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An Energy Aware Resource Utilization Framework to Control Traffic in Cloud Network and Overloads

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ABSTRACT

Energy consumption in cloud computing occur due to the unreasonable way in which tasks are scheduled. So energy aware task scheduling is a major concern in cloud computing as energy consumption results into significant waste of energy, reduce the profit margin and also high carbon emissions which is not environmentally sustainable. Hence, energy efficient task scheduling solutions are required to attain variable resource management, live migration, minimal virtual machine design, overall system efficiency, reduction in operating costs, increasing system reliability, and prompting environmental protection with minimal performance overhead. This paper provides a comprehensive overview of the energy efficient techniques and approaches and proposes the energy aware resource utilization framework to control traffic in cloud networks and overloads.

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1. INTRODUCTION

Cloud is collection of interconnected virtualized dynamically provisioned on demand computing resources based on pay-as-you-go model [1]. The energy consumption and resource utilization are coupled as high energy consumption in cloud is due to the low utilization of computing resources as compare to efficient utilization of computing resources. As per the studies, the average resource utilization in most of the data centers is lower than 30% [2], and the energy consumption of idle resources is more than 70% of peak energy [3]. This massive energy consumption causes significant CO2 emissions, as many data centers are backed by "brown" powerplants.

Cloud data centers are electricity guzzlers especially if resources are permanently switched on even if they are not used. An idle server consumes about 70% of its peak power [4]. This waste of idle power is considered as a major cause of energy inefficiency.

This paper makes a study on taske scheduling policies for energy efficiency and propose an energy aware task scheduling algorithm based on cache memory and broadcasting.

Rest of the paper is organized as follows. Section 2 investigates previous research in energy aware techniques. Section 3 presents a novel energy aware resource utilization framework to control traffic in cloud networks and overloads. Finally, Section 4 concludes the paper.

2. STUDY OF PREVIOUS ENERGY AWARE TECHNIQUES

Table 1 represents the study of previous energy aware techniques.

Table 1. Survey of previous energy aware techniques

Technique	Noteworthy points	Performance metrics	Environment	Results
Efficient resource management for cloud computing environments [5]	Proposed energy efficient scheduling, VM system image, and image management components that explore new ways to conserve power.	Variable resource management, live migration, and minimal virtual machine design, overall system efficiency	Open Nebulla	
Energy based Efficient Resource Scheduling: A Step Towards Green Computing [6]	Proposed an architectural principle for energy efficient management of Clouds, energy efficient resource allocation strategies and scheduling algorithm considering Quality of Service (QoS) outlooks.	QoS	CloudSim	Results show that this approach is effective in minimizing the cost and energy consumption of cloud applications thus moving towards the achievement of Green Clouds.
Energy Efficient Scheduling of HPC Applications in Cloud Computing Environments [7]	Proposed a near-optimal scheduling policy that exploits heterogeneity across multiple data centers for a Cloud provider. Also examined how a Cloud provider can achieve optimal energy sustainability of running HPC workloads across its entire Cloud infrastructure.	Energy cost, carbon emission rate, workload, CPU power efficiency, architectural design, management system.		Results show achievement of on average up to 30% of energy savings in comparison to profit based scheduling policies leading to higher profit and less carbon emissions.
Energy-Efficient Management of Data Center Resources for Cloud Computing: A Vision, Architectural Elements, and Open Challenges [8]	Proposed (a) architectural principles for energy-efficient management of Clouds; (b) energy-efficient resource allocation policies and scheduling algorithms considering quality-of-service expectations, and devices power usage characteristics; and (c) a novel software technology for energy-efficient management of Clouds.	Energy consumption, SLA violation	CloudSim	Results show that energy consumption can be significantly reduced relatively to NPA and DVFS policies – by 77% and 53% respectively with 5.4% of SLA violations
Multi-Objective Approach for Energy-Aware Workflow Scheduling in cloud computing Environments[9]	This technique allows processors to operate in different voltage supply levels by sacrificing clock frequencies. This multiple voltage involves a compromise between the quality of schedules and energy.	Workflow execution time minimization without considering the users' budget constraint.	CloudSim	Results on synthetic and real-world scientific applications highlight the robust performance
Efficient Optimal Algorithm of Task Scheduling in Cloud Computing Environment[10]	Proposed generalized priority algorithm for efficient execution of task and comparison with FCFS and Round Robin Scheduling..	Execution time	CloudSim	
Energy-Efficient Multi-Job Scheduling Model for Cloud Computing and its Genetic Algorithm[11]	This paper mainly focuses on how to improve the energy efficiency of servers through appropriate scheduling strategies.	Energy consumption	Hadoop Mapreduce	
An Energy and Deadline Aware Resource Provisioning, Scheduling and Optimization Framework for Cloud Systems [12]	In this paper, the problem of global operation optimization in cloud computing is considered from the perspective of the cloud service provider (CSP) to provide a versatile scheduling and optimization framework that aims to simultaneously maximize energy efficiency and meet all user deadlines, which is also powerful enough to handle multi-user large scale workloads in large scale cloud platforms.	Operation costs	Monte Carlo simulations	Results show that when GMaP is deployed for the CSP, global energy consumption costs improves by over 23% when servicing 30 - 50 users, and over 16% when servicing 60 - 100 users.
A Resource Scheduling Algorithm of Cloud Computing based on Energy Efficient Optimization Methods[13]	Proposed a dynamic resource scheduling algorithm based on energy optimization of CPU, main memory and storage.	Execution speed, energy optimization	Eucalyptus, Hadoop,	Results show that, for jobs that not fully utilized the hardware environment, using algorithm can significantly reduce energy consumption

