International Research Journal of Advanced Engineering and Science
ISSN: 2455-9024

A Green Cloud-Oriented Computing Architecture for E-Learning Applications

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Abstract**—** *Distributed computing is a very adaptable and practical foundation for running Web applications. E-learning or e-Learning is one of such Web application has progressively picked up fame in the late years, as an exhaustive medium of worldwide instruction framework/preparing frameworks. The advancement of e-Learning Application inside the distributed computing environment empowers clients to get to different programming applications, share information, team up more effectively, and keep their information securely in the framework. Be that as it may, the developing interest of Cloud base has radically expanded the vitality utilization of server farms, which has turned into a basic issue. High vitality utilization not just means high operational cost, which decreases the net revenue of Cloud suppliers, additionally prompts high carbon emanations which are not ecologically well disposed. Consequently, vitality productive arrangements are required to minimize the effect of Cloud-Oriented E-Learning on the earth. E-learning techniques have definitely changed the instructive environment furthermore lessened the utilization of papers and eventually decrease the generation of carbon impression. E-learning technique is a case of Green figuring. Hence, in this paper, it is proposed a Cloud-Oriented Green Computing Architecture for eLearning Applications (COGALA). The e-Learning Applications utilizing COGALA can bring down costs, lessen vitality utilization, and assist associations with constrained IT assets with deploying and keep up required programming in an auspicious way. This paper additionally examined the ramifications of this answer for future research headings to empower Cloud-Oriented Green Computing*.

Keywords**—** *Cloud Computing, green computing, green cloud, e-learning, data centers, energy efficiency*.

I. INTRODUCTION

Cloud computing is another worldview that gives a suitable pool of processing assets with its dynamic adaptability and use of virtualized assets as an administration through the Internet [Poonam (2014)]. The assets can be system servers, applications, stages, framework fragments and administrations. Distributed computing convey administrations independently in light of interest and gives adequate system get to, information asset environment and useful adaptability. This innovation is utilized for more productive and financially savvy registering by concentrating stockpiling, memory, figuring limit of PC's and servers. With the enormous favorable circumstances of distributed computing, this innovation is changed the field of e-learning instruction. The instructive distributed computing [Anjali (2013)] can center the force of a great many PCs on one issue, permitting analysts pursuit and discover models and make disclosures quicker than at any other time. The Educational Institutions can likewise open their innovation foundations to private, open divisions for research headways. The part of distributed computing at Educational Institutions ought not be thought little of as it can give essential picks up in offering direct access to an extensive variety of various scholarly assets, look into applications and instructive devices. The design of an e-learning framework [Palanivel (2014)] created as an appropriated application, incorporates a customer application, an application server and a database server, adjacent to the equipment to bolster it (customer PC, correspondence base and servers). Cloud computing is a very versatile and financially savvy base for running HPC, venture and Web applications [Ashish (2013)]. Be that as it may, the developing interest of Cloud framework has radically expanded the vitality utilization of server farms, which has turned into a basic issue. With the development of fast systems throughout the most recent decades, there is a disturbing ascent in its use included a huge number of simultaneous e-trade exchanges and a large number of Web questions a day. The utilization of extensive shared virtualized datacenters, Cloud registering can offer expansive vitality investment funds. Additionally, the Cloud administrations can likewise encourage increment the web movement and its developing data database which could diminishing such vitality funds [Kamble (2013)]. Green registering is the naturally mindful utilization of PCs and related assets [Kaur (2014)]. Such practices incorporate the execution of vitality proficient Central Processing Units (CPUs), servers and peripherals and in addition diminished asset utilization and legitimate transfer of electronic waste (e-squander). The ways to deal with Green Computing on Educational Institutions are power administration, email, on-line learning and vitality/cost sparing measures. Numerous organizations have included data on their sites about green processing endeavors and how to lessen carbon impressions, Hence, vitality proficient arrangements are required to guarantee the ecological supportability of this new figuring worldview. Green Cloud registering is imagined to accomplish not just productive preparing and use of figuring foundation, additionally minimize vitality utilization [Gaganjot (2013)]. Distributed computing with progressively inescapable front-end customer gadgets cooperating with back-end server farms will bring about a tremendous heightening of vitality utilization. To address this issue, server farm assets should be overseen in a vitality proficient way to drive Cloud-Oriented Green figuring. The vitality proficiency of ICT has turned into a noteworthy issue with the developing interest of Cloud Computing. Consequently, the target of this paper to propose a Cloud-Oriented Green Computing Architecture for e-Learning Applications (COGALA). The COGALA Architecture for

