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A Detailed Study on Heterogeneous Energy Approximation Scheduling Algorithms in Cloud Environment

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Abstract: *Cloud computing is an evolutionary large-scale internet-based computing technology which delivers heterogeneous services through internet. Cloud Computing yields greater flexibility with its dynamic, distributed and virtualized environment. Scheduling in cloud computing is a challenging issue where efficient management of resources are needed to provide continuous reliable services. The main intention of developing efficient scheduling approaches is to provide value added service to service consumers with increased system throughput, reduced complexity, excellent management and maintenance of resources and increased profit for the service providers. This study is made to understand the various scheduling aspects and to know the parameters considered in developing efficient scheduling techniques. In this paper, we focused mainly on various scheduling algorithm for identifying the different aspects considered in the development of novel approaches for scheduling process in the cloud environment. A detailed study on various scheduling techniques helps in identifying the QoS parameters to provide reliable and consistent services to end users.*

Keywords: **Cloud Computing, Flexibility, Service Consumers, Service provider, Scheduling, QoS**

1. INTRODUCTION

In the era of modern cloud computing, various dynamically scalable services are provided through different platform to service consumers on demand as a pay-as-you-use or pay-as-you-go model. In these consumer based business oriented services, providing cost reliable and consistent services to the end users is challenging and also getting profit through those services are significant.

In cloud computing, resources are provided through services rapidly on request depending on the type of task arrives at the datacenter. The task, which arrives at the datacenter, requires compatible resources to be allocated to complete its processing efficiently. Allocation and De-allocation of resources to the task arrived requires efficient scheduling method to uphold the factors such as performance, reliability, scalability, availability and most importantly Energy Efficiency.

Cloud architecture consists of massively distributed datacenters around the globe and provides various scalable resources on demand. The basic services like Software, Platform and Infrastructure are provided to end users to utilize various applications as a service, platform as a service to build applications and infrastructure as a service to use scalable heterogeneous resources on demand respectively.

In this study, we have focused on the various scheduling algorithms which can be considered for the development of novel energy efficient scheduling algorithm to utilize the resources efficiently and balance the load among resources with a limited time constraints.

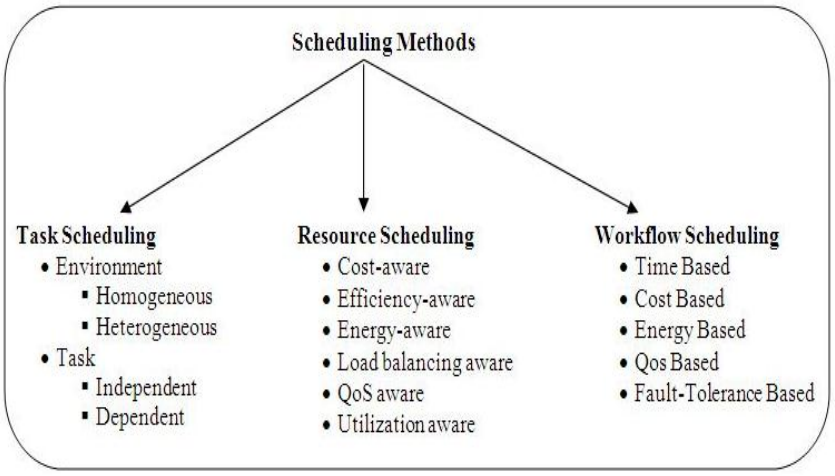
2. SCHEDULING IN CLOUD COMPUTING

In distributed computing, scheduling refers to allocation of available virtualized resources to the tasks arrived at datacenter. As the huge set of resources available at the datacenter, it is impossible to provision the resources to the tasks arriving at the datacenter uniformly. [1]Tasks are allocated to the required compatible resources with the help of efficient resource provisioning scheme by using enormous factors like throughput, network bandwidth and turnaround time in a set of available machines to achieve high performance and better throughput. [2] The virtualized resource is made available to a user to execute task on the leverage basis.

