A Study on newfangled job scheduling algorithms in cloud computing

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ABSTRACT

"Cloud computing is not something new, but something that people remember from 1960s as time sharing and virtual machines". Cloud computing has entirely changed the usage of computer systems by providing greater reliability and flexibility to a variety of operations. It helps the businesses to quickly and effectively adapt to market changes, and helps to promote users' continual access to critical information across various platforms and devices. User's request for a particular resource or other operations can be fulfilled or granted in cloud computing environment. As there exist several different types of users, the particular job has to be scheduled in order to increase the computing efficiency with the available resources. In this paper, we presented a study on different job (task) scheduling algorithms, each with its own technique of execution, consideration of different parameters for better performance and advancement of one over the other.

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1. INTRODUCTION

Cloud computing provides the availability of IT resources, which are at different parts of the world to the users, who wants to access those resources from their work place in the form required by the users through an effective and reliable service provider by maintaining convenience and ease of use to the user [31]. The cloud computing technology intends to provide "computing as a utility" [15] in near future. Cloud computing provides its services online on-demand and pay-as-you-go basis.

User accesses the cloud services through internet by using Mobile, PC and PDA then, Service provider provides the service to user as shown in Figure1.The services are [4] Infrastructure as a service (IaaS) refers to the sharing of hardware resources for executing services. Platform as a Service (PaaS) includes a software execution environment, such as an application server. Software as a Service (SaaS) includes complete applications that are hosted on the Internet.

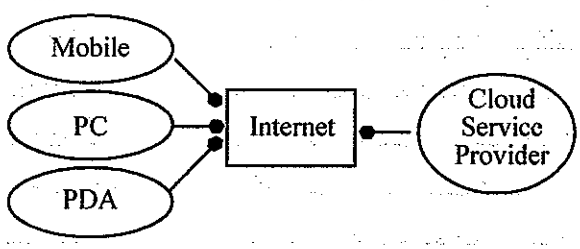


Figure1: Cloud Service

Scheduling is one of the most prominent activities that are executed in the cloud computing environment. Scheduling refers to a set of policies that control the order of work to be performed by a computer system. Scheduling manages that availability of CPU memory. A good scheduling policy gives maximum utilization of resource.

1.1. Need for scheduling in cloud

- Fair resource allocation
- QOS (quality of service)
- Resource utilization
- Energy consumption

1.2. Types of scheduling

1.2.1. Cloud Service Scheduling: At user level, scheduling deals with the problems raised by the service between providers and customers. The system level scheduling handles resource management within the datacenter. Datacenter consists of many physical machines. Millions of tasks from users are received. Assignment of these tasks to physical machine is done at datacenter.

1.2.2. Static and Dynamic scheduling: In static scheduling algorithm, information about the status of the task and resources is known in advance and then the task is scheduled to the resources. In dynamic scheduling algorithm task is allocated at runtime.

1.2.3. Heuristic Scheduling: When the number of instances is large, heuristic scheduling is used. It is a suboptimal algorithm to find reasonably good solutions at reasonably fast rate.

1.2.4. Real Time Scheduling: The primary objectives of real time scheduling are to increase throughput and minimize average response time instead of meeting deadlines.

1.2.4. Online and Batch mode scheduling: In online scheduling algorithm, when the job is arriving, it is executed. The batch mode scheduling is also called as "offline scheduling" in which task is scheduled in batch mode which means the task is executed in specific time interval.

1.2.5. Preemptive and Non-preemptive scheduling: In preemptive scheduling algorithm, a currently executing job can be interrupted and it can be given to another resources. In non-preemptive scheduling algorithm, job is executed on the resources until the job is completed. There are two types of scheduling, which is considered as the key in cloud computing i.e. resource scheduling and job scheduling as in Figure 2. This paper mainly focuses on various job (task) scheduling (algorithms) techniques.

2. Job scheduling in cloud computing

Job Scheduling in cloud computing refers to the dispatch of computing tasks between the different resources according to certain rules of resource use under the given cloud environment. Job scheduling is flexible and convenient [20].Cloud users use the cloud resources through internet. Job scheduling algorithm refers to the mapping of the task to the

cloud environment onto the available resources. The job scheduling goals of Cloud computing is to provide optimal tasks scheduling for users, and to provide the entire cloud system with throughput and QOS (quality of service)at the same time [9].

