HCTL Open Int. J. of Technology Innovations and Research
HCTL Open IJTIR, Volume 7, January 2014
e-ISSN: 2321-1814
ISBN (Print): 978-1-62951-250-1

Energy Efficiency in Cloud Computing

***Mahipal Singh*[*], *Ajay Kumar*[†] *and Dr. Sanjay Bhargava*[‡]**
mahiditdun@gmail.com; kumarajay7th@gmail.com; sanjaybhargava78@gmail.com

Abstract

There has been a rapid increase in demand for computational power which includes resulted in the coming of large data centres. These consume enormous amounts of electricity contributing to steeply-priced operation and co2 fractional laser emissions. The computing model of cloud usage can also be helping the power consumption on the ICT equipments associated with from a vendor and also the user throughout the network. Using the growing usage of computing and emerging it as being transformative trends operating and society, it's important to take into consideration its energy efficiency and it is effects. Most consumers are already heavy users of cloud- enabled services, including email, social websites, online gaming, and several mobile applications. But growing use of clouds should we really contemplate it as an alternate to conventional computing? The efficiency model provides wastage of energy in conventional systems and how it is usually avoided by using cloud computing.

[*]M.Tech. Student, DIT University, Dehradun, India
[†]Assistant Professor, DIT University, Dehradun, India
[‡]Professor, DIT University, Dehradun, India

HCTL Open Int. J. of Technology Innovations and Research
HCTL Open IJTIR, Volume 7, January 2014
e-ISSN: 2321-1814
ISBN (Print): 978-1-62951-250-1

Keywords

Cloud Computing, Energy Efficiency, Cloud Efficiency Model.

Introduction

The cloud computing is the talk of town inside industry in present years. the reports daily emerge displaying the advantages of using this new computing model depending on grid computing. Through effective integration, it handles multi level virtualization and abstraction with the help of countless computing resources, data, storage, applications along with other connected infrastructure therefore the user just creates a wayout with minimum pay-as-per-usage basis. Concurrently while using use of more it based strategy there may be alongside a lot for the environment as being the carbon footprint is enhanced. Thus eventually the balance for usage and the strain on environment needs to be taken care of; therefore an energy efficient mechanism suitable for cloud computing platform is required to be developed [1].

The rising availability of high-speed Internet and IP connections, making the delivery possible for the latest network-based services. While Internet-based e-mail services are already existing since several previous years, new service offerings have been recently expanded to include services based on network storage, network-based computing, etc. These new services are increasingly being offered both to corporate and individual owners. Services on this type have been generically called Bcloud computing services. The cloud computing service model necessitates the provision, by the supplier, of huge pools of good performance computing resources and high- capacity storage devices which have been shared among owners PRN. There are various cloud service models, but generally, owners subscribing towards the service have their data hosted from the service, and have computing resources allocated when needed from the pool. The suppliers offering may also touch the software program applications required by the user. The cloud service model to be successful requires a high-speed network connection to connect the person along with the vendor's infrastructure. Cloud computing potentially has an overall financial benefit, in that owners share a sizeable, centrally managed pool of storage and computing resources, in lieu of owning and managing their own systems [2].

Its financial benefits are actually widely discussed, the transfer of energy usage inside a cloud computing model has brought little attention. With the

e-ISSN: 2321-1814
ISBN (Print): 978-1-62951-250-1

help of large shared servers and storage, cloud computing is typically offering energy savings in the field of computing and storage services, particularly if the user moves toward using computer or possibly a device of lower capability and reduces the energy consumption [4]. Also, cloud computing is responsible in the increase in network traffic and the related network energy consumption [5]. The transmission and switching networks over the internet are the cause of another 0.4% of total electricity consumption in broadband-enabled countries [5]. Besides the obvious must reduce the greenhouse impact with the ICT sector, this ought to reduce energy consumption is usually driven because of the engineering challenges and price of handling the power usage of large data centers and associated cooling. From this, cloud computing will be responsible for increase in size and capacity of information centers and ofcourse networks, if they are properly managed, cloud computing can also bring about all required energy savings.

