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Green Cloud Computing

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ABSTRACT

Cloud computing is a the most scalable and cost-effective infrastructure for running HPC, enterprise and web. Infrastructure has dramatically increased energy consumption of the data center has become an important issue. Hosting cloud computing applications requires a large amount of Energy responsible for high operating costs and carbon dioxide Data center consumption has become a critical issue. You need a cloud computing solution that not only saves you money, but is green Not only does it save energy, it also reduces operating costs. Consumption not only leads to high operating costs Therefore; energy efficient solutions are needed to minimize them Designing such a solution requires a thorough analysis of the cloud Instructions for enabling green cloud computing.

Keywords: Green cloud, dynamic provisioning, multi-tenancy, Datacenter Efficiency.

1. INTRODUCTION

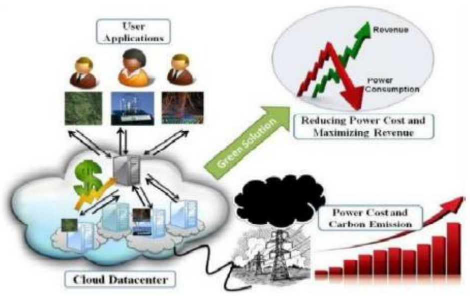
The growing demand is handled by large-scale data centers that consolidate hundreds and thousands of servers with the other infrastructure such as storage, cooling and networking.

Many Internet companies such as Google, Amazon, eBay, etc. Yahoo operates on a very large scale data centers around the world. Commercialization of this Development is now defined as cloud computing. Compute is provided as a pay-as-you-go utility. The advent of cloud computing is rapidly changing that landscape. Ownership-based approach to subscription-based approach It provides access to infrastructure and services that are scalable as needed. Users can store, access and share any amount Information in the cloud. Cloud computing also offers a great opportunity for the computing power your organization needs to manage the massive amounts of data that can be generated every day.

According to IDC (International Data Corporation) Report estimates spending on global IT cloud services increased from $16 billion in 2008 to $42 billion in 2012, This equates to a compound annual growth rate (CAGR) of 27%. Attracted by these growth prospects, web-based businesses (Amazon, eBay, Salesforce.com), hardware vendors (HP, IBM, Cisco), Telcos (AT&T, Verizon), Software Companies (EMC/VMware, Oracle/Sun, Microsoft), etc.

The cloud is essentially a virtualized data center and applications provided as a subscription-type service as shown in the figure.1. It calls for a big quantity of strength to operate. today, a typical data center of 1000 racks require 10 megawatts power-to-Operating results in higher operational costs. For data centers, Green Cloud applications calculating energy costs is an important part of this. Also, in April 2007. Gartner values its information and communication. The technology industry (ICT) generates approximately 2% of total sales.

Global CO2 emissions equivalent to the aviation industry. According to a report published by the European Union, 15% to 30% reduction in emissions required in advance 2020 to keep the global temperature rising.



Cloud energy consumption and carbon footprint infrastructure has become a central environmental issue. Cloud Computing Can Actually Run a Traditional Data Center using technologies such as resources to increase energy efficiency, virtualization and workload consolidation. On the other hand, energy consumption can be reduced by:

Server consolidation that allows different workloads to share

Same physical host with virtualized and idle servers you can turn it off , even the most efficiently constructed data centers.

Instead, it is only mitigated at the highest utilization rather than eliminating harmful CO2 emissions. The reason provided is that cloud service providers are more interested in electricity cost reduction rather than carbon emissions. Apparently no cloud datacentre in the table can be called green. Cloud computing, as an emerging technology, also increases important question of its environmental sustainability. Through the use of virtualized data centers shared in the big cloud computers can save significant energy. However, Cloud services can also increase Internet traffic and the growing database of information can reduce these energy saving. Green Cloud framework to reduce carbon footprint in a healthy way without sacrificingservice quality (performance, responsiveness, and availability) offered by many cloud providers.

