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ENERGY EFFICIENCY IN CLOUD COMPUTING: A REVIEW

Tejaswini K[1] H S Guruprasad[2]
[1]PG Scholar, Department of Computer Science & Engineering,
BMS College of Engineering, Bangalore, Karnataka, India
[2]Professor and Head, Department of Computer Science & Engineering,
B M S College of Engineering, Bangalore, Karnataka, India

ABSTRACT

Cloud computing is an emerging technology which provides metering based services to consumers. Cloud computing offers ITC based services and provide computing resources through virtualization over internet. Data center is heart of cloud computing which contains collection of servers on which Business information is stored and applications run. Data center (includes servers, network, cables, air conditioner etc.) consumes more power and releases huge amount of Carbon-di-oxide (CO2) to the environment. One of the most important challenge in cloud computing is optimization of energy utilization and hence have a green cloud computing. There are many techniques and algorithms used to minimize the energy consumption in cloud. Techniques include DVFS, VM Migration and VM Consolidation. Algorithms are Maximum Bin Packing, Power Expand Min-Max and Minimization Migrations, Highest Potential growth, Random Choice. The main goal of all these approaches is to optimize the energy utilization in cloud. This paper provides overview of literature survey on approaches to have energy efficient cloud.

KEYWORDS: *Cloud, Computing, Energy, Efficiency, Cloud Center, Energy Consumption, Data Center*

I. INTRODUCTION

Cloud computing can be defined as "A Technique for providing pay-as-you-use services and access to the shared resources over network based on consumer request with minimum management risk" [1]. Shared resources include servers, storage, applications, networks, software etc. all these resources are configurable on user demand. Now-a-days most of the business enterprisers and individual IT Companies are opting for cloud in order to share business information. Existing cloud service provider are Microsoft's Windows Azure, Amazon, IBM and Google. The main expectation of cloud service consumer is to have reliable, fast, available service. To satisfy consumer's expectation several Data centres are established all over the world and each Data center contains thousands of servers. Small amount of workload on server consumes 50% of the power supply. Energy consumption by the organizations that provide cloud service is increasing rapidly. After survey, it is concluded that the amount of energy consumed by the data centres is equal to 1.5 % of power supplied to an entire city [2].Cloud service providers ensure that reliable and load balancing services to the consumers around the world by keeping servers ON all the time. To satisfy this SLA provider has to supply power continuously to data centers leads to huge amount of energy utilization by the data center and simultaneously increases the cost of investment [3]. United States Environmental Protection Agency reported that Energy consumed by data center in United States was 100 billion KWh and energy cost will be 75% of the total operation cost in 2014 [4]. The growing technologies and social network applications like Facebook, twitter requires huge amount of storage intern requires several servers to storage the information and hence increases power supply leads to global warming and inconsistency in the atmosphere. The major challenge is utilization of energy efficiently and hence develops an eco-friendly cloud computing [5].

Computer Specialist analyzed that if energy consumption in data center increases ascending order drives to investment on energy cost more than infrastructure cost. More power is needed to cooling and this releases the CO_2 to the environment. In research, it is found that Energy consumed by the IBM Super computer is 20MW which is equal to energy consumed by the 22,000 US building [6]. Huge amount of energy has been wasted due to idle servers and resources in data center. NRDC in one of its report says that idle servers use 69-97 % of total energy in the presence of enabled power management function [7]. Energy also wasted when the server is overloaded. The focus of the study is to distribute jobs at overloaded server to other free server and OFF the idle server to optimize energy consumption. Few techniques such as load balancing, VM virtualization, VM migration, resource allocation and job scheduling etc. are used to solve above problem.

Though there are many techniques to optimize energy consumption in cloud, still there exists an issue regarding how to place the applications in a cloud to reduce energy utilization becomes an urgent problem. This paper presents over view of literature survey on methodologies to have Energy efficiency in cloud. The rest of the paper is organized as follows: Section 2 presents the Literature survey, section 3 presents the conclusion, Section 4 presents future work and the paper concludes with the acknowledgements and the references.

