International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-4, November 2019

Task Scheduling Allocation based on Task Completion Time in Cloud Environment

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Abstract*: Cloud computing is a prominent computing model wherein shared resources can be given as per the customer request at a time. The available resources in the cloud are gathered to execute several tasks that are submitted by the customer. While implementing the tasks, there is a need to optimize performance in terms of execution time, response time and resource utilization of the cloud. The optimization of the mentioned factors in the Cloud Computing can be achieved by one of the major areas known as Load balancing which refers to dealing with client requests from diverse application servers that are functioning in the cloud. An efficient Load Balancing algorithm enables the cloud to be more proficient and enhances customer contentment. So, this survey paper highlights the latest studies regarding the application of Load Balancing techniques for task allocation such as resource allocation (RA) strategies, cloud task scheduling centered on Load Balancing, dynamic Resource Allocation schemes, and cloud resource provisioning scheduling heuristics. Finally, Load Balancing performance for task allocation methods is compared based on task completion time.

***Keywords*: Load Balancing, Cloud Outage, Task Scheduling.**

I. INTRODUCTION

Cloud Computing is an intensifying technology and new trend for computing based on virtualization of resources. On-demand access is an essential factor of cloud computing where the service providers of cloud environment follow a pricing model of pay per use in which the users or the consumers need to pay only for the services they have utilized. Essentially the customer requests are being served by the cloud service providers from anywhere to any corner of the world through virtualization. Datacenters act as the main engines for cloud computing architecture and they play a great role in data storage, processing, and computation. The customers can access the data or the resources as per their need.

Depending upon the resource type used the cloud service models were classified as provision of Software, Platform, and Infrastructure. As everything is provided as a service by the cloud service provider(CSP), there will be a huge demand for the cloud resources and it affects the performance level at the back end, that is the data center. There will be virtual machines which have a great load and could not able to process all the requests that were submitted to the virtual machine by the clients. In such cases, the concept of distributing the load on the cloud has evolved in the name of load balancing. If the resources at data centers are being affected by the imbalance of load assigned to them for processing the requests that are demanded by the customers, there is a great effect on resource utilization that violates the service level agreement (SLA). Equal distribution of the load on the cloud environment either statically or dynamically enables the cloud environment to withstand with its load imbalances and provided demanded services to the customers.

The concepts of scheduling the tasks and migration of tasks in VMS were introduced so that no resource would be left under-utilized or over-utilized. Scheduling of tasks which can be said as cloudlets supports the cloud to deal with the huge demand of requests raised by the customers. Scheduling of cloudlets mainly addresses the challenge of maintaining the load on the cloud environment by guaranteeing equal distribution of workload. This paper discusses the scheduling in cloud computing that deals with load imbalance and maximizes resource utilization.

A. Scheduling in Cloud computing

Proper resource utilization in cloud computing helps the cloud environment to avoid bottlenecks due to raised demand. To make the best use of resources there is a need for scheduling in the cloud environment. Scheduling the resources according to the demand involves a challenge of distributing the load on each resource in an effective way for achieving maximum throughput. The scheduling process collects all the tasks that are submitted in the task queue and assigns them to VMs according to some criteria. And those criteria can be task-based scheduling or VM based scheduling. The scheduling methods also concentrates on SLA and Quality of Services (QoS).

Scheduling of resources in cloud computing can be done in two levels that are either at VM-level or Host-level. If scheduling is done at the VM level, the tasks that are submitted for execution are assigned to a job or task scheduler which is utilized by a VM. Whereas the VM is assigned to the physical hardware when scheduling is done at the host level.

B. Task Scheduling in Cloud computing

In task scheduling, the user submits the task to the system. Now, from the task queue, the tasks move from the task queue to task scheduler.

Manuscript published on November 30, 2019.
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Once the tasks are picked up by the scheduler, the following steps are to be followed in a sequence. Initially, when the task is received at the scheduler level it analyzes the task type and saves the analyzed information into a configuration file.