Cloud Computing

In today's internet world in which the speed from the connection is continuously increasing with technologies like 3G, 4G and also the LTE, the speeds coordinate while using real-world speed that you requires for smooth loading of files. This is quite useful if we speak about the mobility and hardware. This is also useful while discussing about a lot of data that we cannot store at one place. This is useful because companies and organizations do need to store quite a bit of web data but do not want each of the data to use at the same time. As an example if we look at a mobile service agency, it'll have data of numerous subscribers, but at any given time it will need data of only a particular costumer. And it also may require the data of any customer anywhere in the world. So rather then physically storing and accessing data by reviewing the data center, the organization is able to use the cloud. This could enable to reach the data any time anywhere over machines [2].

The term cloud is actually a synonym for the Internet. This usage was originally produced from its common depiction in network diagrams just as one outline of any cloud. This concept goes around 1961, when Professor John McCarthy suggested that computer time-sharing technology might cause a future where computing power and even specific applications could be sold by using a utility-type business model. In the late 1960s, this idea became popular, but faded away in the mid-1970s when it became clear that the IT-related technologies of the day were unable to maintain the ultramodern computing model of the suture.

HCTL Open Int. J. of Technology Innovations and Research
HCTL Open IJTIR, Volume 7, January 2014
e-ISSN: 2321-1814
ISBN (Print): 978-1-62951-250-1

However, since the turn in the millennium, the idea has been revitalized [2]. Now cloud computing is becoming more established from the technical terms. The organizations take advantage of the cloud, build infrastructure and deliver new applications, services and business models, a lot of that happen to be also stuck just using their mobile applications [1, 6, 7]. Figure 1 [16] shows the basics of cloud computing and its services.

Efficiency in Cloud Computing

The gains that individuals join energy efficiency from moving business and private software around the cloud is achieved in the proven fact that data centers which hosts these cloud servers are a great deal more energy efficient versus the IT infrastructure which the small companies deploy as well as proven fact that the servers of internet data centers less complicated more cost-effective. The energy savings are significant, particularly for small companies which deploy inefficient IT services [2].

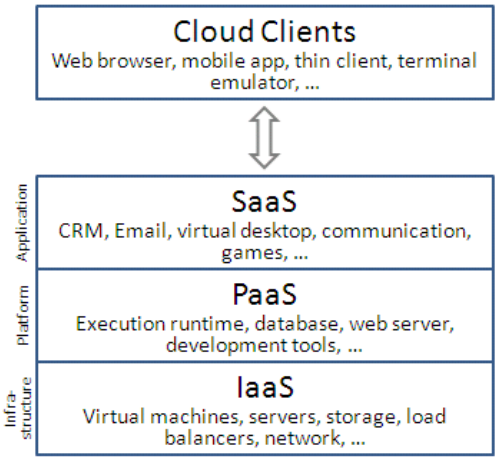

Figure 1: *Cloud Computing Architecture [16]*

Research Work on Energy Efficient Cloud Computing

Green Star Network (GSN)

In [1, 8], an environmentally friendly Green Star Network (GSN) has been presented and established in Canada which was consisted of the GSN core

e-ISSN: 2321-1814
ISBN (Print): 978-1-62951-250-1

which includes six nodes powered by sun, wind and hydroelectricity. The solar power is used at Cybera Calgary and CRC Ottawa. The wind power is used at BastionHost Truro. Three nodes at Rackforce Kelowna and ETS-UQAM Montreal are powered by hydro energy. Since BC and QC provinces have a very large capacity of hydroelectricity, there is no risk and services information interruption within the network because of power outages. Using renewable energies like wind and solar ones is considered better than hydroelectricity because of their non-uniform availability throughout the year. Therefore whenever it's possible, applications are made to run on solar and wind powered nodes. The GSN node at Montreal plays a task of manager (so named the hub node) that opportunistically creates required connectivity for Layer 1 and Layer 2 using dynamic services, then pushes virtual machines (VMs) or software virtual routers on the hub to sun and wind nodes (spoke nodes) when power is available. VMs will likely be pulled back for the hub node when power dwindles. When this happens, the spoke node may transition grid power for running other services if it is required. However, GSN services are powered entirely by green energy. The VMs are utilized to run user applications, particularly heavy computing services. Depending on this testbed network, research experiments are carried out targeting cloud management algorithms and optimization of intermittently-available renewable energy sources. The GSN is usually incorporating green nodes in Ireland (HeaNET), Belgium (IBBT), Spain (i2Cat), China (WiCo), Egypt (Smart-Village) and USA (ESNet).

