IJCSE International Journal of Computer Sciences and Engineering Open Access
Survey Paper Volume-6, Special Issue-2, March 2018 E-ISSN: 2347-2693

A Survey of Algorithms for Scheduling in the Cloud: In a metric Perspective

V.A. Jane[1*], B.J. Hubert Shanthan[2], L. Arockiam[3]

[1*] Dept.Computer Science,St. Joseph's College, Bharathidasan university,Trichy,India.
[2] Dept.Computer Science,St. Joseph's College, Bharathidasan university,Trichy,India.
[1] Dept.Computer Science,St. Joseph's College, Bharathidasan university,Trichy,India.

Corresponding Author: withdifferentjane07@gmail.com, ph.: 8148560014

Available online at: www.ijcseonline.org

Abstract— Cloud computing is a modern technology that provides all types of resources to the users with the help of internet. Resource management is the key factor that decides the performance of the cloud. Scheduling plays a prominent role in managing resources in the cloud. Scheduling also affects the power consumption of the data center. The cost of providing services increases when in appropriate scheduling is used. The environmental pollution increases by the emission of carbon. In this paper scheduling algorithms in the perspective of scheduling metrics such as throughput, response time,
Resource utilization, fault tolerance and performance are presented.

Keywords— Resource scheduling, Cloud computing, Energy, Throughput, Response time

I.INTRODUCTION

A. Cloud Definition

The NIST (National Institute of Standards and Technologies) [1] defines a "cloud computing as a model for enabling omnipresent and also expedient, which is on demand network access to a shared pool of configurable computing resources (Eg: network, server, storage, application, and service) that can be speeded provisioned and also be discharged with list management attempts or service provider interaction". Cloud [2] is a technology which is used for delivering computing services over internet. Cloud enables organizations to use the resources effectively by the virtual machines. Virtual machine [3] acts as a replica for a real machine and it also reduces costs and effort for the organizations. Cloud is a technology which is used in an efficient way of using the internet.

B.Cloud Features

The features of cloud computing consist of elasticity, pay-per use and flexible migration. Elasticity of resources can be increased and decreased according to the change in demand for cloud. The cloud allows [4] end users to use the resources automatically which are known as Self service provisioning. Cloud measures the capacity of the provisioned resources and user pays (pay per use) according to the resources utilized. Organization workloads are transferred easily from one platform to another which reduces cost that means flexible migration and cloud provides various service models to the users such as server, network and storage. Cloud service models are divided into three types that are SaaS, PaaS and IaaS. In SaaS Service Model Cloud applications are delivered to the user via the internet. The installation and maintenance of application software are done by the cloud. In PaaS Cloud provides various platforms and environment to the users that allow the user to develop applications and deploy on the internet. In IaaS Cloud provides resources by virtualization and high-levelAPIs uses the internet.

C. Types of Cloud

The resource location in the cloud is classified into three different categories that are Private, Public, and Hybrid [5]. A private cloud is a type of a cloud that belongs to an organization or a person. It allows restricted access to the users rather than admin. The authority for using resources differs from admin to user. The private cloud is expensive, but secure compared with the other cloud [6]. Public cloud means all virtualized resources in the cloud is openly shared among the users. Public cloud supports huge number of customers with the help of internet. Hybrid cloud is takes the advantages of both public and private cloud [7].

D. Scheduling in Cloud

There are two types resource scheduling [8], static and dynamic scheduling. Scheduling algorithm provides an efficient utilization of resource. Important parameters of scheduling algorithms are cost, time and energy these parameters are plays a vital role in QOS.RSA [9] is significant in scheduling and allocating workload to the

resources. Resource scheduling is a delivery and allocation of resource to the virtualized environment. The main objective [10] of resource scheduling is recognizing the appropriate resource for scheduling. Scheduling algorithms require some metrics to be satisfied that are as follows .The Table 1 depicts the detailed description about Resource Scheduling Metrics in the cloud environments. Section I contains the introduction of resource scheduling section II contain the related work of resource scheduling algorithms, section III contain the of comparison of resource allocation algorithms, section IV concludes research work with future directions.

