Cluster usage analysis of timeline based grid scheduling algorithm

Bimal VO[#1], M. Anand Kumar[*2]

[#]Research Scholar, Dept of Computer Science, Karpagam University, Coimbatore, Tamil Nadu, INDIA.

[*2] Associate Professor, Dept of Information Technology, Karpagam University, Coimbatore, Tamil Nadu, INDIA.

Abstract Grid computing is an ever demanding technology for the effective and fast completion of very compute-intensive applications like space and research problems and it also promises some economic benefits such as utilizing spare resources in other time zones that are in a period of reduced business activity[1]. Much of the Grid computing vision yet remains to be fully implemented, except with relatively specialized applications, and in certain types of environments, such as research and education organizations, or leading-edge financial services companies.[4] One of the barriers to the adoption of Grid computing is the relative complexity of customizing and adapting workloads to make them suitable for hosting on a Grid. Job scheduling software, which automates the assignment of workloads to hosts based on the priority of a job, is relatively mature, but it has traditionally been used to manage resources at the level of individual applications [21]. In order to ensure proper execution of an application that is submitted to a Grid, it is necessary to provide the application with the software environment that it needs to execute. Scheduling algorithms plays an important role in this dynamic execution of jobs.[3]

KEYWORDS — ALEA, CLUSTER, RESOURCE LOADER, GRID COMPUTING, SCHEDULING, TIMELINE

I. INTRODUCTION

Computational Grid has become one of dominant issues in recent distributed computing society. It is very demanding task to design optimal co-allocation of data, CPU and network resource for specific jobs. One of the major issues for the efficient design of computational GRID is to locate appropriate resource on highly heterogeneous and distributed environments. Although there has been a great deal of study on resource management in GRID architecture, less work has been done in relation to the communication bottleneck. In this paper, we analysis the cluster usage inside grid when we apply different algorithms including newly developed TimeLine algorithm.[2].

II. TIMELINE ALGORITHM

In Recent years, various algorithms were introduced like the BestGap, FCFS, PBS_PRO, backfilling, EDF, CONS(Conservative backfilling algorithm) etc in different grid computing projects. The efficiency of these algorithms varied based on the computing environment and computational requirement of the project. The analysis of TimeLine scheduling algorithm and some other algorithms widely used in G-Commerce applications are important to prove the benefits[5]. The objective of the Timeline algorithm is the effective utilisation of idle computing cycles in the late night hours. Hence the Timeline of the country is taken as scheduling criteria. The proposed algorithm, on an average reduces the waiting time of jobs. Alea, a popular simulation tool in job scheduling is employed for conducting experimental studies [7]. Alea has a capacity to deal with common problems related to job scheduling like heterogeneity of jobs, resources and dynamically changing runtime jobs[6]. The simulation environment allows us an easy comparison of the scheduling algorithms. The figure below shows the proposed algorithm[8].

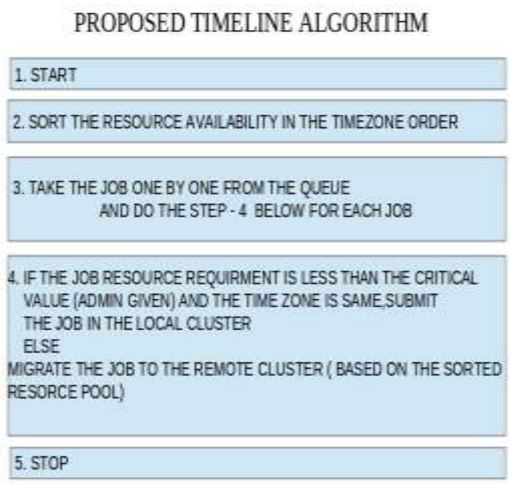

Fig: 2.1

This algorithm is based on the timeline of the country and threshold value or critical value of the job. Threshold value is the minimum load value of a job for executing the job locally (in the same cluster/machine) [19]. It can be static or dynamic value. This value can be set by the grid administrator. In other algorithms the local time factor of the resources is not considered. When we look at the real grid environment, the value of a computing cycle mainly depends on the demand and the availability[20]. The owner of the any grid resources sells his computation cycle at a higher cost when the demand is high and on the other hand the resources will be available at a cheaper rate when the demand is low[22]. This is the strategy in any marketing industry. In a real grid environment, the local load of any resources will be in a saturated level during day time and comparatively low in late night hours. Hence the probability of the availability of the computation cycles and the price are inversely proportional. So the location of the resource and the TimeLine of that region/country plays an important role. These interesting parameters combined effectively in the proposed algorithm.