Efficient LAN Switches

In [1, 9], the feasibility of Dynamic Voltage Scaling method has been checked to get deployed in the LAN switches. The authors focused on the LAN switches particularly especially simply because they form the majority of the network devices in the LAN and in addition they take in the largest percentage of energy. The thorough approach for routers had been excluded through the study. Saving energy in LAN switches means powering off or putting to nap LAN switch components, interfaces or entire switches. Within the paper you'll find the set of basic questions that arise in the approach of putting the switch components to sleep. There is an analysis of traffic data from the LAN showing several periods of its inactivity which they can use for sleeping. Then later can be an algorithm proposed with the sleeping module with the switches.

HCTL Open Int. J. of Technology Innovations and Research
HCTL Open IJTIR, Volume 7, January 2014
e-ISSN: 2321-1814
ISBN (Print): 978-1-62951-250-1

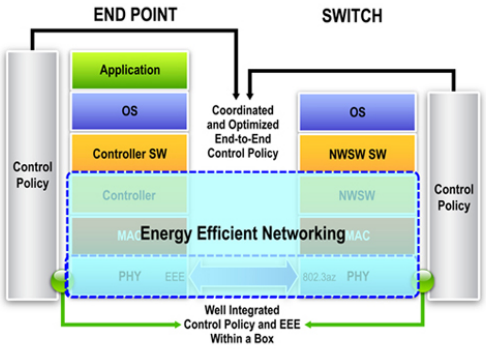

Figure 2: *Energy Efficient LAN [17]*

Improvements at the Cloud Data Center

To start with establishing energy aware solutions at the server level will bring out improvements. It offers the introduction of energy aware hardware. The very first progressive step up this regard will be the using labels like US Energy Star or even the European TCO certification which rate the IT products as per their affect on the surroundings. Laptop computer power might be minimized because of the entry to several well-known techniques. They allow this by lowering the power using of the processors and this can be accomplished with the entry to available power down mechanisms like SpeedStep, PowerNow, Cool'nQuiet or demand based switching. These applications function around the phenomenon of clock gating or power gating. Clock gating is slowing in the CPU Clock Speeds. Power Gating is powering off of the parts of chips when not in use or idle to any process load. By sensing the lack of user machine interaction different redundant hardware parts may be deterred or put in hibernating mode (display, discs, etc.) [1, 10].

According to the Advanced Configuration and Power Interface (ACPI), which defines four energy states of an ACPI compliant computer system. These states consist of G0-accommodating G3-mechanical off state. The states G1 and G2 are further subdivided into sub-states defining which components are to be off in what particular state. For devices and CPU separate power states (D0-D3 for devices and C0-C3 for CPU) are defined which might be much like Global power states. Some of these mentioned techniques are defined for mobile phones but not supply for desktop PCs and the Servers. So these services are to get deployed upon the cloud servers. Also the live migration of processes on the

e-ISSN: 2321-1814
ISBN (Print): 978-1-62951-250-1

memory of VMs should be taken into consideration during virtualization.

A Zero-Carbon Network (ZCN) proposed in [1, 8] is based on the Green Star Network(GSN) project initiated through the Canadian Consortium devoted to the partnership between the network and and green data centers proposes a great platform to build up an environmentally friendly-energy network. The GSN project is focused on the allocation of the physical data centers close to cheap energy sources. The Zero-Carbon network targets on the active and virtual migration in the data centers around green nodes while maintaining anyone services. We propose saving money-Energy Network comprising in the hybrid from the GSN and ZCN depending on the geographic distribution from the data centers. Contrary to the GSN saving money Energy Network comprises of small and medium sized data centers which permit the network to become cost-effective with regard to construction costs. But the spot that the Green Energy Network really needs to be functioning beyond your odds of saving money Star Network the expense of producing and maintaining the network elements for example routers and servers(for tiny and large scale data centers) has got to incorporated. These hardware equipments are extremely well handled and managed through power gating and clock gating mechanisms employed at machines.

