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Truthful Mechanisms for Scheduling Selfish Related Machines Using ACO

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Abstract*—Task scheduling is a major challenge in parallel and distributed systems. Task scheduling techniques in distributed systems are usually based on trusting the Accuracy of the information about the status of resources. In a commercial multi- Cloud environment, individual providers are focused towards increasing their own profits and do not care about the utility of users and other providers. In such an environment, we cannot trust the information presented by the providers.To address the scheduling problem in a commercial multi-Cloud environment using reverse auctions, propose a new truthful mechanism for scheduling single tasks on the set of resources. Then adapt the proposed mechanism to dynamically schedule workflow applications. A new pricing model and truthful scheduling mechanism to find the best resource for executing a task, Ant Colony Optimization is introduced. The proposed system is used to dynamically schedule multiple tasks using multiple servers. Also task rescheduling is achieved when the task is not completed within the time.The monetary cost and execution time of the task is more concentrated in the proposed system.

Keywords*—Ant colony optimization, Dynamic scheduling, Multi-Cloud environment, Task re-scheduling.

I. INTRODUCTION

Cloud computing is the use of computing resources (hardware and software) that are delivered as a service over the Internet. The name comes from the use of a cloud-shaped symbols. Cloud computing entrusts remote services with a user's data, software and computation.

II. CHARACTERISTICS

Cloud computing has a variety of characteristics, with the main ones being:

A.Shared Infrastructure

Uses a virtualized software model, enabling the sharing of physical services, storage, and networking capabilities.

B. Dynamic Provisioning

Allows for the provision of services based on current demand requirements. This is done automatically using software automation, enabling the expansion and contraction of service capability. This dynamic scaling needs to be done while maintaining high levels of reliability and security.

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C. Network Access

Needs to be accessed across the internet from a broad range of devices such as PCs, laptops, and mobile devices, using standard-based APIs (ex. HTTP). Deployments of services in the cloud includes everything from using business applications to the latest application on the newest smartphones.

D.Managed Metering

Uses metering for managing and optimizing the services and to provide reporting and billing information. In this way, consumers are billed for services according to how much they have actually used during the billing period. Cloud computing allows for the sharing and scalable deployment of services , from almost any location, and for which the customer can be billed based on actual usage[1].

III. SERVICE MODELS

Cloud computing services are deployed in terms of business models can differ depending on requirements. The primary service models being deployed are commonly known as:

A.Software as a Service (SaaS)— Consumers purchase the ability to access and use an application or service that is hosted in the cloud, where relevant information for the interaction between the consumer and the service is hosted as part of the service in the cloud.

Enduser application is delivered as a service. Platform and infrastructure is abstracted, and it can be deployed and managed with less effort.

B.Platform as a Service (PaaS)— Consumers purchase access to the platforms, enabling them to deploy their own software and applications in the cloud. The operating systems and network access are not managed by the consumer.

Application platform onto which custom applications and services can be deployed. It can be built and deployed more inexpensively, although services need to be supported and managed.

C.Infrastructure as a Service (IaaS)— Consumers control and manage the systems in terms of the operating systems, applications, storage, and network connectivity, but they do not control the cloud infrastructure. Communications as a Service (CaaS) is one such subset model used to describe hosted IP telephony services. Also, CaaS can be a subset of SaaS.

Physical infrastructure is used to provide computing, storage, and networking as a service, avoiding the expense and need for dedicated systems[1].

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IV. TASK SCHEDULING IN MULTI-CLOUD ENVIRONMENT

Task scheduling is a major challenge in parallel and distributed systems. Task scheduling techniques in distributed systems are based on trusting the accuracy of the information about the status of resources. This information is usually provided by resource providers to a central database which is accessed by schedulers. In some environments,such as Grids , this information considered to be complete and accurate.

In day today's life, the number of commercial Cloud providers is growing rapidly . In a commercial multi- Cloud environment, individual providers are focused towards increasing their own revenue and do not care about the utility of users and other providers. In such an environment, we cannot trust the information presented by the providers.Nowadays, Internet is growing much in solving large scale problems, and also multiple self-interested agents are growing popular. The commercial multi-Cloud environment consists of a set of selfish Cloud providers with private information about their resources. The schedulers should act carefully and not trust the information submitted by providers about the status of their resources, there occurs the possibility of misrepresenting the private information.

The providers are always in need to increase their resources in order to earn more revenues. Game theory is a mathematical approach used to analyze the decisions of agents in a problem modeled as a game[2]. Reverse game theory also called as algorithmic mechanism design is a subfield of game theory which deals with multiple selfish agents.

