Green Cloud Computing Resource Managing Policies a Survey

Kamiya[1], Shakti Nagpal[2]

Computer Science and Engineering, Geeta Enngineering College, Panipat, India

Abstract: ***Green cloud is a buzzword that refers to the potential environmental benefits that information technology (IT) services delivered over the Internet will offer society. The word combines the words green -- meaning environmentally friendly and cloud, the traditional image for online and the shortened name for a type of service delivery model known as cloud processing. According to market research performed by Pike Research, the wide-spread use of cloud processing could trigger a potential 38% decrease in worldwide data center energy expenditures by 2020. The savings is primarily accomplished by consolidating data centers and maximizing power usage efficiency (PUE), improving recycling efforts, bringing down carbon and gas emissions and minimizing water usage in cooling the rest of the centers. Because so much of a data center's energy expenditures support data storage space, the Storage Networking Industry Association (SNIA) features promoted new technologies and architectures to help save energy. This paper surveys resource allocation techniques to enhance power consumption by cloud information centers supporting green cloud computing.***

Keywords: cloud computing, green cloud computing, resource allocation strategies.

1. Introduction

Clouds tend to be basically virtualized datacenters and applications offered as services on a subscription basis as shown in Figure 1. They might require high-energy usage for its operation [1]. These days, the average datacenter with 1000 racks require 10 Megawatt of capacity to operate [2], which benefits in higher working expense. Thus, for a datacenter, the energy expense is a significant element of its running and up-front prices. In inclusion, in April 2007, Gartner estimated that the Information and Communication Technologies (ICT) industry generates about 2% associated with the total global CO2 emissions, that may be equal to the aviation industry [3]. According to a report published by the eu, a decrease in emission volume of 15%–30% is needed before year 2020 to help hold the heat that is international below 2 0C. Thus, power usage and carbon emission by Cloud infrastructures has become a key issue that is ecological. Some studies show that Cloud computing can actually make traditional datacenters more energy saving by utilizing technologies such resource virtualization and work combination. The standard data centres running Web applications have a tendency to be provisioned to address top that is sporadic, which can lead to reasonable resource utilization and wastage of power. Cloud datacenter, on the contrary, reduce the energy consumed through server combination, whereby different workloads can share the same physical number making use of virtualization and unused servers can be turned off.

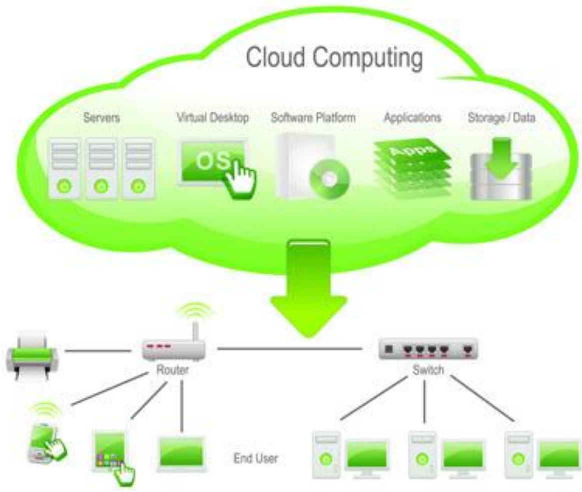

Figure 2: Green Cloud Computing Architecture

A current study by Accenture [4] shows that moving business applications to Cloud decrease carbon impact of companies. Considering the report, small enterprises saw most likely the many dramatic decrease in emissions up to 90 percent when using Cloud resources. Huge corporations can save you at least 30-60 per cent in carbon emissions using Cloud applications, and mid-size businesses can conserve 60-90 %. In contrast towards the above opinion, some studies, for example Greenpeace [5], realize the Cloud sensation may aggravate the situation of carbon emissions and global heating. The main reason given is the collective demand for computing resources is anticipated to additional boost dramatically next couple of years. Perhaps the absolute many effortlessly built datacenter with all the utilization rates that are highest will just mitigate, as in opposition to dump, harmful CO2 emissions. The explanation offered is that Cloud providers tend to be more interested in electricity cost reduction rather than carbon emission