- Later the task is decomposed into several parts:
- Every task will be submitted by the user is associated with an attachment that describes the requirements of the task.
- The schedulers read the description and assign the required resources that are needed for the task execution as per the demand of the customer.
- This is done by a policy namely resource provisioning. As per the instructions of resource provisioning policy, there will be a mapping between the resources allocated and tasks submitted.

This way the scheduling of tasks and allocation of resources to the tasks is done in cloud computing. The following figure depicts the process of the scheduling of tasks in the cloud environment.

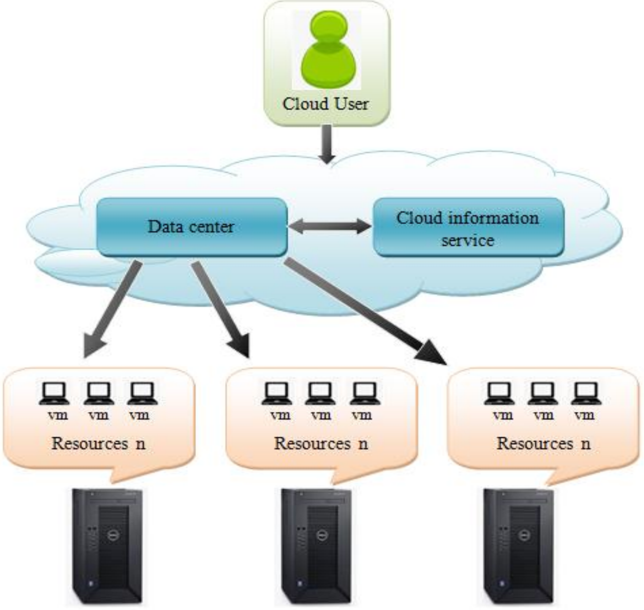

Figure 1: Task scheduling in CLOUD COMPUTING

C. VM Scheduling in Cloud computing

A VM stands as software execution of computing surroundings where the operating system resides, or it is an application program that can be installed as well as run on the operating system. Significant parameters associated with VMs are Number of VMs utilized through applications, Time-taken to make a new VM, to shift an application as of one VM to another, to allocate additional resources to VM Scheduling the fundamental processing units in computing surroundings has constantly been a significant issue. Similar to any other sort of processing unit, VMs require to be scheduled in the cloud to minimize response time, to do the job quicker, and devour less energy [9]. With the help of virtualization technique, all the physical resources that reside at different locations are being assigned to the VM. By using the technology of virtualization, we can make the cloud environment accessible from anywhere by anyone who wishes to utilize the services of the cloud. It also promotes cloud features like scalability and flexibility [10].

This type of scheduling policy in which scheduling at VMs plays a major role, the tasks that are submitted by the user are assigned to the VMs after that those are deployed at various machines that act as hosts. Scheduling of tasks at VM level aims at sharing of resources and achieving QoS constraints and performance of the system. When there is a scheduling policy done at VM level it follows the following sequence.

1. For the collections of VMs, find the apt Physical Machine.
2. Ascertain the correct provisioning scheme for the VMs.
3. Scheduling the tasks on the VMs.

