Financial Plan and Time Limit Alert with e-Science Using Workflow Scheduling in Clouds

P. Vasuki[1] Sathiya Raj S[2] Nikita Jain[3] SathisKumar R[4] Nandhini P[5]

[1]Assistant Professor, Department of Computer Science and Engineering, KSRCE, TamilNadu, India.
Email: vasukiabi@gmail.com

[2,3,4]Student, Department of Computer Science and Engineering, KSRCE, Tiruchengode-637215, TamilNadu, India.

Email: s.sathiyaraj812@gmail.com, nikitajain0803@gmail.com, sathiskumar81298@gmail.com, rajnandhu9397@gmail.com

Abstract - Distributed computing is a hot territory of research in nowadays. Cloud is of four kinds: open, private, crossover and network cloud. The cloud depends on three models: SaaS, PaaS, and IaaS. Errand booking is the region where a ton of research has been finished. All things considered, there is a need to plan the assignments or occupations as clients of the mists are expanding every day. In this paper, we give a broad audit of different research calculations identified with task planning. A couple of principal calculations are FCFS, Cooperative effort, Max-Min, Min-Min, Need based and Most Fit Errand Planning. This paper assesses different most recent calculations dependent on the methods like Cooperative Creature Search, Molecule Swam Enhancement, Subterranean insect State Improvement, Hereditary Calculation, Lining hypothesis and so forth., and propose which calculation is better in the record of different parameters like makespan, absolute undertaking execution time, task holding up time, transmission time, the level of lopsidedness, vitality utilizations and so on.

Keywords - Cloud Computing, SaaS, PaaS, IaaS, Task Scheduling, FCFS, Max-Min, Min-Min, VM (Virtual Machine).

I. INTRODUCTION

Undoubtedly without Information Technology, life is too tough. Nowadays cloud computing is a hot topic which is not only used in the real world but in the area of research also. In information technology era, cloud computing is most recent and important prototype where the information and resources are shared over the Internet as per demand and rights [1][9]. Cloud computing is a combination of machines connected via network technologies. This concept may include parallel computing, network storage technologies, load balancing, virtualization and lots more [5]. Figure 1 demonstrates the concept of cloud computing environment in a better way.

In last decades [19][20], internet growth reached to new heights, so computing resources are now available in a large amount. This leads to the realization of a newcomputing notion known as Cloud Computing. In order to use cloud computing environment, one needs traditional service providers in two different areas and these are infrastructure and service providers. Infrastructure is a cloud computing platform having a combination of software and hardware. Service providers may take infrastructure on rent for serving end-users needs. The most familiar companies like Google, Microsoft and Amazon are using cloud concepts in order to reach to information technology requirements and customer's satisfaction. Cloud computing provides high class optimized services using very large scalable and virtualized resources. Cloud computing services are Software as a Service (SaaS), Infrastructure as a Service (IaaS), and Platform as a Service (PaaS)[8].

In IaaS, the large scale infrastructure is provided to the client in the shape of Virtual Machine (VM). In PaaS, An application creation platform is offered to the developers to generate online applications for end users. One can access the software applications by the cloud provider at the level of SaaS. These kinds of services are made accessible via pay-per-use model to the clients [12]. Figure 2 makes a clear picture of the cloud computing models. Nowadays, many IT as-well-as other commercial industries are looking to move on cloud concepts to provide maximum services at lowcost. In the coming sections 1.1 and 1.2, we are elaborating cloud computing types and task scheduling respectively.

A. Cloud Computing Types

Based on the location parameter, cloud computing can be divided [19][20] into following categories:

a) Public Cloud: Here, computing infrastructure is provided by the vendor and customer has no visibility on the infrastructure. But the resources can be accessible publically.
b) Private Cloud: Here, infrastructure is developed for a private organization. The services can be access by that private

organization only. This type of cloud is more secure than a publicone.

c) Hybrid Cloud: A hybrid cloud is come into existence after merging a private as well as the public cloud. Critical applications may be deployed on a private cloud and the applications having less security can be connected to the public one.

d) Community Cloud: Here, the infrastructure is shared between organizations of the samecommunity.

