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A Study of Various Job & Resource Scheduling Algorithms in Grid Computing

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***Abstract*— In 1990's, the term 'Grid' was coined to denote a proposed distributed computing infrastructure for advanced science and engineering. Grid is a system in which machines are distributed across various organizations. Grid computing is a form of distributed computing. It involves sharing of resources that are heterogeneous and geographically distributed to solve various complex problems and develop large scale applications. As to develop applications, resources are required and so job and resource scheduling becomes one of the key research area in the Grid computing. The goal of scheduling is to achieve highest possible system throughput and to match the application need with the available computing resources. In this paper, we will review the various job and resource scheduling algorithms that will benefit the researchers to carry out their further work in this area of research.**

***Keywords*— Grid computing, Job Scheduling, Resource Scheduling**

I. INTRODUCTION

The growth of internet and the availability of powerful computers and high speed network has made possible the use of geographically distributed and multi-owner resources to solve large scale problems in science, engineering and commerce. The research was done on these topics which led to the emergence of a new paradigm known as *Grid Computing* [1]. In Grid Computing environment, resources are autonomous, distributed and not free. As resources are not free so sharing of resources is necessary. The goal of grid computing is to provide users with access to the resources they need, when they need them.

For developing applications, management of resources and scheduling of jobs are the most crucial problems in grid computing system. To solve these problems, various efficient scheduling algorithms have been proposed that are used to allocate resources. This paper is organized as follows: in section II, various grid scheduling components are presented, section III describes various job and resource scheduling algorithms, section IV compares the various algorithms discussed in section III and section V concludes the paper.

II. THE GRID SCHEDULING COMPONENTS

The Grid is a system that contains various components and resources. The scheduling process in grid is divided into three stages: resource discovering and filtering, resource selecting and scheduling and job submission [2]. An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it. Figure 1 denotes various functional components of grid scheduling system.