Table 1: *Scheduling Metrics*

Metrics	Description
Response time [11]	In Cloud the response time is calculated by the time required by the cloud server to respond/ reply to the cloud user
Scalability [12]	Cloud server automatically adapts based on the resources requested by the user.
Throughput [13]	In Cloud throughput is calculated by total number of requests given by the user and total number of resources that are available in the cloud server.
Resource utilization [14	The Total number of cloud resources utilized by the user
Makespan [15]	The total completion time of the tasks that are given by the cloud uses
Performance [16]	The action or process of performing a scheduling successfully
Fault tolerance [17]	The accepted failure rate of the cloud server

II. REVIEW OF LITERATURE

a) Bargaining based RSA

Prodan et al. [18] proposed acontinuous double action (CDA) mechanism that parley contrast between the resource scheduler and resource manager of market based Continuous Double Action (CDA) model. The scientific application relies on the task of a program output, which is dependent on one another. The algorithm was implemented on the cloud SIM and that model flow and relative error. This mechanism was suited only for uniform workloads.

b) Energy based RSA

Wei et al. [19] proposed a model based on the Dynamic stacklberg game (CSBM-IISN) to allocate resources in the cloud. The Hidden Markov chain model was developed to increase the resource supplied to the end user. HMM was used to forecast the service provider resources.After that (IISG) inaugurated to improve the provider's strategy and maximize the utilization of resource, but this model only focused on reducing the price for the transaction. Nasrin et al. [20] discussed energy consumed by cloud data centers and its causes. Reviews of various algorithms which reduce energy consumption of data center by proposed green computing.

c) PSO –MC Algorithm

Xu et al. [21] proposed a membrane computing theory with particle swarm optimization as (PSO-MC). Membrane system used as a framework. The framework proceeds particle local optimization for inter-membrane after that particle swarm's global search and optimization for inter-membrane by this it finds the optimal solution for resource scheduling. The algorithm only focused on reducing the time.

d) Hybrid scheduling

Michaela et al. [22] proposed an algorithm HySARC^2.The algorithm allocates all the resources into the group on hierarchical way via two phases of execution. First phase allocates resources into groups and the second phase, execute the scheduling algorithm. Their algorithm was suitable for heterogeneous systems. Other type system is not considered.

e) EARTH: Energy - aware autonomic resource scheduling in cloud computing:

Sukpal et al. [23] proposed a framework for reducing the usage of energy in cloud data centers based on fuzzy logic. Data centers energy consumption disturbs the environment by carbon footprints and high amount operational cost to the organization. The proposed framework worked in cloud SIM and the result satisfies various QoS parameters such like self- healing (take action of sudden errors) self -optimization (maximize) resource usage and cost, time efficiency) self-configuration (competence to readjust resource) and self -protecting (identifying and safeguarding the resource from cyber-attacks). But this framework result in only simulated result, there's a possibility to get differ in real world systems. Even though the energy consumption was reduced, but carbon emission was not considered.

f) ACO

Priyanka et al. [24] proposed an algorithm using ACO (Ant Colony Optimization) with some additional genetic operations to improve the cloud performance. Their algorithm proceeded to avoid a deadlock condition on the cloud hosts jobs are scheduled using ACO. This algorithm reduces the resource consumption. But energy consumption was not considered.

Young et al. [25] proposed slave ant-based ant colony optimization algorithm for task scheduling in cloud. The main objective of this algorithm is to

increase the capability of the task scheduler assortment and strengthen planning's adopted from slave ants. Thus, the algorithm avoids the global optimization problem, not considering both heterogeneous clusters and cost.

g) PSO

Ali et al. [26] proposed an algorithm comprised of PSO with Dynamic Adoption to the cloud environment (DAPSO) Dynamic Adoptive PSO was working on the basis of PSO algorithm. PSO was used to minimize the makespan of the task set for optimize the run time and maximize the resource utilization. The proposed algorithm is a dubbing of DAPSO and is called MOAPSO. Their algorithm was more efficient than the PSO algorithm.

h) Meta heuristic

Mala et al. [27] discussed meta heuristic Technique based algorithms such as a PSO,ACO,GA and 2 novel Technique LCA, BAT. The final result shows that all Meta heuristic algorithms are slower than deterministic algorithms and the solutions not optimal.

Chung et al. [28] proposed Distributed Flow by Flow Fair Routing algorithm for maximizing network resources. Their algorithm outperformed a static routing assignment protocol. Their algorithm compared with DDFS (Distributed Dynamic Flow Scheduling) and overcome drawbacks. Thealgorithm is only suitable for homogeneous network link. Synthetic data only performed so the result may vary in real world data.

i) Memory Based Load Balancing Algorithm

Raghul et al. [29] has compared these both algorithms (ECLB & FCFS) considering all the drawbacks they have come to a final conclusion by reducing delay and execution time in the proposed algorithm MUUU. The system (SPPS) works using the (MCLV) algorithm which was a more efficient algorithm. The advantage of the proposed algorithm was the delay time and execution times are reduced. The disadvantages are ample numbers of messages are sent to the scheduler and similar clients are not clustered properly.