Dr. I. Lakshmi, "A green cloud-oriented computing architecture for e-learning applications," *International Research Journal of Advanced Engineering and Science*, Volume 1, Issue 4, pp. 74-81, 2016.

lessening the carbon impression of Cloud Computing in a wholesome way without giving up the Quality, for example, execution, responsiveness and accessibility offered by various Cloud suppliers. The COGALA comprises of the customer (e.g. can be a University or an Educational Institution), a customer situated green cloud middleware and the green dealer. The green cloud middleware give the customer an apparatus to better deal with the conveyance of assignments to cloud with the minimum carbon emanation (i.e. minimum power utilization) and other applicable choice criteria. The middleware is made out of a UI application and a windows benefit. This engineering is planned to such an extent that it gives motivators to both clients and suppliers to use and convey the most "Green" administrations individually. Likewise, it addresses the natural issue from the general utilization of Cloud Computing assets. This article is sorted out as takes after: Section 2 presents about different specialized points of interest that required to compose this paper. Section 3 studied different designs, for example, benefit arranged, cloud-situated and Green-Oriented. The proposed engineering is portrayed in section 4 lastly segment section 5 finishes up this paper.

II. BACKGROUND TECHNOLOGY

This section introduces Cloud Computing and its deployment/service models, impact of E-learning Cloud Computing, Cloud Computing and energy usage, various energy efficiency models and finally Green Computing in e-Learning applications.

A. Cloud Computing

Distributed computing is a model for empowering pervasive, advantageous, on-request organize access to a mutual pool of configurable registering assets (e.g., systems, servers, stockpiling, applications, and administrations) that can be quickly provisioned and discharged with negligible administration exertion or administration supplier communication [Peter (2011)]. The qualities of Clouds incorporate on-request self-benefit, wide system get to, asset pooling, fast flexibility, and measured administration. The accessible administration models are delegated Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS).

- *Infrastructure as a Service (IaaS)*: IaaS is the supply of Hardware as an administration (HaaS), that is, servers, net innovation, stockpiling or calculation, and essential attributes, for example, Operating Systems and virtualization of equipment assets [Hurwitz 2010]. Making a similarity with a monocomputer framework, the IaaS will compare to the equipment of such a PC together with the Operating System that deal with the administration of the equipment assets and facilitate the entrance to them.
- *Platform as a Service (PaaS)*: At the PaaS level, the supplier supplies more than just foundation, i.e. a coordinated arrangement of programming with all the stuff that a designer needs to fabricate applications, both for the creating and for the execution stages. In this way, a PaaS supplier does not give the framework specifically, but rather making utilization of the administrations of an IaaS it shows the instruments that a designer needs, having an aberrant access to the IaaS administrations and, therefore, to the base [Hurwitz 2010].
- *Software as a Service (SaaS)*: In the last level we may discover the SaaS, i.e. to offer programming as an administration. It has its inceptions in the host operations did by the Application Service Provider.

Cloud computing is putting forth on-request administrations to end clients. Mists are sent on physical base where Cloud middleware is executed for conveying administration to clients. Such a framework and middleware contrast in their administrations, authoritative space and access to clients. In this manner, the Cloud arrangements are characterized for the most part into three sorts: Public Cloud, Private Cloud and Hybrid Cloud.

