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Resource Schedulingin Grid Computing : A Survey

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Abstract- Grid computing is a computing framework to meet growing demands for running heterogeneous grid enables applications. A grid system is composed of computers which are separately located and connected with each other through a network. Grids are systems that involve resource sharing and problem solving in heterogeneous dynamic grid environments. Here we present five different approaches/algorithms for resource allocation/ Scheduling in grid computing environment.

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Resource Schedulingin Grid Computing: A Survey

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I. Introduction

Increased network bandwidth, more powerful computers, and the acceptance of the Internet have driven the ongoing demand for new and better ways to compute. Organizations& institutions alike continue to take advantage of these advancements, and constantly seek new technologies and practices that enable them to reinvent the way they conduct business. [1]. The Grid environment is the IT infrastructure of the future promises to transform computation, communication, and collaboration (see figure 1).Depending on the main type of service a grid offers, it can be classified as: computational grid, access grid, data grid or data centric grid [2].

Computational grids provide high performance computing; access grids allow the access to a specific resources; data grids store and move large data sets; and data centric grids enable distributed repositories of data that cannot be stored in a single one. Grid computing is like a distributed computing applies the resources of many computers in a network to solve single problem at the same time-usually to a scientific or technical problem that requires a great number of computer processing cycles or access to large amounts of the efficiency of underlying system by maximizing utilization of distributed heterogeneous resources.

Resource allocation is one of the important system services that have to be available to achieve the objectives from a grid computing. A common problem arising in grid computing is to select the most efficient resource to run a particular program. Also users are requiring reserving in advance the resources needed to run their programs on the grid [3]. In this paper we review the various Dynamic resource allocation algorithms like ELM, ANN, Priority, performance prediction, Genetic algorithm for Grid Computing Environment.

This paper is organized as follows: Section II introduces the problem of resource allocation in grid networks. Section III presents a survey of different resource allocation algorithms in current era. Section IV conclusion.

II. The Problem of Resource Allocation in Grid Environment

Before scheduling the resources in the grid environment, the characteristics of the grid should be taken into account. Some of the characteristics of the grid include:

1. Geographical distribution of the resources
2. Heterogeneity, a grid consists of hardware as well as software resources that may be files, software components, sensor programs,
3. Resource sharing, between different organizations
4. Multiple administrations, where each organization may establish their own different security and administrative policies to access their resources
5. Resource coordination between heterogeneous computing power
6. Scheduling is highly complicated by the distributed ownership of the grid resources as Load balancing.

The problem under such resource allocation algorithms are-

1. An estimation of the computational load of each job.
2. The computing capacity of each resource.
3. An estimation of the prior load of each one of the resources is required.
4. An estimation on maximum completion time(MTC).

On the basis of these key points we survey different types of dynamic resource scheduling algorithms.

III. Survey of Different Resource Scheduling Algorithm

This section provides a brief overview of five existing resource scheduling Algorithms is pursued in grid environment.

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a) ELM

In a Grid environment, there are two levels of resource allocation, one for Grid schedulers and the other for local resource schedulers [4].Before selecting a resource, Grid scheduler does a minimum requirement filtering.

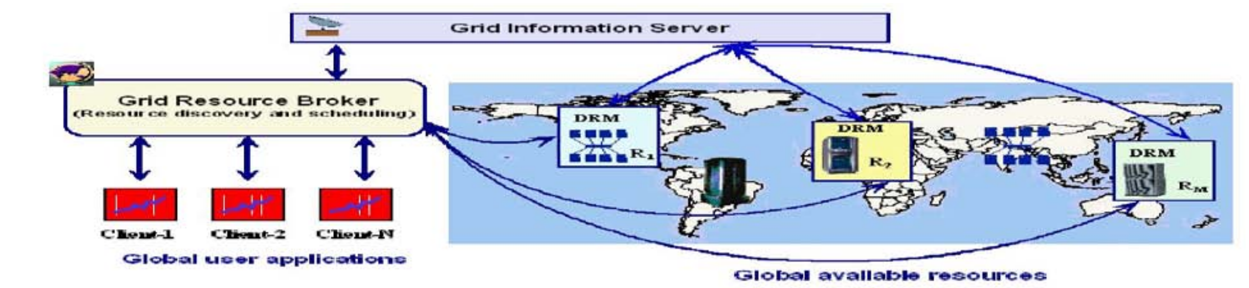

Figure 1 : General Framework of a Computational Grid

which shortlists available resources by comparing resource requirement and job property.

$$\Phi\ (preference): R \times J \rightarrow N1 \quad (1)$$

Where $J = \{J\}$ referring to the set consisting of the job to be scheduled. Note that $|J| = 1$, here resource allocation is considered only one job at a time [5].

But there is a disadvantage is that this policy requires users to have sufficient prior knowledge for a particular problem in order to determine the ranking function.

But use of ELM (fast learning algorithm for single-hidden layer feed forward neural networks (SLFNs))(see figure 2); with prediction resource allocation policy will inherit the feature of fast learning and perform satisfactory.