STRUCTURE OF PAPER

The paper is organized as follow : In section 1, the introduction of the paper is provided along with the structure, important terms, objectives and overall description. In section 2, we discuss completely about the need of green cloud computing.in section 3, we have conversed about the features of clouds enabling green computing and the steps towards the green cloud computing. In section 4, we have mentioned about the green cloud architecture. In section 5 we have displayed the survey results and its testing using the descriptive statistics. In section 6 and 7 conclusion and references of the research is provided.

2. NEED OF GREEN CLOUD COMPUTING

Modern data center, running on cloud computing models host a variety of applications that runs in seconds (e.g. responding to site requests applications such as e-commerce and social media portals with temporary workloads) to those that run for a longer time time (e.g. simulation or processing of large data sets) over shared hardware platform. The need to manage multiple applications in the data center create the challenge of sourcing and allocating resources on demand to meet workload changes over time. Typically, data center resources are statically allocated to applications, based on peak load characteristics, to maintain isolation and provide performance guarantee. Until recently, high performance was is the only concern in data center implementations and this request was met without much concern energy consumption. Data centers aren't just expensive maintained, but also not environmentally friendly. High power costs and huge carbon footprints incurred due to the amount of electricity required to power and cool much servers are hosted in these data centers. Cloud Service Providers must take measures to ensure that their profit margins are not greatly reduced due to high energy costs. Lower Data center energy consumption is challenging and complex problems because computer applications and data are evolving fast when ever larger servers and disks are needed to process them quickly within the request timeframe. Green cloud computing is designed to not only achieve handle and use IT effectively infrastructure but also reduce energy consumption. This is necessary to ensure that the future growth of the Cloud computation is sustainable. On the other hand, Cloud Computing with increasingly invasive front-end client devices with back-end data centers will lead to major escalation energy consumption. To solve this problem, data centers resources must be managed in an energy efficient way to promote Green Cloud

Computing. Especially, Cloud resources must be allocated not only to satisfy service quality user-specified requirements through service-level agreements (SLA), but also to reduce energy consumption.

3. FEATURES OF CLOUDS ENABLING GREEN COMPUTING

It is expected to reduce carbon emissions in cloud computing due toenergy saving infrastructure and minimizing ITinfrastructure itself through multi-tenancy. Main drivertechnology for energy-saving clouds is "virtualization",enables significant improvements in the energy efficiency of cloud service providers. Virtualization is the process of presenting alogical grouping or subset of computing resources so that theycan be accessed away that gives it an advantage over the original
configuration. By consolidating unused servers toform multiple virtual machines sharing the same physicalservers at higher usage, businesses can save significant costsin the form of space, management and energy.

1.Dynamic Provisioning: There are several reasons for this.
oversupply: a) it is difficult to forecast demandat a time; this is especially true for web applications and b)ensure the availability of services and maintenancelevel of quality of service for end users of the infrastructureprovided with a prudent approach that leads to resources. Such situations can be handled easily by Cloudinfrastructure. Virtual machines in the cloud infrastructurecan be migrated directly to another server in case of user's applicationrequires more resources. Monitoring and prediction cloud providersneeds and thus allocate resources according to need.Applications that require less resources cangrouped together on the same server. Therefore, data centers are alwayskeep the server running based on current demand,resulting in lower power consumptionA cautious approach to over-provisioning.

2. Multi-Tenant: Using a Multi-Tenant Approach, CloudIT infrastructure reduces overall energy consumption andrelated carbon emissions. SaaS providers serveseveral companies on the same infrastructure and the same software. HereThe approach is obviously more energy efficient than somecopies of the software are installed on different infrastructures. In addition, companies have different demand patternsin general, and so multiple people on the same server allowthe leveling of peak aggregate demand can be minimizedneed for additional infrastructure. Thesmallest variation ofdemand leads to better and greater predictionenergy saving.

3. Server usage: On-premises infrastructure is usuallyworks with very low usage, sometimes it drops to 5at 10% of average usage. Use virtualizationtechnology, many applications can be hosted andrunning on the same separate server, resulting inusage level up to 70%. Therefore, thisdimnishes the number of active servers. While high utilization servers consume more power, servers running at higher usage can handle more workloads with power consumption.