- *Public Clouds* - Public Cloud is the most widely recognized arrangement show where administrations are accessible to anybody on Internet. A portion of the acclaimed open Clouds are Amazon Web Services (AWS), Google AppEngine, and Microsoft Azure. Open Cloud offers great answers for the clients having little endeavor or with rare base use, since these Clouds give a decent choice to handle crest stacks on the neighborhood base and for a viable scope organization.
- *Private Clouds* - The private Clouds are conveyed inside the introduce of an association to give IT administrations to its interior clients. The private Cloud administrations offer more prominent control over the base, enhancing security and administration flexibility since its get to is confined to one or couple of associations. Such private sending represents an inborn confinement to end client applications i.e. powerlessness to scale flexibly on request as should be possible utilizing pubic Cloud administrations.
- *Hybrid Clouds* - Hybrid Clouds is the organization which developed because of dissemination of both open and private Clouds‟ points of interest. In this model, associations outsource non-basic data and handling to the general population Cloud, while keeping basic administrations and information in their control.
- *The Community Cloud* - In the group arrangement display, the cloud framework is imparted by a few associations to the same strategy and consistence contemplations. This encourages decrease costs when contrasted with a private cloud, as it is shared by bigger gathering.

B. Cloud-Oriented e-Learning

Cloud registering significantly affects educating and learning environment [Fern (2012)]. It is very reasonable in instruction for both understudies and instructors. The cloud based environment underpins the making of new era of e-learning frameworks. In conventional electronic learning model, instructive establishments contribute a tremendous measure of cash on equipment and programming applications, foundation, support and the fitting preparing of staff to empower them to utilize innovation successfully. Nonetheless, in cloud based e-learning model, instructive foundations with

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no base speculations can get capable programming with lower or no in advance expenses and less administration migraines in the classroom. The advancement of e-Learning administrations inside the distributed computing environment empowers clients to get to assorted programming applications, share information, work together more effectively, and keep their information securely in the framework. Besides, it can bring down costs, diminish vitality utilization, and assist associations with restricted IT assets with deploying and keep up required programming in an auspicious way.

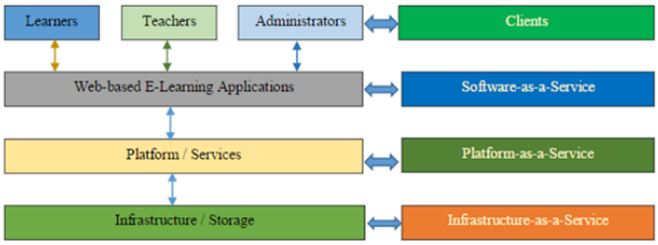

Fig. 1. Cloud-oriented e-learning architecture.

Figure 1 indicates structural engineering for e-taking in framework that the cloud-oriented construction modeling [Manop (2012)] separate under three layers incorporates infrastructure, stage Also requisition. Once framework layer, those taking in assets starting with the accepted framework need aid exchanged of the cloud database As opposed to the common dbms. While on stage layer, another e-taking in framework that comprises of the CMS, AMS, What's more different administration segments were produced. These segments were formed to make the go-between the middle of cloud database and the requisitions. At last once requisition layer, web provision were produced for cooperating for the student's customer. As the selection about cloud registering increases, huge numbers academic organizations are presenting cloud registering innovations under their instruction systems, guaranteeing and delivering All the more versatile and dependable instruction administrations. Numerous instructive organizations need recognized those possibility profits of leveraging cloud registering for budgetary reasons, and additionally to additional propelled educating Furthermore information offering [Mircea (2011)]. A amount for investigations were directed to examine the profits of utilizing cloud registering for e-taking in frameworks [Pocatilu (2009), Pocatilu (2010), Bora (2013)] Also with recommend results for cloud computing-based e-taking in frameworks [Masud (2012), Masud (2012), Bora (2013), Zoube (2010)]. Pocatilu (2010) introduced cloud registering favorable circumstances to e-taking in Likewise continuously low cosset with higher information security, virtualization, incorporated information storage, and the likelihood about following information get. There need aid various favorable circumstances The point when those e-taking in is actualized for those cloud registering technology, they would low cost, progressed performance, moment product update, moved forward archive arrangement compatibility, reductions to people What's more teachers, information security, and so forth throughout this way, observing and stock arrangement of all instrumentation may be enhancement..

