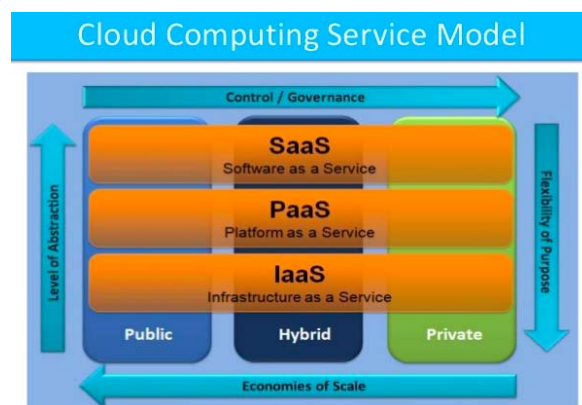a. SaaS
b. PaaS
c. IaaS

Figure 2: Service Models of Cloud Computing

A. SaaS

SaaS is known as software as a service [3]. This type of cloud get access to the shared resources through internet using web services [3]. The app logic

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and data in this type of cloud is centrally located and available to the customer at the front end using browser or thin client [1]. On the daily basis, we are making use of the services which are Google, Facebook etc. [1].

B. PaaS

PaaS is known as platform as a service [3]. This type of cloud allows us to offer the environment for execution of software etc. which is available to the customers using internet [3]. PaaS eliminates the need of creating complicated software by providing the user with pre-configured environment which makes the task very easy for the client [1]. Various examples of PaaS are Microsoft Azure and Google App Engine etc. [1].

C. IaaS

IaaS is known as Infrastructure as a service [3]. IaaS is a sub-type of cloud which avails infrastructure to the clients on shared basis accessed by using internet [3]. Here the user just uses the shared resources without any need of functioning and preserving the resources.

V. DEPLOYMENT MODELS OF CLOUD COMPUTING

The deployment model of cloud computing is various types which are as follows: -
   a. Public cloud
   b. Private cloud
   c. Hybrid cloud
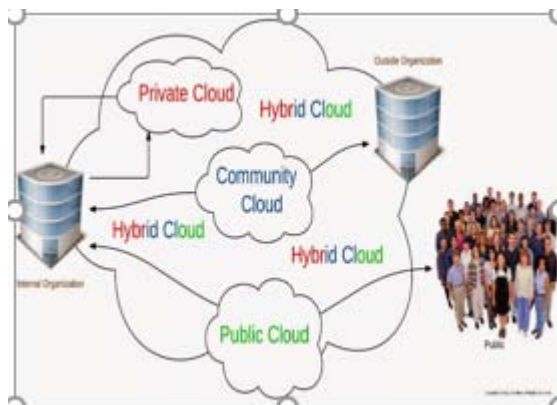

Figure 3: Deployment of cloud computing

A. Public Cloud

Public cloud is the most commercially used cloud [4]. It is the variety of cloud which is open source, available for uses over internet free of cost as and when needed [3]. The most popular public clouds are Microsoft Azure, Amazon Web services etc. [2]. Public cloud provides all three types of facilities which as: - SaaS, PaaS, and IaaS [2].

B. Private Cloud

Private cloud is the proprietary cloud, which means that it belongs to a group or corporation [3]. In this type of cloud, resources get installed, handled by and kept within the corporation or cloud service provider [4].

C. Hybrid Cloud

Hybrid cloud in point of fact is the grouping of characteristics of public and private cloud [3]. Generally, the hybrid cloud finds its implementation in infrastructure service.

VI. BASIC STRUCTURE OF CLOUD

The concept of cloud computing generally seems logical for the user i.e. but in reality at the back-end uses a lot of high-end machines and uses virtualization approach. The structure of cloud consists of the different parts which are broadly divided into two categories which are: -
   a. Front-end
   b. Back-end

