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Perspective Study on task scheduling in computational grid

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Abstract

Grid computing is a form of distributed computing and task scheduling remains the heart of grid computing. The grid resource scheduler gets the request from the user and assigns the tasks to the available resources succeeding in an effective computing practice. The purpose of task scheduling is to allocate resources for executing task. Task scheduling guides resource allocation. The objective of the task scheduling process is to allocate capable resources to each task with specific requirements in order to minimize the makespan. Makespan, Flow time, Resource utilization, Matching proximity, Computation Time are the objectives of grid scheduling. This survey is done by comparing the existing methods of task scheduling.

Keywords: Grid Computing, Heuristic methods, Resource Allocation, Task Scheduling.

I. Introduction

Computational grid is the part of distributed computing systems. Computational grid split the task into multiple tasks and executes them on different grid nodes in parallel. Because of using the resources of grid nodes parallel the computation perform faster. For running applications, resource allocation, resource management, job scheduling, task scheduling are the most substantial problems in grid computing. The purpose of Computational grid is to achieve distributed supercomputing, high throughput, on demand, data intensive and collaborative computing. There are many Communities like government, health maintenance, and science collaborations and also many other communities need the ability to share data and CPU power. So these communities will use the computational grid. The researchers have proposed many efficient scheduling algorithms and methods that are used to solve the problems on allocating the grid resources on task scheduling. This paper describes about the existing and proposed methods as follows: Section II describes about basic grid computing, Section III describes the existing heuristic methods of task scheduling, Section IV describes the proposed methods of task scheduling, Section V describes the Comparative study of various Task Scheduling Schemes in Grid Computing which is proposed by the researchers, Section VI describes the analysis of various papers on task scheduling, Section VII presents the conclusion of the perspective study on task scheduling.

II. Basic Grid Computing

The grid computing is the kind of distributed computing. Different computers in the same network share one or more resources in distributed computing. The grid computing architecture consists of the user, grid scheduler (resource broker) splits the task and distributes to the local scheduler for execution, grid information service which stores the information of the whole resources. Grid scheduling process contains three processes they are Resource discovery, Information gathering and job execution. Task scheduling refers to the way processes are assigned to run on the available processors. Scheduling is concerned with: Processor utilization, Throughput, Turnaround, Waiting time, Response time. Most popular optimization criterion is minimization of make span that is finishing time of largest job. Make span measures the throughput of grid system. Flow time is the sum of the finishing times of jobs. Flow time measures the quality of service of the grid system. Flow time is minimum when jobs are processed in ascending order of processing time on a particular grid resource. Due to economic aspect resource providers and grid managers are interested in the maximum utilization of resource. In grid computing effort is made to process the task on the best possible machine i.e. the machine which takes minimum execution time. Matching Proximity indicates the degree of proximity of a given schedule to the schedule produced by the Minimum Execution Time method, which assigns a job to the machine having the smallest execution time for that job. Due to dynamic nature of grid, computation time needed to generate schedule is also an important criterion for selecting a suitable scheduling method. In grid scheduling problem there is no need to get the optimal solutions. In the highly dynamic environment

it is essential to get high quality feasible solution in short time.

III. Existing Methods

Heuristic Methods of Task Scheduling [1]

a. Opportunistic Load Balancing (OLB) [1]:

In this method earliest machine which is idle is selected without considering the task's execution time. If two or more machines are idle then machine is selected arbitrarily. In this method time required for Scheduling is less and it keeps almost all the machines busy at all possible time.

b. Minimum Execution Time (MET) [1]:

In this method minimum execution time is used to assign the job without considering the machine availability. Job is assigned to the machine on which it can be executed in minimum time. Allocating job without considering machine availability results in load imbalance on grid machines.

c. Minimum Completion Time (MCT) [1]:

In this method job is assigned to the machine that gives minimum completion time for the job. Allocating job in this manner may result in execution of job on less fast grid machines.

d. Switching Algorithm (SA) [1]:

This method of scheduling combines the best features of MCT and MET methods of scheduling. The method tries to use better load balancing of MCT and execution on fastest machine of MET. Here the idea is to first use the MCT till a threshold of balance is reached followed by MET which creates the load unbalance by assigning jobs on faster machines

e. k-Percent Best (kPB)[1]:

This method also attempts to combine the best features of MCT and MET simultaneously instead of cyclic manner.

f. Min-min [1]:

In this method completion time of all unassigned tasks on the entire available machine is used to calculate the minimum completion time (MCT) of task on machine. Then task which gives minimum of MCT is identified and assigned on the machine. Subsequently the assigned task is removed from the list of unassigned task and workload of machine is updated. Above procedure is repeated till unassigned task list get exhausted**.**

g. Max-min [1]:

In this method, similar to min-min method, completion time of all unassigned tasks on all the available machine is used to calculate the minimum completion time of task on machine Then task which gives maximum of MCT is identified and assigned on the machine. Subsequently the assigned task is removed from the list of unassigned task and workload of machine is updated. Above procedure is repeated till unassigned task list get exhausted.

h. LJFR-SJFR [1]:

Largest Job on Fastest Resource – Shortest Job on Fastest Resource (LJFR-SJFR) method allocates largest job on fastest resource to reduce the makespan and allocates smallest job to fastest resource to reduce the time of flow.

i. Suffrage [1]:

Suffrage for a job is the difference between second minimum completion time and first minimum completion time for that job. Suffrage method tries to allocate most suffered jobs in terms of expected completion time first. In this method suffrage is calculated for all unassigned jobs and the job which has maximum suffrage value is assigned to the machine which gives first minimum completion time.

j. Work Queue (WQ) [1]:

It is a method of job allocation. Jobs are randomly selected from the list of unassigned jobs and assigned to the machine with minimum workload. Job assignment repeated in similar manner till list of unassigned jobs get exhausted.

k. Min-max [1]:

Min-max heuristic assigns the jobs to machines by two methods. In first step, similar to min-min method, completion time of all unassigned tasks on all the available machines is used to calculate the minimum completion time (MCT) of task on machine. In the second step for all tasks ratio of minimum execution time (time to execute on fastest machine) to its execution time on selected machine is computed and the task which has maximum value of it is selected for assignment. Then job is removed from unassigned job list, machine workload updated and above cycle of job allocation repeated till list of unassigned jobs get exhausted.

IV. Proposed Methods of Task Scheduling

a. Resource Aware Scheduling Algorithm [2]

Objective: A new task scheduling algorithm called RASA is built through the analysis of two task scheduling algorithms, Min-min and Max-min and To achieve the lower make span this scheduling algorithm is used.

Advantages and Disadvantages:

RASA uses the advantages of Max-min and Min-min algorithms and covers their disadvantages. To minimize the make span.

Applying the RASA algorithm on actual grid environment for practical evaluation can be open problem in this area.

b. Cuckoo Algorithm [3]

Objective: A cuckoo optimization algorithm is proposed for optimal job allocation of resources on each node. This system will allocate the job optimally by considering the requirement of the users and also the minimal execution time.

Advantages and Disadvantages:

This system will allocate the job optimally by considering the requirement of the users and also the minimal execution time.

Once job is allocated to the resource, it is fixed and no other way to change.

c. Load Balanced Min Min Algorithm [4]

Objective: Load Balanced Min-Min (LBMM) algorithm is proposed to reduce the makespan and increases the resource utilization.

Advantages and Disadvantages:

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

To minimize the make span and increase the resource utilization**.**

Applying the proposed algorithm on actual grid environment and considering the cost factor can be open problem in this area.

d. Qos Guided Weighted Mean Time Algorithm [5]

Objective: Resource load balancing and minimizing makespan are the fundamental goals of effective and efficient task scheduling. It turns out to be more complicated when various QoS demands arise from users. To perform the effective and efficient task scheduling this proposed system is used.

Advantages and Disadvantages:

Both heuristics QoS Guided Weighted Mean Time min and QoS Guided Weighted Mean Time Min-Min Max-Min Selective provide better makespan, resource utilization and load balancing than the other heuristics.