4.Data Center Efficiency: As mentioned before, powerData center efficiency has a big impact on total energyuse cloud computing. The most efficient use of energytechnology, cloud providers can significantly improvePUE of their data centers. major cloud service providers canachieve a low PUE of 1.1 to 1.2 or about 40%More energy efficient than traditional data centers. The server design as modular, water or air tank based cooling or advanced power management through power supply Incentive optimization, are all approaches that have improve PUE in the data center. In addition, cloud computing allows services to be moved between multiple data centers works with better PUE values. This is achieved by using high-speed networks, virtualization services, and data center measurement, monitoring and accounting.

4. TOWARDS ENERGY EFFICIENCY OF CLOUD COMPUTING

Application: the SaaS model that changed the game that applications and software are distributed and used. more and More and more companies are turning to SaaS cloud to mitigate
their IT costs. So it becomes very important to deal with energy efficiency at the level of the application itself. However, this class has received very little attraction for many people the apps are used and mostly new Most applications are upgraded or developed versions Use existing tools. To gain energy application-level efficiency, paid SaaS providers interested in deploying

software on the right type of infrastructure who can run the software most efficiently. Here requires research and analysis of the trade-off between performance and power consumption due to running software on multiple platforms and hardware. Software developers should consider compiler-level and larger code-level power consumption when designing their future application implementations using various power-saving techniques suggested in the document.

Cloud Software Stack: Virtualization and Provisioning stack cloud, most of the works in the literary address challenges at the IaaS provider level, where research is focused on resource planning and management to reduce the number of active resource running the user's workload application. VM merge, VM migration, planning, demand forecasting, thermal management and Temperature sensitive allocation and load balancing are used as Basic techniques to reduce energy consumption. Like discussed in the previous section, virtualization plays a role important role in these techniques due to its many characteristics such as merge, live migration, and performance insulation. Consolidation helps manage compromise between performance, resource usage and energy consumption. Similarly, VM migration allows dynamic resource management while facilitating outages management and reduce maintenance costs. Due to many level of abstraction, hard to maintain the implementation data from each virtual machine in the cloud data center. Thereby, Various indirect load estimation techniques are used to Consolidate virtual machines. Although the above consolidation methods can reduce the amount of resources used to serve the user's applications, move and reposition virtual machines for the respective application requests can affect the user's QoS service requests. Because cloud service providers must respond to a certain extent services, some of which focus on energy reduction consumption while reducing the number of SLA violations. Where storage virtualization called Sample-Replicate-Consodate Mapping (SRCMAP) allows power to scale with dynamic I/O workloads by consolidating cumulative workloads across a set physical volume child proportional to workload intensity I/O. Since power is dissipated in the cloud data center by the heat generated by server, some works have also been suggested for dynamic scheduling virtual machines and applications of thermal state or heat dissipation in the data center. The Considering the heat factor in the planning is also improved reliability of the underlying infrastructure.