The resources are limited in premise for tenants and clients, so they leverage resources based on the present requirement to execute tasks through various scheduling techniques and pay for the resources they have leveraged. This results in lean

system and having no resources wasted or unused. Many resource scheduling algorithms are not always based on previously implemented techniques however scheduling dynamically with various factors like current load and the present need of the requesting applications and virtual machines.

Efficient scheduling methods can be implemented at different levels such as Task, which arrives at the datacenter for execution, Resource, which is provided to the task for its completion and finally Workflow, allows flexible utilization of resources to improve efficiency, reduce node disconnection and cloud fault tolerance which results in cost efficiency.



Fig–1: Scheduling methods used in Cloud Environment

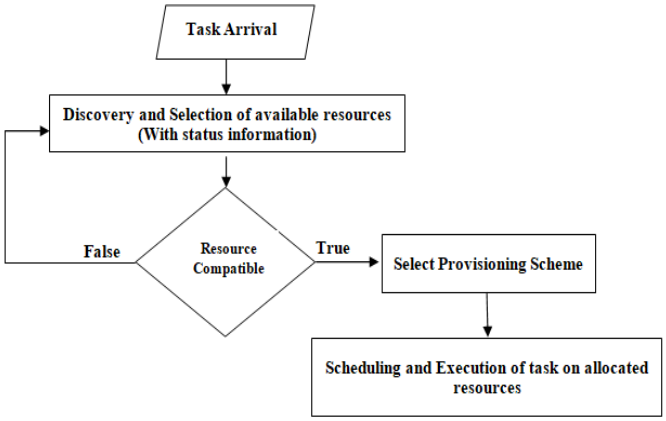
2.1 Types of Scheduling

i. **Static Scheduling** - complete information including status of the resources at the datacenter and requirement for the execution of jobs are defined earlier to map the jobs to compatible resources which results in no failure in job execution by assuming resources are available all the time.
ii. **Dynamic Scheduling** - the task arrives at the datacenter dynamically and executes on an allocated resource based on resource availability. Decision making is needed in the allocation of resources to support scheduling process. This type of scheduling uses job queue, scheduling priorities, but in limit.
iii. **Hybrid Scheduling** - is a method of scheduling mechanisms which considers different scheduling criteria or disciplines in one technique.

3. SCHEDULING PROCEDURE

Scheduling of resources to the task which arrives at the datacenter can be considered in different stages. [4] The scheduling procedure can be stated as follows

a) **Discovery and Selection of Available Resources**: Service broker at the datacenter discovers available resources and gathers the status information of compatible resources for the task arrived.
b) **Selection of Provisioning Scheme:** Determining the appropriate provisioning scheme for the available resources to perform the task.
c) **Scheduling of Task:** Assigning task to the allocated resource in the set of available resources to execute task efficiently.



Fig–2: Scheduling Process of Resources to Tasks arrived

4. PARAMETERS FOR SCHEDULING PROCESS

Many scheduling parameters are considered as important factors in the development of previous scheduling algorithms. They are given as follows: [5]

Energy Consumption factor: Energy utilization optimization is a key factor at the cloud datacenter in providing Quality of Service. Many scheduling algorithms have been implemented to improve energy efficiency by reducing energy consumption and enhancing performance thus making cloud as green computing services.

Load Balancing factor: Load balancing is the way of distributing load across various nodes equally to reduce burden on a single node. That is, no nodes remain under-loaded while a few nodes are overloaded. To increase efficiency of a system in executing the task, many scheduling algorithms maintain the load balanced in cloud environment.

Execution Time factor: It is the specific time taken for the completion of a given task. Many scheduling algorithms are implemented to reduce execution time resulting in improved performance.

Completion Time factor: It is defined as the total time consumed to complete execution of the task which incorporates the execution time and wait time caused by the cloud system. Many scheduling algorithms provided more importance towards reducing completion time of the task.

Deadline factor: It is characterized as the duration of completing a task to the time by which it must be completed. Many scheduling algorithms consider deadline constraints in the execution of task within the given period of time.

