EnerPro: Energy Proficiency Platform in Cloud Environment

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ABSTRACT

Cloud computing is an information technology (IT) paradigm, where computing is served as a utility. It is distributed computing where computing, storage and software are being offered as a service and uses the internet technologies for delivery of IT services to any needed users. Due to the emergence of cloud computing, large data centers came into existence. The data centers become over provisioned i.e. they are highly inefficient at delivering IT services. This faces tremendous energy consumption, carbon dioxide emission and also saving the cost associated with it. So the energy consumption is becoming the key issue for IT organizations nowadays. This is necessary for data centers and providers to produce lesser amount of heat that reduce the total of energy consumed and thereby saving the cost. Energy consumption becomes primary concern to the widespread development of cloud data centers. High energy consumption leads to one of the major cause for the global warming (i.e. high heat dissipation and CO_2 emission) that will affect the environment directly or indirectly. Thus, various algorithms are introduced by the different authors to reduce the energy consumption. This research paper presented a review on the already existing methods and algorithms for solving the problem of high energy consumption.

Keywords: Resource Allocation, Energy Efficiency, Cloud Computing, Virtualization, Virtual Machine Placement,Green Computing

INTRODUCTION

Cloud computing is where cloud services are available to cloud consumers and resources are controlled by the cloud providers. Two main actors are there in the cloud computing environment providers and consumers[1]. The party which offers cloud based IT resource is the cloud provider. They normally own the IT resources that are made available on demand to the user as needed. The party that uses the cloud based IT resources is the cloud consumer. A cloud service is any IT resource that is made accessible via a cloud.

Process of allocating resources like computing processes, storage resources, nodes and virtual machines to applications in cloud computing environment is called Resource Management. Therefore, the resource provisioning is crucial to the capacity of assigning services to manage the variations of the availability of these services in cloud environment. The resource allocation techniques are categorized into two categories which includes strategic based and parametric based resource allocation. Detailed classification of allocation of resources is presented in Figure1.*Strategic based resource allocation*s are further classified on the basis of technique's

behavior and environment whereas *Parametric based resource allocation* is grouped on the basis of the parameters into six divergent groups.

Through the advent of cloud computing, enormous data centers came into existence[2]. The capacity of data centers become over provisioned i.e. they are not efficiently delivering IT services. This faces tremendous energy consumption, carbon dioxide emission and also saving the cost associated with it. So the energy consumption is becoming the key concern for IT organizations nowadays. Large amount of energy consumption leads to one of the cause of global warming i.e. high heat loss and CO_2 emission. It is because of dynamic nature of resources in cloud that it becomes a large scale optimization problem.