It is only based on Quality of Service, the task can be divided into low and high Qos and schedules the task by means of high and low Qos.

e. Particle Swarm Optimization [6]

Objective: This approach aims to generate an optimal schedule so as to get the minimum completion time while completing the tasks.

Advantages and Disadvantages:

Our approach is to generate an optimal schedule so as to complete the tasks in a minimum time as well as utilizing the resources in an efficient way.

f. Firefly Intelligent Swarm Optimization Technique [7]

Objective: The proposed method is to dynamically create an optimal schedule to complete the tasks within minimum makespan.

Advantages and Disadvantages:

Complete the tasks within a minimum makespan and flowtime.

This method concentrates only on completing the task within a minimum make span and not on other process such as resource allocation etc.

g. Multiple Ant Colony Optimization [8]

Objective: The improved MACO approach is to find the optimal solution with a minimum execution time of task.

Advantages and Disadvantages:

The Makespan is minimized by using the load balancing.

h. A Novel Qos Guided Task Scheduling Algorithm [9]

Objective: The goal of grid task scheduling is to achieve high system throughput and to match the application needs with the available computing resources.

Advantages and Disadvantages:

Achieving high system throughput

i. A New Ant Colony Optimization Scheduling Algorithm [10]

Objective: The proposed scheduler proves that best suitable resource is allocated to each task with reduced makespan and execution time when compared with the existing algorithm.

Advantages and Disadvantages:

This algorithm gives the efficient resource allocation to the machines. It is working with only resource

allocation and not on other criteria such as minimizing completion time, execution time etc.

j. Particle Swarm Optimization Algorithm [11]

Objective: In this proposed scheduling approach tasks are grouped and allocated in an Un-uniform manner. The percentage of the total processing capability of all the resources is calculated. Using this percentage of the processing capability of a resource based on the total length of all tasks is calculated.

Advantages and Disadvantages:

Our approach is to generate an optimal schedule so as to complete the tasks in a minimum time as well as utilizing the resources in an efficient way.

k. A Probabilistic Task Scheduling Method [12]

Objective: Probabilistic task scheduling method is used to minimize both the overall mean response time of the tasks which are submitted to the grid environments and total makespan of the environment. The overall mean response time is the important Quality of service measure in grid and to achieve this, Discrete Time Markov Chain is constructed.

On absorbing all the DTMCs the Nonlinear programming problem is defined and by solving the NLP problem the best scheduling path and the minimum mean response time of a particular task can be obtained.

Advantages and disadvantages:

Minimizing the overall mean response time, Minimizing the makespan of the job.

V. Comparative study of various Task Scheduling Schemes in Grid Computing

	PARAMETERS/ PAPERS	OBJECTIVE	MERITS	DEMERITS
1	Resource Aware Scheduling Algorithm [2]	A new task scheduling algorithm called RASA is built through the analysis of two task scheduling algorithms, Min-min and Max-min and To achieve the lower make span this scheduling algorithm is used.	(i)RASA uses the advantages of Max-min and Min-min algorithms and covers their disadvantages. (ii)To minimize the make span	Applying the RASA algorithm on actual grid Environment for practical evaluation can be open problem in this area.
2	Cuckoo Algorithm [3]	A cuckoo optimization algorithm is proposed for optimal job allocation of resources on each node. This system will allocate the job optimally by considering the requirement of the users and also the minimal execution time.	This system will allocate the job optimally by considering the requirement of the users and also the minimal execution time.	Once job is allocated to the resource it is fixed and no other way to change.
3	Load Balanced Min-Min Algorithm [4]	Load Balanced Min-Min (LBMM) algorithm is proposed to reduce the makespan and increases the resource utilization.	(i)LBMM uses the advantages of Max-min and Min-min algorithms and covers their disadvantages. (ii)To minimize the make span and increase the resource utilization.	Applying the proposed algorithm on actual grid environment and considering the cost factor can be open problem in this area.

