International Journal of Latest Trends in Engineering and Technology
Special Issue SACAIM 2016, pp. 297-303
e-ISSN:2278-621X

GREEN CLOUD COMPUTING RESEARCH CHALLENGES: A SURVEY

Mithun D'Souza[1], Jassim Ibrahim[2], Mohammed Rizwan[3] and Dr. S Sathyanarayana[4]

Abstract - With the advent of cloud computing, huge amount of energy is consumed within the cloud day by day. So there is a need for an efficient management of energy in the cloud environment. Energy efficiency is an important aspect of Green Cloud computing. Green computing is an emerging technology which is mainly used to improve the environmental condition and power consumption issues. By implementing green computing in the computer fields like CPU servers and other peripheral devices, we can reduce energy consumption. In this paper, we have discussed some of the green computing issues, solutions and initiatives taken to increase energy efficiency.

Keywords—Green computing, Cloud computing, Energy efficiency, Power consumptions.

I. INTRODUCTION

Cloud computing is a rapidly growing "Internet Based Computing" which provides the different users to host their data on the web using cloud services. Cloud computing is a delivery model that allows users to connect with the server and use hardware, software and other resources. In cloud technology, the software and resources will be shared on the remote servers[14]. Client can access the resources from the server with high speed internet connection [15]. Cloud computing provides reliable and user friendly services like Infrastructure as a service (IAAS), Platform as a service (PAAS) and Software as a service (SAAS) as a subscription based services.

A. Cloud computing:

According to National Institute of Standards and Technology (NIST) – "the major objective of cloud computing is to maximize the shared resources and at the same time the disadvantage is its high infrastructure cost and unnecessary power consumption." [1]. Global warming became a major threat to the environment, with high power consumption and CO2 emission [12].The Deployment models of the cloud include Public cloud, Private cloud, Hybrid Cloud, Community cloud.

Public Cloud**:** A public cloud is one in which the services and infrastructure are provided off-site over the internet [17]. Service providers use the internet to make resources, such as applications (SaaS) and storage that are available to the public on a "public cloud" [16]. Amazon Web Services (AWS) Microsoft Azure, and Google Cloud Platform (GCP) are all examples of public cloud service providers.Public Clouds provide the best economical advantage and are the least

[1] *AIMIT,St Aloysius College Mangalore, Karnataka, India*
[2] *St Aloysius College, AIMIT,Mangaluru, Karnataka, India*
[3] *St Aloysius College, AIMIT,Mangaluru, Karnataka, India*
[4] *First Grade Womens College, Mysuru, Karnataka, India`*

expensive to set-up since it offers a pay-per-usage model and the only costs incurred are based on capacity used. In addition, the cloud provider covers hardware, application and bandwidth costs[18].

Private Cloud: A private cloud is one in which the services and infrastructure are maintained on a private network [18]. The goal of a private cloud is not providing SaaS like public cloud providers, but rather, gaining the benefits of cloud architecture while maintaining control of your own data center [16].Private clouds can be rather expensive and are usually not the best option for the average small to medium sized business [16]. Organizations typically choose to go with a private cloud because they have security and compliance concerns. However, the public cloud is just as secure [18].

Hybrid Cloud: A hybrid cloud includes a variety of public and private options with multiple providers [17]. This allows companies to maintain control of an internally managed private cloud and rely on the public cloud as needed [18].The downside to using a hybrid cloud is that you have to keep track of multiple security platforms [17]. Hybrid cloud works best if your company wants to use a SaaS but also wants a private cloud for additional security. From each organization's point of view, public, private, and hybrid clouds will all have their pros and cons. Ultimately, it comes down to the cloud an organization feels is right for the type of work they are doing. It is important to note that the public cloud is secure and will only become more secure over time, allowing corporations to gradually transition to the most cost-effect solution. Considering best practices and how to integrate and manage your cloud solution is the next step in advancing your business [18].

Community cloud: In Cloud computing, a collaborative effort in which infrastructure is shared between several organizations from a specific community with common concerns like security, compliance, jurisdiction and many more, whether managed internally or by a third-party and hosted internally or externally [19]. This is controlled and used by a group of organizations that have shared interest. The costs are spread over fewer users than a public cloud (but more than a private cloud), so only some of the cost savings potential of cloud computing are realized [20].