C. e-Learning Data Centers

Figure 2 demonstrates an end client getting to Cloud administrations, for example, SaaS, PaaS, or IaaS over Internet. Client information go from his own gadget through an Internet administration suppliers' switch, which thusly associates with a Gateway switch inside a Cloud datacenter. Inside datacenters, information experiences a neighborhood and are handled on virtual machines, facilitating Cloud administrations, which may get to capacity servers. Each of these figuring and system gadgets that are specifically gotten to serve Cloud clients add to vitality utilization. What's more, inside a Cloud datacenter, there are numerous different gadgets, for example, cooling and electrical gadgets that devour control. These gadgets despite the fact that don't specifically help in giving Cloud administration are the real givers to the power utilization of a Cloud datacenter.

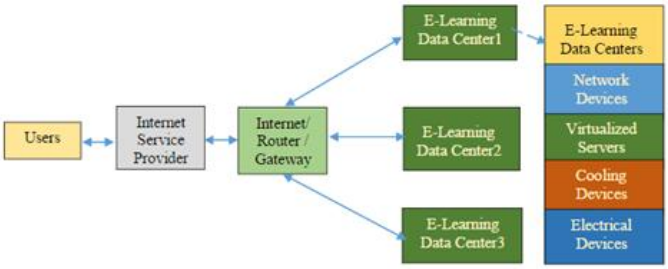

Fig. 2. Usage model of cloud-oriented e-learning.

Client/Cloud software applications - The Cloud processing can be utilized for running e-Learning applications possessed by individual client or offered by the Cloud supplier utilizing SaaS. Here, e-Learning applications are long running with high CPU and memory prerequisites then its execution will bring about high vitality utilization. Along these lines, vitality utilization will be specifically corresponding to the e-Learning application's profile which will bring about much higher vitality utilization than really required. Cloud Software Stack - The Cloud programming stack prompts an additional overhead in execution of end client or learners applications. Case in point, it is outstanding that a physical e-Learning applications server has higher execution proficiency than a virtual machine and IaaS suppliers offer by and large access to a virtual machine to its end clients [Cherkasova (2005)]. Arrange *Devices* - In Cloud registering, since assets are gotten to through Internet, both applications and information are should have been exchanged to the figure hub. In e-Learning applications, if information is truly vast, then it might end up being less expensive and more carbon discharge proficient to send the information via mail than to exchange through Internet. The vitality utilization of these gadgets remains practically the same amid both pinnacle time and sit state.
Datacenter - A cloud datacenter could contain numerous hundreds or a huge number of organized PCs with their relating stockpiling and systems administration subsystems,

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control dissemination and molding gear, and cooling bases. These datacenters can devour monstrous vitality utilization and discharge huge measure of carbon. Consequently, to accomplish the most extreme productivity in power utilization and CO2 emanations, each of these gadgets should be outlined and utilized effectively while guaranteeing that their carbon impression is diminished. Control Usage Effectiveness (PUE) [Rawson (2008)] is a key consider accomplishing the decrease in power utilization of a datacenter is to ascertain how much vitality is expended in cooling and different overheads. PUE of datacenter can be valuable in measuring power productivity of datacenters and hence give an inspiration to enhance its proficiency.

D. Cloud Computing Energy Usage Model

The development of Cloud processing is quickly changing this proprietorship based way to deal with membership situated approach by giving access to adaptable foundation and administrations on-request. It offers gigantic measure of register energy to associations which require preparing of colossal measure of information created practically consistently. The Cloud Computing model is for where the information is to be circulated, so that learning assets will be utilized by a wide range of client in the training streams. Mists are basically virtualized datacenters and applications offered as administrations on a membership premise. They require high vitality use for its operation [Bianchini (2004)]. For a datacenter, the vitality cost is a huge segment of its working and in advance expenses. In this way, vitality utilization and carbon outflow by Cloud frameworks has turned into a key ecological concern. The customary server farms running Web applications are regularly provisioned to handle sporadic pinnacle loads, which can bring about low asset use and wastage of vitality. Cloud datacenter, then again, can diminish the vitality expended through server union, whereby diverse workloads can have the same physical host utilizing virtualization and unused servers can be exchanged off. Indeed, even the most effectively assembled datacenter with the most elevated usage rates will just moderate, instead of wipe out, destructive CO2 outflows. The reason given is that Cloud suppliers are more intrigued by power cost lessening as opposed to carbon emanation. The figure 3 demonstrates that cloud and natural supportability.

