

# Timing of Resources in Cloud Computing by using Multi-Purpose Particles Congestion Algorithm

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## Abstract

Cloud computing has been recently emerged on internet as a model for hosting and providing services. Such model is impressive for business owners due to that there is no more need the users to declare their requirements to prepare a plan for answering them, therefore, an organization can start its work in small size and add more resources only when demand for services is increased. In addition to it, Cloud computing provides more advantages for organizations and individuals. For this reason it has become a hot topic in academic and business environments and as it was expected, many are attracted and nowadays we are facing with many cloud service providers. Generally, resources management within cloud environment, due to their heterogeneity, is a complicated issue. Timing algorithms within parallel distributed systems are playing important role for tasks timing and sending them to the appropriate resources. Timing issue is a technique for equitable distribution of resources to clients and it is for achieving optimal productivity of resources with least responding time and more importantly is to avoid extra overhead on resources. Timing issue in its kind is a NP issue. Therefore its solution through multi-purpose developmental algorithms is an appropriate method. Two purposes of time minimization of task completion and finishing cost to the customer in task timing within cloud environment has conflict and inconsistency that current optimal single-purpose methods cannot resolve them. Therefore, use of new methods by multi-purpose optimization capability provides optimized response according to optimization of all purposes approach. In this research the issue of independent task timing by the purpose of lowest price, least completion time consumption and maximum load balancing within system by using optimized multi-purpose particles congestion algorithm has been studied and it is concluded that the recommended method in comparison with multi-purpose genetic algorithm has better results.

**Keywords:** Cloud Computing, Multi-Purpose Optimization, PSO Algorithm, Timing

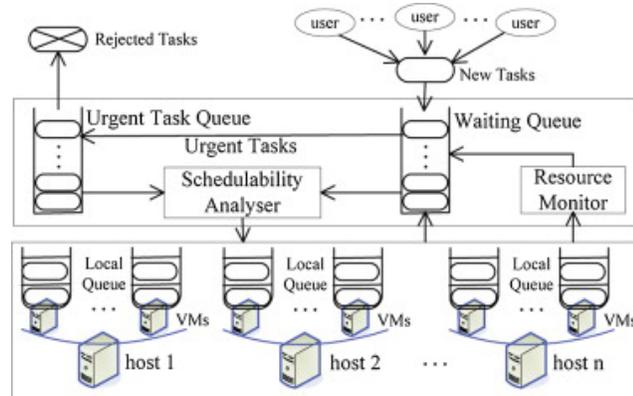
## 1. Introduction

The development of computing is such that we can assume it as fifth public industry after water, electricity, gas and telephone. In such mode, the users are trying to access based upon their requirements and regardless to where a service is located or how it provides the information. Cloud computing is a computing method based upon big computer networks like internet which presents fresh model for distribution, consumption and providing information technology services (including hardware, software, information and other shared computing resources) by using internet. In such status, users are

trying to access based upon their requirements and regardless to service location and the way of provide<sup>1</sup>. Task timing is to allocate resources to tasks during a determined time period that optimization is following one or several purposes. In issue of classic work-flow, set of tasks that are consisting of several operations, by passing through some steps, in an equal path, are processed. In such systems, timing shall be such that the minimum intended services quality is met for user. Usually, users tend to fulfill their tasks within least minimum time and also by minimum coast, by cloud service providers. On the other hand, cloud service provider tends to maximize operating power of his resources to increase his interests as well; these two are in

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conflict with each other and usually are not matched with traditional methods of allocating resources and available timing mechanisms.



**Figure 1.** Timing mechanism. d Cut Dimension – Pseudo Code.

In Figure 1, there is a timing mechanism. In this system, the input tasks enter into a waiting queue and then they enter into a timing analyzer. This part leads the tasks by pre-determined purposes to clusters of virtual machine located on kinds of host. In multi-purpose systems, several purposes shall be considered simultaneously. For this reason, such timing called multi-purpose timing or timing based on service quality.