A day with the development of high speed networks over the last decades, there is an alarming rise in its usage made up of thousands of concurrent e-commerce transactions and an incredible number of internet queries. This ever-increasing need is looked after through large-scale datacenters, which consolidate hundreds and a huge number of computers with other infrastructure such ac, storage space space and system methods. Numerous net businesses such as for instance Google, Amazon, eBay, and Yahoo are running such huge datacenters around the world. The commercialization of these improvements is defined currently as Cloud computing [6], where processing is delivered as utility on a pay-as-you-go basis. Traditionally, business organizations used to invest amount that is huge of and time in acquisition and maintenance of computational resources. The emergence of Cloud computing is rapidly changing this approach that is ownership-based subscription-oriented method by providing accessibility scalable infrastructure and services on-demand. Users can store, access, and share any wide range of information in Cloud. That is, small or medium enterprises/organizations typically usually do not need worry about buying, configuring, administering, and maintaining their processing infrastructure. They are able to focus on sharpening their particular core competencies by exploiting a number of Cloud benefits that are computing as on-demand processing resources, quicker and cheaper pc software development capabilities at low-cost. More over, Cloud computing also provides quantity that is enormous of energy to organizations which require control of great number of data created almost every day. As an illustration, financial businesses have really to keep every day the powerful information about their hundreds of clients, and genomics research has to handle huge quantities of gene sequencing information.

2. Green Cloud Computing

Green cloud is a catchphrase that mentions to the possible environmental benefits that data knowledge (IT) services held above the Internet can proposal society. The word merges the words green meaning environmentally approachable and cloud, the established signal for the Internet and the shortened term for a kind of ability transport ideal recognized as cloud computing. According to marketplace search the wide-spread adoption of cloud computing might lead to a possible 38% reduction in worldwide data center power expenditures by 2020. The savings should be chiefly attained by joining data centers and maximizing manipulation custom efficiency enhancing reprocessing efforts, lowering carbon and gas emissions and minimizing water custom in cooling the staying centers. Because the color green is additionally associated alongside paper money, the label green cloud is from time to time utilized to delineate the cost-efficiency of a cloud computing initiative. In any Cloud computing Environment if we want to improve the Energy Efficiency of the datacenters we must look into improving the resource allocations made to the datacenters by the users as it is one of the most efficient ways to reduce energy consumption.

3. Resource Allocation Strategy

There are various Strategies which are related to Resource Allocation:

1) **Resource Allocation Strategy in Cloud Computing**

In cloud computing, Resource Allocation (RA) [7][8] is the procedure of allocating obtainable resources to the demanded cloud requests above the internet. Resource allocation starves services if the allocation is not grasped precisely. Resource provisioning solves that setback by permitting the ability providers to grasp the resources for every single individual module. Resource Allocation Strategy (RAS) is all concerning incorporating cloud provider hobbies for employing and allocating manipulated resources inside the check of cloud nature so as to encounter the needs of the cloud application. It needs the kind and number of resources demanded by every single request in order to finish a user job. The order and period of allocation of resources are additionally an input for an optimal RAS.

2) **Task Scheduling Algorithms in Cloud Environment**

Cloud users join virtualization[9], automated multimedia, and internet connectivity to furnish their services. A frank agent of the cloud nature is client, server, and web connectivity. A hybrid computing ideal permits client to impact both area and confidential computing services to craft a extra flexible and cost-effective computing utility. The area cloud nature involves Web established request, Data as a ability (DaaS), Groundwork as a Service (IaaS), Multimedia as a ability (SaaS), and Email as a ability (EaaS). A confidential cloud accesses the resources from the area cloud association to furnish services to its clients.

3) **Policy and Job Scheduling Algorithms of Cloud Computing**

Job arranging of cloud computing mentions to the procedure of adjusting resources amid disparate resource users according to precise laws of resource use below a given cloud environment. Resource association and job arranging are the key technologies of cloud computing. At present, there is not a uniform average for job arranging in cloud. Most algorithms focus on job dispatcher that is nearly accountable for all the task allocations, replies and retransmissions.

4) **Resource Allocation Policies in Cloud Computing Environment**

Resource allocation is a subject that has been addressed in many computing areas, such as operating systems, grid computing and datacenter management. A Resource Allocation System (RAS) in Cloud Computing can be seen as any mechanism that aims to guarantee that the applications' requirements are attended to correctly by the provider's infrastructure. Along with this guarantee to the developer, resource allocation mechanisms should also consider the current status of each resource in the Cloud environment, in order to apply algorithms to better allocate physical and/or virtual resources to developers' applications, thus minimizing the operational cost of the cloud environment.