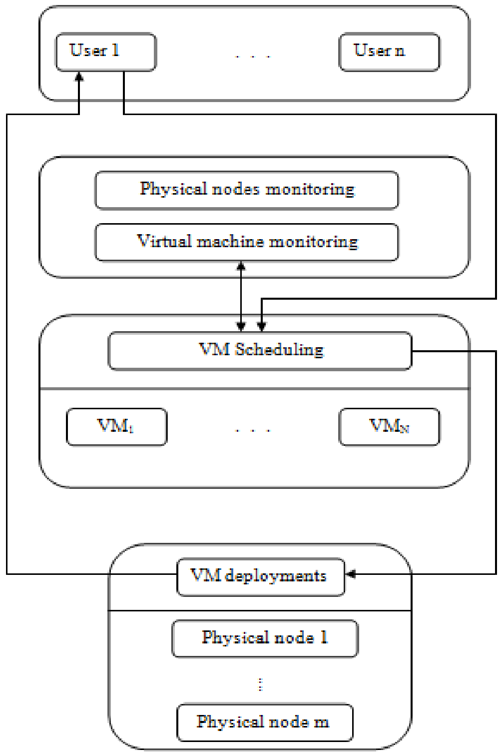

Figure 2: Process of VM scheduling

Figure 2 depicts how VM Scheduling is done at cloud datacenter

II. RELATED WORK

A. Resource Allocation Strategies in Cloud computing

Seyedeh and Saleh [13] suggested allocation policy which is a double action-centered method for allocation of VM in Cloud Computing environments. In this mechanism, the allocation is developed as an integer linear programming model that increases efficiency in allocating the VM's. This mechanism is used for increasing revenue of cloud service providers. This algorithm aims to increase the allocation performance with an optimization model of the heuristic algorithm.

Lixia *et.al* [14] recommended a multiple-QoS load balance RA (MQLB-RAM) centered on RA techniques. There are two phases to this methodology. In the first phase, the virtual peers which are created will be allocated to physical hosts. Whereas in the second phase, the tasks or the cloudlets which are forwarded to the virtual peer by particular user or customer, will be bonded respectively. In this algorithm, the main focus is on assuring the workload balance to make economical use of resources. This algorithm checks for the matching between peer requirements and availability of the resources.

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DOI:10.35940/ijrte.D7409.118419
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Durgadevi and Srinivasan [15] presented a Hybridized Optimization algorithm for resource allocation in a cloud server. SFLA section performs several steps like how to initialize the size of the request submitted by the customer, how the requests are being generated, and how the fitness value estimated, the process of sorting the requests and the final evolution of the user request. created the requests, and estimated the SFLA's fitness value, sorted, divided as well as evaluated the requests of the user. This algorithm is a combination of SFLA and CS to overcome the drawbacks of some other load balancing algorithms.

Guiyi *et.al* [16] introduced an algorithm which is a game-theoretic method used for scheduling the tasks in the cloud computing environment. To resolve the problem of resource allocation this algorithm uses game theory. This methodology comprised two steps: i) each participant solved its optimal issue autonomously, without the deliberation of the facing the problem of resource allocation. For solving and achieving the optimization, an Integer Programming method was proposed, and this method is binary. ii) this algorithm is also meant to devise a method that gives optimal solutions to minimize the loss in efficiency of the cloud environment.

Anton *et.al* [17] presented an algorithm for effective management concerning energy-aware issues of cloud computing. This algorithm aims at the improvement of efficiency of the data center in a cloud environment as far as the energy is considered. This paper also performed a research survey to know how cloud architecture is built to maintain the efficiency factor as far as energy is concerned. The survey continued with some allocation policies that deal with the resources and their availability for assigning them to VM's by taking into consideration of Quality of Services (QoS) factors and device power utilization and characteristics. Finally, this paper also presents the challenges in the current research world that a cloud environment facing to know how it could be advantageous for consumers and resource providers of the cloud computing environment.

Chunlin *et.al* [21] propounded optimization-based resource allocation algorithm. The authors have proposed this mechanism especially for the cloud environment to work as software as a service. To satisfy the end-user requirements and to provide a better solution for the allocation of resources, this approach uses a decomposition method for providing optimized results in terms of profit for the cloud service providers. After all the algorithm is being compared with other too formerly proposed algorithms and gives better results in terms of success ratio of execution time, efficient utilization of the resource, and the profit for CSP's.