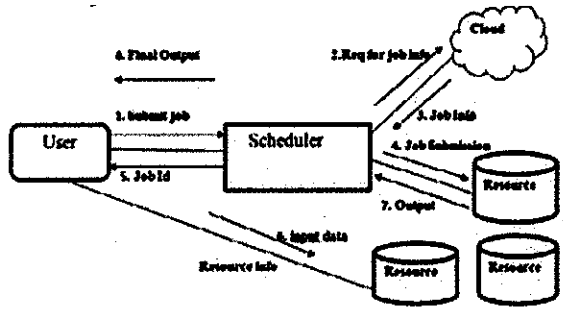
2.1. Characteristics of job scheduling

2.1.1. Job scheduling is global centralized: Cloud computing is a computing model which supply the centralized resources to multiple applications. Therefore, this service makes the job scheduling of cloud computing to achieve a global centralized scheduling.

2.1.2. Each node in the cloud is independent: In cloud computing, the internal scheduling mechanism of every cloud node is independent, and the schedulers in the cloud will not interfere in the scheduling policy of these nodes.

2.1.3. The scalability of job scheduling: The scale of supply of resource from cloud provider is limited in early stages so, in cloud, job scheduling must meet the scalability features, so that the throughput of the task scheduling in the cloud may not be too low.

2.1.4. Job scheduling can be dynamically self adaptive: Expanding and shrinking of applications in the cloud is necessary depending on the requirement. The virtual computing resources in cloud may also expand or shrink at the same time.



2.1.5. The set of job scheduling: Task scheduling is divided into two parts: one is a unified resource pool scheduling which is primarily responsible for the scheduling of applications and cloud API. The other is unified port resource scheduling in the cloud.

2.2. Need for Job Scheduling

Load balance, Quality of service, Economic principles, Best running time, Throughput. Scheduling process can be generalized into three categories [21]: Resource discovering and filtering, resource selection& task submission.

3. Job scheduling algorithms

The various algorithms are discussed and analysed in Table 1.

3.1. Min-Min algorithm

The minimum size task in batch mode is allocated to faster resources. Hence, the algorithm suffers from load imbalance problem.

3.2. User Priority Based Min-Min Scheduling Algorithm for Load Balancing in Cloud Computing [13]

Better span Min-Min algorithm and user priority also satisfied. When high priority task is too large then lower priority task has to wait for long time. So, starvation problem is created.

3.3. Max-Min algorithm

This algorithm does better than min-min algorithm where short tasks are outnumbered the long ones. This chooses large tasks for execution first leading to delays for smaller tasks.

3.4. Improved Max-Min Scheduling Model for Task Scheduling in Cloud [8]

Waiting time is decreased. Result of this algorithm is showing better makespan then all algorithms.

3.5. RASA algorithm [11]

RASA uses the advantages of Max-min and Min-min algorithms and covers their disadvantages.

3.6. Ant Colony Optimization (ACO)-inspired

Metrics of this algorithm show that ACO performance is better than two other (Random and Best effort) algorithms.

3.7. Hybrid Bee Ant Colony Algorithm [11]

PSO based task-resource mapping can achieve at least three times cost savings as compared to Best Resource Selection (BRS) based mapping for our application workflow.

3.8. Bi-Criteria Priority based Particle Swarm Optimization Workflow Scheduling Algorithm for Cloud (BPSO) [26]

In, BPSO, the tasks are executed in the order of their priority which is computed by using the technique that is same as that is defined in HEFT [27]. The assigned priority is used to initialize the PSO. This algorithm has a promising performance when compared with PSO.

3.9. Dynamic level scheduling (DLS) algorithm [12]

Wei Wang and et.al extend the traditional DLS algorithm by considering trustworthiness of resource nodes. Evaluation of the trustworthiness of machines in Cloud environment by the proposed algorithm shows a decrease in the failure probability of the task assignments, and assurance of execution of tasks in a secured environment.

3.10. Dynamic Scheduling Algorithm Based on Threshold [25]

Dynamic scheduling algorithm based on threshold can allocate jobs and resources flexibly and reduce the efficiency impact caused by the synchronization among virtual machines.

3.11. Improved cost-based algorithm for task scheduling in Cloud Computing Environment [23]

The objective is to schedule group of tasks to resources that are having different resource costs and different computation performance in cloud

computing. For this particular algorithm, time taken to complete the tasks after grouping is very less when compared to non-grouping of tasks.

3.12. Job scheduling algorithm based on Berger model in cloud resources [2]

The proposed algorithm uses the berger model for scheduling tasks to cloud resources. The high priority task gets the resource for execution.