A prediction-based resource allocation policy is defined as,

$$\Phi: \hat{k} = \arg\max P\ (R_k, J),\ for\ 1 \leq k \leq |R| \quad (2)$$

where $P : R \times J \rightarrow R$ denotes a predicting function which maps resource and job to a performance value for the underlying preference .In this method machine learning lifts the requirement of sufficient prior knowledge from users and learning can provide accurate and timely results. The training of ELM is currently based on supervised learning, and thus training data needs to be labeled. However, for real-world Grid applications labeled data may not be available all the time. In this approach there is a filter with minimum requirements, if process doesn't full-fill the minimum requirements will be rejected.

b) ANN

Artificial neural networks (ANN) are attempts to reproduce human brain potentialities in a small scale, specially its learning ability. In this approach neuron mathematical model proposed by McCulloch and Pitts (Multi layer perceptron) are used. McCulloch and Pitts had a binary output and inputs, each of different excitatory or inhibitory gains, known as Synaptic weights (or weights) [6].The values of input signals and related weights determined neuron output. Through this model automatically capture the requirements of the user and use it for resource selection (see figure 3).

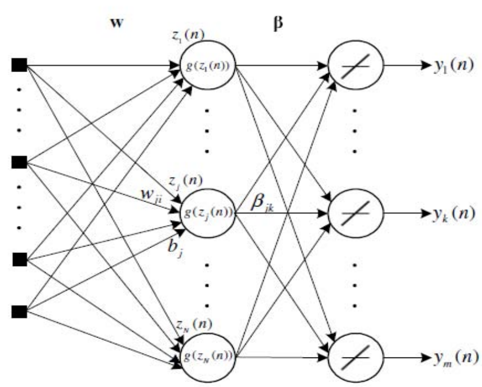

Figure 2 : A sketch of ELM neural network

The effectiveness of the scheduling methods assessed and evaluated using evaluation metrics like make span and flow time. Make span is the time taken by the grid system to complete the latest task; and flow time is the sum of execution times for all the tasks presented to the grid [7-8]. But there is a disadvantage is that this policy requires users to have sufficient prior knowledge for a particular problem. It reduces either make span or flow time.

IV. Priority Scheduler

Priority scheduler completed a task by using highly utilized low cost resources with minimum computational time. Our scheduling algorithm uses the priority queue of resources to achieve a higher throughput (See figure 4). This algorithm is performing better for task in real environment. In this algorithm initially setting the load factor of each resource is zero and priority of each resource is one because there is no process for execution. As the process arrives the load factor of resources increased and priority of resources [9].

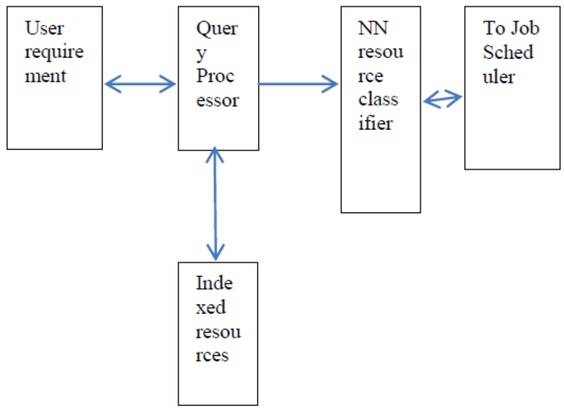

Figure 3 : Grid resource selector

Let T (P_i, R_j) be the total cost for i^{th} process in j^{th} resources can be calculated as-

$$\sum_{i=0}^{m}\sum_{j=0}^{n} \mathrm{T(Pi, Rj)}=\sum_{i=0}^{m}\sum_{j=0}^{n} \mathrm{ti} \times \mathrm{PR} + \mathrm{CT} \quad (3)$$

Where ti is the execution time of process, PR=Priority Number, CT=Communication Time

But still grid application performance remains a challenge in dynamic grid environment because resources can be submitted to Grid and can be withdrawn from Grid at any moment. This characteristic of Grid makes Load Balancing one of the critical features of Grid infrastructure there is another drawback is it is basically calculate load factor on there sources through the total no of jobs but it not concern their properties or related information.

Figure 4 : Shows priority VS. Load factor

V. Performance Prediction

Performance prediction is an Analytical performance model .This system is used with a gravitational wave physics experiment, LIGO(Laser Interferometer gravitational wave observatory) for which initial results indicate an average age of 24% reduction in execution time using the performance prediction versus a random selection of resources [10].In this method Fourier transformation with prophesy function is used .Performance is determined by interaction between the dataflow and computations in the application. (See figure 5) The Prophesy uses the predicted execution times to rank each candidate site. The less execution time is, the higher the site is ranked. The probabilities are also based on the predicted Execution times. Assume that the list of candidate sites is $S_1, S_2, . , S_i, . ,S_n$, and their predicted execution times are $T_1, T_2 ... T_i ... T_n$ respectively[10].We use the following equation to calculate the selection probability of the site S_i:

$$\frac{\frac{1}{Ti}}{\sum_{j=1}^{n}\frac{1}{Tj}} = \frac{1}{Ti\sum_{j=1}^{n}\frac{1}{Tj}} \quad (4)$$

The main drawback isthat, itholds total number of resources till the process is completed. Another drawback is that it is basically works on historical data so reusing the existing data product is not always the best choice in terms of the total execution time and it is non –adaptive in nature.