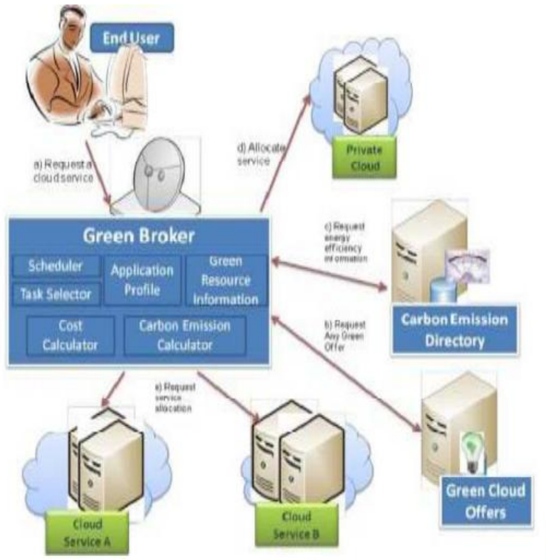
Data center level: cooling, hardware, network and the first storage tier is to build a smart data center and its location choice. There are two main factors in that one is the power supply and the other is the energy efficiency of Equipment. Therefore, the data centers built in to be able to produce electricity from renewable energy sources such as the sun and wind. Currently a data center locations are decided based on their geographical features; climate, fiber connectivity and rich accessibility provide affordable energy. Because of Cloud's primary concern the supplier is a business, the source of energy is also considered as the main source of energy in terms of cost, not carbon emissions. Another matter of concern in the data center, its cooling system contributes to almost one third of total energy consumption. "Two kinds of approaches used: air-based and water-based cooling systems." In both approaches, it is necessary that they are directly cooled equipment rather than the entire area of the room. So a new energy Efficient cooling system is provided based on liquid cooling systems, nano liquid cooling and in servers, in racks, and consecutive cooling by companies like SprayCool. Other moreover, outside temperature/climate can directly affect impact on the energy requirements of the cooling system. Some The system has been built to use fresh outside air to remove heat from the data center. Another level there Energy efficient data centers solved deploy new energy efficient servers and processors. Low-power processors can reduce computer power consumption system to a large extent. Many new energy efficient server's models are currently available in the market from vendors such as AMD, Intel, and others; each of them offers good system performance/watt. These server architectures allow slow down processor clock speed (clock check) or power disable parts of the chip (power supply), if they do not work. Further improve power savings and increase computing power per watts can be achieved using multi-core processors. Use energy-efficient disks such as tiered storage (Solid-State, SATA, SAS) enables more efficient use of power. Power provider is another infrastructure that needs to designed in an energy efficient manner. Their job is to earn food server energy resources by converting high-voltage alternating current (AC) from the grid into low-voltage direct current (DC) that most electrical circuits (e.g. computer) request. These circuits are inside the power supply The device (PSU) inevitably loses energy in the form of heat, dissipated by additional fans inside the PSU. Energy The efficiency of the power supply depends mainly on its load, the number of circuit and other conditions (e.g. temperature). One possible the recommended solution is to replace all power supplies with ENERGY STAR certified ones. This certificate is issued to UAP guarantees a minimum efficiency of 80% at any electrical load.

Monitoring / Counting: To measure the unified efficiency of a data center and improveits performance per watt, Green Grid recommends twospecific metrics called energy efficiency(PUE) and data center infrastructure efficiency (DciE).PUE = Total power of the installation / Power of IT equipmentDciE = 1 / PUE = Capacity of IT equipment / Total capacity of installation× 100%The total capacity of the installation is defined as the power measured atpower meter for data center onlyStrong. The power of IT equipment is defined as the powerconsumed in management, handling and storage orRouting data in the data center.

Network infrastructure: At the network level, energy efficiency is achieved atat node level (i.e. network interface card) or at at the infrastructure level (i.e. switche and router). EnergyEfficiency problems in networks are often referred to as "network", which involves the integration of energy awareness innetwork design, equipment and protocols. There are four types of solutions proposed in the document,i.e. resource consolidation, virtualization, selectionassociativity and scaling. SourceConsolidation helps bring together underutilized devices toreduce overall consumption. Like Merge,Selective device connections includemechanism that allows individual pieces of equipment to operateinactive for a while, the clearer the better for the restnetworked devices. The difference between resourcesselective merge and join isconsolidation applies to shared resources innetwork infrastructure while selective connectivity allowsdisable unused resources at the network edge.

5. GREEN CLOUD ARCHITECTURE

A unified solution to enable Green Cloud computing is proposed. A Green Cloud framework, which considers these goals of provider while curbing the energy consumption of CloudsThe high-level view of the Green Cloud architecture is given in Figure2.