3.13. An efficient Multi Queue Job Scheduling for Cloud Computing [14]

The author proposed MQS (Multi Queue Scheduling) scheduling algorithm, in which first of all task are assigned in ascending order and then it is divided into medium, small and large size queue. Then Meta scheduler allocates the task to the virtual machine. This algorithm shows that it increases user satisfaction and utilize the free unused space, so performance is increased.

3.14. STASR

This algorithm proposed by [30] (Set resources Task Associated Set Resources) (STASR) groups the tasks that are linked to group of resources. The load balances and the waiting time are reduced by distributing the tasks in interrelated groups. Here, the waiting and response time are reduced together and inturn, it can raise the efficiency of the algorithm.

3.15. Stochastic Hill Climbing-A Soft Computing Approach [3]

A local optimization approach, Stochastic Hill climbing is used for allocating incoming jobs to the servers. It showed that in most of the case, Stochastic Hill Climbing (SHC) decrease the response time.

3.16. CSO (Cat Swarm Optimization) [5]

Saurabh Bilgaiyan, Santwana Sagnika Madhabananda Das proposed a heuristic scheduling algorithm with a hypothetical workflow. CSO algorithm provides the transfer of cost between two dependent resources. CSO considers two costs: data transfer cost and other is execution cost. CSO algorithm is inspired by two social behavior of cat, seeking mode and tracing mode. CSO proves to be better in terms of total cost, load balancing and in number of iterations to achieve a best solution..

3.17. TQS (Tri Queue Job Scheduling Algorithm) [16]

Liang Ma, Yueming Lu,Fangwei Zhang, and Songlin Sun proposed an algorithm to avoid the fragmentation at the time of scheduling. This algorithm gives equal opportunity to small, medium and long job using dynamic quantum time to make efficient use of resources. Starvation problem is removed by TQS.

3.18. CPROVISION [29]

SharrukhZaman, Daniel Grosu proposed an auction based mechanism for dynamic VM provisioning. It

takes the user demand into consideration when taking VM's allocation decision. When compared with CGREEDY, it performs better in terms of resource utilization and increased the percentage of served users. In high demands, CPROVISION proves better in term of profit.

3.19. Heterogeneous-Earliest-Finish-Time algorithm (HEFT)

Topcuoglu et. al, [6] presented the HEFT algorithm. This algorithm first calculates average execution time of each task and average communication time between the resources of two successive tasks. HFFT proves to be better in term of cost and it always meets the deadlines.

3.20. OFDT's (An Optimally Fair Dynamic Task Scheduling Algorithm) [22]

In this, Shilpi Saxena, Satyendra Singh Chouhan proposed a dynamic task scheduling technique OFDT's because the traditional methods remains to be at high cost and slow processing rate. This algorithm works on the requirement of each task and then allocates that task to the most appropriate resource. OFDT's performs better in term of cost and execution time when compared with other traditional algorithms.

3.21. The Cloud least laxity First Algorithm [18]

Tasks are recorded first in the order of the least laxity (The time quantum between the deadline of the executed task and its response time.) and then task with least laxity is chosen first to get processed. This algorithm minimizes the extra-cost of each task when the execution time of the job remains acceptable.

3.22. Credit Based Scheduling Algorithm in Cloud Computing Environment

The proposed approach by [1] considers two parameters: Task Length and User Priority. Each task is assigned a credit based on their task length and priority. The proposed algorithm works efficiently and the Makespan of the task is lesser. It is observed that makespan of task is decreases after a certain value in the number of tasks.

3.23. An Enhanced Hyper-Heuristic Scheduling Algorithm [17]

The proposed algorithm not only provides better results than the traditional scheduling algorithms, rather it overtakes the other heuristic scheduling algorithms, in resolving the workflow scheduling and map-task scheduling difficulties on cloud computing environments.

3.24. Energy Efficient Workflow Job Scheduling for Green Cloud [10]

It is a realistic model that consumes less energy and minimizes the CO2 emission. Resource utilization is maximized by using VM (virtual machine) allocation strategy that in turn enhances the system performance. Each task run without affecting the computational performance and ultimately the energy is efficiently used.