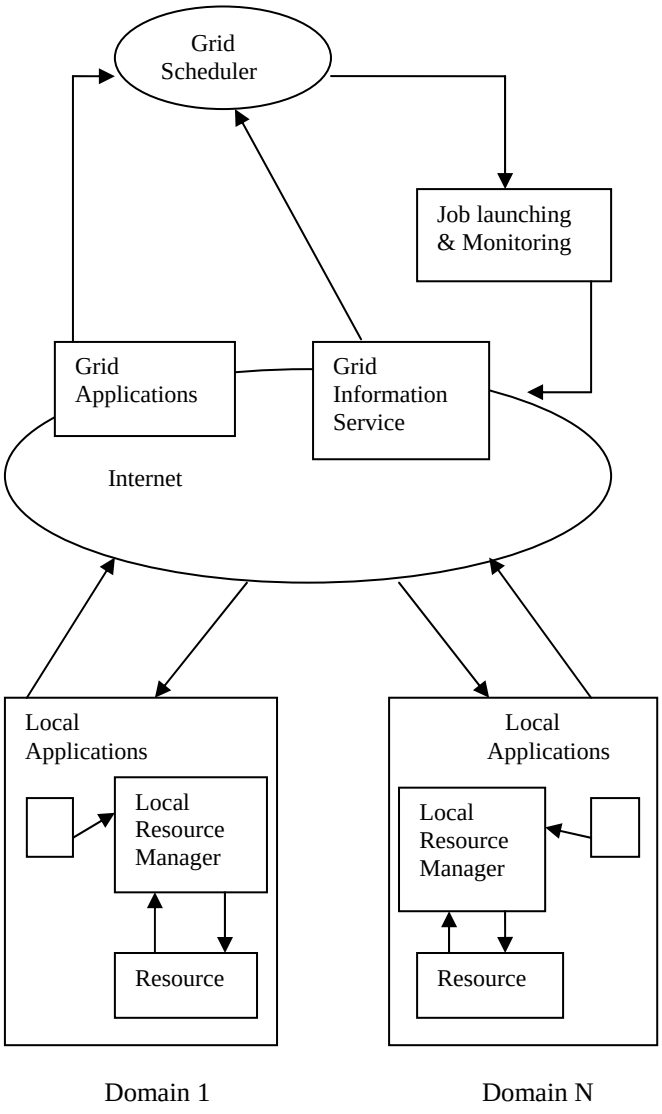

Fig.1 A Logical Grid Scheduling Architecture

Grid Scheduler (GS) receives applications from Grid users, select resources for the applications and finally generate application-to-resource mapping [3]. Grid Information Service (GIS) is responsible for collecting and predicting the resource state information. An example of a GIS is Monitoring and Discovery system (MDS) [4].

A Local Resource Manager (LRM) is responsible for local scheduling inside a resource domain and reporting resource information to GIS.

III. DIFFERENT JOB AND RESOURCE MANAGEMENT ALGORITHMS

Job Scheduling: The aim of job scheduling system is to select the best machines in a grid for various users jobs. For each machine, job schedulers are generated by the management and scheduling system. Effective computation and Job Scheduling is becoming one of the main challenges in grid computing.

A. Efficient Utilization of Computing Resources using Highest Response Next Scheduling in Grid (HRN)

In Highest Response Next Scheduling schema[5], jobs are allotted to number of processors based on job's priority and processor's capability. HRN scheduling algorithm was proposed to correct the weaknesses of both Shortest Job First and FCFS. This algorithm provided for response with time, memory and CPU requirement.

Advantages:

1) It utilizes the resources efficiently.
2) HRN model is much adaptive for Grid environment.

Disadvantages:

1) High turnaround time.
2) Memory and CPU wastage.

B. Node Allocation in Grid Computing using Optimal Resource Constraint(ORC) Scheduling

ORC scheduling algorithm includes the combination of both the Best fit allocation and Round Robin scheduling to allocate the jobs in queue pool[6]. This algorithm improved the efficiency of load balancing and dynamicity capability of the grid resources.

Advantages:

1) Reduces waiting time of job and turnaround time.
2) Increases processing time of jobs.

Disadvantages:

1) High communication overhead.

C. Hierarchical Job Scheduling For Clusters of Work Station (HJS)

Hierarchical job scheduling approach used two levels Scheduling global scheduling & local scheduling[7]. The global scheduler uses separate queues for different type of the jobs for scheduling with the FCFS,SJF and first fit (FF) and the local scheduler uses same queue for different type of the jobs.

Advantages:

1) It uses multi queue to allow more control over the allocation of resources to jobs.
2) Reduces turn6around time.

Disadvantages:

1) This algorithm does not consider the dynamic behavior of the grid resources.
2) Chance of under utilization of grid resources.

D. Scheduling Framework for Bandwidth Aware Job Grouping Based Scheduling in Grid Computing (SFBAJG)

The use of bandwidth in scheduling framework was explored to enhance the performance of job scheduling[8]. The scheduling frame work consisted of job scheduler that obtained information form grid information service (GIS). About the resources on the basis of this information job scheduling was used for grouping of jobs & selecting resources. The framework has a grouping and selection service where matching of jobs is performance based on the information gathered from information collector the information collector will information about the network bandwidth to reach each resource, then this information is used for grouping and selection service to gather the necessary information which is required for job selection the GIS contains all the resources and provide information about them jobs to the respective resources.

Advantages:

1) Improves the dissemination of jobs of jobs in grid computing.
2) This framework is a good alternative for delivering job scheduling process with better job scheduling performance.
3) Reduces total processing time.

Disadvantages:

1) Does not consider memory size constraint.
2) Does not take dynamic resource characteristics.

E. Grouping Based Fire Grained Job Scheduling in Grid Computing(GB FJS)

The grouping based fire grained job scheduling algorithm[9] starts with obtaining info about the resources. In this algorithm, light weight jobs are grouped as coarse grained jobs. The groping based algorithm utilized resourced efficiently of integrates greedy algorithm of FCFS algorithm. To improve processing undertake of fire grained jobs.