Fig. 1 Cloud Computing Demonstration

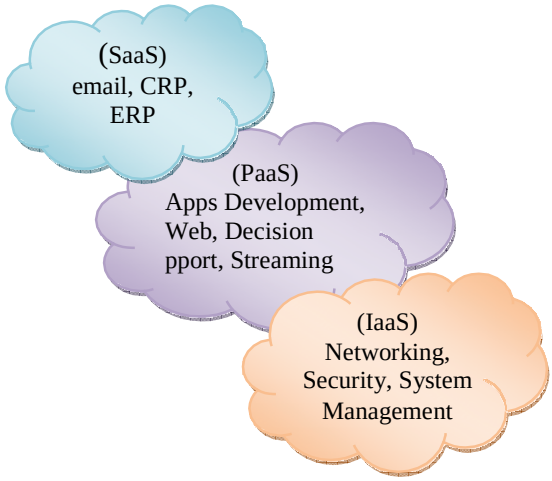

Fig. 2. Cloud Computing Services

B. Task Scheduling

In the Cloud Computing (CC) for the purpose of services, many resources are used such as processors, memory, storage and many applications. The resources are designed and acquired as per needs [1]. The CC prototype had reduced the acquiring cost of hardware and software and maximized the services. Cloud resources are shared between end-users using the concept of virtualization. Virtualization allows optimum utilization of physical resources and energy under remote running environments. A Virtual Machine (VM) works as a vital component of software stacks in the cloud datacenter [1]. As we described earlier the industries have started to move on cloud and the number of users is increasing day by day, so the task scheduling is a key point in CC. The task scheduling is a milestone in the area of computer science. For the quality of service [18], resources allocation among tasks sent by users in a certain time can be handled by scheduling. The target of task scheduling is to ensure on which resource and when a task should be assigned and executed. The hot topics of research may be processed scheduling means thread handling in an operating system, energy management through task scheduler in CC. In last few years, cloud computing has attracted people because of reliability, scalability, cost reduction and information sharing parameters at anytime and anywhere. In the present time, cloud computing is the prime target of everyone rather than other technologies for the purpose of research and utility in real-life. In cloud computing, the target of a process scheduler [2] is to make ensure the proper assignment of all resources among the jobs sent by the different users. A vast number of users requests for a lot of tasks to the cloud system, so it's a challenging issue for cloud system to assign all resources to all tasks. This has to be done keeping in the mind that the Quality of Service (QoS) must not be suffered. In order to ensure QoS [18] to the users, it is a hard necessity of efficient job scheduling. As usual, the users will have the hesitation to pay in the absence of desired performance. So scheduling is the key factor in cloud computing culture. The proper utilization of all available resources at an optimum level is the main aim [4] of the cloud computing system. The scheduling algorithms play a vital role to achieve the same. So, users requested tasks need to be scheduled properly using task scheduling algorithms. The prime goals of a scheduling algorithm are to minimize the execution time, maximize the utilization of resources and load balancing. To assign the task in a proper sequence under problem specific constraints is the main purpose of task scheduling in any computing system [4]. The efficient resource scheduling leads to the high performance of CC environment. The maximum existing scheduling algorithms consider various factors as their prime duty like reducing cost, minimization of make span, optimization of scheduling rate, resource utilization and lots more [7]. In the next section, we are going to present a lot of research papers related to task scheduling algorithms and make their intenseelaboration.

C. Fundamental Scheduling Algorithms

The fundamental algorithms used in task scheduling are following:

a) FCFS (First Come First Serve) algorithm – Usually, this algorithm is considered for parallel processing. It assigns

the jobs to the resource having the shortest waiting queue for incoming jobs i.e. it works on the principle of first in first out [13][21]. Its drawback is that the last job has to wait for a longtime.

b) Round Robin Scheduling Algorithm – It also handles tasks based on the pattern of first in first out. Here in RR algorithm, time is split into various interval slots. If one job is taking more time to complete itself, then the CPU is given to next job which was waiting in a queue [22].
c) Min-Min Algorithm – At very first, this algorithm computes minimum execution time for all tasks and then it assigns shortest jobs to the fastest resources. It is more stable than FCFS algorithm[21][23].
d) Max-Min Algorithm – This algorithm works same as that of Min-Min except that it assigns the largest jobtoa fastest resource. Its performance is better than FCFS and Min-Min algorithms [21][23].
e) Priority Based Algorithm – This algorithm works on the basis of „priority" concept. Here, a job which requires high computing power is given a first priority, a job which needs low computing power is given a low priority and a job which requires medium computing power is given a medium priority. After that, the free resource having high power is assigned to higher priority job. This algorithm performs better as compared to FCFS, Max-min and Min-Min[13][21].
f) Most Fit Task Algorithm – In the case of MFT algorithm, the task which fits best in a queue is executed first, but this algorithm has higher failure rate [22].