All agents might clearly know the mechanism rules. Each agent has a private function which is unknown to the other agents. All agents take part in the game using their private information. Each and every agent may gain or lose depending on the outcome of the mechanism called valuation. The main target is to minimize the social cost of the game.The self-interested agents deal with avoiding the agents lie. In game theory , such mechanism enforcesthe self-interested agents to tell only the truth which are called as truthful mechanisms.An efficient mechanism, by use of payment , motivates the agents to tell the truth about their private information.

The workflow scheduling have been emerged as programming paradigm for the distributed computing infrastructures such as computational Grids and Clouds. The main issue addressed in this paper is, scheduling of workflows in a commercial multi-Cloud environment . The problem of dynamic scheduling in commercial multi-Cloud environment using algorithmic design is being addressed. Each resource is imagined as a selfish agent having some private informations within them and it can be misrepresented to earn morerevenue.

Consider that scheduling in distributed systems is an NP hard problem, the challenge is to propose an efficient scheduling mechanism with low completion time (makespan) and monetary cost . The previous work addressed the scheduling problem [2] in a commercial multi-Cloud environment using reverse auction, a new truthful mechanism forscheduling a single tasks on the set of resources was proposed.

The another proposed mechanism to dynamically schedule workflow applicationsis to develop an auction-based scheduling mechanism for the commercial multi-Cloud environment is of five types:

1. It deals with the non-cooperation nature of scheduling game in multi-Cloud environment.
2. It harnesses the selfish behavior of Cloud providers.
3. This mechanism needs a small amount of public knowledge while each Cloud provider has a large amount of private information.
4. The mechanism has Nash equilibrium.
5. The approach is dynamic and easy to implement.

To analyze the truthfulness of the mechanism and the time and communication complexities, the proposed mechanism is evaluated by comparing it with two classical multi-objective evolutionary algorithms (MOEAs)[2].

V. TECHNIQUES

The related work with its techniquesis describedin four main areas:Multi-Cloud computing, Auction-based truthful schedulingmechanisms in distributed systems , Multi-objectiveworkflow scheduling, Bio-objective Scheduling Strategy.

A.Multi-Cloud computing

In multi-cloud computing, the concept of sky computing been emerged for building a virtual site distributed on several Clouds. The multi-Cloud computing environment is analyzed based on its architectural elements and challenges.In this computing (see fig.1), the Cloud brokers are used for splitting the user requests to multiple service providers with the intension of decreasing the cost for users[3] .

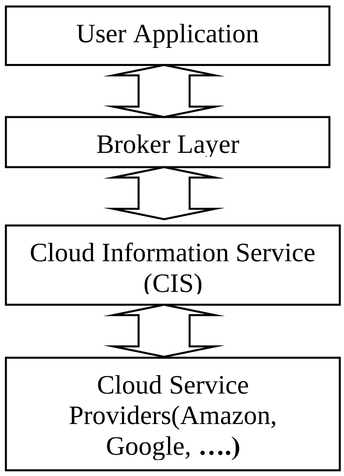

Fig.1 Multi-Cloud Architecture

The user request resources to the cloud service providers like Google, Amazon,GoGrid etc..The cloud information service (CIS) stores all the user details and their queries . The Broker layer is used to identify the selfish behavior of the cloud provider and they give preference to the users who pays with low cost and their task is scheduled first.

B. Auction-based scheduling

Market-based scheduling of resources in distributed systemsis a well-studied research.

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Several economicalmodels like commodities market and auctions havebeen proposed for distributed systems. Also, several auction mechanismsfor distributed resourcesin competing the selfish tasks been analysed.A hierarchical non-cooperative game model for Grids isproposed, in which users are selfish agents.A wellknownVickrey-Clarke-Groves (VCG) mechanism fordistributed systems is proposed for static load balancing. The problem ofload balancing in Grid systems is that it spreads the load oneach computing node. Load balancing minimizes the average completion time of tasks.But thismechanism cares only about its outcome. And thepayments are used to enforce agents tell the truth. The dynamic market-basedmodel for resource allocation in Grids have been introduced[4].

Thebidding algorithm is proposed in which userslook for required resources by updating their bids. Themain impact of antisocial agents might lose on the otheragents who participates in task scheduling mechanismon some related machines .