Makespan factor: It is defined as the total completion time of entire tasks in a job queue. An optimum scheduling algorithm always attempts to decrease the makespan.

Performance factor: Performance shows the total efficiency of a scheduling algorithm to provide quality of service to the service consumers depending on their requirement. An optimum scheduling algorithm provides significance for better performance at both service consumer side and service provider side.

Quality of Service factor: QoS incorporates many service consumers input requirements such as cost for executing a task, deadline constraints, performance, makespan, and so on. An agreement is defined between cloud service consumer and service provider to consider the legal requirements which is characterized in SLA.

5. LITERATURE SURVEY

In [6], four different operations are performed such as evaluation, selection, crossover and mutation by using heuristic approach. Vector representation is used to represent task list. The possible mapping of given task list on available machines are represented through initial population. The task is mapped to machine with position value. A term chromosome is used to represent each job and indicated with the fitness value for the total execution time of all tasks called makespan. This is generated from assigning tasks to machine comprising chromosome.

In [7], volume based cost drivers don't create exact outcomes, because this approach does not determine the complexity of any job or program volume. A preferable approach measures the cost of utilization for each resource such as I/O, Memory and CPU, resulting better performance with accurate cost and better profit by distributing cost among distributed cost equally.

In [8], traditional cost-based scheduling technique is enhanced with appropriate mapping of grouped tasks among available compatible resources. Here, scheduling of task is dependent on the cost of different resources and costs of various tasks are based on its complexity. Grouping of tasks are done on the basis of processing ability of resources and schedule them on selected resources to reduce processing Cost and Makespan.

In [9], improvement of Ant Colony Optimization algorithm is done by modifying the pheromone update mechanism to considerably reduce the Makespan of executed tasks resulting in better performance.

In [10], improvement of response time and load balancing is done by partitioning the tasks among various groups which are repeated to local middleware of the framework resulting in making the system fault tolerant. Resource utilization is enhanced with the help of optimal load balancing. Scheduling of tasks on various resources is done with Lexi-Search Technique to reduce cost. By calculating availability of resource and execution time, the task is assigned with probabilistic measurement.

In [11], multi–criteria and multi-decision priority based new scheduling algorithm is proposed. Here, job resource ratio is considered for setting priority and then priority vector is compared with each queue resulting in higher throughput and less completion time.

In [12], optimal resource utilization ratio, user satisfaction and reduced Makespan are obtained by balancing load on resources and Makespan of the system. Here, user is classified into VIP and Standard client. This algorithm is developed on the basis of basic minmin algorithm which incorporates scheduling of server load and user priority.

In [13], initially, it calculates the tasks priority as indicated by unique characteristics of tasks and sorts them based on priority to return precedence relation of tasks. Finally, schedules each task onto a resource for executing jobs at the earliest as indicated by the sorted queue by evaluating the completion time of each task on different resources.

In [14], Divisible Load Theory approach is used to distribute the load among the existing resources by considering homogeneous processors are utilized to calculate load fractions and processing time for decreasing the total completion time of tasks. The rapid completion of tasks within a specified minimum time is enabled by partitioning the divisible load among various servers resulting in better profit and QoS. This approach is efficient in terms of performance, total cost, efficiency. In this methodology, the completion time from user's end and the total cost from Provider's end were targeted and enhance the increase in number of processors.

In [15], an improved approach of max-min algorithm is provided to get better performance in task scheduling process. Instead of considering only execution time of current task, it considers completion time of all tasks for selecting resource which minimizes total completion time.

In [16], three techniques are proposed to focus mainly on request handling from the heterogeneous systems of users. Initially, the Best-Driven technique, best server machines are selected in heterogeneous networks depending on a calculated benefit value to assign tasks. Next, in Power Best Fit technique, task scheduling in homogeneous systems considers a machine with least power consumption increment. Finally, in Load balancing technique, based on each resource's power frequency ratio the computing capacity of a server is indicated.