5) **Ant Colony Optimization Algorithm for Resource Allocation**

Cloud computing distributed cluster uses a Master/Slaves structure. There is a Chief node accountable for manipulating and overseeing all the Slave nodes. As the specific condition of resource is unfamiliar below cloud circumstance, and the webs do not have a fixed topology, the construction and the resource allocation of the finished cloud nature is unpredictable.

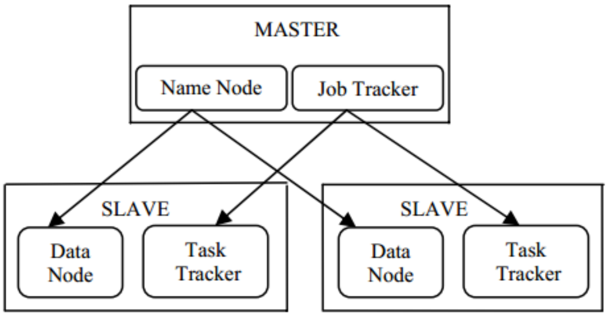

Figure 1: Master/Slaves Structure of Hadoop Cluster

6) **Dynamic Resource Allocation Strategy in Cloud Computing Environment**
Cloud data centers can be a distributed web in construction that is composed of countless compute nodes, storage nodes, and web node. Every single node is industrialized by a sequence of resources such as CPU, recollection, web bandwidth and countless more. These resources are shouted multidimensional resources. The number of adjacent mechanisms (VMs) used in a huge cloud data center every single date can be extremely colossal, and their placement familiarize a momentous burden on the data center web.

7) **Dynamic Resource Allocation using Migration in Cloud**
The cloud computing period guarantees subscribes that it sticks to the ability level accord by bestowing resources as ability and by needs. Though, date by date subscribers' needs are rising for computing resources and their needs have vibrant heterogeneity and period irrelevance. But in cloud computing nature, resources are public and if they are not properly distributed next it will consequence into resource wastage.

4. Related Work

Murugesan, S. et al, in "Green Cloud Computing and Environmental Sustainability" 2012 [10], the authors describe Cloud computing is a highly scalable and cost-effective infrastructure for running HPC, enterprise and Web applications. However, the growing demand of Cloud infrastructure has drastically increased the energy consumption of data centers, which has become a critical issue. High energy consumption not only translates to high operational cost, which reduces the profit margin of Cloud providers, but also leads to high carbon emissions which is not environmentally friendly. Hence, energy-efficient solutions are required to minimize the impact of Cloud computing on the environment. In order to design such solutions, deep analysis of Cloud is required with respect to their power efficiency. Thus, in this chapter, they discuss various elements of Clouds which contribute to the total energy consumption and how it is addressed in the literature. They also discuss the implication of these solutions for future research directions to enable green Cloud computing. The chapter also explains the role of Cloud users in achieving this goal.

Islam, S.S. et al, in "Cloud computing for future generation of computing technology" 2012 [11], the authors describe The emergence of cloud computing, envisioned as the future generation of computing model for its major advantages in on-demand self-service, ubiquitous network access, location independent resource pooling and transference of risk, has established a trend towards building massive, energy-hungry and geographically distributed data centers. It is the latest developments of computing models after distributed computing, parallel processing and grid computing. It achieves multi-level virtualization and abstraction through effective integration of variety of computing, storage, data, applications and other resources, users can be easy to use powerful computing and storage capacity of cloud computing only need to connect to the network. It can also concentrate all computation resources and manage automatically through the software without intervene. In this paper, they highlight the different aspects of cloud computing for finding the actuality of the future generation of commuting in the form of cloud computing after mainframe based computing, personal computing, client server based computing and web server based computing.