During period of increasing workload in the system, when a task is requested by a client, it takes long time to lessen workload and the required resources will be allocated to the intended task. Such strategy is separated from task execution priority; in this case the task owner client can level up his priority by suggesting more amount for it and get accessed to required resources, this issue is considered as one of the chief objections of cloud computing. Current methods of resources allocation are performing a kind of unfair allocation regardless to task priority including FIFO and ROUND-Robin which are used in clouds. In most cloud services, task timing by considering such terms and also considering mentioned obligations within service level agreement is a complicated action. Typically cloud service providers undertake some items as their reliabilities in providing services to clients; therefore, any kind of resources allocation or tasks displacement from a resource to another one shall be done based upon the quality level of agreed service. Service timing is divided into two main categories; user-level and system level. During user-level timing

resolving of service fulfillment between service provider and clients is considered. Mostly such issue refers to economic issues including balance between supply and demand, competition among clients and relative minimizing clients' cost.

In recommended algorithm are considered for the purposes: Load balancing, Service quality, energy consumption in data centers, and time for completion of the work, Costs, equitable usage of resources and productivity of resources.

The issue of timing in cloud environment is a NP complement issue. Therefore, most of such issues are resolved through estimation methods of artificial intelligence like PSO and GA, since such methods are effective solutions for resolving these problems<sup>1</sup>.

The main advantage of multi-purpose algorithm of MO-PSO is that large number of congestion particles cause flexibility of the method against the problem of local optimized response and it has high convergence rate and it leads to find diversity and distribution of better non-defeated solutions in comparison with other multi-purpose algorithms. Since meta-heuristic algorithms are single-purpose and only cover one dimension of issues, in this research we are trying to improve solutions, to increase system performance and to decrease costs in proper time by using multi-purpose developmental algorithms.

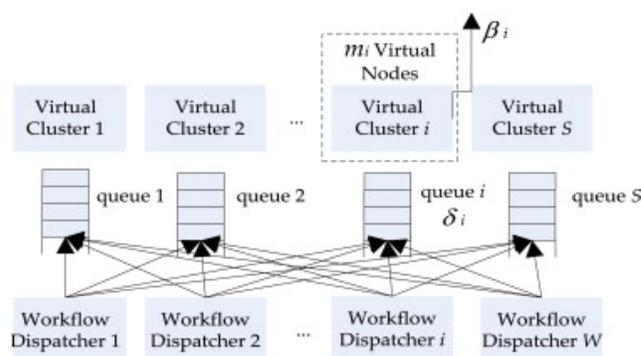
The algorithms can be divided into two groups online and batch, in online mode all the tasks are timed based on online and every task are given to one of the resources based on calling by scheduler. In batch mode, the tasks are timed in group way and the groups will be given to related resources by a shot pause.

Remarkable researching tasks in field of task scheduling and resources allocations in cloud computing have been done by using developmental algorithms. Mr. Wang et al<sup>2</sup> have designed resources scheduling model based on optimization algorithm of particles congestion, regarding to the features of cloud computing resources, time limitations, costs and users' demands. One of important issues for cloud resources providers is the decrease of electricity consumption. This issue causes decrease of operational costs and improvement of system reliability. Nawfal et al<sup>3</sup> have introduced a solution for minimizing power consumption within data centers and improvement their load balance simultaneously and have presented a scheduling algorithm in this regard. Mr. T Song et al<sup>4</sup> have presented optimization of task

scheduling issue and resources allocation by using improved differential-developmental algorithm based on cost and time in cloud computing environment. They are recommending a new algorithm which has the capability of global discovery in big space by combining Tagucci method and differential developmental algorithm. The cost model includes processing step, receiving cost and waiting time that it uses non-defeated multi-purpose optimization methods for finding Pareto strength in all costs and the time of tasks finishing. Mr. Lee<sup>5</sup> have suggested a plan of resources allocation for sharing borrowed resources economical on task scheduling algorithm. The purpose of implementing such research is to achieve high efficiency and fair distribution by simultaneous observance within cloud environment. Also in mentioned research, a model for forecasting task finishing time by considering complicated commercial decisions in order to allocated and schedule the resources have been presented.