Tamanna and Mohanty [22] introduced a Genetic Algorithm-centered Customer-Conscious resource allocation. There will be a consistent change of requirements for the customers when they want to use Cloud services. The cloud service provider must understand the frequency change of requirements for the customer and they need to maintain the cloud environment always to increase the customer satisfaction rate. So, this algorithm is proposed to clear the gap between the consumer and the cloud services. The combination of Genetic algorithm with the shortest task scheduling make the algorithm to be conscious about customer requirements. The idea behind the algorithm is, the cloudlets or the tasks are assigned to VMs in the multi-cloud environment to reduce the makespan time and increase the rate of satisfaction among the customer group. The results produced by conducting experiments and are compared with previous scheduling algorithms and shows that this algorithm outperforms well than the existing algorithms as far as some metrics are concerned.

B. Dynamic Resource Allocation Schemes in Cloud computing

Jixian *et.al* [23] suggested an online auction mechanism centered on the user's right to select the resources and to increase the revenue of service providers. Multiple requests can be submitted by the consumers to the cloud for computation and it follows the principle of pay for what you use model. Even though the customer can reach the cloud environment with multiple requests only a single request can be served at a time. With the proposal of this algorithm, it can be assured that social-economic benefit is increased, and the mechanism is efficient in obtaining the allocation results. This heuristic algorithm works according to the customer requirements awareness and the economical benefit expectations of the resource provider.

Tan *et.al* [24] submitted two dynamic RA schemes, named Speed Switching (SS) scheme, as well as Speed Increasing (SI), to diminish the waiting time expenditure and also that of the complete storeroom, correspondingly. Theoretical analysis along with simulation outcomes proved that this scheme could successfully lessen the expenditure of storage resource, besides, had kept the downloaded time small enough for excellent user experience.

Jing and Xin-fa [25] proposed an optimum computing allocation policy which concentrates on hybrid differential parallel scheduling. Just to classify the computing resources attributes, there is a specific method, which uses cluster samples, is used which gives the analytical information of the available resources for task scheduling. To balance the workload among the resources available, another method that follows the probability for the allocation is used. The resources available and assigned for particular tasks will have some characteristics and those characteristics were taken into account as neighboring samples and are framed as a set of vectors that are standard and using single value decomposition method optimal resource allocation is attained.

Seokho *et.al* [26] presented a framework for the Cloud environment to assure it achieves the SLA. This framework is used for the resource allocation of the cloudlets by considering the intensity of the workload and datacenters location which are distributed at different geographical places. This framework proposes a mechanism which negotiates SLA automatically and it also promotes the implementation of agent-based cloud.

Shahin [27] presented a system model to place the VMs for scheduling the jobs for power consumption to be optimized by using column generation technique. Of time heterogeneity of the workload which could be increased because of the continuous arrival of the tasks. A time axis is maintained for each job to know about the completion of the task and continuously the time slots are verified for the task completion whether it is fully completed or partially completed. If any task is partially completed, then it frees up the VMs by following Bernoulli trials.

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The time axis of job completion shows how many jobs are partially fulfilled and how many are completed to know the workload of the VM's. The concept of VM migration is used to save the energy and balance the load for the unfinished jobs.

Wei *et.al* [28] proposed an algorithm that considers the multi-tenant environment characteristics. This algorithm is based on a model of Stackelberg game in association with the hidden Markov model in a cloud environment. This model is intended to maximize the profits and reduction in cost for both service provider and customer respectively. Stackelberg game is used for the prediction of the bidding dynamically and for selecting the optimal policy forbidding to achieve the maximum resource utilization and profits. It has proved with the help of experimental analysis that the actual transaction price is near to the amount of predicted price.

Weiwei *et.al* [32] propounded a strategy that utilized VM as the minimal RA unit. Also, the threshold centered dynamic RA structure for Cloud Environment which has not only observed but also estimated the resource requirements of the cloud-related applications to adopt the resources virtually to the applications' original needs were propounded. The strategy could dynamically re-configure all resources which are accessed virtually according to the change of load on the resources provided for the particular task in the cloud environment. The utilization cost for the user as per their dynamic need can be reduced and as well there will be an efficient resource utilization is maintained when one examines the results obtained by the users.