Table 1. Scheduling metrics analysed by the various job scheduling algorithms in cloud

Algorithms/ Parameters	Execution time	Response time	Waiting time	Flowtime	Completion time	Makespan	Throughput	Resource utilization	Arriving time	Performance	Cost	Load balancing	Trust	Reliability	Priority	Energy consumption	Deadline	Bandwidth	VM overhead
Min-Min algorithm	√				√														
User priority based Min-Min scheduling algorithm for load balancing in cloud computing.						√		√											
Max-Min algorithm	√				√														
Improved Max-Min scheduling model for task scheduling in cloud						√	√												
RASA algorithm	√				√														
Ant Colony Optimization (ACO) -inspired				√		√													
Hybrid Bee Ant Colony algorithm		√	√						√										
Particle Swarm Optimization (PSO) algorithm												√	√						
Bi –criteria priority based PSO workflow scheduling algorithm for cloud (BPSO)	√											√							
Dynamic level scheduling algorithm	√													√	√				
Dynamic scheduling algorithm based on threshold	√								√			√							
Improved cost – based algorithm for task scheduling in cloud computing environment											√	√							
Job scheduling algorithm based on Berger model in cloud resources						√												√	
An efficient multi queue job scheduling for cloud computing	√																		
STASR	√					√				√						√			
Stochastic Hill climbing – A soft computing approach													√						
Cat Swarm optimization (CSO)												√	√				√		
Tri queue job scheduling algorithm (TQS)	√								√										
CPROVISION									√			√							
Heterogeneous – earliest – finish – time algorithm (HEFT)							√												
An optimally fair dynamic task scheduling algorithm (OFDT's)	√											√						√	
The cloud least laxity first algorithm												√						√	
Credit based scheduling algorithm in cloud computing environment						√												√	
An Enhanced Hyper – Heuristic scheduling algorithm						√													
Energy efficient workflow job scheduling for green cloud																√			√

4. Conclusion

"Cloud computing has the potential to create an irreversible change in how computers are used around the world". The objective of the Cloud computing technology is to move any application stored on a computer in any corner by the user to a remote location, by eliminating all the standard components, including the operating systems and hard drives, which are necessary in today's computers and can be accessed online through a standard browser provided that the user must be registered with the cloud service. With cloud computing, scheduling algorithms always plays an important role. Scheduling of jobs and their task is mandatory. Cloud instead of looking for more additional resources, it makes u se of its existing one to meet all the requirements of its users. The scheduling metrics considered by various scheduling algorithms is analysed in order to make the scheduling in a more effective manner for the jobs (tasks) to complete their execution.

5. References

[1] Antony Thomasa, KrishnalalGa, Jagathy Raj V, *"Credit Based Scheduling Algorithm in Cloud Computing Environment"*, International Conference on Information and Communication Technologies (ICICT) 2014.

[2] BaominXu, *"Job scheduling algorithm based on Berger model in cloud environment"* Advances in Engineering Software 42 (2011), 419–425.

[3] S. Bilgaiyan, S. Sagnika and M. Das, *"Workflow Scheduling in Cloud Computing Environment Using Cat Swarm Optimization"*, 978-1-4799-2572-8/14/$31.00_c,IEEE, 2014.

[4] BörjeOhlman and René Rembarz, *"What Networking of Information Can Do for Cloud Computing"*, 18th IEEE International Workshops on Enabling Technologies: Infrastructures for Collaborative Enterprises.2009.

[5] BrototiMondala, KousikDasgupta and Paramartha Duttab, *"Load Balancing in Cloud Computing using Stochastic Hill Climbing-A Soft Computing Approach."*, Procedia Technology 4, 2012. PP. 783 – 789.

[6] W. Chen and J. Zhang, *"An Ant Colony Optimization Approach to a Grid Workflow Scheduling Problem With Various QoS Requirements"*, IEEE Transactions on Systems, Man, and Cybernetics - Part C: Applications and Reviews, Vol. 39, No. 1, January 2009.

[7] CristianMateos, ElinaPacini and Carlos GarcGarino, *"An ACO-inspired algorithm for minimizing weightedflowtime in cloud-based parameter sweep experiments"* (2013).

[8] S.Devipriya and C.Ramesh, *"Improved Max-Min Heuristic Model For Task Scheduling In Cloud"*, IEEE 2013.

[9] FazelMohammadi , Dr.ShahramJamali and MasoudBekravi, *" Survey on Job Scheduling*

algorithms in Cloud Computing" International Journal of Emerging Trends & Technology in Computer Science (IJETTCS) Volume 3, Issue 2, March – April 2014.

[10] Fei Cao and Michelle M. Zhu, *"Energy Efficient Workflow Job Scheduling for Green Cloud"* in IEEE 27th International Symposium on Parallel & Distributed Processing Workshops and PhD Forum, 2013.

[11] Gokilavani M, Selvi S and Udhayakumar C., *"A Survey on Resource Allocation and Task Scheduling Algorithms in Cloud Environment"*, International Journal of Engineering and Innovative Technology Volume 3, 2013.