In [17], Datacenter Energy-Efficient Network-aware Scheduling (DENS) approach is proposed by combining network-awareness and energy-efficiency for scheduling tasks. This approach minimizes the number of computing servers and avoids hotspots to meet the QoS requirements and enhances performance in job execution. The feedback channels are provided to obtain network-awareness from main network switches resulting in decreased computational and memory overhead.

In [18], an optimized greedy scheduling approach is implemented for selecting a minimum number of the most efficient servers to decrease power consumption while fulfilling the constraint of task response time during scheduling. The different energy consumption levels and number of task response times are generated due to heterogeneous tasks. The minimum power consumption and minimum completion time of a task is considered for optimal assignment of resources.

In [19], an energy-efficient job scheduling approach (e-STAB) has been developed by considering traffic load balancing at cloud datacenter. Congestion and communication delays in the network are reducing by considering traffic requirements of cloud applications.

In [20], a DVFS approach is developed to reduce the energy consumption of cloud infrastructure by running servers at various combinations of frequencies and voltages for minimizing the number of processing servers, reducing energy consumption and encourage increased optimal utilization of resources. The tasks are scheduled efficiently on resources without compromising the performance of the system meeting the requirements of SLA by saving energy.

In [21], they proposed an enhanced version of Weighted Least Connection (WLC) algorithm to provide better load balancing and system efficiency through Dual Weighted Least Connection (DWLC) algorithm. In this approach, processing capacity of the server is dynamically calculated and tasks characteristics are considered for calculating the server load.

In [22], resource renumbering technique is employed for cost-minimization and deadline-constrained workflow scheduling (CMDCWS) model by encoding the position of particle. In this approach, resource reordering and renumbering is incorporated for identifying computational capability of resources (cost per unit time) for differentiate well-performed and poorly-performed particles by reflecting on their features in large scale cloud environment with many tasks.

In [23], multi-objective task scheduling approach is developed to enhance the efficient utilization of datacenter resources by mapping tasks on Virtual Machines. This improves throughput of the datacenter and reduces the cost of processing without violating the application's SLA in cloud environment. In this algorithm, optimal scheduling method is developed by focusing on multiple objectives such as time, cost, bandwidth etc.

In [24], a non-exhaustive technique using a meta-heuristic approach called the BAT algorithm is designed and developed for optimizing NP-hard problems. The binary bat algorithm is incorporated in the Bat algorithm for scheduling workflow in the cloud. The overall cost of a workflow can be reduced using the BAT algorithm to select optimal resources by mapping resources and resources specifically.

In [25], an approach to address the NP-hard problem is designed by using a cuckoo search algorithm for scheduling tasks in a homogeneous cloud infrastructure. CSA is used to reduce the total waiting time of tasks. This approach depends on some cuckoo species obligate brood parasitic behavior along with the Levy flight behavior of some birds and fruit flies.

In [26], a hybrid task scheduling approach is presented by merging two approaches called Cuckoo Search Algorithm (CSA) and Oppositional Based Learning (OBL).This method provides optimal solution to the problem of tasks scheduling performance by enhancing dynamic allocation of resources in cloud environment resulting in improved performance and decreased cost by considering the constraints such as makespan and cost.

In [27], an energy optimization approach, Sharing with Live Migration (SLM) has been proposed to allocate optimal resources to the tasks in a cloud environment efficiently. This approach focuses on the study and prediction of resources for the similar type of tasks and allocates appropriate resources for execution resulting in better performance, minimized processing time and reduced total energy consumption of the datacenter with SLM policies. SLM algorithm exhibits enhanced efficiency of VMs with better utilization of resources and also satisfies QoS constraints of hosted application with a migration process.

In [28], a dynamic traditional algorithm allocation strategy has developed to address the conflicting objectives of algorithms such as FCFS, SJF, RR, Max-Min, Min-Min. This approach allocates the algorithm depending on the type of task resulting in reducing the limitation of other algorithms by trading off between the average waiting time and makespan. This approach can reduce makespan compared to Min-Min algorithm and reduces average waiting time by 46.7% compared to Max-Min approach.