The antisocial agents know the bid value of the winnerwhich is against the assumption of presence of privateinformation. A truthful mechanism is proposed forsingle dimension domain with (1 + ε)-factor fortime is guaranteed as an optimum solution[5].

The continuous double auctionmechanism for scheduling tasks in Grids is proposed and the scheduling problem with respect to time and cost is analysed .

A market-basedContinuous Double Auction model uses an instantiation protocolbetween the scheduler and resource manager. Also a market-based resource allocation model forbatch jobs in Cloud computing clusters been proposed.The problem of this model focus on mainly the social cost. It is the sum of the valuesgained by the allocated users[6][7].

C. Multi-objective workflow scheduling

The multi-objective workflow scheduling is an NP-hard problem,and most of the scheduling workflows use heuristicsto cover the complexity. The HEFT algorithm (Heterogeneous Earliest Finish Time)addresses asingle objective called the makespan.

The existing approaches of multi-objective workflow scheduling hasonly single objectiveoptimization problem and effectively used such methods likebounded objective optimization, lexicographical method,scalarization, and goal programming .

The proposed target to optimize makespan and cost is much concentrated. A budget constraint uses a two-phaseoptimization process by first optimizing makespan in LOSS and budget in GAIN and then rescheduling it to find a solution that satisfies thebudget constraint[8].

D. Bi-criteria workflow scheduling

The bi-criteria scheduling method minimizes the execution cost, meeting a deadline by finding asub-deadline for every workflow task. These are some scheduling methodsclassified as bounded objective optimizations with one constrained objective and optimize anotherobjective with respect to the defined constraints.

The implementation of each scheduling algorithm attempts to find a set of pareto-optimal solutions. But in Genetic algorithms, it has high time complexity . So the problem here is that selection of most adequate solutionfrom the Pareto set. For this, multi-objective list scheduling workflow approach been proposed and it is analyzed for four objectives: Makespan,Cost, Reliability and Energy[9].

The market-orientedscheduling policies been proposed for scheduling a set of independenttasks in hybrid Clouds. Its main goal is to satisfy an applicationdeadline by extending the local computational capacity with Cloud resources. The above mentioned workflow scheduling algorithmsare only static approaches. They are not concerned with the dynamicload of resources in a real environment.

As discussed in the above techniques, all scheduling approaches are suppose to present the resource information correctly by the selfish providers which is doubtful in commercial Clouds. The proposed algorithms which is designed for utility Gridsare not straightly useable in Clouds. The main problem involvedhere is the multiple Clouds. Apart from the related work, the research in this paper[9]is to propose a truthful mechanism for dynamic workflowscheduling in a commercial multi-Cloud environment inpresence of selfish providers. And the proposed mechanism produces a Pareto Optimal solution and itsefficiency is proved theoretically and practically.

E. BOSS: Bio-objective Scheduling Strategy

The current cloud providers usually charge users based on a pay-as-you-go pricing model. This algorithm uses the multi-provider Cloud model and the two objectives : makespan and monetary cost is much concentrated. A new pricing model and truthful scheduling mechanismto find the “best” resource for executing a task,*bi-objective scheduling strategy (BOSS) is* implemented in thebrokerage layer .

The BOSS is based on areverse auction which is a common tool in a market with lots of sellers. Each auction is based on some rules that define the identity of the winner. The most famous result in this mechanismis the VCG ie. sum of the valuations of the agents[10].

In BOSS, each task *i* starts an auction to choose a proper resource for its execution. The task announces its workload to the resources , the dependencies with other tasks, and the required input and output.

Each resource *j* bids by the strategy *si,j* = (*ti,j*, *ci,j*), which is a combination of its time *ti,j* and cost *ci,j* . The strategy *si,j* means that the resource *j* attempts to complete the task *i* until the time *ti,j* with the cost of *ci,j* . Each resource is allowed to bid by more than one strategy in every auction.

The issues arised in BOSS algorithm is to calculate the real completion time of a task, the resource must consider a number of internal details such as the virtual machine startup overhead, latency delay, current load, computing power, availability, ready time, communication bandwidth, task workload, and so on. Also each provider externally performs these calculations.When the task does not complete within its defined time constraint , has to be rescheduled but the existing BOSS does not deal with workflow rescheduling[10].

VI. ANT COLONY OPTIMIZATION APPROACH

A. Construction of Task List

A task list is an order of tasks that satisfies the precedence constraints.

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First define the pheromone and the heuristic for task list construction. Then the procedure for an ant to build a task list is described in detail.