j) A Load Balancing Algorithm Based on Processing Capacities of VMS in Cloud Computing

Ramdeep et al. [30] proposed Load Balancing algorithm by comparing performance of Heuristic Load Balancing Algorithm and Round Robin algorithm. The proposed algorithm reduced the completion time with maximum resource utilization. Their algorithm only solved the problems which exist in the Round Robin and Heuristic Algorithm.

k) Task Based Load Balancing Algorithm by Efficient utilization of VMS in cloud Computing

Ramdeep et al. [31] proposed Dynamic Load Balancing Algorithm and the produced results in average response time, turnaround time and total cost. But, wait time, throughput is not considered.

l) A Packaged based Approach for Load Balancing in Cloud Computing

Amanpreet et al. [32] proposed Packet based Load Balancing Algorithm. The motive of their algorithm is grouping of packages and performs the virtual machine replication in Load Balancing. Outcome of their Algorithm minimum execution time with low cost. Migration of VM is difficult.

m) WAMLB: Weighted Active Monitoring Load Balancing in cloud computing

Aditya et al. [33] Proposed algorithm is based on weight of virtual machine and the final result overcome the existing algorithm. VM status-based task assigned so execution time was minimized. CPU utilization was not considered.

n) LBBSRT: An efficient SDN Load Balancing Scheme based on server response time

Hong et al. [34] proposed algorithm that measured each server capacity and allocate load based on the capacity. Final result shows that minimum average server response time was achieved with good scalability and low cost. Energy saving was not considered.

o) Load Balancing in Cloud Computing environment using improved weighted Round Robin Algorithm for Non-preemptive dependent Task

Chitra et al. [35] proposed algorithm based on the capability of each virtual machine, the length of each requested job, and the interdependency of multiple tasks. Their algorithm produced minimum response time, but the migration of job in a VM was not considered.

p) Improved Bat algorithm for Load Balancing Based Task scheduling

Raj et al. [36] discussed new Metaheuristic, Min-Min, Max-Min, Alpha-Beta and produced as Improvised Bat Algorithm. Min-Min, Max-Min algorithm Task Execution time was minimized and the task is optimistically distributed but the processing time was huge.

q) Load Balancing Mechaninsim using FUZZY Row Penalty Method in the cloud computing environment

Narender et al. [37] proposed solution to load balancing problem using FUZZY technique, which was used for solving the uncertain response time. FUZZY row penalty method, was used for Load Balancing and Unbalanced FUZZY. Outcomes shows scalability, increased performance,

minimized overheads and neglecting of Bottle Neck problem.

III. COMPARISON OF RESOURCE ALLOCATION ALGORITHMS

Table 2: *Comparison of Resource Allocation Algorithms*

Title	Advantages	Disadvantages
Bargaining RSA[18]	This algorithm is more viable for Uniform workloads	It doesn't suit for all types of work loads
Energy RSA[19]	Effective Resource Utilization with minimal cost	Overall completion time of the tasks is high
Energy RSA[20]	Focused on data center (Green computing)	Lack of Resource utilization and on demand Server utilization
PSO –MC[21]	Makespan is optimally reduced in this approach	No other parameters are considered
Hybrid scheduling [22]	Makespan	Resource utilization
EARTH[23]	Energy consumption	Carbon emission
ACO[24]	Resource consumption.	Energy consumption
ACO [25]	Avoids the global optimum.	Cost, heterogeneous clusters
PSO[26]	Minimize the makespan	Server utilization, scalability
Meta heuristic [27]	All Meta heuristic algorithms are slower than deterministic algorithms	Solutions not optimal.
Meta heuristic [28]	Maximize network resources	Synthetic data only performed so the result may vary in real world data.
MLBA [29]	Delay time and execution times	Similar clients are not clustered properly.
VMLBA [30]	Maximize resource utilization.	Not suitable in all problems
TLBA[31]	**Average response time, tumaround time and total cost.**	**Waiting time throughput.**
PLBA [32]	Minimum execution time with low cost.	Migration of VM
WAMLB [33]	Execution time was minimized	CPU utilization
LBBSRT[34]	Minimum average server response time, low cost	Energy saving
LBAWR[35]	Minimum response time	Migration
IBAT[36]	Task Execution time is minimized and the task is optimistically distributed	Processing time is huge
Fuzzy[37]	Scalability increased performance, minimized overheads and neglecting of Bottle Neck problem	Server utilization

IV.CONCLUSION

Cloud computing technology is developing day by day with huge number of new challenges. One of them is scheduling. This paper mainly focuses on analyzing scheduling algorithms which are used to maximize utilization of resources with minimum energy consumption, reduces makespan, quality of service, cost and power reduction. Many algorithms are proposed to give powerful scheduling. Since the scheduling is critical, the more research can be done in this area for the betterment of the results.