In [29], a combinational approach called Dominant Sequence Clustering (DSC) technique for task scheduling and a Weighted Least Connection (WLC) technique for load balancing are developed. Primarily tasks are clustered depending on priority using DSC algorithm, where user tasks are represented as a graph of one or more clusters. Then, each task with average execution and communication time considered for ranking using Modified Heterogeneous Earliest Finish Time (MHEFT) algorithm where the highest priority task is scheduled first resulting in increased resource utilization. In Load balancing, virtual machines (VM) are clustered using a mean shift clustering (MSC) algorithm using kernel functions and weight is assigned with CPU speed and CPU idle rate computation to each VM depending on client connectivity using WLC algorithm. Depending on server weight, capacity and client connectivity to the server load is distributed using WLC algorithm.

The response time can be increased for task allocation with the selection of highly weighted and least connected server. The factors like makespan, resource utilization, response time and service reliability are used to evaluate this approach resulting with increased performance and optimal resource utilization.

Table-1: Comparison of Heterogeneous Scheduling Approaches in Cloud Computing

Algorithm/ Scheduling Method	Parameters used for Scheduling	Implementation Tool	Execution Environment	Type of jobs	Outcomes
Genetic Algorithm [6]	Makespan, Efficiency, Performance, Optimization	CloudSim	Numerical Simulation	Vector Representation (Chromosomes)	Time utilization and Resource utilization consideration, Task scheduling is done through Genetic algorithm
Optimized Activity Based Cost Algorithm [7]	Cost, Profit, Priority	SimGrid	Cloud	List of Tasks	Measures the cost and performance more accurately on the basis of cost of resource utilization
Improved Cost Based Algorithm [8]	Cost, Performance, Task Grouping	CloudSim	Cloud	Group Task	Cost of Resources and performance computation is considered prior to scheduling
Modified Ant Colony Optimization Algorithm [9]	Throughput, Pheromone Updating rule	GridSim	Grid	Independent	Improvement in the performance of Grid system by improving pheromone method update
Job Scheduling based on Horizontal Load Balancing [10]	Fault Tolerance, Load Balancing, Response Time, Resource Utilization, Cost, Execution Time	Lexi-Search	Cloud	Task partitioned into groups	Probabilistic assignment based on cost, High probability of resources and tasks are selected for execution without finalizing with the total completion time of tasks
Priority Based Job Scheduling Algorithm [11]	Makespan, Priority of Tasks, Expected Completion Time	CloudSim	Numerical Simulation	Dynamic Batch mode	Designed based on Multiple Criteria decision making model by considering three level of priorities - Scheduling, Resource and Job
User-Priority Guided Min-Min scheduling Algorithm [12]	Makespan, Priority, Resource Utilization, Load Balancing	Matlab	Cloud	Independent task	Priority is provided to users for improving load balancing without increasing total completion time.
QoS-Driven Task Scheduling [13]	Makespan, Average Latency	CloudSim	Cloud	Sorted Queue of Tasks	Uses many QoS parameters to assign priority to the Tasks and evaluates the completion time of each task on various services and assigns based on sorted task queue.
Cost-Based Multi-QoS Job Scheduling [14]	Cost, Load Balancing, Makespan, Quality of Service, Performance	CloudSim	Numerical Simulation	Group of Jobs	Uses Divisible Load Theory to distribute task equally on all available resources to achieve better performance without considering dynamic workload.
Improved Max-Min Heuristic Model [15]	Maximum Execution Time, Minimum Completion Time, Makespan	CloudSim	Numerical Simulation	Meta Tasks	Enhances the performance of Max-Min algorithm by incorporating completion time rather than individual execution time.
Energy-Aware Task Scheduling in Datacenter (Benefit-Driven, Power Best Fit, Load Balancing) [16]	Load balancing, Cost, Energy Consumption	CloudSim	Cloud	Balanced Workloads for computing and data transfer requirements	Reduces energy consumption and cost, even though more number of servers used. But some QoS factors and Completion time of tasks is not deeply focused.
DENS: data center	Traffic Load	GreenCloud	Cloud	Data-Intensive	Optimizes the tradeoff between job