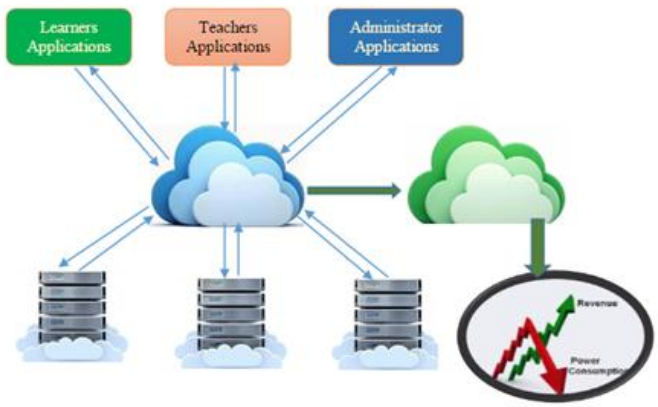

Fig. 3. Cloud and environmental sustainability.

E. Cloud-Oriented Green Computing

E-taking in systems have drastically transformed those instructive surroundings Furthermore Additionally decreased the utilization from claiming papers Also at last decrease those processing of carbon foot shaped impression. E-taking in procedure may be a sample of Green registering. Cloud – Oriented Green registering focuses on a transforming base that combines flexibility, administration quality, and diminished utilization of vitality. Vitality emergency fills green computing, Also green registering needs calculations What's more instruments will make overhauled for vitality proficiency. There is An compelling reason to utilize registering assets efficiently, successfully Also monetarily. The Different methodologies should green data engineering would virtualization, energy management, Materials reusing Also Working from home. It may be essential on essentially lessen contamination Furthermore considerably easier control utilization. Those engineering for vitality productive Clouds is "Virtualization," which permits huge change done vitality proficiency for cloud suppliers Eventually Tom's perusing leveraging those economies of scale connected with vast number for associations offering the same framework [Smith (2003)]. Toward merging about underutilized servers in the manifestation of various virtual machines offering same physical server In higher utilization, organizations could addition helter skelter reserve funds in the type about space, management, Furthermore vitality.

F. Cloud-Oriented Green Computing Architecture

Cloud computing, being a developing innovation likewise brings up noteworthy issues about its ecological manageability. Using substantial shared virtualized datacenters Cloud registering can offer vast vitality reserve funds. Be that as it may, Cloud administrations can likewise promote increment the web movement and its developing data database which could diminishing such vitality investment funds. With vitality deficiencies and worldwide atmosphere, the power utilization of server farms has turned into a key issue. Therefore, there is a need of green distributed computing arrangements that can't just spare vitality, additionally lessen operational expenses. The fundamental physical figuring servers give equipment foundation to making virtualized assets to meet administration requests. The key variables that have empowered the Cloud figuring to lower vitality use and carbon discharges from ICT are progressive provisioning, multi-occupancy, server usage and server farm effectiveness [Accenture (2010)]. Because of these Cloud highlights, associations can diminish carbon outflows by moving their applications to the Cloud. These investment funds are driven by the high productivity of huge scale Cloud server farms. Enhancing the asset use and diminish control utilization are key difficulties to the achievement of working a distributed computing environment. To address such difficulties, it is proposed to outline the Green - Cloud design for server farm such e-Learning. The Figure 4 demonstrates the Cloud-Oriented Green Computing Architecture. In Green - Cloud figuring framework, there are four principle elements

included and they are Consumers/Brokers, Green Resource Allocator, Virtual Machines (VMs) and Physical Machines.