REFERENCES

[1] P. Mell and T. Grance, The NIST Definition of Cloud Computing, National Institute of Standards and Technology, InformationTechnology Laboratory Technical Report Version 15, 2009.

[2] Velagapudi Sreenivas, Prathap,M and Mohammed Kemal, "LoadBalancing Techniques: Major Challenge In Cloud Computing – A Systematic Review", IEEE International Conference on Electronicsand Communication Systems (ICECS), 2014

[3] Anitya Kumar Gupta, Srishti Gupta, "*Security Issues in Big Data with Cloud Computing*", International Journal of Scientific Research in Computer Science and Engineering, Vol.5, Issue.6, pp.27-32, 2017

[4] Botta, A., de Donato, W., Persico, V. and Pescape. A, "Integration of cloud computing and internet of things: a survey. Future Generation Computer Systems, Vol.56, pp.684-700, 2016

[5] Rajesh Verma , "Comparative Based Study of Scheduling Algorithms for Resource Management in Cloud Computing Environment", International Journal of Scientific Research in Computer Science and Engineering, Vol.1, Issue.4, pp.17-23, 2013

[6] L. Benedict Carvin, BJ. Hubert Shanthan, A.DalvinVinothKumar, Dr.L.Arockiam, "Role of Scheduling and Load Balancing Algorithms in cloud to improve the Quality of Services", International Journal of Computer Science, Vol.5,No.1,pp:1454-1462, 2017.

[7] BJ. Hubert Shanthan, A. DalvinVinothKumar,Er. KarthigaiPriyaGovindarajan ,Dr.L.Arockiam, "Scheduling for Internet of Things Applications on Cloud:AReview",Imperial Journal of Inter disciplinaryResearch(IJIR), Vol.1, No.3, pp:1649-1653,2017.

[8] Anitha H M, P. Jayarekha , "Security Challenges of Virtualization in Cloud Environment", International Journal of Scientific Research in Computer Science and Engineering, Vol.6, Issue.1, pp.37-43, 2018

[9] Qi, Z.T.L., Cheng, Z., Li, K., Khan, S.U., Li, K.: An energy-efficient task scheduling algorithm in DVFS-enabled cloud environment. J. Grid Comput. **14**(1), 55–74 (2016) 3.

[10] Garima Malik and Gaganjot Kaur, "*Hybrid Approach to Round Robin and Priority Based Scheduling Algorithm*", International Journal of Computer Sciences and Engineering, Vol.4, Issue.2, pp.114-116, 2016.

[11] Jiang, J., Lin, Y., Xie, G., Fu, L., Yang, J.: Time and Energy Optimization Algorithms for the Static Scheduling of Multiple Workflows in Heterogeneous Computing System. J. Grid Comput., 1–22 (2017). https://doi.org/10.1007/s10723-017-9391-5

[12] Ebrahimirad, V., Goudarzi, M., Rajabi, A.: Energy-aware scheduling for precedence-constrained parallel virtual machines in virtualized data centers. J. Grid Comput. **13**(2), 233–253 (2015).

[13] Singh, S., Chana, I.: Metrics based workload analysis technique for IaaS cloud. In: The Proceeding of International Conference on Next Generation Computing and Communication Technologies 23 - 24 April 2014, Dubai, pp. 1–6 (2014).

[14] N. Deshai, P. Penchala Swamy, G.P. Saradhi Varma, "Enhanced Query Processing Technique Using RASP Effective Services in Cloud", International Journal of Scientific Research in Computer Science and Engineering, Vol.5, Issue.4, pp.76-78, 2017

[15] Singh, S., Chana, I.: Cloud resource provisioning: survey, Status and Future Research Directions. Knowl. Inf. Syst. **49**(3), 1005–1069 (2016).

[16] Singh, S., Chana, I.: Q-aware: quality of service based cloud resource provisioning. Comput. Electr. Eng. **47**, 138–160 (2015).

[17] Singh, S., Chana, I.: QoS-aware autonomic cloud computing for ICT. In: The proceeding of International Conference on Information and Communication Technology for Sustainable Development (ICT4SD - 2015), Ahmedabad, India, 3 - 4 July 2015, pp. 569–577. Springer, Singapore (2016)

[18] Prodan, R., Wieczorek, M., Fard, H.M" Double auction based scheduling of scientific applications on distributed grid and cloud environments"J. Grid Comput.**9**(4), 531–548 (2011)

[19] V.K. Saxena, S. Pushkar, "*Privacy Preserving using Encryption Proxy in Data Security*", International Journal of Scientific Research in Computer Science and Engineering, Vol.5, Issue.2, pp.36-41, 2017

[20] Nasrinakhter and Mohamed Othman "Energy aware resource allocation of cloud data center: review and open issues" DOI 10.1007/s10586-016-0579-4, 2016.