B. Pheromone

To build a task list, an ant has to determine an order of the tasks. In existing studies of ACO for scheduling problems like shop scheduling problems and the RCPSP, there are mainly two types of pheromone models for finding an order of tasks.

The first type is the absolute position model that defines the pheromone of putting a task tj to the k-th position of the task list. Since the absolute position model can only indicate the desirability of putting a task to a certain position, it is found that the model can lead to highly sub-optimal solutions.

To improve this model, Merkle et al. developed a summation rule. The summation rule uses the sum of the pheromone values of putting a task tj to the positions 1 to k. In this way, the deficiency of the absolute position model has been overcome and the resulting approach is effective.

The second type of pheromone model is the relative position model that defines pheromone on the link between two tasks and uses the pheromone to indicate the desirability of putting one task directly after the other one. The disadvantage of this model[11] is that the relative positions of two tasks may become meaningless when the two tasks are reconcilable with respect to resource (machine) consumption.

To improve this model, Blum developed a relation-learning model that only defines pheromone on the links between two related tasks in the same group or processed by the same machine for shop scheduling problems[11]. In this way, the relation-learning model overcomes the deficiency of the conventional relative position model and achieves promising performance. For the considered software project planning problem, since one task can be assigned to several employees, one employee can undertake several tasks simultaneously, and skill proficiency is considered, it is more difficult to define related tasks for the relation-learning model.

Therefore, by adopting the absolute position model with the summation rule in the proposed approach will be good and effective. The summation rule will be described in construction procedure of task list.

C. Heuristic

i)The minimum slack (MINSLK) heuristic is adopted for task list construction.

ii)A task with a relatively smaller MINSLK implies that this task is more urgent.

iii)The MINSLK for a task tj, which is denoted as MINSLKj, can be estimated as follows:

Step a) Estimate the shortest possible makespan of each task tj, then select maxheadj, its the most proficient employees of tj and assume these maxheadj employees dedicate all of their working hours to j. Here maxheadj is the maximum headcount for tj and the proficiency of employees for tj can be evaluated.With this assumption, the shortest possible makespan of tj can be estimated .

Step b) Based on the shortest possible makespan of each task, the earliest start time and the latest start time of each task can be evaluated, and the MINSLK is calculated by the difference between the latest start time and the earliest start time of the task[11].

D. Construction Procedure

To build a feasible task list, each ant maintains an eligible Set of tasks that satisfy the Precedence constraint. The construction includes the following steps:

Step a) Put the tasks that can be implemented at the beginning of the project (i.e., the tasks that do not have any precedence tasks) into the eligible Set.

Step b) For k = 1 to n, process the following sub-steps b1) and b2) repeatedly:

Step b1) Select a task from eligible Set and put the task to the k-th position of the task list. In the selection rule, at first a random number q uniformly distributed in [0,1] is generated and is compared with a parameter qt. If q<qt, then the task tj from the eligible Set with the largest value is chosen to put into the k-th position. Otherwise, the task is selected using the roulette wheel selection scheme. This selection rule is designed based on the pseudo random proportional rule in the ACS and the summation rule.

The characteristic of the pseudo random proportional rule is that ants have a probability qt to select the task with the maximum pheromone and heuristic values directly, so that the algorithm can strongly exploit the past search experience of ants. The characteristic of summation rule is to use the sum of the pheromone values of putting tj to the positions 1 to k instead of simply using the pheromone value in the rule. In this way, the deficiency of the absolute position pheromone model can be overcome.

Step b2) Update the eligible Set by removing the selected task from eligible Set and adding new feasible tasks that satisfy the precedence constraint into eligible Set[11].

E. Pseudo-code for the ant colony system

Algorithm

Begin
Initialize
While stopping criterion not satisfied do
Position each ant in a starting node
Repeat
For each ant do
Choose next node by applying the state transition rule
Apply local pheromone update
End for
Until every ant has built a solution
Update best solution
Apply global pheromone update
End While
End

The pseudocode for Ant colony system andthe flowchart of ACO algorithm is described in fig.2 below in detail .

1) Initialization of algorithm:All pheromone values and parameters are initialized at the beginning of the algorithm.

2) Initialization of ants:A group of M artificial ants are used in the algorithm. In each iteration, each ant randomly selects a constructive direction and builds a sequence of tasks.

3) Solution construction:M ants set out to buildM solutions to the problem based on pheromone and heuristic values using the selection rule of the ACS algorithm.

