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An Optimization of Processor Allocation Method in Heterogeneous Multi-Cluster Computing

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Abstract— Cluster computing is an innovative technology which broadens horizons in whole world business but shortcomings of cluster are becoming hindrance to opt this technology. So, frequent optimizations are required to make this technology commendable. The foremost area of concern is processor allocation, utilization rate, system performance and job scheduling in heterogeneous multi-cluster systems due to which this mechanization lacks behind. To resolve these problems we propose an enhanced approach towards processor allocation in heterogeneous multi-cluster systems which maximize the resource utilization rate, increase system performance and manage load efficiently.

Index Terms— Cluster Computing, Processor Allocation, Job Scheduling, Co-allocation, Heterogeneity.

1 Introduction

CLUSTER computing can be defined as a union of the several areas of parallel, distributed, high-performance and high-availability computing.The clusters can broadly be classified into two major categories: one is homogeneous multi-cluster systems and other is heterogeneous multi-cluster systems. In homogeneous multi-cluster systems, all processors have the same computation capability, which does not make any major difference to allocate a job on different processors. However, in heterogeneous multi-cluster (HMC) systems, multiple clusters have diverse computation capacity, communication capability and memory size. The HMC systems can further be classified into two classes: single site allocation and multi-site co-allocation. The single site allocation defines that the whole system has enough amount of available processors for execution of job but no single cluster itself has sufficient processors to accommodate it. Whereas multi-site co-allocation defines that single job is allocated to multiple sites at the same time interval.

A lot of research has been carried out in parallel processing but cluster computing is becoming an interesting topic of research among academic and industry applications including network developers, system designers, language designers, algorithm developers, researchers, students and faculties. The cluster computing platform has an incredible impact on scientific and engineering applications such as earthquake and hurricane prediction, astrophysics and oceanography, finite element analysis, DNA sequence analysis, as well as, on commercial applications such as database server, web server, FTP server and e-mail server, which can be benefit from the use of clusters. Data mining applications are also benefited by the use of clusters, they provide data storage and data management services for available data sets.

Both job scheduling and processor allocation are two important aspects of cluster computing which prohibit users from using cluster services. Processor allocation is a process of selecting an appropriate portion of free processor from a system for allocating job in a queue. In HMC systems, processor allocation is accountable for selecting available processors between clusters for job execution. The heuristics have been developed for processor allocation such as best fit and fastest first. The different allocation decisions tends to have significant impact on overall system performance.Variety of techniques have been developed for processor allocations in HMC systems that dynamically guide the process of allocation simulation under various workload and resource conditions.

Section 2 describes the related work done in the field of processor allocation in cluster computing. Section 3 discusses the gaps in existing literature. Section 4 describes the proposed model and in section 5 we conclude with our work.

2 Related Work

A lot of research has been carried out in field of cluster computing for processor allocation. Many methods, techniques and schemes have been proposed for processor allocation in multi-cluster systems.

The couple of processor allocation techniques have been developed in cluster computing for allocating an appropriate portion of free processors in a system for allocating job in a queue [7, 3]. In homogeneous grid, best fit processor allocation method has been proposed in which job allocated to particular site will left the least number of free processors when allocated to that site and results in low resource fragmentation [5, 12]. For heterogeneous grid systems, fastest first method has been

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proposed that emphases on speed heterogeneity and allocates a job to the fastest participating site that can execute the job [6].The intelligent processor allocation algorithm [9] has been proposed that focusses on improving processor allocation in heterogeneous grid computing by considering both resource fragmentation and speed heterogeneity under different workload conditions. The main focus on this method is to dynamically shuffle between best-fit and fastest-fit.Ramírez-Alcaraz [4] states that online scheduling of non-pre-emptive parallel jobs in grids is done using grid scheduling model where at first stage jobs are allocated to site, while in second stage local scheduling is done at each site. Results obtained on simulation shows that proper distribution of processor requirements over grid shows high performance improvements then information available from user runtime estimates and local schedulers. The co-allocation [11] uses resources provider offers and vance reservation planning whose objective is to minimize job makespan and waiting time, maximize resource utilization rate and load balancing among all resources providers. The co-allocation algorithm is non-pre-emptive, and all jobs are pendent [1, 11].In heterogeneous multi-cluster system (HMC), the issues of processor allocation for parallel jobs arises. Processor allocation is found to be responsible for allocating available processors among different clusters for job execution. In traditional systems, HMC were ruled by processor geneity or resource fragmentation that leads to development of allocation algorithms such as Random Fit (RF), Best Fit (BF) and Fastest First (FF) etc. In this paper, temporal look-ahead (TLA) processors allocation method is described which uses an allocation simulation to guide the decision of allocating a processor. The allocation decisions are dynamically taken in accordance to current workload and system configuration. TLA concerns about the single site allocation in HMC in tion to the speed heterogeneity i.e. the heterogeneity in puting speed. TLA works by using scoring function which marks the line of distinction from other processor allocation algorithms. The extraordinary features of TLA are firstly, TLA directly takes into consideration the specific performance metric (ATT) for taking all processor allocation decisions. ly, TLA scoring function is dynamic in nature because the allocation decision is fabricated dynamically in accordance to current workload and system configurations that can be changed adaptively. Thirdly, TLA uses the execution time information of waiting jobs to have more precise effects of each allocation. Finally, simulation results indicate that with precise estimation of runtime information, TLA shows high performance provement in comparison to other processor allocation methods and shows up to an 87% performance improvement at its peak [8].