Advantages:

1) It reduces total processing time.
2) Reduces execution time of the jobs.
3) Maximize the utilization of the resources.

Disadvantages:

1) It does not consider memory size constraint.
2) Preprocessing time of job grouping is high.

F. A Bandwidth- Aware Job Grouping - Based Scheduling On Grid Environment (BAJGS)

In bandwidth aware job grouping based scheduling algorithm the job grouping concept is explored coupled with bandwidth aware scheduling[10]. This algorithm focuses on grouping independent jobs having small processing requirement into jobs with larger processing requirements and then schedules them according to network

conditions. The concept of bandwidth was used for performing load balancing at stream control transmission protocol (SCTP) layer. Its main objective was to provide the in-order delivery over multiple paths. This approach reduces total job processing time as compared to job scheduling without grouping.

Advantages:

1) This algorithm focuses on grouping jobs with small processing requirements into jobs with larger processing requirements.
2) Minimizes total processing time.

Disadvantages:

1) Does not implement load balancing scheme.
2) This algorithm does not include QOS requirements.

G. An Agent Based Dynamic Resource Scheduling Model with FCFS Job Grouping Strategy in Grid Computing (ABDRS)

The agent based dynamic resource scheduling strategy focuses on maximize the processing time of jobs[11]. The process of selecting a job is based on maximum heap tree. The processed outsource model is a hierarchical two layer approach in which top layer is called grid level an d other is called cluster level.

Advantages:

1) This algorithm enhances scalability, robustness and load balancing availability of the Grid.
2) Maximize resource utilization.
3) Minimize processing time of jobs.

Disadvantages:

1) This algorithm does not implement job and resource scheduling with genetic algorithm to increase the performance.

H. A Dynamic Job Grouping Based Scheduling for Deploying Application with Fine Grained Task on Global Grid (DJGBS)

Dynamic job grouping based scheduling algorithm group the jobs according to MIPS of the resource[12]. It selects resource in first come first serve order. It selects jobs and group the jobs and assigns the group jobs in FCFS order and compare to resource if group job MI is less that to resource MIPS of this process continues until the resource MIPS is less to group job.

Advantages:

1) It maximizes the utilization of the resource.
2) It reduces the total processing time of jobs.

Disadvantages:

1) It does not consider the bandwidth and memory size constraints.

I. Virtual Computing Grid Using Resource Pooling (VCGRP)

Virtual computing grid means that the system can choose a resource of allocate tasks to it[13]. It is a single point web based access known as virtual computing grid portal and the virtual computing grid monitor is a central resource manager for the system.

Advantages:

1) Cost Effective model.

Disadvantages:

1) Not much reliable.
2) Since it is cost effective solution quality of service has been play done in the prototype model.

IV. COMPARISON OF VARIOUS JOB AND RESOURCE SCHEDULING ALGORITHMS

In this section we compare the various scheduling algorithm algorithms discussed above. The table shows the compare ion based on response time, resource utilization and load balance done with these scheduling algorithms.

TABLE 1
COMPRESSION OF VARIOUS JOB AND RESOURCE SCHEDULING ALGORITHM

Paper	***Architecture H/D/C***	***Environment HE/HO***	***RT***	***RU***	***LB***	***DY***
HRN	D	HO	HI	HI	HI	HI
ORC	*D*	*HE*	*HI*	*HI*	*HI*	*HI*
HJS	H	HO	AVG	HI	HI	HI
SFBAJG	H	HE	HI	HI	LO	AVG
GFJS	D	HE	HI	HI	HI	HI
BAJGS	D	HE	HI	HI	LO	HI
ABDRS	H	HE	HI	HI	HI	HI
DJGBS	D	HE	HI	HI	HI	HI
VCGRP	D	HE	AVG	HI	HI	HI

V. CONCLUSIONS

In this paper we have discussed various job scheduling algorithms that can be used to schedule different jobs. This paper also describes the various components of the grid scheduling system. A brief comparison of various algorithms based on various parameters like distributed, hierarchical, centralized, response time, resource utilization etc has been summarized in the table

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