Technique	Noteworthy points	Performance metrics	Environment	Results
A bio inspired Energy Aware Multi objective Chiropteran Algorithm (EAMOCA) for hybrid cloud computing Environment [14]	Chiropteran Algorithm (EAMOCA) is developed by bringing together the echo localization and hibernation properties for scheduling resources as well as conserving energy.	Energy conservation, SLA violation CPU performance, VM migration	Private cloud	Resuls show promotion of energy salvation in cloud environment in a well delineated manner.
A Cooperative Two-Tier Energy-Aware Scheduling for Real-Time Tasks in Computing Clouds [15]	Proposed a cooperative two-tier energy aware scheduling technique to establish a constructive cooperation between the schedulers of a broker and its hosts in order to reach an optimal scheduling in terms of power consumptions and turnaround time.	Power consumption, turnaround time.	CloudSim	Results show that the proposed task scheduling approach not only reduces the total energy consumption of a cloud by 41%, but also has profound impacts on turnaround times of real-time tasks by 85%.
A green energy efficient scheduling algorithm using the DVFS technique for cloud datacenters [16]	Proposed a scheduling algorithm for the cloud datacenter with a dynamic voltage frequency scaling technique.	Resource utilization; energy consumption		
A Parallel Bi-objective Hybrid Metaheuristic for Energy-aware Scheduling for Cloud Computing Systems [17]	Investigated the precedence-constrained parallel applications particularly on high-performance computing systems like cloud computing infrastructures for minimizing completion time without paying much attention to energy consumption.	Makespan, energy consumption.	ParadisEO	Results show clearly the superior performance of ECS over the other algorithms like DBUS and HEFT
Adaptive energy efficient scheduling for real time tasks on DVS enabled heterogeneous clusters [18]	To address energy efficiency and power consumption cost proposed a novel scheduling strategy – adaptive energy-efficient scheduling or AEES. The AEES scheme aims to adaptively adjust voltages according to the workload conditions of a cluster, thereby making the best trade-offs between energy conservation and schedulability.	Power electricity cost, system reliability. Adaptivity		Results show that AEES significantly improves the scheduling quality of MELV, MEHV and MEG.
An Energy Aware Framework for Virtual Machine Placement in Cloud Federated Data Centres [19]	To lower the power consumption while fulfilling performance requirements proposed a flexible and energy-aware framework for the (re)allocation of virtual machines in a data centre.	Energy and CO2 emissions	FIT4Green project	Results show that the presented approach is capable of saving both a significant amount of energy and CO2 emissions in a real world scenario on average 18%within test case.
An Energy Efficient Task Scheduling Algorithm in DVFS enabled Cloud Environment [20]	Proposed a DVFS-enabled energy-efficient workflow task scheduling algorithm DEWTS in order to obtain more energy reduction as well as maintain the quality of service by meeting the deadlines.	Energy consumption ratio (ECR), system resource utilization ratio, average execution time, energy saving ratio.	CloudSim	Results show that DEWTS can reduce the total power consumption by up to 46.5 % for various parallel applications as well as balance the scheduling performance.
An Energy-Saving Task Scheduling Strategy Based on Vacation Queuing Theory in Cloud Computing [21]	In this the average sojourn time of tasks and the average power of compute nodes in the heterogeneous cloud computing system under steady state is analyzed. Next, based on the busy period and busy cycle under steady state, the expectations of task sojourn time and energy consumption of compute nodes in the heterogeneous cloud computing system is analyzed and energy consumption is reduced.	Energy consumption	Matlab	Results show that the proposed algorithm can reduce the energy consumption of the cloud computing system effectively while meeting the task performance.
A novel energy-efficient resource allocation algorithm based on.	The objective of this paper is to optimize resource allocation using an improved clonal selection algorithm (ICSA) based on makespan optimization and energy	Makespan, energy consumption	CloudSim	