B. Green computing:

Green cloud computing is the term which is mainly used to reduce energy consumption and improve the efficient use of resources in cloud computing [21]. Nowadays, Data centers and IT industry use cloud computing where the user can access application as a service from anywhere in the world. Cloud computing refers to the delivery of services including applications, resources and data over the Internet on demand. Green IT embraces the measurements of environmental sustainability, the economics of energy efficiency, and the total cost of ownership. It is the study and practice of using computing resources efficiently [3].As per the survey conducted by EPA [12]- US Environmental Protection Agency on Global Greenhouse Gas Emissions, 65% of carbon dioxide is generated by fossil fuel and industrial processes whereas industry alone produces 21% of Greenhouse gas which primarily involve fossil fuels burned on site at facilities for energy. Electricity production by burning of coal, natural gas, and oil for electricity contributes 25% of global greenhouse gas emissions which is supplied to these industries that generates heat and which is the largest single source of global greenhouse gas emissions. The extensive consumption of energy in IT industry is one of the main root causes of current global warming. In this situation, need to save energy have become a top most priority in almost all segments of the IT market.

Green computing is needed to reduce the power consumption and environmental waste. The technologies of green computing are Virtualization, Green Data Center; Cloud computing, grid computing and Power optimization. The main objective of green computing is to improve the energy efficiency and reduce the power consumption and use of toxic as well as hazardous materials. Green computing is mainly intended to design better computer system i.e. their processing speed should be better which consumes less power. Green Computing is the practice of designing, manufacturing, using and disposing of a computer server and some peripherals like monitors, printers, storage devices etc., efficiently and effectively with no impact on environment [6]. But these practices include efficient implementation of server and peripherals as well as reduce the power consumption. The increase in the amount energy consumption in the world became a critical problem. The large data centers have increased the demand of energy for the development and maintenance of complex data-intensive applications [7]. In the management of Data center, the problem of power consumption and application's quality of services are significant [5].The need for energy efficiency has become a critical factor in the design of high performance computing [4]. Data center requires lot of power and cooling system in the cloud environment. They use large amount of power/energy and release a huge amount of heat and gases [2]. To reduce this power consumption, green computing is used.Green computing is required to design advanced and better computer system, i.e., their processing speed must be better and should consume less amount of energy.

C. Cloud Architecture:

The below figure illustrates Cloud Architecture [13]. The whole system can be categorized into the core stack and the management. The core stack is divided into three layers: (1) Resource (2) Platform and (3) Application. The Resource layer can be referred as infrastructure layer which is comprises physical resource and virtualized resource. Physical and virtualized resource can be computing i.e. server, storage and networking resources. The Platform layer is the most complex part which could be divided into many sub-layers. For e.g. a computing framework achieves transaction dispatching or task scheduling. A storage sub-layer provides unlimited storage and caching capability. The Application server and other components support the same general application logic as earlier with either on-demand capability or flexible management, such that the system will not block the components [13]. Based on the underlying resource and components, the application could support large and distributed transactions and management of huge volume of data. All the layers provide external service through web service or other open interfaces.