energy-efficient network-aware scheduling [17]	Balancing, Energy Efficiency, Congestion			Workloads (DIWs)	consolidation for minimizing the amount of computing servers and distribution of traffic patterns for avoiding hotspots in the data center network.
Task Scheduling and Server provisioning [18]	Energy Consumption, Task response time, Deadline	Matlab	Cloud	Balanced Workload for computing and data transfer requirements.	Results show that a datacenter consumes an average over 70 times less than a datacenter using a random-based task scheduling scheme by meeting deadline of task.
e-STAB: Energy-Efficient Scheduling for Cloud Computing Applications with Traffic Load Balancing [19]	Energy efficiency, Network Awareness, Quality of Service, Performance	GreenCloud	Cloud	Data-Intensive Workloads (DIWs)	Based on Traffic Load, Congestion and by avoiding Delay, Load balancing and Energy Efficiency is achieved
A Green Energy Efficient Scheduling algorithm using DVFS Technique [20]	Energy Efficiency, Makespan, Execution Time,	CloudSim	Cloud	High Performance Computing (HPC).	Reduces energy consumption as per load in the system resulting in better Makespan
Dual Weighted Least – Connection) DWLC Scheduling Algorithm [21]	Load Balancing, Efficiency, Performance	CloudSim	Cloud	Weight differences of servers and tasks	Reasonable dynamic strategy is adopted to determine the weight of each server to effect the real-time load of each server more accurately
Renumber Strategy Particle Swarm Optimization [22]	Cost	CloudSim	Cloud	Group of Tasks	Renumbering strategy is used for resources to enable a better learning on particles of PSO algorithm.
Multi-objective Task Scheduling [23]	Average Turnaround Time	CloudSim	Cloud	Set of Tasks	Assignment of QoS values to both tasks and resources and utilizes Non Dominated sorting approach to solve multi-objective function.
BAT Algorithm [24]	Cost	CloudSim	Cloud	Interdependent Tasks	A meta-heuristic algorithm called BAT algorithm is used to minimize the cost of execution.
Cuckoo Search Algorithm [25]	Speed of Convergence	Matlab	Cloud	Array of Tasks	Meta-heuristic algorithm to help in increasing speed of convergence.
OCSA: Task Scheduling Algorithm [26]	Cost, Makespan	CloudSim	Cloud	Array of Tasks	Improve Scheduling Performance, minimizes Cost and Makespan parameter by using hybrid approach of oppositional Cuckoo Search algorithm
SLM Energy Optimization Scheduler for Cloud Computing Datacenter [27]	Energy Utilization, Makespan	CloudSim	Cloud	Group of Tasks	Provides better performance by saving power and reduces processing time aiming network load minimization and minimizing energy cost.
Dynamic Task Scheduling algorithm [28]	Average Waiting Time, Makespan, Execution Time	CloudSim	Cloud	Group of Tasks	Allocates algorithms based on the type of tasks among FCFS, RR, SJF, Max-Min, Min-Min and reduces conflicting objective of these approaches.
Dominant Sequence Clustering(DSC) and Mean Shift Clustering (MSC) Algorithms [29]	Response Time, Makespan, Resource Utilization, Service reliability	CloudSim	Cloud	Array of Tasks	Increase in resource utilization and performance by using task clustering and ranking approach.

6. CONCLUSION

The massive demand of cloud computing services led to the need of efficient management of resources while providing on-premise reliable services to service consumers. Scheduling of resources and management of those resources in task execution plays a crucial role in service delivery. In this paper, we have made a detailed study on heterogeneous scheduling techniques, which helps in addressing the various scheduling algorithm's outcome. In this study, we have analyzed the present work in each approach by providing each algorithms outcome and better scheduling algorithm can be implemented by improving efficiency factor, balancing load on resources by optimizing the parameters such as Makespan, Cost, Energy Consumption and Performance. This comprehensive study on various scheduling approaches leads to enhance the QoS and performance metrics in developing efficient scheduling algorithm.