With the usage of Virtual machines and doing Server Consolidation in the data center, a cloud provider is effective in reducing total power consumption for the clients if we do compromise of performance degradation [1, 11]. By choosing a more energy efficient allocation policy, energy consumption on cloud platforms could be reduced by approximately 7% to 14%, lowering overall energy costs by about 11% to 26%. This kind of improvement comes at the expense, however, of increased CPU load [1, 12]. For allocation of Virtual Machines we should instead allocate the group of Virtual Machines (VM) towards the several processes the criterion to become observed is the fact that there should be minimum volume of migrations along with the migration is usually to be done about the VMs that are fitted with the absolutely no or least load on the assigned processes or even in short the VMs using the lowest using of CPU. According to this criterion of VMs selection for process allocations we find the Modified Best Fit Decreasing algorithm proposed in [1, 13] for dynamic reallocation with the VMs to minimize energy consumption.

After the allocation of the VMs the next thing is Task Consolidation at cloud, that is a method of maximizing cloud computing resource, which brings advantages for instance usage of resources, rationalization of maintenance, IT

e-ISSN: 2321-1814
ISBN (Print): 978-1-62951-250-1

service customization, QoS and also other reliable services, etc but it surely didn't mean maximizing energy efficient usage. But taking into consideration the architecture proposed in [1, 14] the Energy-aware Task Consolidation (ETC) mechanism there has been a significant reduction in the facility consumption of up-to 17% improvement in managing task consolidation for cloud systems and therefore it can be implemented here.

Balance Reduce (BAR) is a data locality driven task algorithm proposed in [1, 15] and it in addition schedules the duties by subtracting a worldwide vies and adjust task data locality dynamically good network state and cluster workload. BAR tries to further improve data locality and once cluster is overloaded it decreases your data locality to create tasks start early. Thus this scheduling algorithm could be implemented for task scheduling with the Virtual Machines.

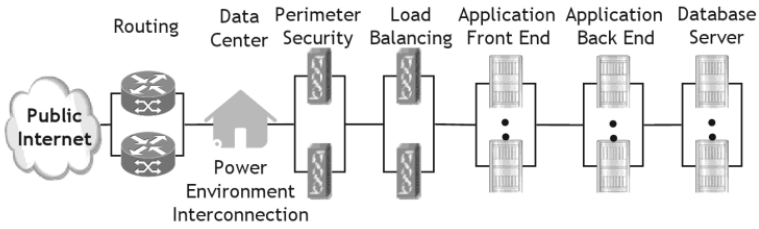

Figure 3: *Energy Efficient Cloud Data Center [18]*

Improvements in the Network

A lot more Energy Efficient Network is the second stage of growth and development of our Green-Cloud. It offers the mechanism for calculation of the power consumed among any two nodes throughout the packet path. To match the data collected to the energy consumption we are competent to transfer the energy load along the network in a very more desirable manner in order that we have an energy-aware network distribution.

To be able to set down minimum pressure in the network inside the cloud computing resource utilization we must measure the energy consumed by every one of the network devices. Several power measurement tools ought to be utilized inside network at first to measure the ability usage and also the extent of CO2 release parallel for it to be able to manage the energy efficient network. The information then collected must be employed to calculate the network load of power distribution on the network.

e-ISSN: 2321-1814
ISBN (Print): 978-1-62951-250-1

Like the procedure by which a bank evaluates pressure load on the network ATMs so as to re-credit the bank ATMs depending upon the burden within the machines. As an example the ATMs for the more populous cities will be required to be re-credited using a much prior basis versus the machines inside the less populous cities, or there can be the scenario of several other ATMs for sale in its locality. The busy machines are going to be required to be re-credited, with greater regularity compared to machines which have lesser load.