3 Gaps In Existing Literature

- In heterogeneous multi-clusters, either dedicated or non-dedicated, have individual computing characters. As heterogeneous node computing characteristics are unique, node finish times will be at variance for each. As a consequence, faster nodes will have to wait in idle states for slower nodes that lead to inefficient use of cluster resources. Increase in resource utilization rate is an important issue for resolution. Hence, there is need of effective scheduling policy which will overcome the problem like resource fragmentation, speed heterogeneity, system loading, and for which different workload source is required.
- There are some queries that are still unanswered some of them are: Is processor allocation method can operate with different scheduling methods; is different performance metric can be used to optimize the performance.
- There is proposal for single site allocation of processor but no provision for multi-site co-allocation of processor in heterogeneous multi-cluster systems.
- In HMC systems, clusters work by routing all work through front end nodes balancing load and efficiently distributing it among various leftover active nodes. The various processor allocation methods, techniques have been developed but have limited processing power.

4 Proposed Methodology

A processor allocation and job scheduling method for heterogeneous multi-cluster systems for different system configurations is proposed.

The processor allocation method proposed includes both single-site allocation and multi-site co-allocation that mark the line of distinctions from other methods proposed.

J_i – job to be scheduled

X_i – Numer of BPU's required

Collect all information related to jobs from publically available downloadable workload logs. Create global waiting queue to accommodate all submitted jobs. Dynamic central scheduler maintains record of input jobs their arrival time, service time and processor demand for job execution. Once the scheduling session is started dynamic central scheduler dynamically allocates the job using FCFS (first come, first serve). The scheduled jobs are passed for site selection by N_i processors. The jobs with 'e' constant variance workload are submitted. Scheduling session is started again for site selection; the job J_i selected which require X_i number of BPU's (branch processing unit). If Job J_i processor requirement is less than available number of processors X_i perform site selection (J_i, X_i) else perform co-allocation for (J_i, X_i). The allocation and de-allocation of processors take place simultaneously. The co-allocation takes place if required numbers of processors are more than available. If allocation is successful export output

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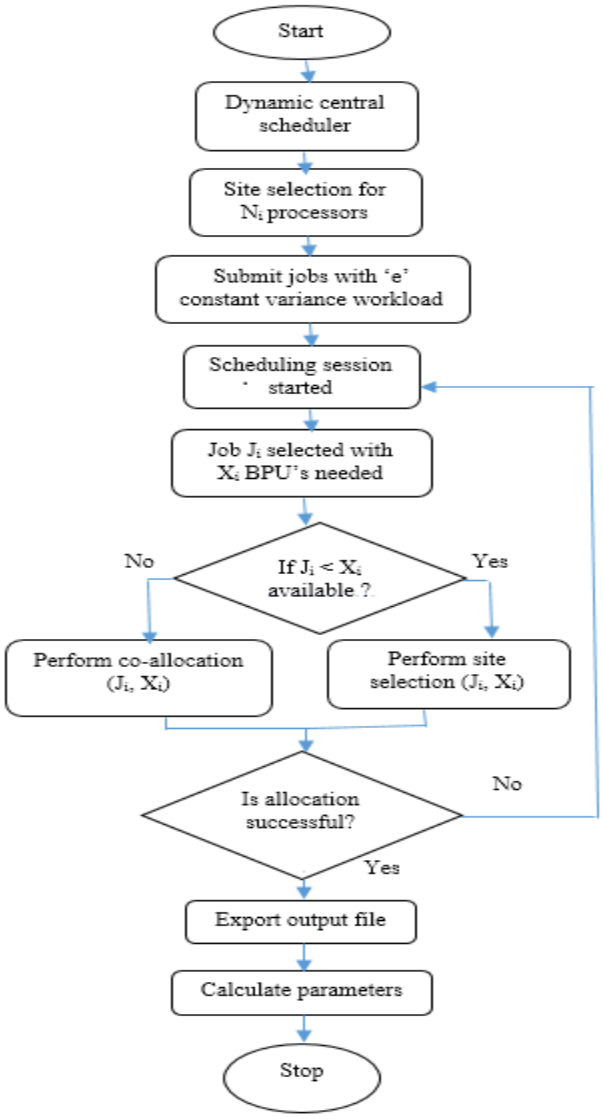

Figure 4.1. Proposed methodology

file and calculate parameters else schedule jobs again.

5 Conclusion & Future Scope

An ongoing trend shows that processor allocation is an extensive aspect of cluster computing which bars users from using cluster services. The processor allocation and scheduling has a significant impact on overall system performance. There is a fear of degradation of system performance because of improper processor allocation to jobs due to which there is a hindrance to adopt this technology. The whole focus has been made on making the single site allocation in HMC systems leaving multi-site co-allocation. So, to resolve this problem a model has been proposed which intensify processor allocation. It gives surety that processor allocation will be such that it will optimize the resource utilization rate, system performance and efficiency. In future, we will implement this model to pragmatic project to make this model reliable and proficient for usage. Further, more parameters can be added for enhancement.

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