Owusu, F. et al, in "The Current State of Understanding of the Energy Efficiency of Cloud Computing" 2012 [12], the authors describe Cloud computing has been hailed as the achievement of the long-held dream of computing as a utility and has the potential to transform a large part of the Information and Communication Technology (ICT) industry. Cloud computing is both a business and an economic model which has been gaining popularity since 2006 and it is currently the most talked about technology in the ICT industry. Because it views hardware and software as commodities, the cloud is an example of a disruptive technology. It offers enterprises the opportunity to reduce hardware and software cost and the potential reduction of maintenance and support staff. Data centers and cloud computing services providers hope that the widespread adoption of the cloud will bring them more profit and they are actively promoting the technology. The cloud has had its share of controversy; ranging from the definition of cloud computing to its energy efficiency. This paper discusses one area of controversy; the energy efficiency of cloud computing. They outline previous contributions to the discussion of energy efficiency of cloud computing, provide a working definition of cloud computing and discuss its importance, which will grow as the technology matures and becomes well known.

Lawey, A.Q. et al, in "Distributed Energy Efficient Clouds Over Core Networks" 2014 [13], the authors describe In this paper, they introduce a framework for designing energy efficient cloud computing services over non-bypass IP/WDM core networks. They investigate network related factors including the centralization versus distribution of clouds and the impact of demand, content popularity and access frequency on the clouds placement, and cloud capability factors including the number of servers, switches and routers and amount of storage required in each cloud. They study the optimization of three cloud services: cloud content delivery, storage as a service (StaaS), and virtual machines (VMS) placement for processing applications. First, they develop a mixed integer linear programming (MILP) model to optimize cloud content delivery services. Our results indicate that replicating content into multiple clouds based on content popularity yields 43% total saving in power consumption compared to power un-aware centralized content delivery. Based on the model insights, they develop an energy efficient cloud content delivery heuristic, DEER-CD, with comparable power efficiency to the MILP results. Second, they extend the content delivery model to optimize StaaS applications. The results show that migrating content according to its access frequency yields up to 48% network power savings compared to serving content from a single central location. Third, they optimize the placement of VMs to minimize the total power consumption. Our results show that slicing the VMs into smaller VMs and placing them in proximity to their users saves 25% of the total power compared to a single virtualized cloud scenario. They also develop a heuristic for real time VM placement (DEER-VM) that achieves comparable power savings.

Priya, B. et al, in "A survey on energy and power consumption models for Greener Cloud" 2013 [14], the authors describe The growing demand of computation, large data storage needed for running a high performance computing enterprise and high dimensional data based web application increases the energy and power consumed by large infrastructure. Cloud computing is providing a solution as part of the Green IT initiative to reduce the adverse environmental impacts and save energy. Our paper describes important metrics of cloud computing which makes it greener. They discuss the various power and energy models and identify major challenges to build a model for Green Cloud. They also discuss the ways to reduce power and energy in terms of cloud computing services. Our work surveys the various models and helps understand the road map for a greener cloud.

Oriaku, C. et al, in "Holistic View Angles of Cloud Computing Services Provisions" 2012 [15], the authors describe Cloud computing services (CCS) is a modern blend of provisioning technologies and management of resources formed on limited requirements such as accessibility, hypotheses of elasticity and massive deployment. This paradigm offers on-demand IT resources such as applications, networks, services, data, servers and storage that are readily accessible through the Internet. Need for globalisation and collaboration is currently driving the adoption/rollout of cloud technology. Therefore, the current provision of CCS is focused and segmented, addressing explicit concerns according to these needs. This presents challenges for integrated services such as the missing interfaces concerning the diverse attributes of CCS, the required techniques and dependencies for efficient rollout/adoption. This paper proposes 6-view angles necessary for offering CCS, including all their important criteria and categories. These proposed views should help CCS architects and software developers achieve diverse optimised services, enhance these services in relation to communication, power usage, and interfaces that will ease cost and time, make these services desirable and accessible.

Hulkury, M.N. et al, in "Integrated Green Cloud Computing Architecture" 2012 [16], the authors describe Arbitrary usage of cloud computing, either private or public, can lead to uneconomical energy consumption in data processing, storage and communication. Hence, green cloud computing solutions aim not only to save energy but also reduce operational costs and carbon footprints on the environment. In this paper, an Integrated Green Cloud Architecture (IGCA) is proposed 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 making, whether to use local machine processing, private or public clouds, is smartly handled by the middleware using predefined system specifications such as service level agreement (SLA), Quality of service (QoS), equipment specifications and job description provided by IT department. Analytical model is used to show the feasibility to achieve efficient energy consumption while choosing between local, private and public Cloud service provider (CSP).