Parallel to this particular phenomenon, the info has to be collected as a way to evaluate a highly occupied network to be distinguished from your less occupied networks. It of transaction from the network may be the Data Packet. So multiple probes might be deployed on the network junctures to measure the traffic distribution at different hours of waking time and dependant on this data collected power consumed by the network is calculated and later assigned to individual users or even the network users in that direction. The routing path with the data packets can be identified by sending route identifying packets among all edge nodes periodically. Depending on the data collected to the high traffic network there has to be the network.

As proposed from the [1, 9], the energy efficient mechanism for LAN switches can be implemented for the establishment of energy efficient network for the Green-Cloud infrastructure along with the final network level scenario as shown inside the figure 2 is developed.

Improvements at the Client Level

To start with energy-aware network compliance with the client level we propose the application of browser having less carbon footprint, beyond just the using clock gating and power gating based user machines as shown in the Figure 4 [1, 2].

Conclusion

The energy efficient mechanisms need to be managed through all of the intermediates involved right through the communication network beginning from the server level for the client level. We've got proposed the techniques which enable energy efficient mechanism to earn an income within the cloud network and wheresoever you will find the chance of lowering the carbon footprint with the employed infrastructure or the available alternate occurs it's being proposed which ensures the decrease in CO2 emission from your used ICT equipments.

e-ISSN: 2321-1814
ISBN (Print): 978-1-62951-250-1

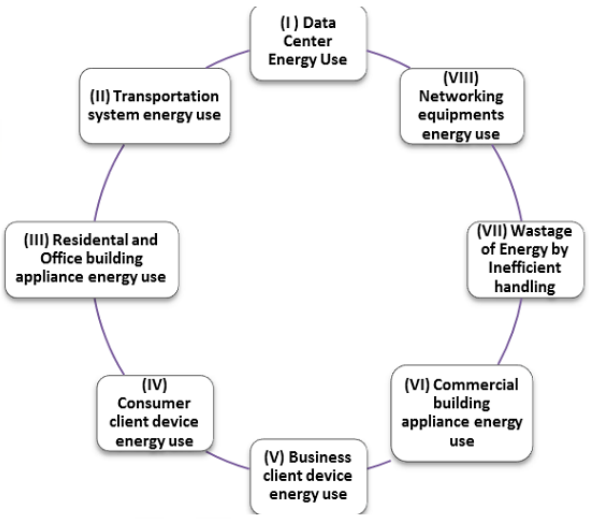

Figure 4: *Energy Efficient Cloud at Client Level [2]*

References

[1] Prince Sharma, Dr. Amar Jeet Singh, A Green-Cloud Network Scenario: Towards Energy Efficient Cloud Computing, International Journal of Advanced Research in Computer Science and Software Engineering, ISSN: 2277-128X, Volume 2, Issue 10, October 2012.

[2] Puru Agrawal, Cloud Computing and Energy Efficiency Cloud as an Alternative to Green Computing, International Journal of Science and Research (IJSR), ISSN (Online): 2319-7064, Volume 2 Issue 11, November 2013.

[3] Ms. Jayshri Damodar Pagare, Dr.Nitin A Koli, Energy-Efficient Cloud Computing: A Vision, Introduction, and Open Challenges, International Journal of Computer Science and Network, ISSN (Online): 2277-5420, Vol 2, Issue 2, April 2013.

[4] Jayant Baliga, Robert W. A. Ayre, Kerry Hinton, and Rodney S. Tucker, Green Cloud Computing: Balancing Energy in Processing, Storage, and Transport For processing large amounts of data, management and switching of communications may contribute significantly to energy consumption and cloud computing seems to be an alternative to office-based computing, January 2011.

e-ISSN: 2321-1814
ISBN (Print): 978-1-62951-250-1

[5] J. Koomey, Estimating Total Power Consumption by Servers in the U.S. and the World, Oakland, CA: Analytics Press, 2007.

[6] Cloud Computing, The 2011 IBM Tech Trends Report, 2011, pp.8

[7] John W. Rittinghouse and James F. Ransome, Cloud Computing, CRC Press: 2010.

[8] Mathieu Lemay, Kim-Khoa Nguyen, Bill St. Arnaud, Mohamed Cheriet, Convergence of Cloud Computing and Network Virtualization: Towards a Zero-Carbon Network.