- The Cloud buyers or their merchants submit benefit demands from anyplace on the planet to the Cloud. It is vital to notice that there can be a contrast between Cloud customers and clients of sent administrations.
- The Green Resource Allocator goes about as the interface between the Cloud framework and shoppers. It requires the collaboration of the accompanying parts to bolster vitality effective asset administration.
- Multiple Virtual Machines (VMs) can be powerfully begun and ceased on a solitary physical machine to meet acknowledged solicitations, subsequently giving greatest adaptability to arrange different parcels of assets on the same physical machine to various particular prerequisites of administration solicitations. Numerous VMs can likewise simultaneously run applications taking into account diverse working framework situations on a solitary physical machine.

The target of this paper is to outline a Cloud-Oriented Green Computing Architecture for e-Learning Applications. Henceforth, it is proposed to survey existing works in the zone of engineering of Cloud Computing, Green Computing and both.

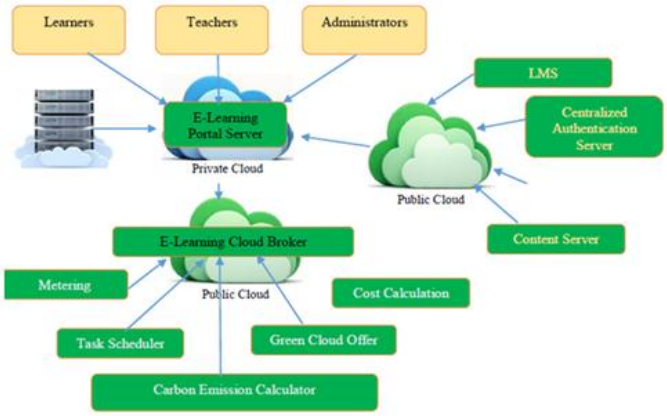

Fig. 4. Cloud-oriented cloud computing architecture.

III. Survey and Related Works

This section review existing works in the area of Cloud Computing architecture and Green Computing architecture and energy efficiency. Service Oriented Cloud Computing Architecture (Lohm 2013) is used to transfer E-learning into the cloud. These architectures cover challenges of e-learning such as scalability, application development, efficient use of resources, saving expense, and security. Engin (2013) presented some possible cloud solutions in e-learning environments by emphasizing its pros and cons. It is of paramount importance to choose the most suitable cloud model for an e-learning application or an educational organization in terms of scalability, portability and security. We distinguish various deployment alternatives of cloud computing and discuss their benefits against typical e-learning requirements. Developments in computing are influencing many aspects of education. The purpose Faten (2013) is to assess the potential value of cloud computing as a platform for e-learning. In particular, the paper will discuss how cloud computing is different from other forms of computing and what makes it unique. As well is this, the potential advantages and disadvantages of using cloud computing as a platform for e-learning will be outlined. Finally, the requirements of implementing cloud computing will be discussed, along with an assessment of the challenges to implementation, and some potential ways to overcome them. Cloud computing has attracted a great deal of attention in the education sector as a way of delivering more economical, securable, and reliable education services. (Ji 2013) proposed and introduces a cloud-based smart education system for e-learning content services with a view to delivering and sharing various enhanced forms of educational content, including text, pictures, images, videos, 3-dimensional (3D) objects, and scenes of virtual reality (VR) and augmented reality (AR).

Tomm (2012) presented the real-time virtualized Cloud infrastructure that was developed in the context of the IRMOS European Project. The paper shows how different concepts, such as real-time scheduling, QoS-aware network protocols, and methodologies for stochastic modelling and run-time provisioning were practically combined to provide strong performance guarantees to soft real-time interactive applications in a Virtualized environment. The efficiency of the IRMOS Cloud is demonstrated by two real interactive e-Learning applications, an e-Learning mobile content delivery applications and a virtual world e-Learning applications.

Anwar (2012) introduced the characteristics of the current E-Learning and then analyses the concept of cloud computing and describes the architecture of cloud computing platform by combining the features of E-Learning. The authors have tried to introduce cloud computing to e-learning, build an e-learning cloud, and make an active research and exploration for it from the following aspects: architecture, construction method and external interface with the model. Green Computing or Green IT refers to the study and practice of using computing resources in an eco-friendly manner in order to tone down the environmental impacts of computing. It is the practice of using computing resources in an energy efficient and environmentally friendly manner. Shalabh (2013) discussed how Green Computing can be incorporated into different institutions, corporate/business sectors or may be in various IT companies. To reduce unnecessary energy consumption due to hazardous materials has become a major topic of concern today.