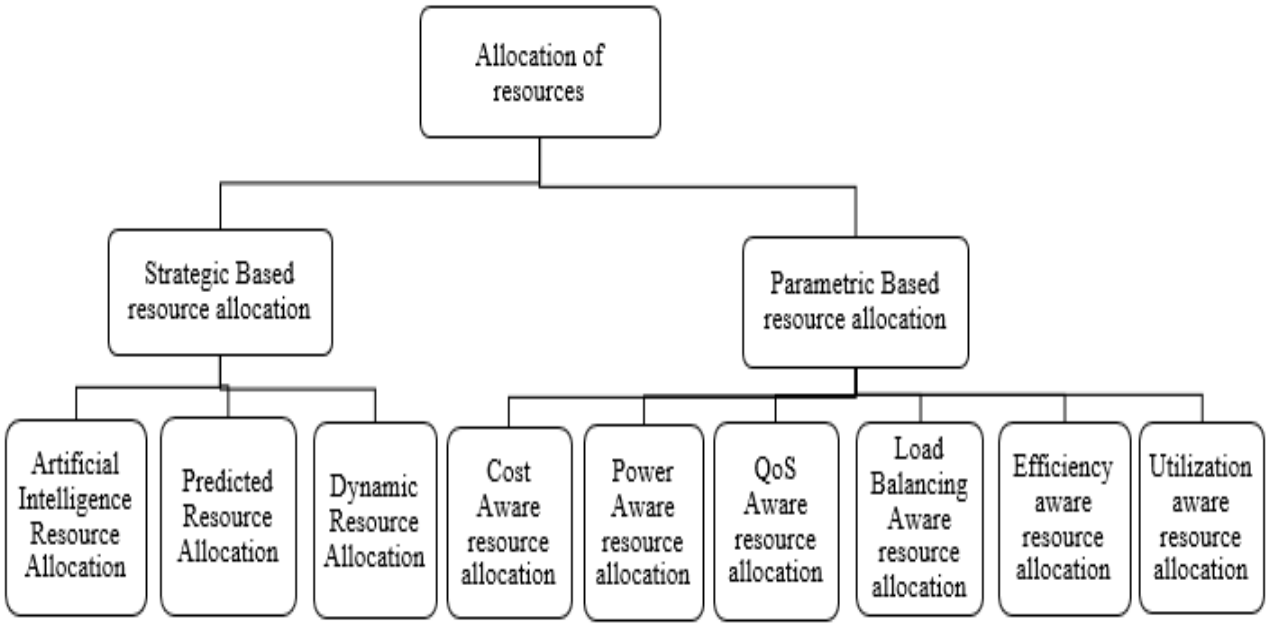

Figure.1. Categorization of allocation of resources in cloud computing

Energy-aware resource allocation comes under the power aware resource allocation which comes under the parametric based resource allocation. To reduce the measure of energy consumed and heat generated in the data centers, it concentrates on green computing. These techniques achieve success in countering the emanating complications of the heat production and energy used up in the data centers. This is necessary for the data centers and providers to produce lesser amount of heat that reduce the total of energy consumed and thereby saving the cost. Because of the increasing growth of data center, the increasing dissipation of idle power become considerable causes of heat and energy inadequacy[3]. Green computing is used for efficient utilization of resources by decreasing the amount of heat generated and energy exhausted in data center[4]. Many researchers proposed different algorithms, models and techniques to allocate resources in such a manner that the allocation should minimize the amount of heat generated and diminish the

energy utilization in cloud data centers. Resources are allocated to the cloud consumers so that they should be effectively and efficiently utilized.

The introduction part is followed by the various sections: Section II reviews the work already done to cut the volume of energy consumed. Section III provides details of existing algorithms for energy- aware resource allocation. Analysis of the existing algorithms for resource allocation is done and comparisons are presented in Section IV. In the end Section V concludes the paper with brief summary.

RELATED WORK

Inefficient utilization of resources is primary issue to attain energy efficacy in cloud environment. Furthermore because of the dynamic and heterogeneous nature of resources in cloud, it becomes a large scale optimization problem.

- Gao et al[5] have anticipated an algorithm to solve the problem of VM placement.
- Dashti et al.[6] uses Particle Swarm Optimisation (PSO) algorithm for reassigning the migrated virtual machines in the overloaded host for improving allocation of resources and acquire more benefit in the data center. It assures reduced response time and QoS (SLA) for more energy efficacy, by proposing an innovative heuristic method for balancing the cloud provider's overload by dynamic resource re-allocation.
- Kansal and Chana[7] proposed an ERU model for managing the resources to enhance utilization efficiently. The main goal of the proposed model is declining energy consumption of data centers without degrading practical efficiency of users' application. A technique based on Artificial Bee Colony meta-heuristic is suggested to detect suitable job-node pair which attempts to increase the energy efficacy by the efficient resource utilization. This model minimizes utilization of energy and CO_2 emission which leads to the need of green computing.
- Pavithra and Ranjana [8] have proposed a weighted first-come-first-served (WFCFS) algorithm to develop framework for energy efficient resource provisioning with dynamic placement of VM using energy-efficient load balancer in cloud. The CloudSim is used to perform the simulation and the simulation results show the improved performance by decreasing the energy consumed, execution time and reduced cost in comparison with the static environment.