[9] Maruti Gupta, Satyajit Grover, Suresh Singh, A feasibility study for power management in LAN switches, Proceedings of the 12th IEEE international conference on network protocols, ICNP 2004, 5-8 Oct 2004, pp 361-371.

[10] Andreas Berl, Erol Gelenbe, Marco di Girolamo, Giovanni Giuliani, Hermann de Meer, Minh Quan Dang and Kostas Pentikousis, Energy- Efficient Cloud Computing. The Computer Journal, August 2009.

[11] Hadi Goudarzi and Massoud Pedram, Energy-Efficient Virtual Machine Replication and Placement in a Cloud Computing System, IEEE Fifth International Conference on Cloud Computing, 2012.

[12] Ryan Jansen Paul R. Brenner, Energy Efficient Virtual Machine Allocation in the Cloud, DOI 978-1-4577-1221-0/11, IEEE, 2011.

[13] Anton Beloglazov and Rajkumar Buyya, Energy Efficient Allocation of Virtual Machines in Cloud Data Centers, 10th IEEE/ACM International Conference on Cluster, Cloud and Grid Computing, 2010.

[14] Ching-Hsien Hsu, Shih-Chang Chen, Chih-Chun Lee, Hsi-Ya Chang, Kuan-Chou Lai, Kuan-Ching Li and Chunming Rong, Energy-Aware Task Consolidation Technique for Cloud Computing, Third IEEE International Conference on Coud Computing Technology and Science, 2011.

[15] Jiahui Jin, Junzhou Luo, Aibo Song, Fang Dong and Runqun Xiong, BAR: An Efficient Data Locality Driven Task Scheduling Algorithm for Cloud Computing, 11th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing, 2011.

[16] Cloud Computing from Wikipedia. http://upload.wikimedia.org/wikipedia/commons/3/3c/Cloud_computing_layers.png

e-ISSN: 2321-1814
ISBN (Print): 978-1-62951-250-1 *References*

[17] Energy Efficient LAN Switches, Broadcom Corporation. http://www.broadcom.com/images/features/een_diagram2.jpg

[18] Eric Bauer, Randee Adams, Reliability and Availability of Cloud Computing, ISBN: 9781118393987, Book published by John Wiley & Sons, 2012.

[19] Amrit Suman, Mahesh Gour and Raksha Mehra, Cloud Computing: A Modern Art and its Research Challenges, Edition on Cloud and Distributed Computing: Advances and Applications, Volume 2 - August 2013 of HCTL Open Science and Technology Letters (STL), ISSN: 2321-6980, ISBN: 978-1-62840-833-1.

[20] Aman Sagar, Bineet Kumar Joshi and Nishant Mathur, A Study of Distributed Denial of Service Attack in Cloud Computing (DDoS), Edition on Cloud and Distributed Computing: Advances and Applications, Volume 2 - August 2013 of HCTL Open Science and Technology Letters (STL), ISSN: 2321-6980, ISBN: 978-1-62840-833-1.

[21] Shakti Dhar Tiwari, Mahesh Kumar and Preeti Mishra, Cloud Computing: Implementation of Software as a Service (SaaS) Multitenancy, Edition on Cloud and Distributed Computing: Advances and Applications, Volume 2 - August 2013 of HCTL Open Science and Technology Letters (STL), ISSN: 2321-6980, ISBN: 978-1-62840-833-1.

[22] Mahesh Kumar and Shakti Dhar Tiwari, Cloud Computing: Various Aspects of Cloud Security, Edition on Cloud and Distributed Computing: Advances and Applications, Volume 2 - August 2013 of HCTL Open Science and Technology Letters (STL), ISSN: 2321-6980, ISBN: 978-1-62840-833-1.

[23] Gaurav Mohan Singh, Mahipal Singh Kohli and Manoj Diwakar, A Review of Image Enhancement Techniques in Image Processing, HCTL Open International Journal of Technology Innovations and Research, Volume 5, Sept 2013, ISSN: 2321-1814, ISBN: 978-1-62840-986-4.