The goal of this architecture is to make the Cloud green from both the user and provider point of view. In the green cloud architecture, users submit their cloud service requests through the new Green Broker middleware that manages the selection of a green cloud provider to satisfy the user's request. A user service request can be of three types, i.e. software, platform, or infrastructure. Cloud employees can subscribe to their service as a publicly available green service through Green Broker. Green services include green services, prices and when to access them for the lowest carbon footprint. Green Broker obtains the current position of energy limits for the use of various cloud services from the carbon footprint directory. It holds all data related to the energy efficiency of the cloud service. This data can include the PUE and cooling efficiency of the service provider cloud data center, network costs and the carbon footprint of electricity, Green Broker calculates the carbon emissions of all home Cloud service provider The requested cloud service provider. It then selects the set of services that will cause the least carbon emissions and purchases those services on behalf of the users. "The Green Cloud framework is designed to track overall energy usage to meet user needs. It is based on two key components, the Carbon Emission Catalog and the green Cloud offering, which tracks the energy efficiency of each Cloud provider and incentivizes the Cloud providers to make their services available.""On the user side, Green Broker plays an important role in monitoring and selecting cloud services based on the user's QoS requirements and ensuring the minimum carbon footprint to serve the users. In general, users can use the cloud to access any of these three types of services (SaaS, PaaS, and IaaS) and therefore their service processes must also be energy efficient." According to other arguments, on the cloud provider side, each cloud layer should be environmentally conscious**1)SaaS Level**: Since SaaS providers mainly offer software installed on their own datacenters or resources from IaaS providers, the SaaS providers need to model and measure energy efficiency of their software design, implementation, and deployment.For serving users, the SaaS provider chooses the datacenters which are not only energy efficient but also near to users. The minimum number of replicas of user's confidential data should be maintained using energy-efficient storage.

2) PaaS level: PaaS providers usually provide the platform application development services. Facilitation platform Application development ensures the whole system Effect energy. This can be done by including the energy profiling tools like JouleSort. It's software energy efficiency standards measure energy consumption needed to perform external sorting. In addition, the platforms itself can be designed to have different code level optimizations can cooperate with the basic energy domain compiler efficient application execution. Different from the app development, the Cloud platform also allows deployment user applications on the Hybrid Cloud. In this case, to achieve Maximum energy saving, platform configuration application and decide which part of the application or data must be handled internally and in the cloud.

3) IaaS level: Providers at this layer play the most important role in the success of all green architectures from the IaaS level no provide only stand-alone infrastructure services, but also support other services provided by Clouds. By using virtualization and consolidation, energy consumption is further reduced by Power off the server not in use. Multiple energy meters and sensors installed to calculate current energy efficiency of each IaaS provider and their websites. This information is regularly informed about Carbon Emissions by cloud service providers Telephone directory. Various green schedules and resources Procurement policy will ensure minimum energy consumption. In In addition, the cloud service provider designs different green offers and pricing plan to incentivize users to use service during off-peak hours or maximum energy savings hours.

6. MAKING CLOUD MORE GREEN

Mainlythreemethodshavebeentestedtocreateagreencloud environment.Theseapproacheshavebeentestedindatacentresundertestconditions.Thepracticalapplicationofthesemethodsisstillbeingstudied.Themethodsare:

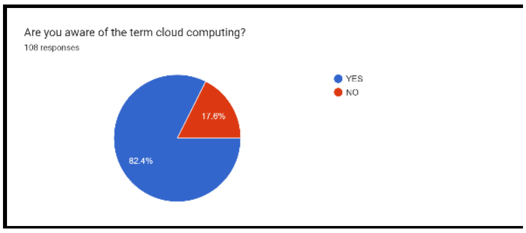
Dynamic Voltage Frequency Scaling (DVFS) technique: - Each electronic circuit will have a running clock combined with. The operating frequency of this meter is set so that the supply voltage is regulated. So this method is highly hardware dependent and not control according to different needs. Power The savings are also small compared to other approaches. The The ratio of energy saved to incurred costs is also low.

Resource allocation or virtual machine migration: In the cloud computing environment, eachphysical machine hosting several virtual machines onon which applications are executed. These virtual machines cantransferred between servers based on different needs andavailable resources. The VM migration method focuses onmove virtual machines in a way to power upless than. The most energy efficient buttons are selected andthe virtual machines are moved to them.