Technique	Noteworthy points	Performance metrics	Environment	Results
immune clonal optimization for green cloud computing, [22]	consumption models in cloud computing environment.			
A new energy-aware task scheduling method for data-intensive applications in the cloud [23]	In this method, first, the datasets and tasks are modeled as a binary tree by a data correlation clustering algorithm, in which both the data correlations generated from the initial datasets and that from the intermediate datasets have been considered. Hence, the amount of global data transmission can be reduced greatly, which are beneficial to the reduction of SLA violation rate. Second, a "Tree-to-Tree" task scheduling approach based on the calculation of Task Requirement Degree (TRD) is proposed, which can improve energy efficiency of the whole cloud system by reducing the number of active machines, decreasing the global time consumption on data transmission, and optimizing the utilization of its computing resources and network bandwidth	Network bandwidth, resource utilization		Results show that the power consumption of the cloud system can be reduced efficiently while maintaining a low-level SLA violation rate.
DENS: data center energy efficient network aware scheduling [24]	This work underlines the role of communication fabric in data center energy consumption and presents a scheduling approach that combines energy efficiency and network awareness, named DENS to balance the energy consumption of a data center, individual job performance, and traffic demands. The proposed approach optimizes the tradeoff between job consolidation and distribution of traffic patterns.	Energy efficiency and network awareness individual job performance, and traffic demands	CloudSim	
A novel virtual machine deployment algorithm with energy efficiency in cloud computing [25]	To improve the energy efficiency of large-scale data centers, TESA is firstly proposed. Then based on the TESA, five kinds of VM selection policies are presented. Considering energy efficiency, the MIMT is chosen as the representative policy to make comparison with other algorithms.	Energy efficiency	CloudSim	Results show that, as compared with single threshold (ST) algorithm and minimization of migrations (MM) algorithm, MIMT significantly improves the energy efficiency in data centers.
Energy efficient scheduling of virtual machines in cloud with deadline constraint [26]	Proposed an energy efficient scheduling algorithm, EEVS, of VMs in cloud considering the deadline constraint, and EEVS can support DVFS well. A novel conclusion is conducted that there exists optimal frequency for a PM to process certain VM, based on which the notion of optimal performance–power ratio is defined to weight the homogeneous PMs.	Power ratio	CloudSim	Results show that proposed scheduling algorithm achieves over 20% reduction of energy and 8% increase of processing capacity in the best cases
Energy Efficient VM Scheduling for Cloud Data Centers: Exact Allocation and Migration Algorithms [27]	Presented two exact algorithms for energy efficient scheduling of virtual machines (VMs) in cloud data centers. Modeling of energy aware allocation and consolidation to minimize overall energy consumption leads to the combination of an optimal allocation algorithm with a consolidation algorithm relying on migration of VMs at service departures. The optimal allocation	Migration cost, power consumption	OpenNebula, OpenStack	Results show the benefits of combining the allocation and migration algorithms and demonstrate their ability to achieve significant energy savings while maintaining feasible convergence times when compared with the best fit heuristic.