II. LITERATURE SURVEY

Tesfatsion et.al [9] proposed a management technique for datacenter where number of VMs, CPU frequency and number of Cores are all taken into consideration to improve the energy efficiency. Amount of power consumption by the system can be calculated by these management techniques and they calculate the power consumption as output for given inputs. A feedback controller is used to optimally configure the system for energy efficiency. Buyya et.al [10] presents challenges in cloud with respect to energy and cost while meeting SLAs. The paper focuses on the energy efficient management of data center resources for cloud. The paper discusses a) energy-efficient architectural principles for cloud management b) resource allocation and scheduling policies for energy efficient cloud considering QoS and characteristics of power usage by devices and c) novel software technology for cloud management. Cloudsim toolkit is used for simulation. Mueen Uddin et. al. [18] proposed a framework for large and complex server plantations to have energy efficiency and low CO_2 emission to the environment. The framework consists of five phases in order to implement green data centers for cloud. The paper divided datacenter resources into different pools and applies green metrics like PUE, data center efficiency on those resources to measure the performance of each resource individually and also uses virtualization technology for proper implementation of green IT data center.

Pinheiro et. al. [12] concentrated on the optimization of power utilization in heterogeneous computing nodes attending multiple applications. The paper focuses on workload and performance at the serving node. The nodes are switched and the idle nodes are turned off based on the load balancing to optimize the power utilization. Meenakshi Sharma et. al. [13] analyzed different VM load balancing algorithms and developed a new algorithm in VM to achieve better response time, cost and energy efficiency. The new load balancing algorithm finds the response time of the individual resources in the data center and sends ID of resource having low response time to the controller of data center to assign job to this resource and hence increases the performance. Cloudsim is used to implement this algorithm. Gaganpreet et. al. [17] proposes a power efficient technique for workload distribution to the servers by merging VMs using VM Live Migration. This technique uses dynamic wakeup call to off the servers or to restart the inactive servers to schedule the workload into the server by dynamically initiating the wakeup call to decrease the response time of the user and hence power. Live migration algorithm uses priorities of the VMs to migrate from one server to another server. Simulation has been done using MATLAB. Dzmitry Kliazovich et.al [35] proposed a scheduling solution called e-STAB to produce green cloud. The solution provides energy-aware job allocation and traffic load balancing in data center network. The traffic load balancing scheduler will improve energy consumption and QoS of application by reducing the waiting time of packets in the traffic and loss of packets in the traffic. The experiment is done using GreenCloud simulator to determine the efficiency of the proposed scheduling solution.

Sukhpal Singh et. al. [20] proposed an energy efficient resource scheduling framework and an algorithm that includes interaction between various components of data center and its performance. The paper proposes a) architectural principals for cloud management and b) resource allocation and scheduling

strategies considering QoS to have energy efficient data center. Architectural policies are verified and implemented using Z specification language. Cloudsim toolkit is used to estimate the performance of the datacentre. Altino M. Sampaio et.al [24] presented two dynamic scheduling algorithms a) Cloud Manager Algorithm and b) POwer and Failure-Aware Relaxed time (POFARE) algorithm to make maximum utilization of resources in the virtual cluster when individual nodes in virtual cluster is subjected to failure. The first algorithm helps to reserves maximum resources required for task execution. The second algorithm tries to utilize minimum resources for task execution by considering the parameters required for the task to execute. These algorithms dynamically construct virtual clusters and dynamically readjust virtual clusters for consumer's task execution. Chia-Ming Wu et.al [25] presented a scheduling algorithm using dynamic DVFS technique for data center to increase resource utilization and hence decreasing the energy consumption for task execution. Job scheduling is done according to job priority to select the VMs for its execution which is selected based on the weight computed. DVFS controls the voltage and frequency supply to the servers and can reduces the energy utilization while the servers are in idle state or light workload state. Experiment results shows that this algorithm is better in reducing energy utilization when compared with existing scheduling algorithms. Altino M. Sampaio et.al [33] presented a consolidation technique for energy aware and reliability aware scheduling algorithm. The paper presented an energy optimization mechanism to detect opportunities to minimize energy and readjust virtual to physical mapping by executing power-aware and failure-aware decision making algorithms. The paper implemented sliding window condition detection mechanism with its parameter to improve energy and fault-tolerance.