[21] Xu Zhe-jun "Research on Cloud Computing Resource Scheduling Based on PSO-MC Algorithm"International Journal of Grid Distribution Computing Vol. 8, No.4, (2015), pp. 153-162, 2015

[22] Mihaela-Andreea Vasile, Florin Pop,Radu-Ioan Tutueanu,Valentin Cristea " HySARC^2: Hybrid Scheduling Algorithm Based on Resource Clustering in Cloud Environments" International Conference on Algorithms and Architectures for Parallel Processing ICA3PP: Algorithms and Architectures for Parallel Processing, pp 416-425(2013)

[23] SukhpalSinghandInderveerChana "EARTH: Energy-aware autonomic resource scheduling in cloud computing"Journal of Intelligent & Fuzzy Systems 30 1581–1600(2016)

[24] Priyanka Mod , Prof. Mayank Bhatt "ACO Based Dynamic Resource Scheduling for Improving Cloud Performance" International Journal of Science, Engineering and Technology Research (IJSETR), Volume 3, Issue 11, November(2014)

[25] YoungJu Moon,HeonChang Yu,Joon-Min Gil and JongBeom Lim"A slave ants based ant colony optimization algorithm for task scheduling in cloud computing environments"Human-centric Computing and Information SciencesDOIhttps://doi.org/10.1186/s13673-017-0109-2 (2017)

[26] Ali Al-maamari and Fatma A. Omara" Task Scheduling Using PSO Algorithm in Cloud Computing Environments" International Journal of Grid Distribution Computing Vol. 8, No.5, pp.245-256 (2015)

[27] MalaKalra,SarbjeetSingh"A review of metaheuristic scheduling techniques in cloud computing" Egyptian Informatics Journalhttps://doi.org/10.1016/j.eij.2015.07.001 (2015)

[28] Chung-Ming Cheung,Cheong Leung "DFFR: A Distributed Load Balancer for Data CenterNetworks" *IEEEInternational Conference on Communication Systems (ICCS)*DOI**:** 10.1109/ICCS.2016.7833574 (2017)

[29] G. Raghu, Neeraj K. Sharma, Shridhar G. Domanal and G. Ram Mohana Reddy "Memory-Based Load Balancing Algorithm in Structured Peer-to-Peer System" *Progress in Intelligent Computing Techniques: Theory, Practice, and Applications,* pp.431-439(2018)

[30] Ramandeep Kaur and Navtej Singh Ghumman. "A Load Balancing Algorithm Based on Processing Capacities of VMs in CloudComputing" *Big Data Analytics* (2018)

[31] Ramandeep Kaur and Navtej Singh Ghumman "Task-Based Load Balancing Algorithm by Efficient Utilization of VMs in Cloud Computing"*Big Data Analytics* pp 55-61 (2018)

[32] Amanpreet Chawla and Navtej Singh Ghumman.: Package-Based Approach for Load Balancing in Cloud Computing " *Big Data Analytics* pp 71-77 (2018)

[33] Aditya Narayan Singh and Shiva Prakash "WAMLB: Weighted Active Monitoring Load Balancing in Cloud Computing"Big Data Analytics pp 677-685 (2018)

[34] Hong Zhong, Yaming Fang, Jie Cui "LBBSRT: An efficient SDN load balancing scheme based on server response time" http://dx.doi.org/10.1016/ (2017)

[35] D. Chitra Devi and V. RhymendUthariaraj "Load Balancing in Cloud Computing Environment Using Improved Weighted Round Robin Algorithm for Non-preemptive Dependent Tasks"*The Scientific World Journal* Volume 2016 (2016), Article ID 3896065, 14

[36] Bibhav Raj, Pratyush Ranjan, Naela Rizvi, Prashant Pranav ,andSanchita Paul "Improvised Bat Algorithm for LoadBalancing-Based Task Scheduling"*Progress in Intelligent Computing Techniques: Theory, Practice, and Applications* pp 521-530 (2018)

[37] Narander Kumar and Diksha Shukla"Load Balancing Mechanism Using Fuzzy Row Penalty Method in Cloud ComputingEnvironment"*Information and Communication Technology for Sustainable Development* pp 365-373(2018)