Table 1: Analysis of dynamic resource allocation schemes in Cloud computing

Researcher Name and year	Model Used	Purpose	Limitations
Jixian et.al [23]	Heuristic algorithm to attain the RA	Attain allocation outcomes quickly and also augment the social welfare of the cloud resource provider	It consumed more execution time and practicality of the auction mechanism is poor.
Jing and Xin-fa [25]	Hybridized differential parallel scheduling	RA in CLOUD COMPUTING	It consumed much time for allocating the resources in CLOUD COMPUTING.
Seokho *et.al* [26]	SLA centered CLOUD COMPUTING	Enable RA.	High Operational cost.
Wei *et.al* [28]	Cloud RA model centered on an imperfect information Stackelberg game (CSAM-IISG)	RA	Diminished efficiency.
Sokol *et.al* [30]	ThinkAir	Smartphone virtualization at the cloud.	Consumes much time.

C. Cloud Task Scheduling Based on Load Balancing

Keng-Mao *et.al* [33] gave a methodology for scheduling the virtual machines by aiming the equal distribution of load on the cloud environment. And the name of the algorithm is an ACOPS (Ant Colony Optimization (ACO) with Particle Swarm (PS)). This algorithm uses previous data about the workloads and uses that information to predict the upcoming requests flow to become accustomed to environments which change dynamically. The computing time is being diminished by the usage of the ACOPS algorithm as the requests which could not be satisfied by the scheduling policy are not accepted for processing and this could deal with the workload imbalance in the cloud environment. diminish the scheduling time, this paper utilized pre-reject modules to lessen the solution dimensions and integrated the PSO operator to augment the convergence speed of the ACO scheduling procedure. This methodology could be employed with limited information and utilized the workload of past requests for predicting the workload with new input requests. Experiential results signified that the proffered algorithm could hold the load balance in a dynamic environment and also could outperform the other methodologies. The proposed algorithm helps the cloud to withstand and balance the workload.

Priya et.al [37] recommended F-MRSQN (Fuzzy-centric Multi-dimensional Resource Scheduling and Queuing Network) methodology for effectual resources scheduling and also for optimization of the load for every customer request with the efficient progress of data center. A multidimensional queueing network framework was executed for LB in cloud infrastructure. It could effectually augment effective scheduling of resources and average success rate using Multi-dimensional Queuing Load Optimization algorithm. Thereafter by using F-MRSQN, the computational complexity of tasks is reduced with effective distribution of load on the cloud environment.

Tamilvizhi and Parvathavarthini [38] put forward a perspective on employing a fault-tolerant framework that glooms the cloud server execution with the cloud selection. To shield health monitoring and network congestion as of fault detection with migration method, it adaptively managed the appearance of faults. It effectually diminished the data-unavailability that Cloud computing used on the amount of the network traffic in the cloudlets of the cloud server.

Hicham et.al [39] propounded a frame for TS optimization centered on dynamical dispatch queues and hybridized meta-heuristic (MH) algorithms. This methodology utilizes '2' hybridized MH algorithms, the initial one utilizing Fuzzy Logic with PSO Algorithm (FLPSO), and the next one utilizing Simulated Annealing with PSO algorithm (SAPSO). The target of this methodology was to attain the best order of tasks to diminish the waiting time. Several tests were done to evaluate this methodology's performances when contrasted to other works as of literature like PSO-LDIW, SGA, MGA, MACOLB, and PSO-RIW.

Sanjaya *et.al* [40] proffered a pair-centric TS algorithm for Cloud Computing environment, which was grounded on the eminent optimization algorithm, termed Hungarian algorithm (HA). Therefore, the algorithm regarded unequal clouds and jobs and paired the jobs to make a scheduling decision. Subsequently, simulate this algorithm and contrast it with '3' prevailing algorithms, a) first-come-first-serve, b) HA with lease time along with c) HA with converse lease time in 22 disparate datasets. The performance assessment evinced that this algorithm generates good layover time in contrast to prevailing algorithms.