Wei Zhao et al, in "Modeling and simulation of cloud computing: A review" 2012 [17], the authors describe Cloud computing provides computing resources as a service over a network. As rapid application of this emerging technology in real world, it becomes more and more important how to evaluate the performance and security problems that cloud computing confronts. Currently, modeling and simulation technology has become a useful and powerful tool in cloud computing research community to deal with these issues. In this paper, to the best of their knowledge, they review the existing results on modeling and simulation of cloud computing. They start from reviewing the basic concepts of cloud computing and its security issues, and subsequently review the existing cloud computing simulators. Furthermore, they indicate that there exist two types of cloud computing simulators, that is, simulators just based on software and simulators based on both software and hardware. Finally, they analyze and compare features of the existing cloud computing simulators.

Narayan, A. et al, in "Power-Aware Cloud Metering" 2014 [18], the authors describe The cost of electricity contributes significantly to the operating expense incurred in hosting cloud services. It is necessary to consider this cost while charging the consumers for their service utilization. In this work, they arrive at a metering mechanism for cloud services, in which the price of a cloud service tracks the variable input cost of electricity from a smart grid. The power-aware cloud metering developed here is a dynamic pricing and billing model where tariff for a cloud service is varied in accordance with the input electricity cost. They arrive at a model for power consumption of virtual machines hosted on the cloud infrastructure. This power consumption model is used in calculating the cost of operation of the service. A cloud instance leased by a consumer is billed based on the cost of operation obtained, and its resource utilization. Experimental results validate the approach presented.

Itani, W. et al, in "Accountable energy monitoring for green service routing in the cloud" 2013 [19], the authors describe In this paper, they present the design and implementation of G-Route (Green Route), an autonomic service routing protocol for constructing energy-efficient service provider paths in collaborative cloud computing architectures. The chief contribution of this work resides in autonomously selecting the optimal set of composite service components sustaining the most efficient energy consumption characteristics among a set of providers for executing a particular consumer service request. The routing protocol processes accountable service energy measurements extracted securely from within the provider sites or data centers using trusted computing technologies and cryptographic mechanisms. By pushing green computing constraints into the service routing protocol decision engine, they can leverage the collaborative cloud computing service model to maximize the energy savings achieved by focusing on a path of providers that executes the service requests instead of directing the green computing efforts towards a single provider site. The major goal of G-Route is to enhance the energy savings in the overall cloud computing infrastructure. The protocol design is deployed in a real cloud computing environment using the Amazon EC2 cloud platform. The analyses of the protocol convergence characteristics, traffic overhead, and resilience demonstrate the capability of the proposed system to significantly reduce the overall energy requirements of collaborative cloud services.

Tahamtan, A. et al, in "A Cloud Repository and Discovery Framework Based on a Unified Business and Cloud Service Ontology" 2012 [20], the authors describe Cloud computing introduces a fundamental shift in service delivery. A market registry, flexibility, exchangeability and integration of services are important issues for its success. In this work they introduce a unified Cloud and business service ontology with querying capabilities. Our framework addresses two aspects: on the one hand it gives answer to leading question how they can structure the term Cloud computing (as a question of basic research) and how they can enable a matching between offered Cloud services and demand. It closes the gap how they can summarize and describe Cloud services in a standardized way. On the other hand, it particularly addresses the demand for flexibility and exchangeability by the Cloud Computing paradigm and can serves as a repository of services.

Murugesan, S. et al, in "Green IT: An Overview" 2012 [21], the authors describe Enterprises, governments, and societies at large have a new important agenda: tackling environmental issues and adopting environmentally-sound practices. While many people consider IT is part of the problem to environmental pollution, it can be saviour too. IT is both a solution and a problem for environmental sustainability. They can exploit the power of IT in innovative ways to address mounting environmental issues and make their IT systems Â-Â and their use Â-Â greener. Green IT refers to environmentally sound information technologies and systems, applications, and practices. This chapter examines environmental impacts of IT and explains what Green IT is. It presents a holistic approach to greening IT and highlights how IT could help businesses in their environmental initiatives and reduce their carbon emissions