[12] Haluk, T, Salim, H., and Wu, M.Y, *"Performance-effective and low complexity task scheduling for heterogeneous computing"*, IEEE Transaction on Parallel and Distributed Systems, vol. 13, no.3 pp: 260-274, Mar 2002.

[13] Huankai Chen, Professor Frank Wang, Dr Na Helian and GbolaAkanmu *"User Priority Guided Min-Min Scheduling Algorithm For Cloud Computing"*, IEEE 2013.

[14] Karthick A V and Dr.E.Ramraj, R. Ganapathy Subramanian, *"An Efficient Multi Queue Job Scheduling For Cloud Computing"*, IEEE 2014.

[15] Klaithem Al Nuaimi, Nader Mohamed, Mariam Al Nuaimi and Jameela Al-Jaroodi, *"A Survey of Load Balancing in Cloud Computing: Challenges and Algorithms."* IEEE Second Symposium on Network Cloud Computing and Applications. 2012.

[16] Ma L, Y. Lu, F. Zhang and S. Sun, *"Dynamic Task Scheduling in Cloud Computing Based on Greedy Strategy"*, Springer-Verlag Berlin Heidelberg, (2013).

[17] R. Priyanka and M. Nakkeeran, *"An Enhanced Hyper-Heuristics Task Scheduling In Cloud Computing"*, International Journal of Computer Science and Mobile Computing. ISSN 2320–088X IJCSMC, Vol. 4, Issue. 2, February 2015, pg.130 – 135

[18] Quentin Perret1, Gabriel Charlemagne1, Stelios Sotiriadis2, Nik Bessis2 *"A deadline scheduler for jobs in Distributed systems"*. 27th International Conference on Advanced Information Networking and Applications Workshops.2013.

[19] RajkumarBuyya, *"A Particle Swarm Optimization-based Heuristic for Scheduling Workflow Applications in Cloud Computing Environments, Cloud Computing and Distributed Systems Laboratory"*, Department of Computer.

[20] Rajveer Kaur and SupriyaKinger, *"Analysis of Job Scheduling Algorithms in Cloud Computing"* International Journal of Computer Trends and Technology (IJCTT) – volume 9 number 7 – Mar 2014.

[21] Ram Kumar Sharma and Nagesh Sharma, *"A Dynamic Optimization Algorithm for Task Scheduling in Cloud Computing With Resource Utilization"*, International Journal of Scientific Engineering and Technology, Volume No.2, Issue No.10, pp. 1062- 1068.

[22] S. Saxena and S. S. Chouhan, *"OFDTs:-An Optimally Fair Dynamic Task Scheduling Algorithm in Cloud Environment"*, 978-1-4799-5173-4/14/$31.00, IEEE, (2014).

[23] S. Selvarani and G.S. Sadhasivam, *"Improved cost-based algorithm for task scheduling in cloud computing"*, computational intelligence and computing research, pp.1-5, 2010.

[24] ShamsollahGhanbaria and Mohamed Othmana, *"A Priority based Job Scheduling Algorithm in Cloud Computing"*, Procedia Engineering 50, and PP. 778 – 785(2012).

[25] Sonia Sindhu, *"TASK SCHEDULING IN CLOUD COMPUTING"* International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 4 Issue 6, June 2015.

[26] Thomas Yeboah and Odabi, *"Hybrid Bee Ant Colony Algorithm for Effective Load Balancing And Job Scheduling In Cloud Computing"*. West African Journal of Industrial and Academic Research April 2015 Vol.13 No. 1.

[27] Verma and S. Kaushal, *"Bi-Criteria Priority based Particle Swarm Optimization Workflow Scheduling Algorithm for Cloud"* Proceedings of 2014 RAECS UIET Panjab University Chandigarh, 06-08 March, 2014.

[28] Wei Wang, GuosunZeng, Daizhong Tang and Jing Yao, *"Cloud-DLS: Dynamic trusted scheduling for Cloud computing"*, Expert Systems with Applications 39, PP. 2321–2329(2012).

[29] S. Zaman and D. Grosu, *"Combinatorial Auction-Based Dynamic VM Provisioning and Allocation in Clouds"*, Third IEEE International Conference on Coud Computing Technology and Science, (2011).

[30] N. Zanoonand D.Rawshdeh, *"STASR: A New Task Scheduling Algorithm For Cloud Environment"*, Network Protocols and Algorithms ISSN 1943-3581 2015, Vol. 7, No. 2.

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