II. EXISTING ALGORITHMSOVERVIEW

The main target of this paper is to put light on various algorithmic strategies related to task scheduling in cloud computing environment. The techniques are as follows:

i) Symbiotic Organism Search Optimization Based Task Scheduling in Cloud Computing Environment

M. Abdullahi et al. [1] designed a discrete version of Symbiotic Organism Search meta-heuristic algorithm. To schedule independent tasks, this method was implemented in CloudSim tool. Among various virtual machines makespan, response time and degree of imbalance were measured. DSOS performance was found better than SAPSO. DSOS minimized average makespan 3.8% - 25.5% which is less than SAPSO for 300 through 1000 instances of tasks respectively. In a larger search space DSOS outer-performed than SAPSO.

ii) A Novel Scheduling Algorithm for Cloud Computing Environment

S. Sagnika et al. [2] introduced a task scheduling hybrid algorithm which is based on Genetic Algorithm using a queuing model in order to reduce waiting time, and length of the queue of the system. The simulation was performed for comparative analysis between FCFS and GA. The experiment elaborated that GA gave 20% better results than FCFS. The simulation parameters were an average number of customers and average waiting time.

(iii) Multi-Objective Tasks Scheduling Algorithm for Cloud Computing Throughput Optimization

In order to improve the throughput, L. V. Atul et al. [3] proposed a multi-objective task scheduling algorithm without disturbing Service Level Agreement (SLA) for SaaS cloud environment. The proposed approach is an optimal scheduling technique. Authors said maximum task scheduling algorithms are based on only execution time but in the case of cloud computing environment various parameters are needed like execution time, cost and bandwidth of user etc. The proposed algorithm was simulated using CloudSim and gave better throughput and outperformed than FCFS and priority scheduling. Multi-Objective Task Scheduling in Cloud Environment using Nested PSOFramework

R. K. Jena [4] proposed multi-objective task scheduling nested Particle Swarm Optimization technique in order to optimize processing time and energy. This TSPSO technique was simulated in CloudSim which is an open source (freely available) tool. The simulation results were compared with existing algorithms (BRS and RSA) and found better with respect to optimal balance results in the case of multi-objectives tasks scheduling. The parameters of simulation were used a number of datacenters, a number of PE per Datacenter, Speed of PE, Power Consumption, a number of Tasks, Tasks length, time, energy and failed tasks. The proposed approach fits where datacenters and user job changes dynamically. This multi- objective approach worked effectively using the system resources to reduce energy and makespan. So the proposed technique MOPSO is better than BRS and RSA techniques.

(iv) Random task scheduling scheme based on reinforcement learning in cloudcomputing

P. Zhiping et al. [5] suggested fine-grained cloud computing system model and optimized task scheduling scheme. In fact, authors designed a novel approach to task scheduling based on reinforcement learning and queuing theory in order to optimal task scheduling. The state aggregation technologies were employed to speed up the learning progress. Authors developed a tool for simulation in MATLAB and used the parameters like the length of job, the total numbers of jobs, the total number of VMs, VM memory, VM bandwidth and number of VMs buffer, the number of PEs requirements, a number of datacenters and number of hosts for experiments. The results exhibited the task scheduling efficiency and bare the relationship between the arrival rate, server rate, number of VMs and buffer size.

(v) A Hybrid Heuristic Workflow Scheduling Algorithm for Cloud ComputingEnvironments

M. Sahar et al. [6] offered a hybrid technique using Particle Swarm Optimization and Gravitation Search algorithms. The proposed algorithm worked on parameters like Processing Cost, Transfer Cost, and Deadline Limitations. This approach can be used by both end-users and utility providers. All the experiments were simulated in CloudSim toolkit. The simulation results showed about 70%, 30%, 30% and 50% cost reduction after comparison to non-heuristic technique, PSO algorithm, gravitational search algorithm and hybrid genetic-gravitational algorithmrespectively.