REFERENCES

[1] Venkatesa Kumar. V and S. Palaniswami," A Dynamic Resource Allocation Method for Parallel Data Processing in Cloud Computing", 2012, Journal of Computer Science 8 (5), ISSN 1549-3636, Science Publications, page no: 780-788.

[2] Weiwei Lina, James Z. Wangb, Chen Liangc and Deyu Qia, "A Threshold-based Dynamic Resource Allocation Scheme for Cloud Computing", 2011, 1877-7058, Elsevier Ltd, PEEA 2011 Doi:10.1016/j.proeng.2011.11.2568, page no: 695 – 703.

[3] A. Thomas Henzinger, V. Anmol Singh, Vasu Singh, T. Wies and D. Zufferey, "Static scheduling in Clouds," Proceedings of the 3rd USENIX conference on Hot topics in cloud computing, pp. 1-6, 2011

[4] M. E. Frincu, S. Genaud and J. Gossa, "Comparing Provisioning and Scheduling Strategies for Workflows on Clouds," 2013 IEEE International Symposium on Parallel & Distributed Processing, Workshops and Phd Forum, Cambridge, MA, 2013, pp. 2101-2110, doi: 10.1109/IPDPSW.2013.55.

[5] T. Mathew, K. C. Sekaran and J. Jose, "Study and analysis of various task scheduling algorithms in the cloud computing environment," 2014 International Conference on Advances in Computing, Communications and Informatics (ICACCI), New Delhi, 2014, pp. 658-664.

[6] C. Zhao, S. Zhang, Q. Liu, J. Xie and J. Hu, "Independent Tasks Scheduling Based on Genetic Algorithm in Cloud Computing," 2009 5th International Conference on Wireless Communications, Networking and Mobile Computing, Beijing, 2009, pp. 1-4, doi: 10.1109/WICOM.2009.5301850.

[7] Q. Cao, Z. Wei and W. Gong, "An Optimized Algorithm for Task Scheduling Based on Activity Based Costing in Cloud Computing," 2009 3rd International Conference on Bioinformatics and Biomedical Engineering, Beijing, 2009, pp. 1-3, doi: 10.1109/ICBBE.2009.5162336.

[8] S. Selvarani and G. S. Sadhasivam, "Improved cost-based algorithm for task scheduling in cloud computing," 2010 IEEE International Conference on Computational Intelligence and Computing Research, Coimbatore, 2010, pp. 1-5, doi: 10.1109/ICCIC.2010.5705847.

[9] Soumya Banerjee, Indrajit Mukherjee, & P.K. Mahanti. (2009). Cloud Computing Initiative using Modified Ant Colony Framework (Version 4745). http://doi.org/10.5281/zenodo.1059767.

[10] Mousumi Paul, Debabrata Samanta, Goutam Sanyal, "Dynamic Job Scheduling in Cloud Computing Based on Horizontal Load Balancing", IJCTA, 2011.

[11] Ghanbari, Shamsollah & Othman, Mohamed. (2012). A Priority Based Job Scheduling Algorithm in Cloud Computing. Procedia Engineering. 50. 778–785. 10.1016/j.proeng.2012.10.086.

[12] Huankai Chen, Frank Wang, Na Helian, Gbola Akanmu, "User-Priority Guided Min-Min Scheduling Algorithm For Load Balancing in Cloud Computing", IEEE, 2013.

[13] Wu, X., Deng, M., Zhang, R., Zeng, B., & Zhou, S. (2013). A task scheduling algorithm based on QoS-driven in cloud computing. Procedia Computer Science, 17, 1162-1169.

[14] Abdullah, M., & Othman, M. (2013). Cost-based multi-QoS job scheduling using divisible load theory in cloud computing. Procedia computer science, 18, 928-935.

[15] Devipriya, S., & Ramesh, C. (2013, December). Improved max-min heuristic model for task scheduling in cloud. In Green Computing, Communication and Conservation of Energy (ICGCE), 2013 International Conference on (pp. 883-888). IEEE.