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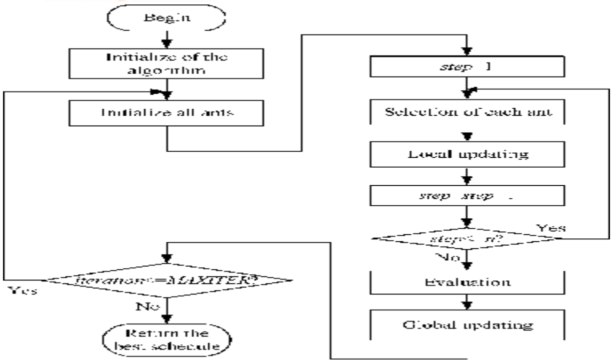

Fig.2 Flowchart of the ACS algorithm.

4) Local pheromone updating:Soon after an ant maps a service instance *sji* to task *Ti* , the corresponding pheromone value is updated by a local pheromone updating rule.

5) Global pheromone updating:After all ants have completed their solutions at the end of each iteration, pheromone values corresponding to the best-so-far solution are updated by a global pheromone updating rule[11].

VII. SYSTEM ARCHITECTURE

A new pricing model and truthful scheduling mechanism to find the "best" resource for executing a task, Ant Colony Optimization is introduced. In the proposed system, task re-scheduling is done when the task is not completed within the time. Execution time of the task and cost is more concentrated in the proposed system. Then adapt the proposed mechanism to dynamically schedule multiple tasks on a set of resources using multiple servers in a commercial muti-cloud environment. Fig.3 shows the system architecture of my proposed work.

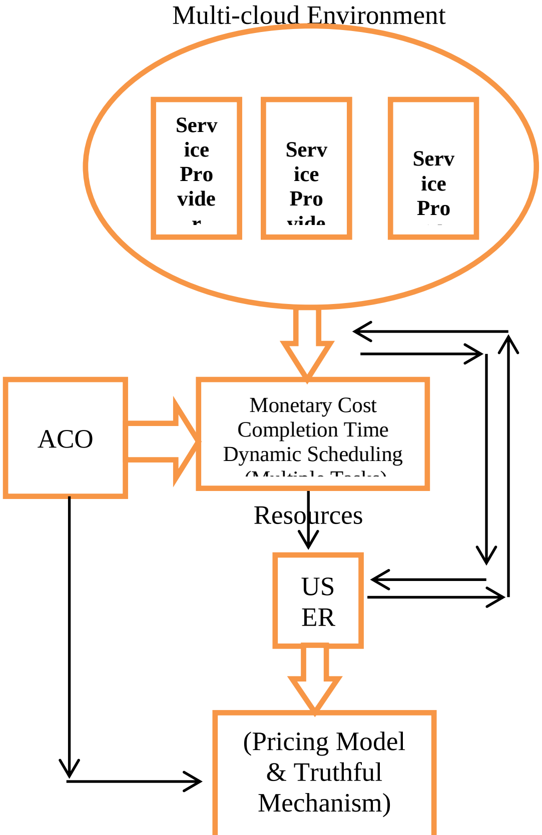

Fig.3 System Architecture

The advantage is that, each provider performs calculations such as real completion time of a task. Task workload internally and the real cost of executing a task on a resource is again internally calculated by the provider.In proposed system, assume that the payment details of all the cloud providers are private. Using VCG payment method, the premium cost of the cloud provider is calculated.

VIII. PROPOSED MODULES

This system is done for cloud service processing to provide secure scheduling to the user issued tasks.

Input:

The input of this project is a number of tasks which is given by user to the service provider

Behavior:

The behavior of this project is when users provide the tasks to service provider, number of intermediate layers are used. The tasks are ranked and scheduled and assign the task to each resource and compute the tasks and the payment will be paid based on the time and cost of the resource.

Output:

The output of this project is tasks are computed and rescheduling is done when more tasks are assigned to one particular resource.

A. Users & resources module

In this module, user is sending the multiple tasks to service provider through any web application. Task will be of any job computation, download or upload the files etc. The cloud server resource's information is stored in the cloud service information layer.