(vi) Enhanced Particle Swarm Optimization for Task Scheduling in Cloud ComputingEnvironments

A. I. Awad et al. [7] said the key factor of cloud computing is task scheduling means, to allocate best suitable resources for the task to be executed. While executing a task the parameters should be considered like time, cost, scalability, makespan, reliability, availability, throughput etc. The proposed algorithm worked for availability and reliability whereas most scheduling algorithms do not work for reliability and availability in cloud computing environment because of the complexity. The authors proposed a mathematical model using Load Balancing Mutation a particle swarm optimization (LBMPSO) for task scheduling based on the parameters like execution time, reliability, transmission time, round trip time, makespan, transmission cost, and load balancing between virtual machines and tasks. LBMPSO worked for resources management and rescheduled task that lead failure allocation. The proposed model LBMPSO was compared with standard PSO, random algorithm, and Longest Cloudlet to Fastest Processor (LCFP) and found that it gave better results considering the parameters like makespan, round trip time, execution time and transmission cost, and task assignment. This approach can work for any number of resources and tasks.

(vii) Dynamic Multi-Objective Task Scheduling in Cloud Computing Based on Modified Particle Swarm Optimization

A. I. Awad [8] said task scheduling is a vital research area in cloud computing. The proposed approach is a mathematical model multi-objective Load Balancing Mutation particle swarm optimization (MLBMPSO) used to schedule the allocation of tasks to resources. It was based on two objective functions to reduce total cost and round trip time. The proposed approach improved the reliability in cloud computing and considered the availability of resources and ensured load balancing between a virtual machine and tasks in comparison to other algorithms. This technique could be used to allocate any number of tasks andresources.

(viii) An Agent-Based Approach for Resource Allocation in the Cloud Computing Environment

F. E. Mohamed et al. [9] told that resource allocation is a major issue in cloud computing. In cloud computing, the users and providers have various and different aims; users want to minimize the expenditure of minimum time and efficiency while providers target to reduce the revenue by increasing the resources utilization. On the other hand, it is quite difficult to use the resources in an effective manner and allocate the resource mutually. Researchers proposed an agent-based approach to knot various cloud providers with various cloud users. The main aim of the proposed approach was to allow users to pick up appropriate resources according to their need. The simulation results showed that autonomous agent had provided the intelligence to the cloud for user‟s interactions and resources allocation.

(ix)An Energy-Saving Task Scheduling Strategy Based on Vacation Queuing Theory in CloudComputing

C. Chunling et al. [10] said reducing energy consumption in cloud computing is a very important issue. In cloud computing, incoming jobs have nature of randomness and computing node needs power all the time to awaitincoming tasks which lead to energy wastage. So, scientists proposed an energy saving task scheduling algorithm using queuing model. Here first, vacation queuing model was used with exhaustive service to reproduce task schedule for heterogeneous cloud computing environment. Secondly, scientists analyzed time and energy consumption of computation nodes in above said heterogeneous cloud environment. Later on, a task scheduling algorithm was proposed based on similar tasks to reduce the energy consumption. After performing simulation results it was found that the proposed algorithm was able to perform better and can reduce energy consumptioneffectively.

(x) A Novel Cost-Based Model for Energy Consumption in CloudComputing

A. Horri et al. [11] proposed an energy consumption model for time-shared policy in virtualization layer of cloud computing system. CloudSim simulator was used for modeling of time-shared policy for cost and energy usage based upon the output obtained from the real system, after that the proposed model was evaluated with various scenarios. The cache interference costs were considered in the proposed technique and the costs were based on the size of data. After simulation, it was found that the energy utilization might be extensive and it could be different with different parameters such as the quantum parameter, data size and the number of virtual machines on a host. The output showed that the proposed model was valid and demonstrated that there was a trade-off between QoS and energy utilization in cloud computingsystem.

(xi) Virtual Machine Scheduling in Cloud Computing Environment

T. Yousef et al. [12] demonstrated a generalized precedence algorithm which gave efficiency in contrast with FCFS

and Round Robin Scheduling. The results were computed in CloudSim for the unreliable number of virtual machines workload outlined and justified that it provided a good production as compared to usual scheduling methodologies.