Virtualization is a method that in addition to hiding physical resources, provides access to resources for users. In this method, the resources are shared or separated simultaneously among several different environments that are known as “virtual machine”. Mr. Zhang et al<sup>6</sup> multi-purpose scheduling based on presented sequential optimization developed by automatic community for optimizing the design of very complicated and dynamic systems. The behavior of sequential optimization has been used for servers’ virtual clusters in data centers. In Figure 2, a model of queue in resources allocation system has been presented for a virtualized cloud platform. Distributors of multiple work-flows distribute tasks to different queues. Each virtual cluster is used for receiving tasks from a specific queue. The major advantage of multi-purpose scheduling method is significant workload time decrease and at the same it is close to optimal performance of the system. Multi-functional work-flow in real workload of LIGO has been obtained from theory of Earth's gravitational wave analysis. Recommended algorithm produces a small set of semi-optimized scheduled solutions in high speed and efficient. This article indicates that searching time through semi-optimized work-flow scheduling has been remarkably decreased in comparison with using Mont Carlo method.

Mr. Bloglozov et al<sup>7</sup> first have presented an optimal architecture for efficient energy in cloud computing then based on above architecture, they have studied researching challenges in scope of resources allocation algorithms,



**Figure 2.** Queuing model for Virtual resource allocation system.

Mr. Bloglozov et al<sup>7</sup> first have presented an optimal architecture for efficient energy in cloud computing then based on above architecture, they have studied researching challenges in scope of resources allocation algorithms, resources providers and scheduling algorithms regarding to the level of expectations from service quality for efficient energy management. They have presented a method in order to allocate exploration energy-aware for providing data center resources that improves energy productivity in data center on dynamic workflow and providing service with quality, at the end the performance of recommended model is evaluated by using Cloudsim tool. Mr. Gasiur et al<sup>8</sup> have suggested a security-oriented solution for scheduling  $N$  independent tasks on  $M$  machines in parallel in order to minimize three different purposes. The purpose of such algorithm is to minimize failure probability, time of task finishing and the delay of each task entering. They use meta-heuristic algorithm, multi-purpose genetic algorithm with non-defeated ordering for resolving such issue. This approach based on dominant Pareto, not only presents appropriate solution, but also presents set of non-defeated solutions. Also in this research a mechanism in order to decide for choosing the best strategy for Pareto has been provided. Mr. Chen et al<sup>9</sup> have explained a strategy before immigration based on three dimensions of using processor, operational power of network and rate of read and write on disk. In order to receive an optimal solution, the combination of genetic algorithm with issue of backpack on several fitness functions to study the effectiveness of method has been tested. Mr. Zhang Wen et al<sup>10</sup> have presented a scheduling method based on a model from time-cost-trust on cloud computing resources by using sub-tree algorithm. This method can fulfill users’ concern for getting confident about obtaining resources and the efficiency of such

algorithm is high. In this method, three factors of time, cost and trust are introduced as three criteria, not as purpose. Therefore, in this research, optimal solution is not introduced. Ms. Ramezani et al<sup>11</sup> have presented a comprehensive multi-purpose model in order to optimize task scheduling for minimizing task performing time, task displacement time and cost of task performing. In this approach regarding to speed and accuracy of optimization particles congestion algorithm, multi-purpose algorithm based on multi-purpose particles congestion method for representing an optimal solution for the model has been used, and in order to implement and evaluate recommended model, they have developed MO-Jswarm algorithm.