Shailesh et.al [21] presented a job scheduling and job allocation scheme to minimize the number of resources or hosts used and hence saving energy. The paper enhanced the strategy of EESAS with EASY Backfilling FCFS to reduce the users waiting time and hence increase in performance. This algorithm uses Power ON VMs and Migrating VMs based on consumer request and their experiment compares EESAS with EESAS with EASY Backfilling FCFS techniques and proved EESAS with EASY Backfilling FCFS is better than EESAS. Ching-Hsien Hsu et.al [28] proposed an Energy aware Task Consolidation model (ETC) which restricts the CPU utilization by the task to a below specific peak threshold. This is done by consolidating tasks among virtual clusters to reduce the energy consumption and this model also considers network latency during task migration from one virtual cluster to another. ETC is applied on Virtual clusters and VMs in the same racks or on the rack where network bandwidth is constant in data center and the idle state VMs also considered. Performance of ETC is compared with MaxUtil which is a greedy algorithm used to maximize cloud resources and concludes that power consumption is less over MaxUtil. Xiaobo Cai et.al [30] proposed Energy-aware QoS (E-Q) model to minimize the energy utilization while meeting performance considering specified QoS. This model proposed a deployment of jobs/Tasks algorithm to allow physical resources to satisfy the performance requirement by the set of jobs to minimize the energy consumption in cloud. The E-Q model describes the data centers energy consumption and QoS levels and it can be applied to large scale virtualized data center infrastructures. Wenhong Tian et.al [31] proposed Dynamic Bipartition-First-Fit (BFF) algorithm to overcome the scheduling problem of allocation of parallel jobs on multiple machines. The main aim of this algorithm is to minimize the total busy time of online real-time scheduling of all identical machines in some condition for heterogeneous machines. The job request contains start-time, end-time, processing time and capacity demand for its processing. Online scheduling these jobs to virtual machines is done using BFF algorithm to optimize energy consumption. Sina Esfandiarpoor et.al [8] proposed a technique of Consolidating VMs based on cooling and network structures so that best utilization of servers and racks in datacenter and hence reduce the utilization of energy in datacenters. Online assignment of VMs to physical machines in the racks based on the resource availability is done to increase the CPU utilization of servers. This can be achieved through Live Migration mechanism of VMs. Hence power consumption in the cloud datacenter can be minimized. Nakku Kima et.al [26] developed a model to calculate energy consumed by each virtual machine based on in-processor procedures produced by it without any dedicated measurement devices. The paper also proposed a power-aware scheduling algorithm which allocates computing resources to the users request based on the energy consumption measurement obtained using above mentioned model. The proposed scheduling scheme is implemented using Xen virtualization system and evaluation showed that 5% of energy can be saved using this scheduling. Peng Xiao et. al. [27] presented an energy

efficient VM scheduling policy to prevent energy loss due to I/O virtualization. The paper proposes a Share-Reclaiming with Collective I/O (SRC-I/O) policy which enables the VMs to share their CPU in certain cases to increase CPU utilization and hence reduce energy consumption. This separates I/O intensive VMs from CPU intensive VMs and experiment showed that system with SRC-I/O scheduler performs well when compared with existing scheduler algorithms. Jian Cao et.al [32] presented a power-aware VM allocation approach based on demand forecast. This approach consists of following steps: a) using Holt-Winters exponential smoothing method to forecast all demands of next period b) using knapsack algorithm, find the appropriate allocation between VMs and hosts c) parameters in Holt-Winters model are updated using self-optimizing module and the same module determines the reasonable forecast frequency. Experimentation is done using Cloudsim simulator and result shows that the proposed approach can reduce energy during switching off/on of hosts compared to other approaches.