A. Front-End

Front-end of the cloud is very simple, easy to understand and the main sources of contact for the client or user while using the cloud services [5]. The client-end includes computer system enabled with internet. All the required software's are already installed in the computers which act as an interface for the user [5].
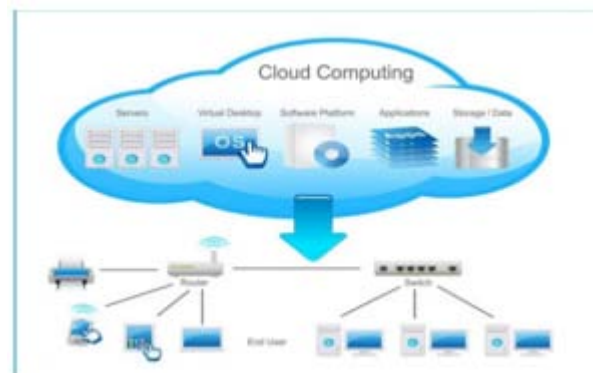

Figure 4: Layout of cloud

B. Back-End

Back-end is the main running environment where the shared resources accessed by the client are working [5]. This consists of large number of high-end devices for computation, storage and applications [5]. There are various duties which the back-end offer to the front-end are as follows: -

• Providing safety measures, traffic controller and rules.

• Applying rules for communication between connected networks.

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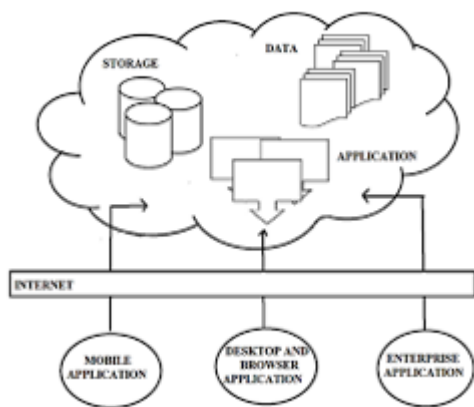Dept of Comp. Sci. & Eng, SEST, Jamia Hamdard, New Delhi (India)

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Figure 5: View of Cloud Computing

Due to large number of high computing devices such as servers, routers, virtual machines, switches, computer systems which are running 24*7 for making the cloud services available to the clients or customers, there are issues

which are increasing with time and need to take measures for controlling them.

VII. ISSUES OF CONCERN

These issues actually have some part in contributing to the global warming.

The issues of concern here in cloud are:

1. Hazardous gases released while machines are running to keep the cloud service available to the clients [6].

2. High power consumption for running the high computing system [6].

Basically, link exits between both the issues. In order to work on these aspects green computing has come into action.

VIII. GREEN COMPUTING

With the development in the technology, the number of computer systems have increased which has amplified the power consumption and in turn amplified the amount of hazardous gases [6]. The frequency with which earlier technology is getting obsolete is also a reason for products getting obsolete and producing e-waste. Due to these reasons need green computing came into picture [11].

Green computing is same as green chemistry, mainly works for making environment biologically bearable [6]. This means that its main aim is to protecting environment from the high computing devices [6]. The concept of green computing has started since 1987.
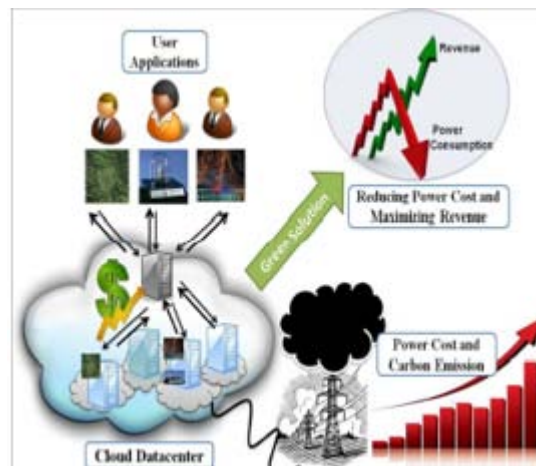

Figure 6: Green Computing [6]

Green computing distillates mainly to diminish influence of engineering processes and developments in the environment around us [6].

The different methods of green computing are included in following categories: -

a. Decreasing the Electronic Waste.

b. Decreasing the carbon emission by working on the energy efficiency.

c. Switching to the means which reduces the effect on the surroundings [9].

In the IT industry, the areas which mainly contribute to the carbon emission are as follows:

1. Data Centers
2. Company Architecture and Roles
3. Technology

8.1 Data Centers

Data Centers are the main working areas where computation of all processes, storing and organized [11].

Keeping all these resources available 24*7 leads to huge power consumption which is one of the sources for hazardous gases [11]. The power consumption ratio of the organizations data centers is half the amount of power consumed and hazardous gases emitted by all other works of the organization [11].