Mr. Tan et al<sup>12</sup> have introduced three different methods, workflow scheduling model, phase modeling and multi-purpose linear planning modeling In order to optimize trustable workflow scheduling. In this algorithm minimal-maximal method of three elements of time, cost and trust are considered as main purposes. Mr. Wang et al<sup>13</sup> specifically have focused on decreasing energy consumption in data center. By combining data of energy-aware and place-aware in scheduling of some asks, a second ranked multi-purpose programming model based on decrease mapping in order to improve energy productivity in service providers has been presented. In this approach, first the changes of energy consumption by servers performance is determined and then regarding to that task scheduling strategies are depended on data placing policy, the place of data regarding to the status of current network will be adjusted dynamically.

In this article, a proper second ranked programming model by special encoding and decoding methods, by using multi-purpose genetic algorithm in order to speed up to converge has been presented.

Mr. Saloy et al<sup>14</sup>, is trying to design and develop Cloud Resources Broker (CLOUDRB) for effective management of resources and completion of the tasks in applicable programs by considering determined time-limit by user. In this article an applicable and integrated model for task scheduling based on determined time and optimized algorithm of particles congestion and regarding to resources allocation mechanism has been presented.

The purpose of this action is to minimize time of implementation and cost based on specific fitness function.

Mr. Fang et al<sup>15</sup> have recommended optimization particles congestion algorithm for the issue of resources allocation. The purpose of this algorithm is to find the best task scheduling within resources based upon the sum of implementing time duration, resources reserve and the quality of service on each task. The mechanism of non-defeated Pareto in this algorithm has been presented in order to search optimal multi-purpose solutions.

Mr. Lee et al<sup>16</sup> have presented an algorithm by the approach of load balance based on multi-purpose genetic algorithm. This algorithm has presented a new mapping among physical and virtual machines that has resolved the problem of lack of load balance by using set of immigration operators of virtual machines. Mr. Liu et al<sup>17</sup> have recommended an scheduling algorithm based on multi-purpose genetic algorithm. Such algorithm is specifically considering energy consumption decrease and increasing benefits from these services. Mr. Arabi et al<sup>18</sup> have recommended a task scheduling algorithm by approach of load balance based on ant colony algorithm. Such algorithm, has presented a method of optimized searching of resources for tasks allocation to virtual machines. Also in this article, in addition to approach of workload balance, minimization of task completion time duration is also considered.

Remarkable researching activities have been done in field of management, scheduling, resources allocation and scheduling of workflow within cloud computing by using developmental algorithms. One of the important issues for providers of cloud resources is to decrease electricity consumption. This issue causes decrease of operational costs and improvement of system reliability.

### 3. Method

The optimization algorithm of particles congestion is used for issues that the possible answer includes exploring in big searching environment of potential solutions. The issue that is presented here is the issue of tasks allocation to resources within cloud environment that has big solution searching space.

The important purpose in optimization of this issue is to minimize Makespan and cost function. We assume:

$n$  : Number of received tasks.

$T = \{t_1, t_2, \dots, t_n\}$  : set of received tasks.

$N_{PM}$  : Number of physical machines within cloud.

$m$  : Number of *VMs*.

$VM_j$  :  $j$  virtual machine  $j = \{1, 2, \dots, m\}$

$PM_z = \{k | VM_k \in z \text{ th}, z \in \{1, 2, \dots, N_{PM}\}\}$  : set of virtual machines that are placed in  $Z$  physical machine.

$SP_p = \{k | VM_k \in P \text{ th cloudprovider}, P \in \{1, 2, \dots, cp\}\}$  : set of virtual machines that are allocated to  $P$  provider.

$B_{ck}$  : Bandwidth between center and  $K$  virtual machine.

$cp$  : Number of cloud providers.

$C_p$  : Maximum capacity for  $P$  provider.

$x_{ik} = 1$  : if  $i$  task is allocated to  $k$  virtual machine,

otherwise  $x_{ik} = 0$

$DE_{ik}$  : The amount of data that  $i$  task is allocated to  $k$  virtual machine.