(xii) Dynamic Task Scheduling Algorithm based on Ant ColonyScheme

B. N. Kamolov et al. [13] said finding the optimal solution is called as NP-hard. Ant colony optimization method could be used for designing of efficient scheduling methods. In this research, scientists proposed a task scheduling algorithm that used a modified ant colony optimization technique. The proposed method was implemented in WorkflowSim for performance measurement. After simulation, it was concluded that the proposed Probabilistic Load Balancing Algorithm (PLAC) reduced average makespan about 6.4% as compared to usual Ant colony Optimization and 11.5% as compared to Min-min method.Optimized service level agreement based workload balancing strategy for cloudenvironment

B. S. Rajeshwari et al. [14] presented a two-stage scheduling algorithm. The proposed algorithm was implemented using CloudSim tool and used response time as a parameter. After experiments, it was found that the proposed algorithm gave better response time, effective resources consumption, reduced waiting time and load balance among servers as compared to existing algorithms.

(xiii) Task Scheduling Using PSO Algorithm in Cloud ComputingEnvironments

M. Ali et al. [15] implemented a Dynamic Adaptive Particle Swarm Optimization algorithm (DAPSO) in order to enhance the performance of basic Particle Swarm Optimization by reducing the make-span and increasing the resource consumption for a task. The proposed method is the combination of Dynamic PSO and Cuckoo Search method which is called MDAPSO. The simulation showed that MDAPSO and DAPSO performed well as compared to original PSOmethod.

(xiv) Evaluating map reduce tasks scheduling algorithms over cloud computing infrastructure

A. Qutaibah et al. [16] evaluated the major MapReduce scheduling algorithms like FIFO, Matchmaking, Delay andmultithreadedlocalityonvirtualizedsystem.Theevaluated algorithms were tested on behalf of two parameters: simulation time and energy consumption. The results showed that the MTL technique is better than existingschedulers.

(xv) A workload balanced approach for resource scheduling in cloudcomputing

K. Ritu [17] proposed a new Load Balanced Resource Scheduling (LBRS) Algorithm which balanced resource scheduling. PHP environment was used for implementation which is freely available. The parameters were taken: arrival rate, servicing rate etc., and the proposed LBRS approach performed than existingones.

III. EVALUATION OFALGORITHMS

We have studied various latest task scheduling algorithms proposed by various scientists. The comparison of latest task scheduling algorithms is shown in Table 1. The comparison parameters are as Makespan, Response Time, Degree of Imbalance, Execution Time, VM Buffer, Server rate, Round Trip Time, Transmission Time, Task Distribution, and Energy Consumption etc. The tools used by various researchers are CloudSim, WorkFlowSim, and Matlab as shown in Table 1 as well.

TABLE I. ALGORITHMS COMPARISON

Algorithm	Simulation Parameters	Findings	Environment
Symbiotic Organism Search Optimization [1]	Particle Size, Self-Recognition Coefficient, Social Effect, Static Inertia Weight, Variable Inertia Weight, No. of Iterations, No. of Organisms	In a larger search space, it performed better in account of Makespan, Response time and Degree of Imbalance	CloudSim
Genetic Algorithm using Queuing Model [2]	Response Time, Average Waiting Time, Length of Queue, Arrival Process, Service Process, No. of Servers andServer Capacity	Better than FCFS Scheduling	Not Mentioned
Multi-Objective Task Scheduling [3]	No. of Tasks, No. of VMs	Better than FCFS and Priority Scheduling in term of Execution Time	CloudSim