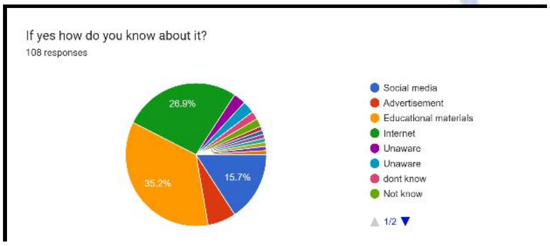
Algorithmic approach: - It has been experimental determined that an ideal server consumes about 70% The energy used by a server is fully utilized. Using a neuron network forecasting, green priority scheduling algorithm estimate the dynamic workload required on the servers. Therefore The server does not need the device disabled to minimize number of servers running, minimizing power consumption to consumption points to provide benefits to everyone else levels. Additionally, more servers are added to help ensure service level agreements. The main thing is to protect the environment and reduce total cost of ownership while ensuring service quality.

7. SURVEY QUESTIONNAIRE AND RESULTS

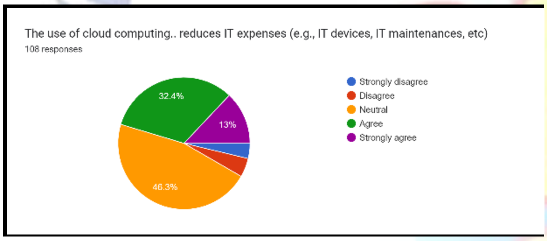
1.Are you aware of the term cloud computing?



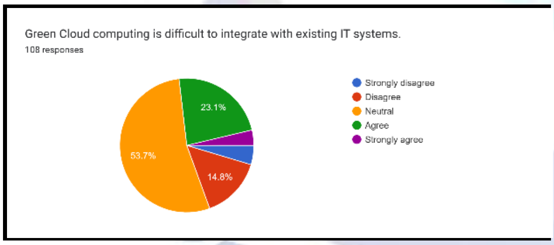
2.If yes how do you know about it?



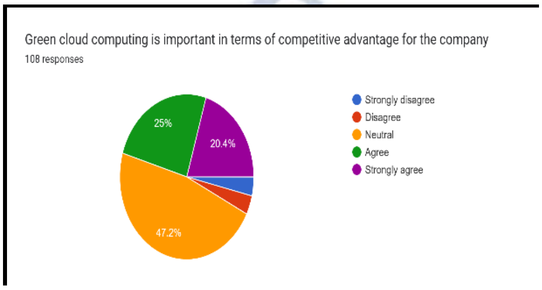
3. The use of cloud computing. reduces IT expenses (e.g., IT devices, IT maintenances, etc)



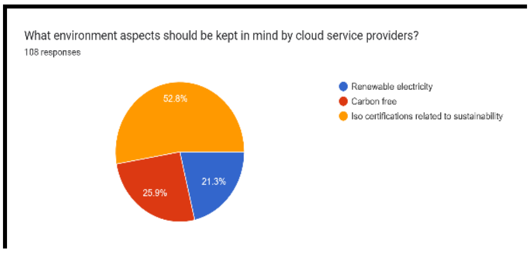
4. Green Cloud computing is difficult to integrate with existing IT systems.



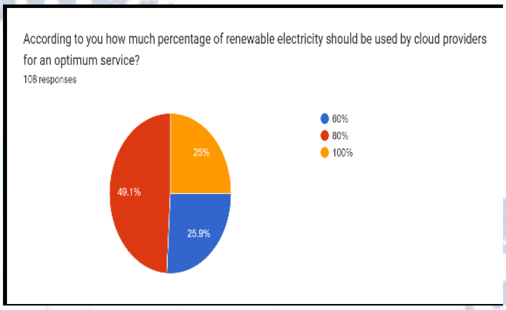
5. Green cloud computing is important in terms of competitive advantage for the company



6. What environment aspects should be kept in mind by cloud service providers?



7. According to you how much percentage of renewable electricity should be used by cloud providers for an optimum service?