$VM_{m_k}$  : Memory capacity in  $k$  virtual machine.

$VM_{C_k}$  : Amount of capacity of  $k$  virtual machine.

$P_{\text{cost}_j}$  : The cost of one unit virtual machine for  $j$  provider.

$r_p$  : Total number of supported virtual machines by  $k$  provider that implements tasks in  $pt$  time period.

Time of task implementation on  $k$  virtual machine is

$T_{\text{exe}_k}$  that is calculated as below:

$$T_{\text{exe}_k} = \sum_{i=1}^n x_{ik} * \frac{DE_{ik}}{VM_{m_k} * VM_{C_k}}$$

Time of total implementation of task is equal to:

$$T_{\text{exe}} = \sum_{k=1}^m T_{\text{exe}_k}$$

Total time for transferring tasks is equal to:

$$T_{\text{trans}} = \sum_{k=1}^m \sum_{i=1}^n x_{ik} * \frac{DE_{ik}}{B_{ck}}$$

cost of implementing the tasks for providers is equal to:

$$C_{\text{exe}} = \sum P \text{ cost}_p * r_p * \left( \sum_{k \in SP_p} T_{\text{exe}_k} \right)$$

Which  $r_p$  is equal to:

$$r_p = \sum_{k \in SP_p} \min\left(\sum_{i=1}^n x_{ik}, 1\right)$$

### 3.1 Fitness Functions

Three of most important purposes considered in optimizations related to scheduling issue of cloud environment are: Makespan, cost and load balance. Load balance is highly significant due to having the advantages such as increasing resources efficiency and also response time decrease.

#### 3.1.1 Minimization of Makespan

Makespan or longest time length of task scheduler completion is the first purpose that is introduced as purpose function. Makespan means the longest completion time length among all system processors participating in scheduling. We assume that  $t_i$  indicates size of  $i$  task and  $C_j$  is the processing speed of  $j$  processor.

$$t_{\text{exe}}(i, j) = \frac{T_i}{C_j}$$

For each processor there will be a completion time from implementing tasks which are allocated to. for calculating Makespan, task completion time on each resource shall be determined to consider the longest as Makespan. Therefore, task completion time on each resource is obtained by using above equation:

$$t_{\text{complete}}(j) = \frac{\sum_{k \in A_j} T_k}{C_j}, 1 \leq j \leq m$$

Such that  $A(j)$  are set of tasks indexes that are given to  $j$  resource. Now we can calculate Makespan:

$$\text{Makespan} = \text{Max}\{t_{\text{complete}}(j)\}, 1 \leq j \leq m$$

### 3.1.2 Price Minimization

As it is mentioned, cloud providers can charge users for cost amount based on the amount of resource they used. Therefore scheduling algorithms in cloud environment considers users' requests for completion their applicable programs in most possible economic method to lessen the cost for them and also keep the clients satisfied. Therefore, the second purpose function is total cost of tasks scheduling implementation which shall be minimized. Assume that  $W_j$  is unit price of  $j$  resource for use per second. Therefore, the cost of  $i$  task implementation on  $j$  resource is obtained by using above equation:

$$\text{Price}(j) = t_{\text{complete}}(j) \times w_j$$

Then total cost for scheduling is calculated by equation below:

$$\text{Total Cost} = \sum_{j=1}^m \text{Price}(j)$$

### 3.1.3 Maximizing Load Balance

As it is mentioned, load balance mechanism is distribution of load on each evaluative resource fairly. Load balance maximizes resources and system efficiency and minimizes task implementation time. For obtaining such purpose, load balance mechanism shall be fair in distribution of load on all the resources and this requires the minimization of load difference between resource with heaviest load and resource with lightest load. In order to define load balance, first we determine the average of resources efficiency. For calculation of average of resources efficiency we shall first calculate expected efficiency of each resource based on given tasks which is obtained according to equation with division of tasks completion time of each resource to Makespan:

$$P_u(j) = \frac{t_{\text{complete}}(j)}{\text{Makespan}}, 1 \leq j \leq m$$

Please note that high amount of resource efficiency average is not always indicating appropriate load balance. Therefore, we calculate resource efficiency average:

$$\bar{P} = \frac{\sum_{j=1}^m P_u(j)}{m}$$

Now by minimization of square standard deviation mean,

$P_u(j)$  we can improve load balance in whole resources.