IV. Proposed Architecture - COGALA

As new distributed computing technologies like Clouds become increasingly popular, the dependence on power also increases. The majority of the energy used in today's society is generated from fossil fuels which produce harmful CO2 emissions. Therefore, it is imperative to enhance the efficiency and potential sustainability of large data centers. Therefore, there is a need to create an efficient Cloud computing system that utilizes the strengths of the Cloud while minimizing its energy and environmental footprint. In order to correctly and

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completely unify a Green aspect to the next generation of Distributed Systems, a green-oriented architecture is needed.
Challenges in Cloud-Oriented E-Learning
With the huge growth of the number of students, education contents, services that can be offered and resources made available, e-Learning system dimensions grow at an exponential rate. The challenges regarding this topic about optimizing resource computation, storage and communication requirements, energy efficiency and dealing with dynamic concurrency requests highlight the necessity of the use of a platform that meets scalable demands and cost control. From the above study of current efforts in making Cloud computing energy efficient, it shows that even though researchers have made various components of Cloud efficient in terms of power and performance, still they lack a unified picture. Cloud providers, being profit oriented, are looking for solutions which can reduce the power consumption and thus, carbon emission without hurting their market. Therefore, it is provided provide a unified solution to enable e-Learning using Green Cloud Computing.

A. COGALA Architecture

The COGALA architecture can be divided into the following layers:

- Infrastructure layer as a dynamic and scalable physical host pool, software resource layer that offers a unified interface for e-learning developers, resource management layer that achieves loose coupling of software and hardware resources, service layer, containing three levels of services (software as a service, platform as a service and infrastructure as a service), application layer that provides with content production, content delivery, virtual laboratory, collaborative learning, assessment and management features.
- Infrastructure layer is composed of information infrastructure and teaching resources. Information infrastructure contains Internet/Intranet, system software, information management system and some common software and hardware; teaching resources is accumulated mainly in traditional teaching model and distributed in different departments and domain. This layer is located in the lowest level of cloud service middleware, the basic computing power like physical memory, CPU, memory is provided by the layer. Through the use of virtualization technology, physical server, storage and network form virtualization group for being called by upper software platform. The physical host pool is dynamic and scalable, new physical host can be added in order to enhance physical computing power for cloud middleware services
- Software Resource Layer mainly is composed by operating system and middleware. Through middleware technology, a variety of software resources are integrated to provide a unified interface for software developers, so they can easily develop a lot of applications based on software resources and embed them in the cloud, making them available for cloud computing users.
- Resource Management Layer is the key to achieve loose coupling of software resources and hardware resources. Through integration of virtualization and cloud computing scheduling strategy, on-demand free flow and distribution of software over various hardware resources can be achieved.
- Service layer has three levels of services namely, SaaS (Software as a service), Paas (Platform as a service), IaaS (Infrastructure as a service). In SaaS, cloud computing service is provided to customers. As is different from traditional software, users use software via the Internet, not to need a one-time purchase for software and hardware, and not to need to maintain and upgrade, simply paying a monthly fee.

Application layer is the specific application of integration the teaching resources in the cloud computing model, including interactive courses and sharing the teaching resources. The interactive programs are mainly for the teachers, according to the learners and teaching needs, taken full advantage of the underlying information resources after finishing made, and the course content as well as the progress may at any time adjust according to the feedback, and can be more effectiveness than traditional teaching. Sharing of teaching resources include teaching material resources, teaching information resources (such as digital libraries, information centers), as well as the full sharing of human resources. This layer mainly consists of content production, educational objectives, content delivery technology, assessment and management component.