EXISTING ALGORITHMS FOR ENERGY-AWARE RESOURCE ALLOCATION

The data centers, in order to curb the demand for the exponentially growing computational power and storage problem, have come up with high speed data servers and equally reliable storage services[9]. This in turn demands increased power consumption and the judicious use of this energy consumption is equally viable and demanding[10].To reduce the energy consumption various algorithms are introduced. Different energy-aware resource allocation algorithms are presented as (Figure 2):

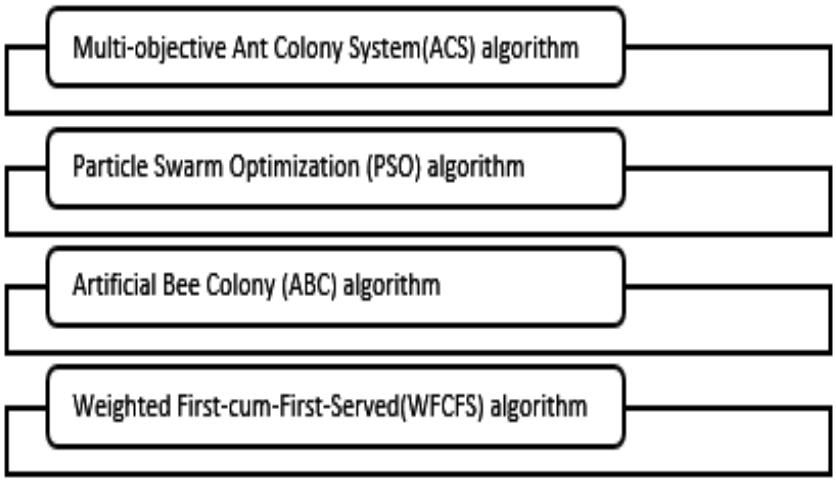

Figure2: Energy-aware resource allocation algorithms

A. Multi-Objective ACS_Ant Colony System Algorithm

The issue of virtual machine assignment through server nodes is solved by a multi-objective ant colony system (ACS) algorithm. It is an improved edition of ACS algorithm and mainly based on an ACS (Ant colony system).This algorithm aims to enhance entire consumption of power and wastage of resources at the same time. This algorithm minimizes both power consumption and resource wastage. The algorithm is implemented in the following phases: in an introductory level, all factors are given. Each ant receives virtual machine requests, hosts server and starts allocating virtual machines to hosts. A local pheromone update is performed once an ant has built a movement. After all ants have constructed their solutions, a global update is performed.

B. PSO_Particle Swarm Optimisation Algorithm

The issue of virtual machine assignment through server nodes is solved by a multi-objective ant colony system (ACS) algorithm. It is an improved edition of ACS algorithm and mainly based on an ACS (Ant colony system).This algorithm aims to enhance entire consumption of power and wastage of resources at the same time. This algorithm minimizes both power consumption and resource wastage. The algorithm is implemented in the following phases: in an introductory level, all factors are given. Each ant receives virtual machine requests, hosts server and starts allocating virtual machines to hosts. A local pheromone update is performed once an ant has built a movement. After all ants have constructed their solutions, a global update is performed.