$$P_{msd} = \sqrt{\frac{(\sum_{j=1}^m P_u(j) - \bar{P})^2}{m}}$$

## 4. Discussion

In this part we simulate and evaluate the efficiency of recommended methods in last part about tasks scheduling by the method of multi-purpose optimization in cloud environment, therefore, we first obtain the best answer by using genetic algorithm and multi-purpose particles congestion with approach of two purposes of Price and Makespan, then we represent recommended three purpose algorithm with approach of Price, Makespan and Load Balance by the best algorithm regarding to its performance. The methods of evaluation, in cloud environment are trying to do schedule some of independent tasks. These tasks are the result of breaking applicable programs to executable smaller parts independently that the users give them to cloud environment for implementation. First we optimize tasks scheduling by standard algorithm with different but fixed mutation rates for optimization of two purposes of Makespan and price.

In order to study algorithm efficiency accurately, the average of number of repetitions by every mutation probability in 10 times test for establishing set of completed answers with all the population members are indicated in above figure. It is clearly shown in Figure 4 that the mutation probability of 0.35 produces the quickest optimized answer.

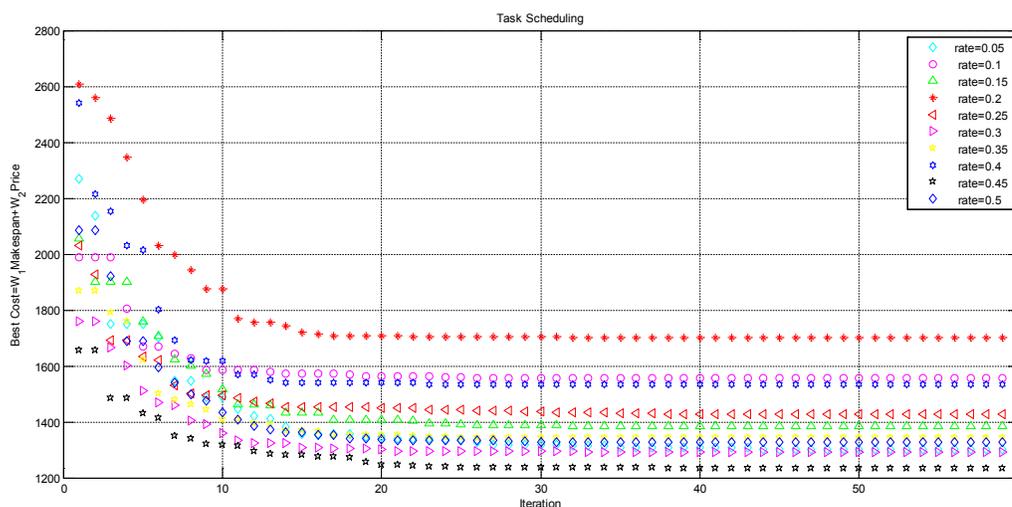
**Table 1.** The calculated crowding distance in a two-objective minimization problem

Parameter	Numbers
Population size	200
Number of generation	100
Number of tasks	500
Number of sources	50
Range of tasks	20-100(MI)
range of source cost	1-5(G\$/sec)
Range of processor's speed	2-10(MI/sec)
Number of tests	10
Number of optimal goals	2

**Table 2.** Parameters of Genetic Algorithm

	Cross Over Possibility	Mutation Probability
Multi Objective Genetic Algorithm	0.9	(0.05) 0.5 – 0.05

The obtained answer quality from above multi-purpose genetic algorithm with different mutation rates is indicated in Figure 3.