Figure 7: Data Center [18]

Green Grid Consortium coined a derivation to calculate the energy productivity in data centers using Power Usage Effectiveness [11].

PUE = Total Capacity of Power/ Power of the Equipment.

The PUE if equal to 1, means that the data center is 100% energy resourceful in accordance to the energy consumed by IT organizations [11].

8.2 Company Architecture and Roles

The main aim of the organization is to increase the output by making use of the all the resources in-order to fulfill the needs of the customer [11]. The company mainly cares on the aspects such as power dispensation, frequency of execution, increasing operative throughput and guaranteed turnover [11]. Whereas company does not worry for energy ingesting, hazardous gases and electronic waste [11].

8.3 Technology

Technology is the talk of the day and is improving day by day. With time, all the new developments got implemented in organizations which in turn is leading to profit. As more and more technical developments get adopted in companies it is have a direct impact on the power consumed [11].

IX. PRACTICES FOR REDUCING THE POWER CONSUMPTION

The various practices using which the power consumed for functioning of the machines diminishes are as follows: -
   a. Turning Off the Devices after being used [6].
   b. Enabling Power Saving Modes in Machines [6].
   c. Sleep Mode in I/O (Input/ output) Devices [14].
   d. Hibernate Mode [14].
   e. Machine Standby Mode [14].

A. Turning Off the Devices after being used

We should stick to a habit of turning off the machines after the work is over. It is the easiest, simplest method used
to diminish the power consumed by the machines [6]. In spite of this mode there is minute power which is still used up [6].

B. Enabling Power Saving Modes in Machines

The power being consumed can also be diminished by enabling power saying modes in the machines or equipment's. For diminished the power used up, the easiest method is Screen Saver [6].

C. Sleep Mode

Sleep Mode in I/O Devices means that when any of the devices is not being used for a certain time then it enters the sleep mode where the power consumption

is less as compared to the running state of the devices [6].

D. Hibernate Mode

Hibernate mode is a step ahead of the standby mode as it totally power off's the device [14]. In this mode, the current state of the processes, memory etc. remains stored. When the computer is restarts, and saved state is restores [14]. A system in this mode uses only 3 watts of electricity [14].

E. Machine Standby Mode

In the standby mode, the machine after being idle for some time will almost shutdown the connected devices will lead to minimizing the power consumed [14]. Here, only the volatile memory remains active to keep the data [14]. The standby mode only uses 5 watts of power supply [14].

X. APPROACHES TO GREEN COMPUTING

There are many approaches used for green computing, which are: -
   a) Algorithmic Productivity
   b) Virtualization
   c) VoIP
   d) Terminal Servers
   e) Storage
   f) Better Data Center Cooling Methods
   g) Green Data Centers
   h) Resourceful Server Allocation
   i) Recycling
   j) Correct Throwing Away of Waste

A. Algorithmic Productivity

By Algorithmic productivity, we mean the best output which can influence the number systems & resources being used for performing a task [10]. According to a report, Google search engine in a single search operation generates 7 grams of hazardous gases [10].

B. Virtualization

Virtualization is the most cost efficient tools of green computing [10]. By virtualization, we mean abstraction of highly computing resources which creates multiple logical resources on a single resource [9]. The concept of virtualization is mostly used in server environment and data storage [10]. With virtualization, not only creates multiple logical resources on a single high computing device but also joins multiple resources are to create a single virtual resource [9].

C. VoIP

VoIP is known as Voice Over Internet Protocol, it defines the technologies used to send/receive voice messages through WWW [10]. This protocol avails cheap and clear connectivity medium [15]. This is in turn diminishes the amount of metallic waste [10].

D. Terminal Servers

In spite of all the calculation, processing etc. done on the main server; the operating system is still involved at the clients end which results in large amount of power consumption [10]. The power consumption can get diminished by introducing terminal servers. The terminal servers consume 1/8th the amount to power in comparison to the normal work station [6]. This concept is found mostly to create virtual labs [6].

E. Storage

For storage, hard drives used which consumed some amount of energy due to the rotating element but the energy consumed is less in contract to the other parts connected to the system [10]. The development in technology introduced flash memory/DRAM, which consumes lesser energy then hard drives [10].