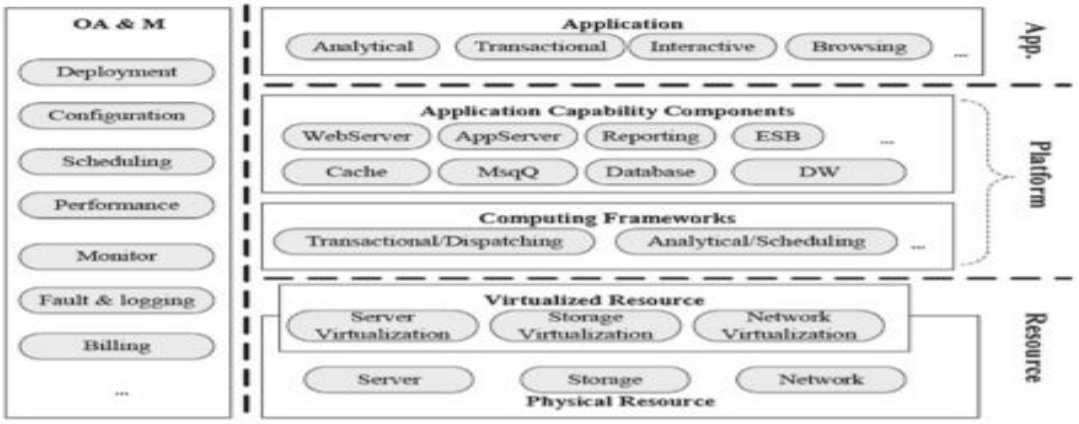

Figure 1: Cloud architecture[13]

II. RESEARCH ISSUES IN GREEN COMPUTING

Energy is the most valuable resource of which a significant portion is now consumed to supply power to computers and computing interfaces. High performance parallel and distributed systems which include data centers, super computers, real time systems and so on, requires high amount of power supplies and also needs air conditioning to keep them cool. The rapid growth in computing is very quickly increasing the consumption of natural resources like oil and coal which might effect in energy shortage. These issues have been raised by the researchers from time to time and the possible measures are being taken. Still there are many areas yet to be explored. Here we present some notable areas of research in green computing [8]:

A. New Optimization Techniques in Performance-Energy-Temperature Aware Computing:

The exponential growth in computing activity and the rising concern for energy conservation have made energy efficiency in computers a technological issue of prime importance [8]. The balance between Performance-Energy-Temperatures should be done so that we get maximum benefits. Designing techniques which are more favorable for green computing which include performance, energy and temperature and are most important for energy efficiency.

B. New high-efficiency data center:

Energy efficiency is much more accurate in bigger data centers as compared to the smaller data centers. Different standards are formed to measure the efficiency of data centers. Standards such as power usage Effectiveness (PUE) which is defined as the ration of total facility power divided by IT equipment power. It states the amount of power consumed by the facility which is used to power the IT equipment. Hence it is quiet challenging to make the bigger data centers power efficient [8].

C. Developing Green Maturity Model:

Full equipment life cycle is an important area for green maturity model, with energy reduction as the best measure of greenness. The need of maturity models for equipment, IT organizations, and computing techniques is an issue which has been addressed by some researchers but is limited to specific areas. Green maturity model for virtualization [10] depicts that each level describes the degree of green characteristics.

D. Information Resource Tier Optimization:

The information resource tier signifies database management systems in the global computation world. For example- databases, directories, file-systems, and flat files. It also consists the integration of different database structures so that different databases can be analyzed irrespective of their storing mechanisms and data structure [22, 23].

E. Wireless Sensor Network for Data Center Cooling:

Data center cooling is the major issue to be taken care of in power consumption. Data centers which are the backbone of computing organization must be reliable and available at any point of time, but measuring the effectives and maintaining the baseline is the major issue. In such a situation wireless sensors play a vital role in managing data centers power management[11].

F. Monitoring:

Frequent system failures have worried the need for quicker response to potential data center uptime threats. To help facility managers and IT personnel control these issues, more and more operators are turning to DCIM's real-time, alarming/alert engine—that offers visibility across all aspects of the data center.

III. GREEN CLOUD COMPUTING SOLUTIONS

Energy efficiency is the main factor which should be considered in data center planning and building phases. Some of the possible solutions are listed below:

A. Research and select the right energy supplier:

Selecting the most affordable energy supplier is the most important and a major decision for controlling and managing data centers energy consumption. Through research one can select the best supplier which can provide cleaner source of energy and ensure that the data center uses reliable, greener power that doesnot cost the nature [24].

B. Lowering the cooling costs by using outside air:

40% of energy costs accounts for the cooling of data centers. Using natural surroundings and reducing the impact of sunlight makes a big change in the heating of the data centers. For Example: Toronto data center in which PEER 1 uses a system activated by outside temperatures falling below 10 degrees Celsius. When these conditions occur, air is drawn into cool water from a local well that in turn cools IT equipment in the facility [24].