Polito, S.G. et al, in "Cloud-enabled NGN architecture with discovery of end-to-end QoS resources" 2013 [22], the authors describe Cloud computing offers remote resources on top of which users can deploy their own services, as well as ready to use services. Computing resources located in different sites and belonging to multiple providers can be used for a service. One requirement for the user to get access to cloud services is being connected with the remote computing resources. Similarly, interworking between computing resources located in different sites requires network resources connecting them. Therefore, cloud services can be thought as composed of computing and network resources. Quality of service (QoS) constraints can be posed on both of them. This is motivating a request for cloud architectures able to discover remote computing and QoS network resources. Design of such architecture is still an open issue. In this paper, they provide a proposal for it. They leverage on the existing Next Generation Network architecture, which was designed for IP services, and propose extensions to address the cloud provisioning requirements. The proposed extensions are about control and transport layer functions for automatic discovery of computing and QoS networking resources, respectively. Simulation results show the scalability of the discovery model in networks with increasing size and number of cloud providers.

Dong Yuan et al, in "An Algorithm for Cost-Effectively Storing Scientific Datasets with Multiple Service Providers in the Cloud" 2013 [23], the authors describe The proliferation of cloud computing allows scientists to deploy computation and data intensive applications without infrastructure investment, where large generated datasets can be flexibly stored with multiple cloud service providers. Due to the pay-as-you-go model, the total application cost largely depends on the usage of computation, storage and bandwidth resources, and cutting the cost of cloud-based data storage becomes a big concern for deploying scientific applications in the cloud. In this paper, they propose a novel algorithm that can automatically decide whether a generated dataset should be 1) stored in the current cloud, 2) deleted and re-generated whenever reused or 3) transferred to cheaper cloud service for storage. The algorithm finds the trade-off among computation, storage and bandwidth costs in the cloud, which are three key factors for the cost of storing generated application datasets with multiple cloud service providers. Simulations conducted with popular cloud service providers' pricing models show that the proposed algorithm is highly cost-effective to be utilised in the cloud.

5. Conclusion and Future Works

This paper surveys resource allocation strategies to improve energy consumption by cloud data centers supporting green cloud computing. In any Cloud computing Environment if we want to improve the Energy Efficiency of the datacenters we must look into improving the resource allocations made to the datacenters by the users as it is one of the most efficient ways to reduce energy consumption. In particular, energy-efficient computing and architectural principles for energy-efficient management of Clouds supporting green computing is still new. A Green Energy-efficient resource allocation policy and scheduling algorithms considering, a number of open research challenges, addressing which can bring substantial benefits to both resource providers and consumers. Future work will focus on implementing a Energy efficient green resource allocation policy. We will present the design and implementation of an automated resource management system that achieves a good balance between the two goals, overload avoidance and reduction of Physical Machines used and hence Green Computing.

References

[1] Armbrust, Michael, Armando Fox, Rean Griffith, Anthony D. Joseph, Randy Katz, Andy Konwinski, Gunho Lee et al. "A view of cloud computing." Communications of the ACM 53, no. 4 (2010): 50-58.

[2] Rimal, Bhaskar Prasad, Eunmi Choi, and Ian Lumb. "A taxonomy and survey of cloud computing systems." In INC, IMS and IDC, 2009. NCM'09. Fifth International Joint Conference on, pp. 44-51. Ieee, 2009.

[3] Foster, Ian, Yong Zhao, Ioan Raicu, and Shiyong Lu. "Cloud computing and grid computing 360-degree compared." In Grid Computing Environments Workshop, 2008. GCE'08, pp. 1-10. Ieee, 2008.

[4] Lombardi, Flavio, and Roberto Di Pietro. "Secure virtualization for cloud computing." Journal of Network and Computer Applications 34, no. 4 (2011): 1113-1122.

[5] Armbrust, Michael, Armando Fox, Rean Griffith, Anthony D. Joseph, Randy Katz, Andy Konwinski, Gunho Lee et al. "A view of cloud computing." Communications of the ACM 53, no. 4 (2010): 50-58.