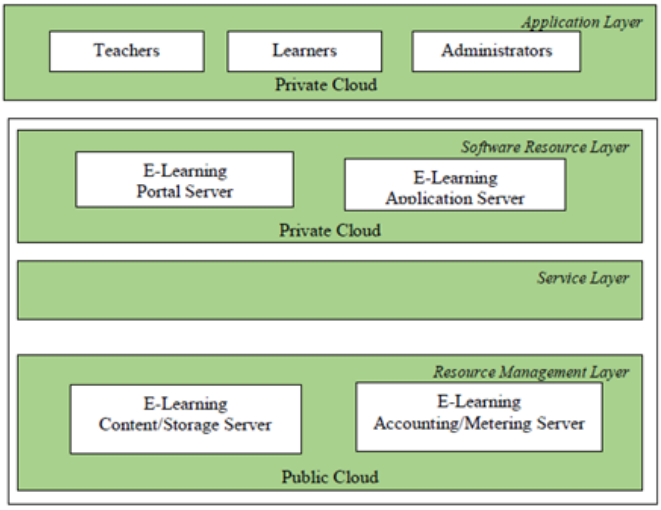

Fig. 5. Cloud-oriented green computing architecture for e-learning.

B. How COGALA Works?

In the COGALA architecture, learners/teachers submit their Cloud service requests through a new middleware Green Broker that manages the selection of the greenest Cloud provider to serve the user's request. A learner/teacher service request can be of three types i.e., software, platform or infrastructure. The Cloud providers can register their services in the form of green offers" to a public directory which is accessed by Green Broker. The green offers consist of green services, pricing and time when it should be accessed for least carbon emission. Green Broker gets the current status of

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energy parameters for using various Cloud services from Carbon Emission Directory. The Carbon Emission Directory maintains all the data related to energy efficiency of Cloud service. This data may include PUE and cooling efficiency of Cloud datacenter which is providing the service, the network cost and carbon emission rate of electricity, Green Broker calculates the carbon emission of all the Cloud providers who are offering the requested Cloud service. Then, it selects the set of services that will result in least carbon emission and buy these services on behalf users. The COGALA architecture is designed such that it keeps track of overall energy usage of serving a user request. It relies on two main components, Carbon Emission and Green Cloud offers, which keep track of energy efficiency of each Cloud provider and also give incentive to Cloud providers to make their service "Green". From user side, the Green Broker plays a crucial role in monitoring and selecting the Cloud services based on the user QoS requirements, and ensuring minimum carbon emission for serving a user. In general, a user can use Cloud to access any of these three types of services (SaaS, PaaS, and IaaS), and therefore process of serving them should also be energy efficient. Cloud Computing use latest technologies for IT and cooling systems to have most energy efficient infrastructure. By using virtualization and consolidation, the energy consumption is further reduced by switching-off unutilized server. Various energy meters and sensors are installed and calculated the current energy efficiency of each service providers.

C. Energy Consumption

To measure the unified efficiency of a datacenter and improve its' performance per-watt, the Green Grid has proposed two specific metrics known as the Power Usage Effectiveness (PUE) and Datacenter Infrastructure Efficiency (DciE). PUE = Total Facility Power/IT Equipment Power DciE = 1/PUE = IT Equipment Power/Total Facility Power x 100% The Total Facility Power is defined as the power measured at the utility meter that is dedicated solely to the datacenter power. The IT Equipment Power is defined as the power consumed in the management, processing, and storage or routing of data within the datacenter. The expected benefits for which planned to implement COGALA are environment friendly, efficient and time saving.

V. Conclusions and Future Directions

In this paper, it analyzed the benefits offered by Cloud computing by studying its fundamental definitions and benefits, the services it offers to end users, and its deployment model. E-learning system is facing challenges of optimizing large-scale resource management and provisioning, according to the huge growth of users, services, education contents and media resources. We have settle the goodness of a Cloud Computing solution. The features of the Cloud Computing platform are quite appropriate for the migration of this learning system, so that we can fully exploit the possibilities offered by the creation of an efficient learning environment that offers personalized contents and easy adaptation to the current education model. Then, it discussed the components of Clouds that contribute to carbon emission and the features of Clouds that make it "Green". Even though the proposed Cloud-Oriented Green Architecture embeds various features to make Cloud computing much more Green, there are still many technological solutions are required to make it a reality.

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