C. Adapting existing structures rather than re build:

Adapting the "reuse" approach for the construction of the data centersprovide many benefits. Steps for the reuse of the existing structures such as buildings will reduce the construction time and cost.If there are any functional or environmental reasons, then only these structures needs to be changed [24].

D. Planning space intelligently:

Planning the data center design guarantees the most effective use of space and minimizes the over utilization of power and cooling.

E. Building data center energy efficiency into procurement strategies:

Energy efficiency of the data centers can be increased by carefully selecting the purchase of IT equipment. Selecting the criteria as the part of the purchase process ensures better performance of hardware at technical as well as green level.

F. Dynamic Provisioning:

Reducing computing resource waste by more accurately and matching server capacity with demand. Faced with difficulties in accurately predicting demand, IT managers often over-allocate server, storage, and networking infrastructure. Cloud providers have more accurate and dedicated means for monitoring and predicting demand, allowing them to avoid unnecessary over-allocation of infrastructure for greater efficiency and sustainability. Efficient provisioning occurs on the client end as well: the pay-as-you-go nature of cloud computing, together with self-service, encourages clients to consume only what they need, with consumption turned off at expiration times.

IV. GREEN CLOUD COMPUTING INITIATIVES

A. Energy saving initiatives:

Computer devices are used in power saver mode to reduce the power consumption. This helps to save energy by turning off the equipment at the end of the working day or not being used.

B. Improved Data Center Cooling Methods:

This is done by improving the data center cooling configuration by eliminating extensive amount of energy leaks. Effective methods include raised floors to improve airflow, moving cooling systems closer to servers to concentrate cold air in the right place, exchanging hot and cool server passageway to improve airflow and use water-based air conditioning systems [3].

C. Storage Methods:

Storage drives are an important element of data center infrastructure. More energy is required to power these hard drives. This energy can be reduced by using large capacity drives and performing data center audits to eliminate redundancies in the system [3].

D. Efficient Server usage by Virtualization technique:

Usually, IT companies have been using many servers or data centers to do a specific task. These servers/data servers must be efficiently used. One of the mechanisms is load balancing which selects the optimum resource among several other resources. To perform these tasks, a single server can be used to power these virtual servers by making use of virtual software which dramatically reduces energy consumption [3].

E. Discover different sources of energy:

The efficient resource utilization leads to the growth of efficient methods. The renewable and natural energy sources are being used to power data. This helps to generates fewer CO2 emissions [3].

V. CONCLUSION

Green computing research challenges and solutions to these are discussed in this paper, which help us to reduce power consumption and the heat generated in processing. By unplugging the computer or using LCD and flash drives, it is possible to reduce energy consumption. Through more environment friendly usage and by using current lower power technologies, computers can be made more energy efficient. The computing industry is more prepared and far more competent than almost any other industry when it comes to facing and responding to rapid change. Environmentally it is not a good thing that most PCs, especially in companies have typically entered a landfill after only a few years in service. However, this reality does at least mean that a widespread mindset already exists for both adapting to and paying money for new computer hardware on a regular basis. Hence, whereas it took decades to get more energy efficient cars on the roads, it will hopefully only take a matter of years to reach a state of affairs where most computers are using far less power than they needlessly waste today.Technology is not a passive observer, but it is an active contributor in achieving the goals of Green Computing. IT industry is putting efforts in all its sectors to achieve Green computing. Equipment recycling, reduction of paper usage, virtualization, cloud computing, power management, Green manufacturing are the key initiatives towards Green computing. Current challenges to achieve Green Computing are enormous and the impact is on computing performance. Government regulations are pushing Vendors to act green; behave green; do green; go green; think green; use green and no doubt to reduce energy consumptions as well. All these efforts are still in limited areas and currently efforts are mainly to reduce energy consumption, e-Waste but the future of Green Computing will be depending on efficiency and Green products.