Multi-Objective Task Scheduling using Nested Particle Swarm Optimization [4]	No. of Data-centers, No. of PE (Processing Elements) per Data-Center, Speed of PE, Power Consumption, No. of Tasks, Tasks Length, Time, Energy and Failed Tasks	Better than BRS and RSA Techniques	CloudSim
Random Task Scheduling Based on Reinforcement [5]	Length of Job, No. of Jobs, No. VMs, VM Frequency, VM Memory, VM Bandwidth, No. of VM Buffer, No. of PEs, No. of Datacenters and No. of Hosts	Efficient in Task Scheduling and Load Balancing, Revealed the relationship between arrival rate, server rate, no. of VMs and buffer size	Matlab Ver. 2012a
Hybrid Heuristic Workflow Scheduling [6]	Processing Cost, Transfer Cost, Deadline Cost	Better in cost reduction than PSO, Gravitational Search and Hybrid Gravitational Search	CloudSim
Enhanced Particle	Length of Tasks, No. of Tasks,	Minimized Round TripTime,	CloudSim
Swarm Optimization for Task Scheduling [7]	File Size, Output Size, No. of VMs, MIPS, VM Memory, Bandwidth, No. of Datacenters and Hosts	Execution Time, Transmission Time and Achieved Load Balancing	
Dynamic Multi-Objective Task Scheduling Based on Modified PSO[8]	Length of Task, No. of Tasks, File Size, Output Size, No. of VMs, MIPS, VM Memory, Bandwidth, No. of Datacenters and Hosts	Improved Task Completion Time, Execution Cost, Distribution of Tasks	CloudSim
Agent Based Approach for Resource Allocation [9]	Memory, No. of PE, Cost of PE, Power of PEs, No. of Physical Nodes	Made Cloud Intelligent for User's Interaction and Resource Allocation	CloudSim, JADE
Energy Saving Technique using Queuing Theory[10]	Amount of Tasks, Task Arrival Interval, Average Service Time of Nodes, CPU Frequency, Coefficient between Power and CPU Frequency, Idle Power of Compute Node, Sleep Power of Compute Node, Recovering Power of Compute Node, Threshold of Idle Period, Transition time from sleep state to running state,Objective weight coefficient	Increased Task Performance and Reduced Energy Cost	MATLAB
A Novel Cost Based Model for Energy Consumption [11]	No. of Hosts, CPU Type, RAM, MIPS, Cache Memory, Storage, Power consumption by each host, No. of VMs	results indicated that the energy consumption might be considerable and it could vary with different parameters such as the quantum parameter,data size, and the number of VMs on a host	CloudSim
Generalized VM Scheduling[12]	No. of Tasks, No. of VMs, VM Memory, Storage, CPU Speed, MIPS	Gave better results than FCFS and Round Robin Algorithm	CloudSim and Windows7
PLAC Algorithm using Modified ACO [13]	No. of Datacenter, No. of Hosts, No. of VMs, MIPS of PE per VM, VM Memory,Bandwidth, Type of Manager	Performed better than ACO and Max-Min in account of Average Makespan and Minimum Makespan	WorkFlowSim

IV. CONCLUSION

This paper elaborates a number of research papers related to task scheduling techniques in cloud computing. In existing algorithms optimization as well as other techniques like PSO, GA, Enhanced PSO, ACO, Queuing Theory, Agent-Based approach, Multi-Objective approach and lots more have been used. The main focus of these algorithms was to minimize makespan, reduce execution time, transmission time, consume less energy even after incrementing in the numbers of jobs and VMs, proper use of VMs buffer size etc. Symbiotic Organism Search Optimization based algorithm performed better in terms of makespan, response time and degree of imbalance for a larger search space. Genetic Algorithm based on Queuing Model outer-performed than FCFS. Multi-Objective task scheduling algorithmperformed better than FCFS and Priority Based algorithm in an account of execution time. Multi-Objective task scheduling using Nested PSO gave better results than BRS and RSA techniques. Random Task Scheduling based

on Reinforcement worked effectively in load balancing as well as task scheduling. Hybrid Heuristic Workflow Scheduling worked better in cost reduction as compared to PSO, Gravitational Search, and Hybrid Gravitational Search algorithms. Enhanced Particle Swarm Optimization gave maximum efficiency to reduce round trip time, execution time, transmission time and achieved load balancing as well. Dynamic Multi-Objective task scheduling based on Modified PSO improved task completion time, execution cost, and distribution of tasks over different nodes. Agent- Based Approach for Resource Allocation provided the intelligence to the cloud for user's interaction and resource allocation. PLAC algorithm using modified PSO was found better than ACO and Max-min in terms of minimum makespan and average makespan. As we discussed earlier in our paper, the different kind of industries have started to move in cloud computing and the users of cloud computing are increasing day by day. To achieve overall system performance with limited cost factor, a better algorithm for task scheduling is expected to schedule different user‟s tasks.

In future, there is a wide scope of enhancement of the scheduling algorithms using meta-heuristic techniques, using machine learning techniques or by making hybrid techniques.

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