Fig: 2.2

Based on certain parameters, the entire job can be

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1. Sort the resource in Timezone order
2: stopping condition := false;
3: if queue is empty then
4: stopping condition := true;
5: end if
6: while stopping condition = false do
7: j := first job in queue;
8: if j in queue can be executed then
9. Check the timezone and job_length.
10. If job_resource requirement < critical_job_resource
requirement and timezone is same zone, do 10a else do 11
10a: k := select cluster ; goto 13
11.Select the last resource in the pool if it is not free select next
last and so on and  do 12.
12. Select the cluster
13: Remove j from queue and send it on k;
14: if queue is empty then
15: stopping condition := true;
16: end if
17: else
18: stopping condition := true;
19: end if
20: end while
```

migrated to a remote system where the timeline gap is more. This approach leads to a considerable improvement in the waiting time of jobs in the job pool. Time Line algorithms or simply TL performs job scheduling based on the load, threshold value of job, geographic time of resource and job etc.

III. KEY ELEMENTS IN TIMELINE ALGORITHM

3.1 Processing Elements (PE)

The PE or Processing Element represents the CPU unit, defined in terms of Millions Instructions Per Second (MIPS) rating. There is an assumption that all PEs under the same Machine have the same MIPS rating [9].

3.2 Job Loader

Class JobLoader generates the workload for the simulation. PWA, GWA, MetaCentrum and Pisa workloads. Selection is done via file extension (swf,gwf,mwf,pwf). Alea supports GRID WORKLOADS FORMAT (GWF) which is described at the GRID WORKLOAD ARCHIVE (GWA)[10].

3.3 Resource Queue

It is the data structure maintained by the resource scheduler. It contains the list of resources to be available for executing the job. In the case of Timeline scheduling algorithm, resource scheduler arrange the resources based on the timeline of the geographic location of the resource[11].

3.4. Job Queue

Similar to resource queue, It is the data structure maintained by the job scheduler. It contains the list of batch jobs to be submitted for processing. In any scheduling strategy, the arrival of batch jobs is not predictable [12].

3.5 Threshold value / Critical value

Threshold value or critical value in the TimeLine algorithm is the minimum load value of a job for executing the job locally(in the same cluster/machine)[13]. This value can be set by the grid administrator because this varies based on the grid project. So the better approach is to allow administrator to decide this value before starting the execution. The unit of critical value is PE[14].

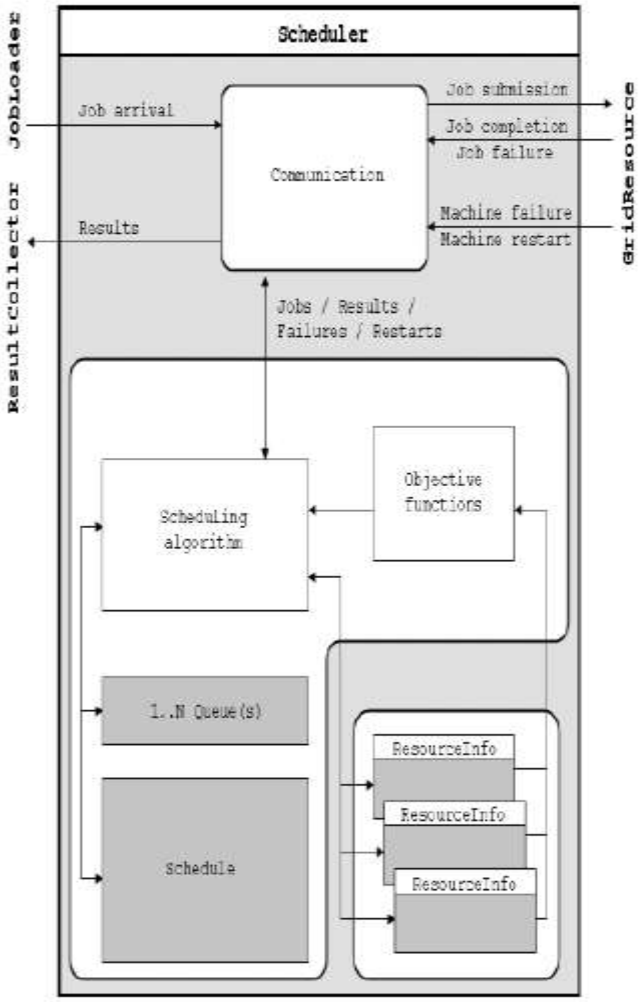
3.6 Experiment Setup class

When we setup TimeLine algorithm the 'Experimentsetup' class, where we can define all important parameters of the Timeline algorithm implementation [15]. The setup is manual and the updation of proper parameters including variables are necessary. The most important is to select data set "metacentrum", which are necessary for the simulation of Timeline algorithms. In Alea, the failures will be created manually. We use the file *.falures to add machine failures during the execution. Alea is not supporting spontaneous automatic failures. The user should manually create it. In this research work assumes no failures. So by default all the experiments were done without any machine failures. So we neglected the file *.falure[16].