Mahendra and Subhash [41] recommended a heuristic strategy that integrates the i) MAHP (Modified Analytical Hierarchy Process), ii) BATS (bandwidth aware divisible scheduling) + BAR optimization, iii) divide-and-conquer and iv) LEPT (Longest Expected Processing Time) Pre-emption methodologies to execute RA and TS.

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DOI:10.35940/ijrte.D7409.118419
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In this strategy, every task was done before its original allocation to the cloud resources utilizing a MAHP procedure. The RA was done utilizing the integrated BAR + BATS optimization methodology, which regarded the load and bandwidth of cloud resources as constraints. The divide-and-conquer methodology ameliorated this methodology, as was proven experimentally via contrasting to the prevailing BATS and IDEA (improved differential evolution algorithm) prototypes when response and turnaround times were utilized as performance metrics.

Table 2: Analysis of cloud task scheduling based on load balancing

Researcher Name and year	Model Used	Purpose	Limitations
Fahimeh *et.al* [34]	Task-centered system LB methodology utilizing PSO (TBSLB-PSO)	TS in CLOUD COMPUTING.	TS performance is bad.
Dhinesh and Venkata [35]	HBB-LB	Attain a balanced load on VMs for elevating the throughput.	LB with only self-standing tasks.
Chunlin *et.al* [36]	A replica-aware TS algorithm.	To diminish the response delay.	Data de-duplication issue cloud computing
Hicham *et.al* [39]	TSDQ (Dynamic dispatch Queues) and hybridized MH algorithms.	TS Optimization.	Few QoS parameters are taken.
Mahendra and Subhash [41]	heuristic strategy	Execute TS and RA.	Turnaround time together with response time is bad.

D. Cloud Resource Provisioning and Scheduling Heuristics

Sukhpal and Rajkumar [43] propounded an approach for self-managing the cloud resources to execute the workloads which are formed as cluster by using a method termed as SCOOTER that effectually organize the execution of the tasks by provisioning available resources in the cloud environment and upholds the SLA (i.e. Service Level Agreements) by concerning features for management of the cloud . And also the maximal feasible QoS parameters were needed to improve cloud-centric services. Lastly, the performance of SCOOTER's was appraised on a cloud environment which describes the QoS parameters with optimization namely EC (Cost associated with the execution of task), SLA violation rate, detection of faults rates, time to execution, resource usage, resource conflict, waiting time, throughput and intrusion detection rates.

Sukhpal and Inderveer [44] suggested a QoS-centric resource provisioning and scheduling prototype. Primarily, the expectations and requisites of a cloud user are collected. Subsequently, workloads were examined and clustered in respect of their patterns. They were re-clustered depending on QoS metrics utilizing k-means-centered clustering algorithm. Furthermore, scheduling was done depending on disparate scheduling policies.

Long and Xiaoping [45] introduced an iterative population-centric MH. As per the shift vectors attained at the time of the search, timetables were made rapidly. The pertinent amounts of on-demand or reserved resources were evaluated by an incremental optimization methodology. The usage of every resource was balanced in a propitious way and with this, its probabilistic matrix got updated for performing the subsequent iteration. The introduced algorithm was contrasted to modified prevailing algorithms for similar issues. Experiential results delineated the algorithm's effectiveness.

Parmeet and Shikha [46] proffered an ameliorated Shuffled Frog Leaping Algorithm (ASFLA) centric technique for RP and also workflow scheduling in an IaaS (Infrastructure as a service) cloud environment. The ASFLA's performance was contrasted with the top-notch SFLA and PSO algorithms. The ASFLA's efficacy was appraised over some eminent scientific workflows of disparate sizes utilizing a custom Java-centric simulator. The outcomes evinced a marked augmentation in the performance conditions of attaining minimal execution cost and satisfying the schedule deadlines.