4	QoS guided weighted mean time algorithm [5]	Resource load balancing and minimizing makespan are the fundamental goals of effective and efficient task scheduling. It becomes more complicated when various QoS demands arise from users.	Both heuristics QoS Guided Weighted Mean Time min and QoS Guided Weighted Mean Time Min-Min Max-Min Selective provide better makespan, resource utilization and load balancing than the other heuristics.	It is only based on Quality of Service, the task can be divided into low and high Qos and schedules the task by means of high and low Qos.
5	Particle Swarm Optimization [6]	This approach aims to generate an optimal schedule so as to get the minimum completion time while completing the tasks.	This approach is to generate an optimal schedule so as to complete the tasks in a minimum time as well as utilizing the resources in an efficient way.	It is working with only resource allocation and not on other criteria such as minimizing completion time, execution time etc.
7	Firefly Intelligent Swarm Optimization [7]	The Proposed method is to dynamically create an optimal schedule to complete the tasks within minimum makespan.	The ultimate goal of this approach is to give the optimal scheduling path.	It is working with only resource allocation and not on other criteria such as minimizing completion time etc.
8	A Novel Qos guided task scheduling algorithm [9]	The goal of grid task scheduling is to achieve high system throughput and to match the application needs with the available computing resources.	It is a quality of service process which gives the solution to user requirements.	Based only on quality of service measure.
9	A New Ant Colony Optimization [10]	The proposed scheduler proves that best suitable resource is allocated to each task with reduced makespan and execution time when compared with the existing algorithm.	This algorithm guarantees efficient resource allocation of the machines.	It is working with only resource allocation and not on other criteria such as minimizing completion time etc.
10	Particle Swarm Optimization [11]	In this proposed scheduling approach tasks are grouped and allocated in an Un-uniform manner. The percentage of the total processing capability of all the resources is Calculated.	This approach is to generate an optimal schedule so as to complete the tasks in a minimum time as well as utilizing the resources in an efficient way.	It is not concentrating on the execution time, waiting time, response time etc.

Table – I: Comparative study of various Task Scheduling Schemes in Grid Computing

VI. Analysis of various papers on task scheduling

A new task scheduling algorithm called RASA [2] is built through the analysis of two task scheduling algorithms, Min-min and Max-min and to achieve the lower make span this scheduling algorithm is used. A cuckoo optimization algorithm [3] is proposed for optimal job allocation of resources on each node. This system will allocate the job optimally by considering the requirement of the users and also the minimal execution time. Load Balanced Min-Min (LBMM) algorithm [4] is proposed to reduce the makespan and increases the resource utilization. Load balancing and minimizing makespan are the essential objectives of an effective and efficient task scheduling. It becomes more complicated when various QoS demands arise from users. To perform the effective and efficient task scheduling this Qos guided weighted mean time algorithm [5] is used. Particle swarm optimization [6] approach aims to generate an optimal schedule so as to get the minimum completion time while completing the tasks. The Firefly intelligent swarm optimization [7] is to dynamically create an optimal schedule to complete the tasks within minimum makespan. The improved MACO [8] approach is used to find the optimal solution by the task which have minimum execution time. The goal of novel Qos guided task scheduling algorithm [9] is to achieve high system throughput and to match the application needs with the available computing resources. The New ant colony optimization scheduling algorithm [10] proves that best suitable resource is allocated to each task with reduced makespan and execution time when compared with the existing algorithm. In Particle swarm optimization algorithm [11] tasks are grouped and allocated in an Un-uniform manner. The percentage of the total processing capability of all the resources is calculated. Using the percentage of the processing capability of a resource based on the total length of all tasks is calculated. These are the analysis of the surveyed papers.

VII. Conclusion and Future Enhancements

In this paper, various existing and proposed task scheduling algorithms in grid computing have been surveyed and also the analyses have been done. On absorbing the survey makespan, mean response time are the most user oriented quality of service so by minimizing the mean response time of the task can achieve high performance computing. Our future work will be based on developing the efficient task scheduling method that will reduce the response time, makespan, flowtime, and resource utilization.

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