Technique	Noteworthy points	Performance metrics	Environment	Results
	algorithm is solved as a bin packing problem with a minimum power consumption objective.			
Energy Efficient Utilization of Resources in Cloud Computing Systems [28]	In this paper, two energy-conscious task consolidation heuristics are presented. These heuristics maximizes the resource utilization and explicitly takes into account both active and idle energy consumption. It assigns each task to the resource on which the energy consumption for executing the task is explicitly or implicitly minimized without the performance degradation of that task.	Energy consumption, resource utilization		The results in this study should not have only a direct impact on the reduction of electricity bills of cloud infrastructure providers, but also imply possible savings (with better resource provisioning) in other operational costs (e.g., rent for floorspace).
EnergyAware Genetic Algorithms for Task Scheduling in Cloud Computing [29]	In this paper independent tasks scheduling in cloud computing as a biobjective minimization problem is considered with makespan and energy consumption as the scheduling criteria. Dynamic Voltage Scaling (DVS) is used to minimize energy consumption and to propose two algorithms to find the right compromise between make span and energy consumption.	Makespan, energy consumption		Results show that the two algorithms can efficiently find the right compromise between make span and energy consumption.
Energy Efficient Migration and Consolidation Algorithm of Virtual Machines in Data Centers for Cloud Computing [30]	In this a dynamic energy efficient virtual machine migration and consolidation algorithm based on a multi resource energy efficient model is proposed. This algorithm has minimized energy consumption with Quality of Service guarantee and also reduced the number of active physical nodes and the amount of VMs migrations.	Energy consumption, quality of service		Results show better energy efficiency in data center for cloud computing
Energy-Efficient Scheduling of Urgent Bag-of-Tasks Applications in Clouds through DVFS [31]	In this a cloud aware scheduling algorithm is proposed that applies DVFS to enable deadlines for execution of urgent CPU-intensive Bag-of-Tasks jobs to be met with reduced energy expenditure. Algorithm has significantly reduced the energy consumption of the cloud while not incurring any impact on the Quality of Service offered to users.	Minimum frequency, power consumption	CloudSim	Results show that proposed approach reduces energy consumption with the extra feature of not requiring virtual machines to have knowledge about its underlying physical infrastructure.
Enhanced Energy-efficient Scheduling for Parallel Applications in Cloud [32].	An Enhanced Energy-aware Scheduling (EES) heuristic algorithm is proposed to reduce energy consumption still meeting performance based SLA in data center running parallel applications. This algorithm ensures that the job finish before the deadline decided at the earliest. The main idea of this approach is to study the slack room for the non-critical jobs and try to schedule the tasks nearby running on a uniform frequency for global optimality.	Energy consumption, power consumption, SLA violation.	Real Processors.	Results show that EES is able to reduce considerable energy consumption while still meeting SLA.
Energy Efficient Heuristic Resource Allocation for Cloud Computing [33]	Heuristic algorithm is proposed; that could be applied to the centralized controller of a local cloud that is power aware. Proposed cloud scheduling model is based on the complete requirement of the environment. Here mapping between the cloud resources and	Energy consumption	CloudSim	Results show the MaxMaxUtil heuristic algorithm is preferred over others.

Technique	Noteworthy points	Performance metrics	Environment	Results
	the combinatorial allocation problem is created and an adequate economic-based optimization model is proposed based on the characteristic and the structure of the cloud.			
Energy-Efficient Application-Aware Online Provisioning for Virtualized Clouds and Data Centers [34]	In this an energy-aware online provisioning approach is proposed for HPC applications on consolidated and virtualized computing platforms. Energy efficiency with an acceptable QoS penalty is achieved using a workload-aware, just-right dynamic provisioning mechanism and the ability to power down subsystems of a host system that are not required by the VMs mapped to it.	Energy efficiency, VM provisioning, resource configuration	HPC workload traces from widely distributed production systems and simulation Tools	Results show that compared to typical reactive or predefined provisioning, proposed approach achieves significant improvements in energy efficiency with an acceptable QoS penalty.
Energy-efficient Task Scheduling Model based on MapReduce for Cloud Computing using Genetic Algorithm [35]	In this a new energy-efficient task scheduling model is proposed based on MapReduce to improve the energy efficiency of servers. To solve this model, an effective genetic algorithm with practical encoding and decoding methods and specially designed genetic operators are used.	Energy efficiency	Hadoop Mapreduce	Results show that the proposed algorithm is effective and efficient.
Towards Energy Aware Scheduling for Precedence Constrained Parallel Tasks in a Cluster with DVFS [36]	Proposed a scheduling algorithm in DFVS-enabled clusters for executing parallel tasks. The proposed algorithm finds slack time for non-critical jobs without increasing scheduling length. Also developed green SLA based mechanism to reduce energy consumption by return users tolerant increased scheduling makespans.	Task execution time, energy consumption, SLA	Cluster with multiple Turion MT-34 processors	Test results justify the design and implementation of proposed energy aware scheduling heuristics and can achieve up to 44.3% energy saving in the simulation
SEATS: Smart Energy-Aware Task Scheduling in Real-time cloud Computing [37]	Proposed SEATS, a virtual machine scheduling algorithm, which aims to reach the optimal level of utilization by offering more computing power to virtual machines of a host. SEATS makes hosts execute their virtual machines faster to reach their optimal utilization levels without needing to migrate virtual machines which eventually leads to reducing power consumption.	Quality of service, energy optimization	CloudSim	Results show that proposed method not only reduces total energy consumption of a Cloud by 60 %, but also has a profound impact on turnaround times of real-time tasks by 94 %. It also increases the acceptance rate of arrival tasks by 96 %.
Real-Time Tasks Oriented Energy-Aware Scheduling in Virtualized Clouds [38].	To guarantee system schedulability a novel rolling-horizon scheduling architecture is proposed for real-time task scheduling in virtualized clouds. Then a task-oriented energy consumption model is given and analyzed. Based on scheduling architecture, a novel energy-aware scheduling algorithm named EARH is proposed. Furthermore, two strategies are proposed in terms of resource scaling up and scaling down to make a good trade-off between task's schedulability and energy conservation.	System schedulability, energy consumption.	CloudSim	Results show that EARH significantly improves the scheduling quality of others and it is suitable for real-time task scheduling in virtualized clouds.
Proactive Scheduling in Cloud Computing [39]	Proposed a service ranking algorithm on the basis of detailed performance monitoring and historical analysis and based on their contribution, a weight age is assign to all service quality factors or performance metrics and as a	Time consumption, Service Level Agreements (SLAs) Violations, QoS		Two experiments one with traditional approach and other with pattern recognition fault aware approach. The results show the effectiveness of the scheme.