Maria *et.al* [47] suggested an RP and scheduling methodology that resolves ambiguities and also performance variability of the cloud and workload. Customize the MH for resolving combinational optimization issues. RP and scheduling decisions – whilst optimizing disparate metrics, namely i) application execution time and ii) monetary leasing costs of cloud resources – were made on cloud computing out of ambiguities met in Cloud Computing environments. The tests evinced that the RP and scheduling plans recognized by this methodology nicely handled ambiguities and assured that the application deadline was met.

Meenakshi *et.al* [48] suggested the strategy that made resource allocation with the least waste and utmost gain. Subsequently, the requests are raised by the customer and are submitted to the allocation manager, which in turn forward in the direction of the request tuner. Now the resource tuner verifies for the parameters defined by QoS. According to the verified parameters, the clustering is done and then optimization of resource utilization is done by an algorithm namely GWO and the allocation of resources is done according to the priorities associated with the description file of the tasks.

Babak and Ioannis [49] recommended the BSDS (Block Software-Defined Storage), a prototype for orchestration to be automated, management, and deployment of the system storage by isolating the data layer as of control. This black box strategy permitted BSDS to become stronger when there is a change made in the considered infrastructure, and the knowledge as of the internal condition of the storage back-ends was not requisite. Consequently, the self-learned scheduler was fully decomposed to the down-stream infrastructure. This prototype assessed '3' policies say, the *StrictQoS*, *EfficiencyFirst* and *QoS First.*

Performance of disparate TS algorithm was contrasted grounded on the task completion time, which is delineated using figure 3,

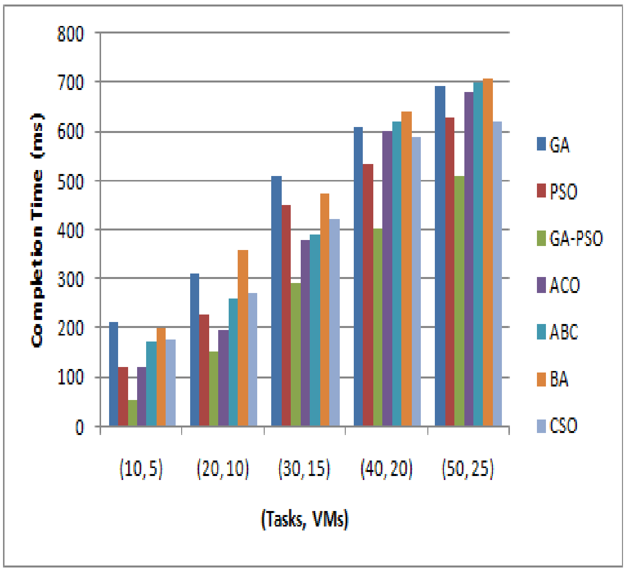

Figure 3: Completion time of the different task scheduling algorithms used in Cloud computing

Figure 3 contrasts the completion time of the disparate TS algorithms say GA, PSO, and GA-PSO [53] ACO, ABC, BA, and CSO. ACO, ABC, BA, PSO, and CSO are the swarm intelligence centered methods and GA algorithm is Bio-Inspired methodology. Tasks vary as of 10 to 50. The completion time is different for disparate scheduling algorithm. From this observation, hybridization of the disparate algorithms takes less time for completing the process. Also, they perfectly allocated resources on the cloud server and executed better scheduling operation

III. CONCLUSION

Task allocation and LB have been thoroughly researched in past decades. Here, several related studies and its results are presented concerning this topic. This paper proffers a literature survey on various LB techniques for task allocation in a Cloud environment. The various sorts of TS algorithms and their respective limitations are delineated briefly. This literature work enlightens various prevailing LB methods say, RA strategies, cloud TS centered on LB, dynamic RA schemes in Cloud Computing, and cloud RP scheduling heuristics for task allocation. Future work addresses the current research problem that was discussed above. Using the hybridized TS algorithms showed better results to assign the resource for computing the requests in the Cloud Computing environment. It will be more motivating in the upcoming years to enhance the performance of the task allocation approaches.

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