**Figure 3.** Two-dimensional optimal solutions to test the mutation rate 200 population.

As it is indicated in figures, multi-purpose genetic algorithm with approach of purposes' weights accumulation for different mutation rates has been implemented and

the results have been indicated in diagrams. Now the best choice of mutation rate is chosen and the results of above algorithm are compared with multi-purpose particles accumulation algorithm. In Figure 5, it is clear that multi-purpose particles mass algorithm in comparison with genetic algorithm indicates better results therefore continue of work will be resumed by algorithm of multi-purpose particles mass.

Here specifically three purposes of Makespan, price and load balance simultaneously by using multi-purpose optimization algorithm for the issue of task scheduling, optimization and Pareto will be established for them. We have studied the issue by algorithm of particle mass and by population rate of 200 and 500, and the results are indicated in Table 4.

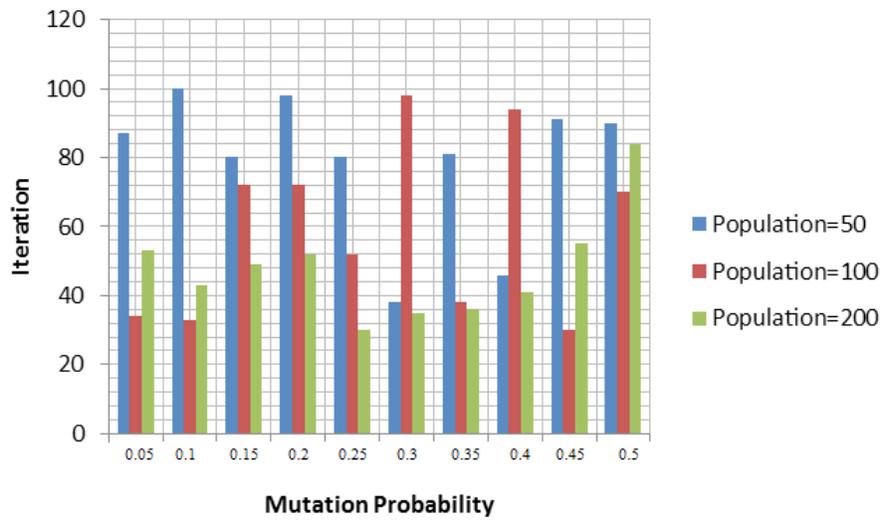
## 5. Conclusion

The resource model in cloud computing is such that all cloud resources are single processor and each resource has three special feature. First feature, the processing speed of each resource's processor in millions of instructions per second, second feature, the price of each resource based on money per second

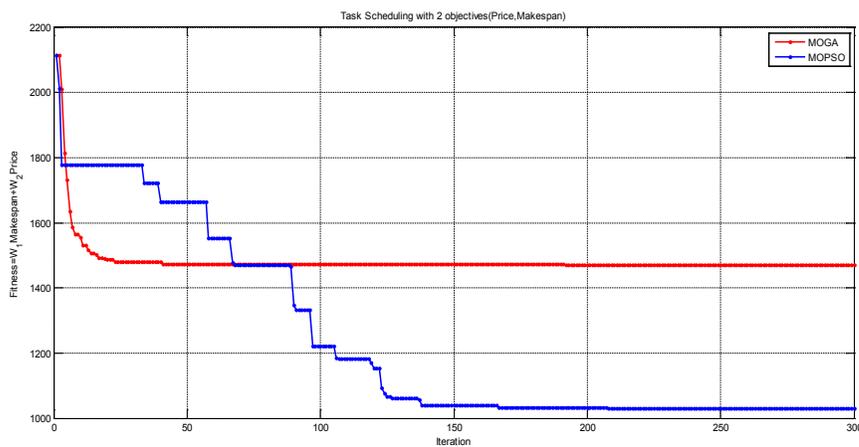
and third feature the specific tasks on each resource which are existed on resource before starting the implementation of scheduling and the resource after finishing of that