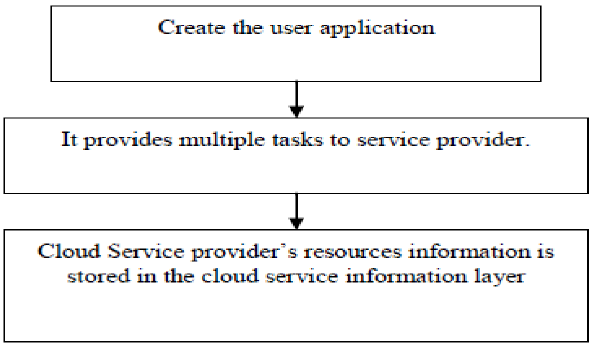

Fig 4. Users and resources information

B. Task Rank Module

In this module, users send the multiple tasks to cloud service provider. Before completing the tasks, first they are ranked based on their cost. Then, these tasks are sorted in descending order based on their ranking .

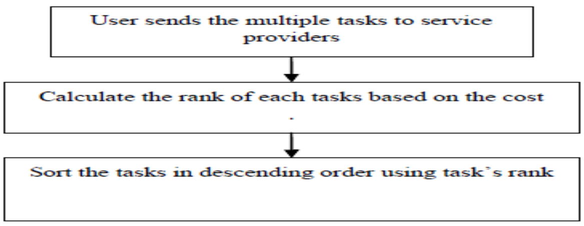

Fig 5. Task Rank

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C. Winner allocation module

In this module, the tasks are assigned to winner i.e. cloud resource from the tasks list. Then, these tasks are loaded into particular resource. Next, the resources are used to compute the tasks.

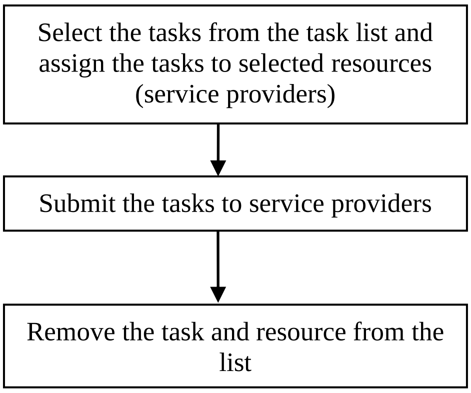

Fig 6. Winner allocation

D. Payment module

In this module, user will measure the payment of each resource and pay the amount to the resources. The payment will be calculated using difference between time and cost of the allocated resource. Next, calculate the utility of each resource using difference between the payment of the resources and real cost of the resources.If resource is assigned to one task, at same time if arrives another task, it is assigned to another resource without disturbing the previous one.

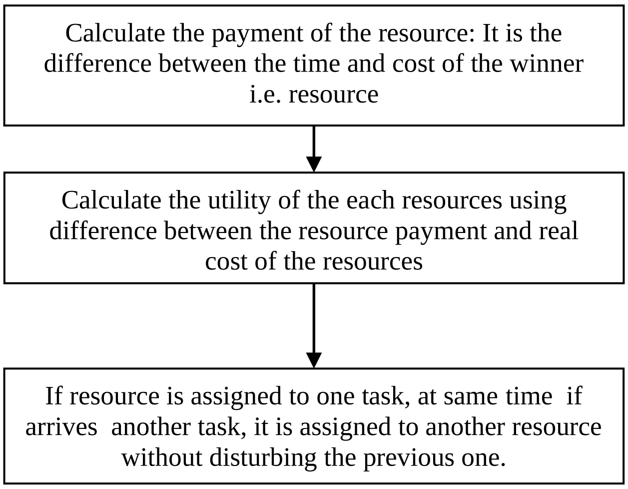

Fig 7, Payment module

IX.CONCLUSION

In this paper, a new pricing model andtruthful mechanism for dynamic scheduling of multiple tasks using multiple servers in commercial multi-Cloud environment is proposed.The mechanism for scheduling of scientific workflowswith respect to optimization of two objectives, makespan and monetary cost, and to prove the truthfulness of the mechanism efficiently. And also provide secure scheduling when compute tasks in the cloud server using Ant Colony Optimization algorithm. With this ACO, task re-scheduling is also done when the task is not completed within the time, but the existing mechanism does not deal with workflow rescheduling.Therefore, the generated solutions of the proposed mechanism are approximately Pareto optimal.Using ACO for Task scheduling in Multi-cloud environment, the Security and its Performance is high.Also,the resources are used very effectively. The low cost tasks are computed reliably.

X. FUTURE WORK

The comparison is made for the ACO algorithm with the Tabu Search (TS) algorithm for the multi-skill workflow scheduling problem. The comparison results can tell whether the TS is effective OR whether the ACO performs better. In proposed system, assume that the payment details of all the cloud providers are private. In future, using VCG payment method, the premium cost of the cloud provider is calculated.

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