REFERENCES

[1] SonuChoudhary, "A Survey on Green Computing Techniques", Department of Computer Science, Acropolis Institute of Technology and Research Indore bypass road Mangliya square , SonuChoudhary / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (5) , 2014, 6248-6252

[2] Masood Anwar, Syed FurqanQadri and AhsanRazaSattar, "Green Computing and Energy Consumption Issues in the Modern Age", IOSR Journal of Computer Engineering (IOSR-JCE) e-ISSN: 2278-0661, p-ISSN: 2278-8727Volume 12, Issue 6 (Jul. - Aug. 2013), PP 91-98 www.iosrjournals.org www.iosrjournals.org 91.

[3] Prof. Gurpreet Singh and Er.Gurdeep Singh, "green computing initiatives for environmental issues", The 2015 WEI International Academic Conference Proceedings.

[4] Er. SukhdeepKaur, Er. Ritika ,Er. Meena Rani, "Comparative Analysis upon Energy Efficiency between Cloud Computing and Green Computing", Volume 4, Issue 9, September 2014 ISSN: 2277 128X International Journal of Advanced Research in Computer Science and Software Engineering.

[5] Zhiwu Liu, Ruhui Ma, Fanfu Zhou, Yindong Yang, Zhengwei Qi, Haibing Guan" Power-aware I/O-Intensive and CPU-Intensive Applications Hybrid Deployment within Virtualization Environments" IEEE 2010.

[6] The green grid consortium (2011).

[7] Anton Beloglazov, RajkumarBuyya, Young Choon Lee, Albert Zomaya, "A Taxonomy and Survey of Energy-Efficient data centers and cloud computing system", Advances in Computers, vol. 82.

[8] Aditya et al., International Journal of Advanced Research in Computer Science and Software Engineering 3(10), October – 2013

[9] http://www.intel.com/products/processor/core2duo/specifications.htm

[10] Ma Liangli; Chen Yanshen; Sun Yufei; Wu Qingyi, "Virtualization Maturity Reference Model for Green Software," Control Engineering and Communication Technology (ICCECT), 2012 International Conference on , vol., no., pp.573,576, 7-9 Dec. 2012

[11] Rodriguez, M.G.; Ortiz Uriarte, L.E.; Yi Jia; Yoshii, K.; Ross, R.; Beckman, P.H., "Wireless sensor network for data-center environmental monitoring," Sensing Technology (ICST), 2011 Fifth International Conference on , vol., no., pp.533,537, Nov. 28 2011-Dec. 1 2011

[12] Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.), "Global Greenhouse Gas Emissions Data by EPA – US Environmental Protection Agency ". IPCC (2014). Climate Change 2014: Mitigation of Climate Change .Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA].

[13] L. Qian, Z. Luo, Y. Du, L. Guo, Cloud computing: An overview, in Proceedings of 1st International Conference on Cloud Computing (Beijing, China, 2009), pp. 626–631

[14] SangeethaN.Dhamdhere , "Cloud computing and virtualization technologies in Libraries", A volume in Advances in Library and Information Science (ALIS) book series.

[15] R.Murugan, "Study of Compute Application Resources Sharing for Android with Cloud Computing", International Journal of Innovative Research in Computer and Communication Engineering.

[16] http://www.asigra.com/blog/cloud-types-private-public-and-hybrid.

[17] Judith Hurwitz, Robin Bloor, Marcia Kaufman, Fern Halper, "Comparing public, private, and hybrid cloud computing options", http://www.dummies.com/programming/networking/comparing-public-private-and-hybrid-cloud-computing-options/

[18] https://www.stratalux.com/blog/comparing-public-private-hybrid-clouds/

[19] https://en.wikipedia.org/wiki/Community_cloud

[20] https://www.stratalux.com/blog/comparing-public-private-hybrid-clouds/

[21] Aditi Mahajan[1], Anita Ganpati[2], "A Study of Energy Efficiency Techniques in Cloud Computing",International Journal of Computer Science and Mobile Computing, Vol.3 Issue.8.

[22] http://www.cra.org/ccc/files/docs/init/bigdatawhitepaper.pdf

[23] K. Michael and R. Clarke, ―Location and Tracking of Mobile Devices: Überveillance Stalks the Streets, Computer Law & Security Rev., vol. 29, 2013, pp. 216-228.

[24] http://www.computerweekly.com/feature/Improving-data-centre-power-consumption-and-efficiency