**Table 3.** Optimal solutions for different choices

Best Price	Best Makespan	Best Cost	Factors Mutation-rate
3287.072	366.6227	1534.8024	0.05
3292.3362	280.382	1485.1637	0.1
3510.698	298.5951	1583.4363	0.15
3268.0826	222.5252	1440.7482	0.2
3276.4398	246.9322	1458.7352	0.25
3139.2317	257.4643	1410.1713	0.3
3146.1674	249.874	1408.3913	0.35
2875.2251	393.3425	1386.0955	0.4
2963.4092	380.7519	1413.8148	0.45
3127.7048	186.3122	1362.8693	0.5



**Figure 4.** The number of repetitions in creating solutions for testing the mutation rate.



**Figure 5.** Comparison of the genetic algorithm, and the algorithm of particle mass.

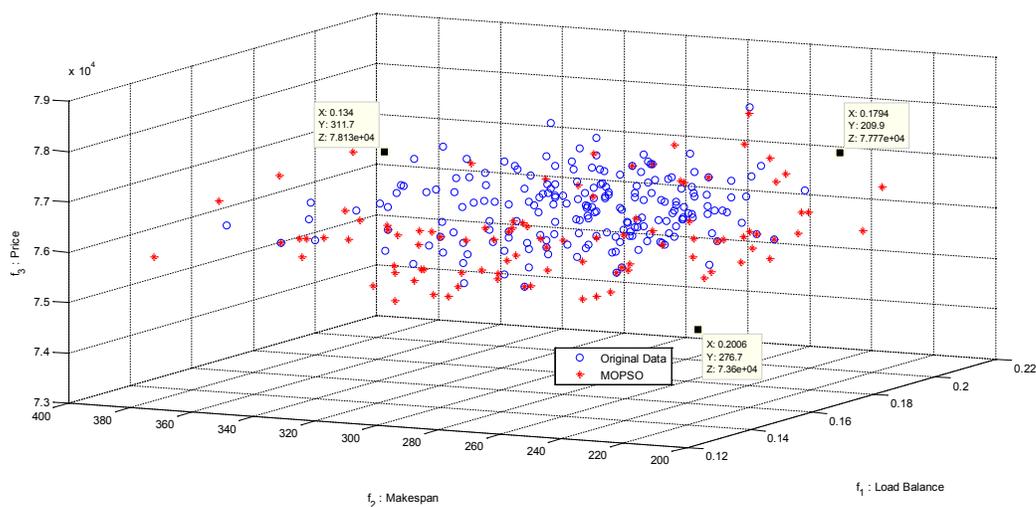


Figure 6. Three dimensional Pareto Strength to test with a population of 200

Table 4. Comparison of the results of MOPSO algorithm with three goals

The best Load balance			The best Makespan			Best price			Metric Population
Load balance	Mix pen	price	Load balance	Mix pen	price	Load balance	Mix pen	Price	
0.148	321	75719	0.204	219	76311	0.213	292	72088	200
0.135	319	75044	0.170	214.5	75910	0.190	276.9	71560	500

task starts to complete new task. This is an important factor that shall be considered. The purpose of this algorithm is to optimize independent tasks scheduling in cloud environment, establishing an optimized response that such optimized response is the possible optimal choice for tasks assignments that considers optimal purposes by a fixed ratio. When the number of population members is more it needs more repetitions to displace all the population to set of responses. Subsequently, by more number of populations, the quality of answers also increases. In these tests, the impact of mutation rate is observed on the result of multi-purpose genetic algorithm. Therefore, in this action, in addition to that we increased algorithm convergence speed in achieving optimal response; we can observe the improvement of this response quality by changes in mutation rate. At the end, we can optimize algorithm of multi-purpose particles mass by considering three purposes of price, Makespan and balance rate that this is the first time that this action is done.

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