[16] Weicheng Huai, Zhuzhong Qian, Xin Li, Gangyi Luo, and Sanglu Lu, "Energy Aware Task Scheduling in Data Centers, Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications", volume: 4, number: 2, pp. 18-38, 2013.

[17] Dzmitry Kliazovich, Pascal Bouvry, Samee Ullah Khan, "DENS: Data Center Energy-Efficient Network-Aware Scheduling, Cluster Computing", special issue on Green Networks, vol. 16, no. 1, pp. 65-75, 2013.

[18] Ning Liu, Ziqian Dong, Roberto Rojas-Cessa, "Task Scheduling and Server Provisioning for Energy-Efficient Cloud-Computing Data Centers", IEEE 33rd International Conference on Distributed Computing Systems Workshops Task, 2013.

[19] Dzmitry Kliazovich1, Sisay T. Arzo, Fabrizio Granelli, Pascal Bouvry and Samee Ullah Khan, "e-STAB: Energy-Efficient Scheduling forCloud Computing Applications with Traffic Load Balancing", IEEE International Conference on Green Computing and Communications andIEEE Internet of Things and IEEE Cyber, Physical and Social Computing e-STAB, 2013.

[20] Chia-Ming Wu, Ruay-Shiung Chang, Hsin-Yu Chan received, "A green energy-efficient scheduling algorithm using the DVFS technique for cloud datacenters", Elsevier, 2013.

[21] Lianying ZHOU, Xingping CUI, Shuyue WU, An Optimized Loadbalancing Scheduling Method Based on the WLC Algorithm for Cloud Data Centers, Journal of Computational Information Systems, 2013.

[22] Li, H. H., Fu, Y. W., Zhan, Z. H., & Li, J. J. (2015, May). Renumber strategy enhanced particle swarm optimization for cloud computing resource scheduling. In Evolutionary Computation (CEC), 2015 IEEE Congress on (pp. 870-876). IEEE.

[23] Lakra, A. V., & Yadav, D. K. (2015). Multi-objective tasks scheduling algorithm for cloud computing throughput optimization. Procedia Computer Science, 48, 107-113.

[24] Raghavan, S., Sarwesh, P., Marimuthu, C., & Chandrasekaran, K. (2015, January). Bat algorithm for scheduling workflow applications in cloud. In Electronic Design, Computer Networks & Automated Verification (EDCAV), 2015 International Conference on (pp. 139-144). IEEE.

[25] Navimipour, Nima & Milani, Farnaz. (2015). Task Scheduling in the Cloud Computing Based on the Cuckoo Search Algorithm. International Journal of Modeling and Optimization. 5. 44-47. 10.7763/IJMO.2015.V5.434.

[26] Krishnadoss, Pradeep & Jacob, Prem. (2018). OCSA: Task Scheduling Algorithm in Cloud Computing Environment. International Journal of Intelligent Engineering and Systems. 11. 271-279. 10.22266/ijies2018.0630.29.

[27] Alshathri, Samah & Ghita, B.V. & Clarke, Nathan. (2018). Sharing with Live Migration Energy Optimization Scheduler for Cloud Computing Data Centers. Future Internet. 10. 86. 10.3390/fi10090086.

[28] A. K. M. Mashuqur Rahman Mazumder, K. M. Aslam Uddin, N. Arbe, L. Jahan and M. Whaiduzzaman, "Dynamic task scheduling algorithms in cloud computing," 2019 3rd International conference on Electronics, Communication and Aerospace Technology (ICECA), Coimbatore, India, 2019, pp. 1280-1286, doi: 10.1109/ICECA.2019.8822020.

[29] Al-rahayfeh, Amer & Atiewi, Saleh & Abuhussein, Abdullah & Almi'ani, Muder. (2019). Novel Approach to Task Scheduling and Load Balancing Using the Dominant Sequence Clustering and Mean Shift Clustering Algorithms. Future Internet. 11. 10.3390/fi11050109.

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