DESCRITIVE STATISTICS

Descriptive statistics describes the features of dataset providing summaries and data samples.

Are you aware of the term cloud computing?	
Mean	0.819048
Standard I	0.03775
Median	1
Mode	1
Standard I	0.386825
Sample Va	0.149634
Kurtosis	0.843484
Skewness	-1.6816
Range	1
Minimum	0
Maximum	1
Sum	86
Count	105

If yes how do you know about it?	
Mean	2.342857
Standard I	0.125378
Median	2
Mode	1
Standard I	1.284737
Sample Va	1.650549
Kurtosis	-0.85341
Skewness	0.578766
Range	4
Minimum	1
Maximum	5
Sum	246
Count	105

The use of cloud computing..
reduces IT expenses (e.g., IT devices, IT maintenances, etc)

Mean	2.238095
Standard I	0.094272
Median	3
Mode	3
Standard I	0.965997
Sample Va	0.93315
Kurtosis	-1.39648
Skewness	-0.17112
Range	3
Minimum	1
Maximum	4
Sum	235
Count	105

Green Cloud computing is difficult to integrate with existing IT systems.

Mean	2.240385
Standard I	0.086952
Median	2
Mode	2
Standard I	0.886744
Sample Va	0.786314
Kurtosis	2.011614
Skewness	1.123689
Range	4
Minimum	1
Maximum	5
Sum	233
Count	104

Green cloud computing is important in terms of competitive advantage for the company

Mean	2.695238
Standard I	0.113328
Median	3
Mode	3
Standard I	1.161264
Sample Va	1.348535
Kurtosis	-0.95433
Skewness	-0.31798
Range	4
Minimum	1
Maximum	5
Sum	283
Count	105

What environment aspects should be kept in mind by cloud service providers?

Mean	1.961905
Standard I	0.071514
Median	2
Mode	2
Standard I	0.7328
Sample Va	0.536996
Kurtosis	-0.20226
Skewness	0.358405
Range	3
Minimum	1
Maximum	4
Sum	206
Count	105

According to you how much percentage of renewable electricity should be used by cloud providers for an optimum service?

Mean	0.801905
Standard I	0.013932
Median	0.8
Mode	0.8
Standard I	0.142762
Sample Va	0.020381
Kurtosis	-1.00932
Skewness	-0.01386
Range	0.4
Minimum	0.6
Maximum	1
Sum	84.2
Count	105

8. CONCLUSION

The commercial potential of cloud computing and its contribution to the reduction of carbon emissions by ICT has led to a series of discussions about whether cloud computing is truly green. The environmental footprint of data centers is forecast to triple between 2024 and 2025, now accounting for 7.8 billion tons of carbon dioxide per year. There are reports of Green IT data center and cloud analytics that show cloud computing as "green", while others suggest it will lead to an alarming increase in carbon emissions. Although our Blue Cloud framework integrates various features to make cloud computing much greener, many technological solutions are still needed to make it happen: enabling efficient use of energy throughout the system. To enable green cloud data centers, cloud providers must understand and measure data center power and conservation strategies, server power consumption, and cooling requirements. , using device resources to achieve maximum efficiency for the design of total solutions in the planning and resource provision of applications in the data center, all factors such as cooling , network, memory and processor must be taken into account. For example, merging VM though effective technique to reduce overall strength the use of data centers, also raises questions related to demand redundancy and geographic diversity of the right location maintained to satisfy the SLA to the user. Last but not least, the responsibility belongs to both suppliers and customers to ensure that technology does not bring about irreversible changes possible endanger the health of human society. Implementation data centers close to renewable energy sources and maximized Use green energy in their established data centers. Before adding new technologies like virtualization, cost analysis must be performed to bring real benefits in terms of Effect energy. In short, just improve the efficiency of device, cloud computing cannot be certified as green. The key is to make the use of carbon more efficient both from the point of view of the user and the provider. Cloud provider need to reduce the need for electricity from the cloud and take important steps towards using renewable energy sources instead of just Find ways to reduce costs.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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