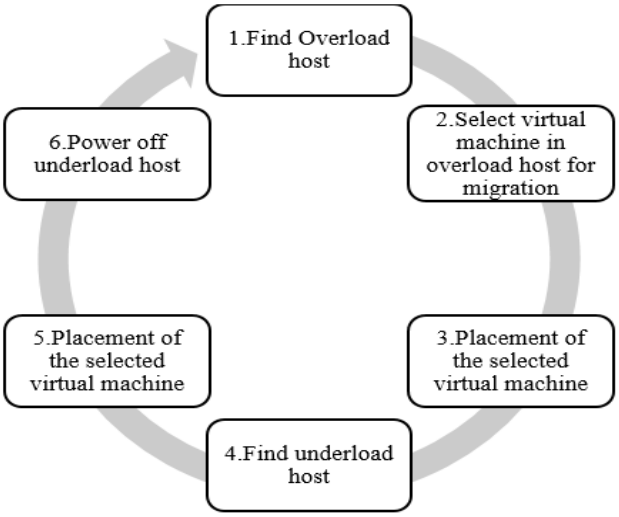

Figure3: Phases of PSO algorithm

C. ABC Algorithm_Artificial Bee Colony

Artificial bee colony algorithm was proposed by Dervis Karaboga in the year 2005 and is a swarm intelligence-based optimization algorithm. The ABC meta-heuristic based energy-aware resource utilization technique is proposed for detecting the suitable task-node pair. The proposed method aims to increase the energy efficacy by efficient and effective use of resources. This can help organizations in increasing satisfaction of customers and by reducing EC leads to the need of green computing and hence results in reduction of CO_2 emission. The main goal of the model is declining energy consumption of data centers without degrading practical efficiency of users' application.

According to the user requirements, the providers of cloud provide access to the resources which are required by the users. This is accomplished in such a manner that resource consumption should be maximum, thereby increasing the energy efficacy and performance of the data center in clouds. The main goal is that the resources should be efficiently and effectively scheduled.

D. Weighted FCFS_First-cum-First-served

Weighted First-cum-First-Served (FCFS) is example of energy aware load balancing algorithm in which the main aim is to minimize consumption of power, processing cost and execution time. It is suitable for dynamic environments. The main purpose of load balancing algorithm is to maximize throughput, avoid overload and delay. In weighted First-cum-First-Served (FCFS) method, in view of the quantity of tasks on which it requests, each task is assigned a weight. First the tasks are embedded into the line in the request of entry time. Then they are arranged according to the ascending order of their weight. It is used in VM allocation according to the weight. Thus, the workload is shifted from overloaded servers to under-loaded servers with the help of load balancing, thereby enhancing the utilization of resources[8][12].

COMPARATIVE ANALYSIS OF ENERGY-AWARE RESOURCE ALLOCATION ALGORITHMS

This section presents a brief summary and comparison of work that has been by researchers in this field. It can be seen that the work based on energy consumption is recent and uses latest techniques and algorithms for its reduction. Table 1 presents a several algorithms that deals with the energy consumption in cloud environment. The table provides a general overview of energy-aware resource allocation schemes in the cloud computing technologies based on the area of study, limitations, techniques and technologies that restrict the overexploitation of resources to enhance the energy efficiency.

TABLE I
COMPARATIVE ANALYSIS OF ENERGY-AWARE RESOURCE ALLOCATION ALGORITHMS

Algorithm	**Multi-objective ant colony system(ACS) algorithm**	**Particle Swarm Optimisation (PSO)**	**Artificial Bee Colony (ABC)**	**Weighted First-Cum-First-Served (WFCFS)**
Year	2013	2016	2015	2016
Objective	To efficiently minimize loss of resources and power utilization	To enhance the energy efficacy and users' QoS(SLA)	To minimize the amount of energy consumed in clouds	To develop framework for energy efficient resource provisioning with dynamic placement of virtual machines using energy aware load balancer in cloud
Focus of study	VM Placement	VM Replacement	Energy Consumption	VM Placement
Results	Performance is better	Improve the Performance	Minimize energy consumption and execution time	Resource Utilization is improved
Limitations	Considers only parameters of providers of cloud	Only traditional algorithm is compared	Does not consider workload of nodes	Comparison with existing algorithms is not done

CONCLUSION

In this paper, various energy-aware resource allocation algorithms named multi-objective ant colony system algorithm, Particle Swarm Optimization, Artificial Bee Colony and Weighted First-Cum-First-Served (FCFS) have been proposed as well as analyzed. Further, these

algorithms are compared on the basis of different parameters. Multi-objective ACS, PSO and Weighted FCFS focuses on VM placement problem while Artificial Bee colony Algorithm is used for energy consumption. The aim of these algorithms is to efficiently allocate the resources so that it should diminish the volume of energy exhausted in cloud environment. It also provides limitations of various energy-aware resource allocation algorithms.

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