IV. SCHEDULING ENTITY

The Scheduler is an important part of the TimeLine simulation. Its action is driven by various events and corresponding messages. The arrival of all jobs will be stored in the JobLoader. Using the JobLoader and the corresponding messages and informations, it communicate with the GridResources[21]. Figure 4.1 shows a scheduler. GridResources is a file that contains job submission/completion and failure detection. The failure detection is not included in this work. The ResultCollector is another program used for periodical result collection. The main job of ResultCollector is performing scheduling decisions. These scheduling decisions varies according to the selected scheduling policy[17].

Fig:4.1



The Scheduler was designed as a modular, extensible entity. The scheduler is composed of three main parts as shown above Fig: 4.1.

V. PERFORMANCE ANALYSIS OF CLUSTERS.

The other experiments were also carried out using Alea simulation tool applying the purposed algorithm as well as the other three scheduling algorithms in the grid environment. The performance of the algorithms were analysed by varying the different parameters such as total number of jobs. It is observed that when the submitted job is equal to 10000, all the scheduling algorithms show a higher request for CPUS, except TimeLine algorithm.

In Figure-5.1, Figure-5.2 and Figure-5.3, and Figure-5.4, the cluster usage analysis of the above three algorithms are plotted respectively when the total jobs are 10000.

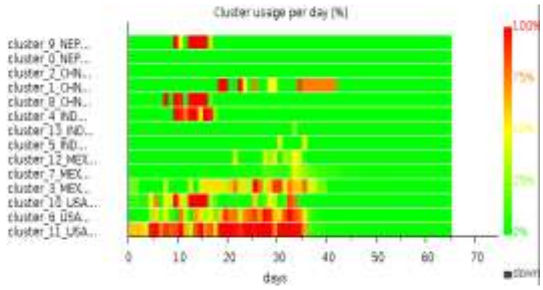


Fig: 5.1

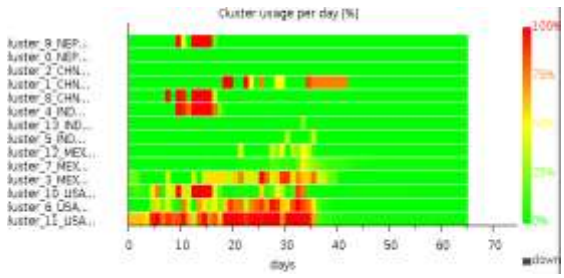


Fig: 5.2

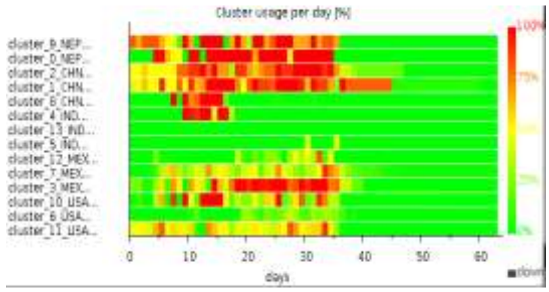


Fig: 5.3

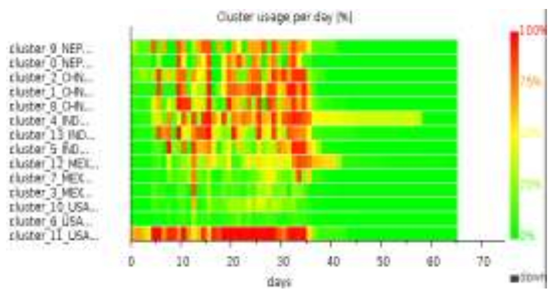


Fig: 5.4

The Figure 5.1 to Figure 5.3 shows the cluster usage of traditional algorithms. In CONS, each job gets a guaranteed staring time. So many instances of time, the clusters are not free and it creates a huge waiting time. On the other hand, in the case of PBS_PRO, it is a multi queue priority based scheduling. It is noted that the high cost local resources are busy and the low cost resources are free. So other jobs have to wait for some time. Hence the resource demanding jobs are intentionally putting in waiting state.

In Best Gap, job which is lower in the queue is moved to the idle machines without delaying the execution of the job at the top of the queue. It is scattered the job in many idle machines, which again cause some delay in putting the job in the right best gap.

In the cluster usage of TimeLine algorithm (Figure 5.4), it is clear that the job distribution is more scattered. The low threshold jobs are submitted in the local area while the lengthy jobs are submitted in the remote area based on three factors.(as mentioned in the above section). These considerations will impact dramatically in the improvement of cost per cycle and waiting time of individual jobs.

VI. Conclusion

In this paper we study the cluster usage of various scheduling within the framework of the GRID computational architecture. We proposed a noble algorithm called TimeLine algorithm and studied its cluster usage. The future work includes the dynamics in GRID environments with cluster failures as well as practical design of the grid clusters across the globe by considering the timeline parameter.

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