F. Better Data Center Cooling Methods

The aim of such methods is placing the servers near to the cooling systems so that cold air focuses the main site, drops the outflow of energy and making use of aqua cooling mechanisms [10].

G. Green Data Centers

The main aim of the Green Data Centers is the use of renewable sources for producing electricity [11]. Now a day's setting up the data center near the renewable energy sources [11]. This step has already been taken by several organizations such as Microsoft, Google etc.

Microsoft has put up its data center in Central Washington to make use of the two huge water resources in the area, i.e. driven by hydro-electricity.

H. Resourceful Server Allocation

In order to make efficient use of the algorithm's the resources are properly assigned for execution. In case of data centers, assignment of servers to execute the processes depending on the speed of sending and receiving of data [8].

I. Recycling

Recycling is the process of reusing the products which in turn keep the amount of waste less [6]. This also keeps harmful material away from getting disposed into the any off the natural resources [6]. To understand it lets see the examples which are: -

1. In case of CRT monitors, recycling of parts such as glass, chromium, mercury and lead for use [6].

2. In CD's/Dvd's, there are recyclable parts such as plastic, glass and nickel etc. [6].

3. Batteries-The parts from the batteries which are supplying power to all devices such as mobile phones, laptops, I/O devices [6].

Recycling is the technique used to make components reusable and the people involved in this process are known as recyclers [11]. The recyclers are of two types which are: -

a) Formal Recyclers
b) Informal Recyclers

- **Formal Recyclers**

Formal Recyclers include the companies authorized to execute the recycling process [11]. The licenses issuing company varies depending on the type of the material being recycled [11].

- **Informal Recyclers**

Informal Recyclers include people who are not authorized by the government to do recycling. Being unauthorized means government has not provided license to the people [11].

I. Correct Throwing Away of Waste

This means that the waste which cannot be recycled, disposed in such a way that it does not have harmful effect on the environment around us [6].

Energy Star

Figure 8: Energy Star [6]

Energy star program is one of the first manifestations ofthe green computing. Energy Star served as a sort of deliberate label awarded to computing products that succeeded in minimizing the usage of energy while augmenting efficiency.

A voluntary labeling project was framed by US Environmental protection Agency in 1992, coined as Energy Star. This was introduced to advance and diagnose Energy-Efficiency

Energy Star is a worldwide standard for energy-efficient items began in the United States of America

It was initially made as a United States government project during the early 1990s, yet Australia, Canada, Japan, New Zealand, Taiwan and the European Union have likewise embraced the program.

Gadgets conveying the Energy Star logo, such as PC items and peripherals, kitchen appliances, structures and different items, generally use 20%–30% less energy than required by government standards.

Energy Star details contrast with everything, and set by either the Environmental Protection Agency or the Department of Energy.

Energy Star items:
1. Computers and peripherals
2. Servers
3. Home application
4. Heating and cooling products
5. Home electronics items
6. Imaging gear

The term "Green computing" was most likely coined shortly after the Energy Star project started.

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XI. PROPOSED MODEL

In a data center, large or small, every device such as servers etc. have primary, secondary and backup servers configured such that if primary fails we have other alternative to continue the work. All these keep running 24*7 in turn releasing harmful gases.

As we know the routers work to find all possible paths between source and destination but transfer the data through the shortest path. In case of any problem in the shortest path then it switches to the next shortest path.

Implementation of an algorithm or a device in data centers such that when there is any issue in the main devices then automatically the back devices already configured should come into action till that time the devices should stay in sleep or standby mode. Thus, diminishing the power consumption which in turn diminishes the release of hazardous gases.

This will help us in having some controlling the further addition of hazardous gases.

XII. CONCLUSION

With each day, the technology is becoming more and more advance in turn leading to increase in the release of hazardous gases. In order to control this more and more awareness needs to make people aware about Green Computing. Various measures already being taken to control the diminish the intake of power which in-turn will diminish the release of hazardous gases in the environment. All the methods, techniques, policies if efficiently applied will led to efficient green computing.

Green Computing is not a mission but it is an undertaking which results to environmental cleanliness. Green is not a single job it collectively consists of many tasks for implementation. All people should directly or indirectly get involved in this undertaking to make the green computing successful.

In the End, Green Computing is slowly and steadily taking us towards clean and pure environment.

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