Technique	Noteworthy points	Performance metrics	Environment	Results
	final point aggregated to compute ranking score (R) of a service by developed formula.			
A Resource Scheduling Strategy in Cloud Computing based on Multi-agent Genetic Algorithm [40]	In this an integrated assessment model considering both resource credibility and user satisfaction is established and a resource scheduling strategy based on genetic algorithm is designed on the basis of this model.	Resources credibility, user satisfaction.	CloudSim	The numerical results show that this scheduling strategy improves not only the system operating efficiency, but also the user satisfaction.
Research on Batch Scheduling in Cloud Computing [41]	This paper provides the task scheduling algorithm based on service quality which fully considers priority and scheduling deadline. The improved algorithm combines the advantages of Min-min algorithm with higher throughput and linear programming with global optimization, considers not only all the tasks but also the high priority tasks.	Budget, deadline	CloudSim	Result shows that compared with the Min-min and DBCT the completed tasks of the improved algorithm increase about 10.6% and 22.0%, on the other hand the completed high priority tasks also increases approximately 20% and 40%.
Emergency Resource Scheduling Problem Based on Improved Particle Swarm Optimation [42]	An Improved Particle Swarm Optimization algorithm (IPSO) is proposed to overcome the problems such as long computing time. The algorithm uses the randomicity and stable tendentiousness characteristics of cloud model, adopts different inertia weight generating methods in different groups, the searching ability of the algorithm in local and global situation is balanced effectively.	Long computing time		Results of example show that the algorithm has faster search speed and stronger optimization ability than GA and PSO algorithm.
Cloud Computing Resource Dynamic Optimization Considering Load Energy Balancing Consumption [43]	In this an intelligent optimizing strategy of virtual resource scheduling is designed which fully takes into account the advantages of cloud virtual resource. It improves the selection and cross processing in GA and takes the optimal span and load function as the double fitness function to make the resource scheduling efficiency improved obviously.	Efficiency of resources, load balancing, optimal span	CloudSim, Hadoop	Test research indicates that scheduling efficiency can be promoted and the load balancing can be improved at the same time under the conditions of large scale tasks, which indicates that this method has great effectiveness.

3. PROPOSED ENERGY AWARE RESOURCE UTILIZATION FRAMEWORK

Cloud Computing is one of the most fast evolving computing platform which is the future of supercomputing. A time will come when everyone would be on the cloud network and at that time it is essential for the cloud network to perform well. Cloud is also a computing server and hence it takes every order as million instruction set. These instruction sets are often referred as Jobs. Scheduling an instruction set or job requires a lot of computing one wrong placement may lead to wastage of energy units. The proposed work has taken these issues in a very serious manner and has designed an architecture diagram which deal with the job scheduling process from start to end. The proposed algorithm covers placement of the job at server, monitoring of the server to prevent them from overloading and when they are exhausted from jobs, the creation of Virtual Machine is also a part of the proposed work. The proposed algorithm enhances the MBFD Algorithm by introducing artificial intelligence to it.