Kim et. al. [11] presented a problem of resource allocation in virtualized server infrastructure leading to more energy consumption. They proposed a model to optimize the energy utilization; the model predicts performance deprivation of service when current service is joined with other services. Along with energy optimization, the paper also proposes performance aware resource allocation. This model uses response time, CPU utilization as performance metrics and round robin (RR) process scheduler. Abbas Horri et.al [23] proposed a QoS aware novel resource allocation algorithm using VM consolidation technique by using resource utilization history of VM. The proposed algorithm involves four steps a) identify which hosts are overloaded b) select VMs from overloaded hosts c) identify hosts which are under loaded and select VMS from those hosts for migration and d) determine new placement for VMs. This technique uses Cloudsim simulator for implementation and evaluation of this algorithm. Chaima Ghribi et.al [15] implemented VM allocation and Migration algorithms that together minimize the energy utilization and migration cost. They used linear numerical program analogous to exact allocation together with VM migration algorithm to save energy via consolidation which is better than best fit algorithm.

Yanwen Xiao et.al [14] proposed an energy efficient dynamic data placement algorithm to solve data placement problems in cloud and two optimized batch scheduling algorithms to save energy while scheduling nodes. Batch scheduling algorithms makes use of dynamic data placement algorithm and it also solves time-constraints and power-constraints problems successfully. Cloudsim toolkit is used for simulation. Mueen Uddin et.al [16] explores metrics to measure of a data center to have a green cloud computing. Metrics are related to PUE for measuring performance and data center efficiency to reduce global worming effects. This paper identified and implemented these green metrics in one of the tier level of data center. Efficiency of data center is observed by measuring PUE metrics time to time to have an exact knowledge about metrics role in power utilization. Nader Nada et. al. [19] contributed an overview of literature survey on different energy efficient frameworks and literature survey on different metrics to have energy efficient cloud. The paper also explains about importance of identifying and implementing various matrices that place a vital role in improving performance of data centre. The paper also explains when and where to use different frameworks to have green cloud. The paper recommended FVER instead of PUE as a better metrics for measuring datacentre efficiency.

Manjot Kaur et.al [22] presented an energy efficient model for cloud to keep track of how much level of atmosphere is getting polluted due to the emission of various gases like CO_2, CO etc (Greenhouse gases) by the various data centers and also identifying the amount of greenhouse gases in atmosphere due to data centers. This helps to implement different energy efficient cloud framework. The paper also presents amount of energy consumed at various levels and various components of datacenter. Carlos de Alfonso et.al [29] proposed cost models to compare physical and cloud clusters on cloud to know the energy efficient viable clusters on cloud based on total-cost of ownership (TCO). Comparison using these models results that cloud clusters are economically viable for organization with high usage rate when compared with physical clusters and these are best option for organizations and start-ups with respect to computational requirements. Sarbjeet Kaur et.al [34] proposed an energy efficient minimum CPU utilization algorithm to optimize energy consumption in cloud data center. This algorithm selects VM which utilizes minimum CPU for migration based on minimum CPU Utilization selection policy and will reduce number of VMs to be migrated and dynamically reallocation of VMs and switching off

idle VMs. The experiment is conducted using CloudSim simulator, result shows that this algorithm can reduce better energy when compared with other approaches.

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III. CONCLUSIONS

As the relevance and importance of Cloud Computing is continuously increasing, the importance of Energy efficiency in Cloud Computing is increasing parallely. This paper discusses the various methodologies and techniques of energy efficiency in Cloud Computing which is the cutting edge of research today.

IV. FUTURE WORK

The research work is being carried out on VM Migration Techniques for energy conservation in the cloud. The VM consolidation and dynamic resource management algorithms are being researched for the optimization of energy in the cloud.

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AUTHORS BIOGRAPHIES

Tejasvini K is currently pursuing her Master's degree in Computer Science and Engineering at BMS College of Engineering, Bengaluru, India. Her areas of interest are energy and power efficiency of cloud computing. She holds her Bachelor's degree in Computer Science and Engineering from Visvesvaraya Technological University, Belgaum, India.

H S Guruprasad holds Ph.D. in Computer Science. He is working as Professor and Head in the Department of Computer Science Engineering at BMS College of Engineering, Bangalore, India. He has over two decades experience in teaching field. His research interests include Networks and Communication, Cloud Computing and Sensor Networks.