[6] Buyya, Rajkumar, Chee Shin Yeo, and Srikumar Venugopal. "Market-oriented cloud computing: Vision, hype, and reality for delivering it services as computing utilities." In High Performance Computing and Communications, 2008. HPCC'08. 10th IEEE International Conference on, pp. 5-13. Ieee, 2008.

[7] Foster, Ian, Yong Zhao, Ioan Raicu, and Shiyong Lu. "Cloud computing and grid computing 360-degree compared." In Grid Computing Environments Workshop, 2008. GCE'08, pp. 1-10. Ieee, 2008.

[8] Zhenhuan Gong, Xiaohui Gu, and John Wilkes. "Press: Predictive elastic resource scaling for cloud systems." In *Network and Service Management (CNSM), 2010 International Conference on*, pp. 9-16. IEEE, 2010.

[9] V. Vinothina, R. Sridaran, and Padmavathi Ganapathi. "A survey on resource allocation strategies in cloud computing." *International Journal of Advanced Computer Science and Applications (IJACSA)* 3, no. 6 (2012).

[10] Ruay-Shiung Chang; Gao, J.; Gruhn, V.; Jingsha He; Roussos, G.; Wei-Tek Tsai,"Mobile Cloud Computing Research - Issues, Challenges and Needs",IEEE,Service Oriented System Engineering (SOSE), 2013 IEEE 7th International Symposium on,2013

[11] Murugesan, S.; Gangadharan, G.,"Green Cloud Computing and Environmental Sustainability",Wiley-IEEE Press,Harnessing Green IT:Principles and Practices,2012

[12] Islam, S.S.; Mollah, M.B.; Huq, M.I.; Aman Ullah, M.,"Cloud computing for future generation of computing technology",IEEE,Cyber Technology in Automation, Control, and Intelligent Systems (CYBER), 2012 IEEE International Conference on,2012

[13] Owusu, F.; Pattinson, C.,"The Current State of Understanding of the Energy Efficiency of Cloud Computing",IEEE,Trust, Security and Privacy in Computing and Communications (TrustCom), 2012 IEEE 11th International Conference on,2012

[14] Lawey, A.Q.; El-Gorashi, T.E.H.; Elmirghani, J.M.H.,"Distributed Energy Efficient Clouds Over Core Networks",IEEE,Lightwave Technology, Journal of,2014

[15] Priya, B.; Pilli, E.S.; Joshi, R.C.,"A survey on energy and power consumption models for Greener Cloud",IEEE,Advance Computing Conference (IACC), 2013 IEEE 3rd International,2013

[16] Oriaku, C.; Lami, I.A.,"Holistic View Angles of Cloud Computing Services Provisions",IEEE,Cyber-Enabled Distributed Computing and Knowledge Discovery (CyberC), 2012 International Conference on,2012

[17] Hulkury, M.N.; Doomun, M.R.,"Integrated Green Cloud Computing Architecture",IEEE,Advanced Computer Science Applications and Technologies (ACSAT), 2012 International Conference on,2012

[18] Wei Zhao; Yong Peng; Feng Xie; Zhonghua Dai,"Modeling and simulation of cloud computing: A review",IEEE,Cloud Computing Congress (APCloudCC), 2012 IEEE Asia Pacific,2012

[19] Narayan, A.; Rao, S.,"Power-Aware Cloud Metering",IEEE,Services Computing, IEEE Transactions on,2014

[20] Itani, W.; Ghali, C.; Chehab, A.; Kayssi, A.; Elhajj, I.,"Accountable energy monitoring for green service routing in the cloud",IEEE,Communications and Information Technology (ICCIT), 2013 Third International Conference on,2013

[21] Tahamtan, A.; Beheshti, S.A.; Anjomshoaa, A.; Tjoa, A.M.,"A Cloud Repository and Discovery Framework Based on a Unified Business and Cloud Service Ontology",IEEE,Services (SERVICES), 2012 IEEE Eighth World Congress on,2012

[22] Murugesan, S.; Gangadharan, G.,"Green IT: An Overview",Wiley-IEEE Press,Harnessing Green IT:Principles and Practices,2012

[23] Polito, S.G.; Nicoletti, T.; Maniscalco, V.,"Cloud-enabled NGN architecture with discovery of end-to-end QoS resources",IEEE,Intelligence in Next Generation Networks (ICIN), 2013 17th International Conference on,2013