In this research paper, we are particularly focusing on the cloud server maintenance and scheduling process and to do so, we are using the interactive broadcasting energy efficient computing technique along with the cloud computing server**.** Job handling has been done using one of the finest swarm intelligence techniques called Artificial Bee Colony Algorithm. Artificial Bee Colony algorithm monitors the performance of the servers or host in order to check that they do not get overloaded.

Figure 1 represents a complete transaction process from user to server. The user can have n number of jobs and its request would be posted on central server. The central server looks into the requirement of the user and checks into the cache memory. If any service of such kind is already done in the past and if there are

more than two vendors or sub servers who have done similar kind of work then it goes for the feedback of the subservers. There can be N number of sub server. Here in the architecture diagram it is represented by S1….SN. The sub server takes the tasks from the central server and executes them in timely fashion. If any sub server has a feedback for similar kind of job then the availability of the sub server is checked and if it is available then the work is provided to the sub server.

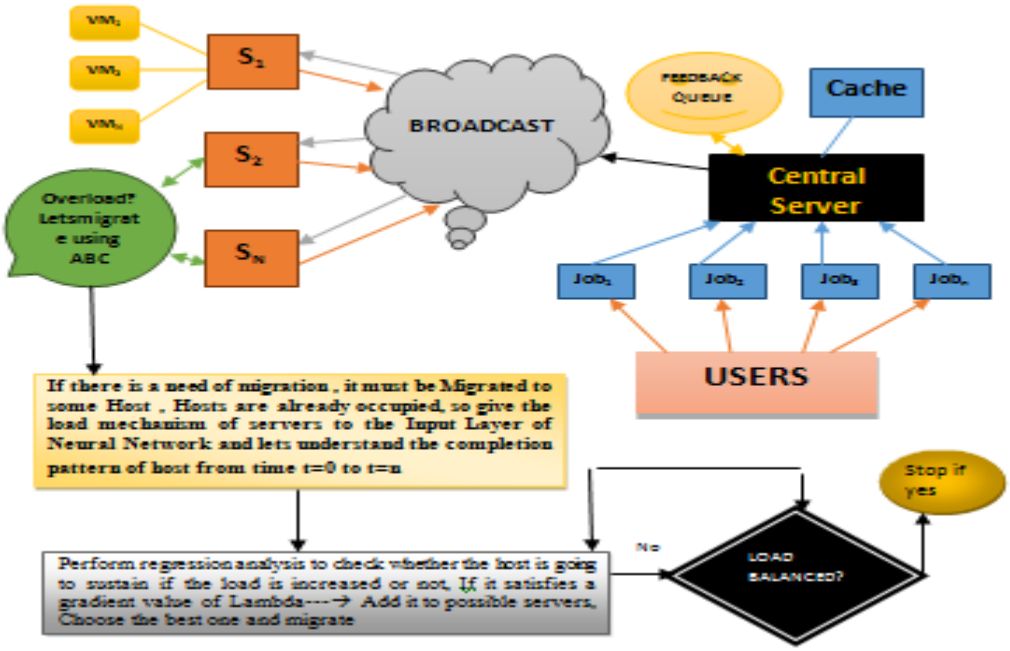

Figure 1. Energy aware resource utilization framework

The concept of the broadcast is applied on two places. First when there is no server in the cache memory or in the feedback queue and second when the feedbacks queue server is unavailable. The central server acts back on the responds of the sub servers. The response can be only taken from those sub servers who are in the range of the user demand. The range would be calculated with the help of distance formula. Another situation is considered that the sub server is overloaded with tasks and it is unable to provide memory it to its VMs. In such a case the VMs would have to be migrated from one sub server to another sub server. The process takes a lot of energy if not done efficiently. In order to attain the goal artificial bee colony algorithm is applied. The artificial bee colony algorithm takes the available servers as input bees and process them according to the designed fitness function.

4. CONCLUSION

The energy efficiency of computing resources plays a significant role in the overall energy consumption of the data center. The energy efficient task scheduling solutions are required to attain variable resource management, live migration, minimal virtual machine design, overall system efficiency, reduction in operating costs, increasing system reliability, and prompting environmental protection with minimal performance overhead. This paper provides a comprehensive overview of the energy efficient techniques and approaches and proposes the energy aware resource utilization framework to control traffic in cloud networks and overloads.

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