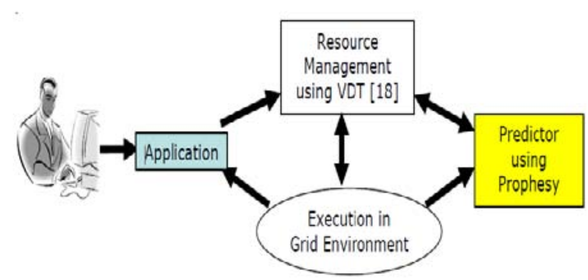

Figure 5 : System workflow

VI. Genetic Algorithm

Heuristic approach like genetic algorithm is used to solving the resource allocation in the grid. Genetic algorithm is used to solve the both the unit commitment problem and the heterogeneous resource Scheduling problem for grid computing [12]. Resource Allocation problem is represented in a chromosome. The chromosome is made up of genes, each representing one asset of the system. Each solution has a fitness value associated with it. These values are used to evaluate the chromosomes that are trying to be optimized. Group of chromosome in the population may violate a constraint because it might be able to produce a child that performs well and fixes the constraint violation as it evolves. There are many different ways to perform crossover, selection and mutation to generate new Childs. (See figure 6) As the number of generations increases, however, the genetic algorithm is less likely to keep a chromosome that violates any of the constraints. In the initial population, it is usually beneficial to have some type of genetic preconditioning in the form of seeding. This seeding uses some number of solutions in the initial population that are not generated at random. Initial seeds that do not violate any constraints. The main benefit of genetic algorithm is that it is adaptive in nature, and reduce make span and flow time both .The fundamental criterion is that of minimizing the make span, that is, the time when finishes the latest job. A secondary criterion is to minimize the flow time that is,

Global Journal of Computer Science and Technology (A) Volume XIII Issue II Version I Year 2013

minimizing the sum of finalization times of all the jobs. These two criteria are defined as follows:

$$\text{Make span: } \min_{si \in sched}\{\max_{j \in jobs} Fj\} \text{ and} \qquad (5)$$

$$\text{Flow time:} \min_{si \in sched}\{\textstyle\sum_{j \in jobs} Fj\}$$

Where F_j denotes the time when job j finalizes, *Sched* is the set of all possible schedules and *Jobs* the set of all jobs to be scheduled [11]. The drawback of the genetic algorithm is that it provides optimal solution but doesn't provide the best solution.

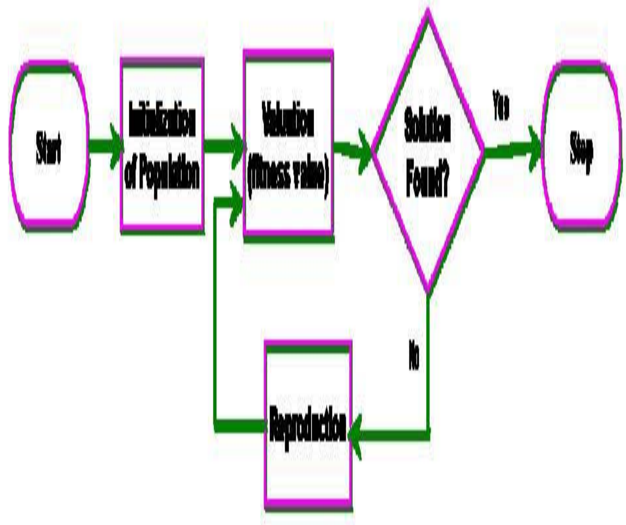

Figure 6 : Flowchart of GA Iteration

VII. Conclusion

In heterogeneous grid environments, availability of resources may possibly fluctuate so resource allocation is an NP complete problem where there is no final solution. In this review we have find different approach about resource allocation. Based on dynamic resources allocation technique. Our main objective is to review the various grid resource scheduling strategies which will in turn serve as a guide for researchers We seen that Priority allocation of grid computational are not successful method for resource utilization. For the ELM ANN and Performance Prediction provide best solution but real-world Grid applications labeled data may not be available all the time. For the application of meta-heuristic function improve the performance of the time span of process execution and determine the failure of process. The genetic algorithm works on both flows time and make span, but it provide optimal solution .we can be analyzed for problem of resource allocation such that new research could be focused to produce better solution by improving the effectiveness and reducing the limitations. In future our focus on developing an efficient resource allocation algorithm which not only reduce the communication time of applications with adaptability of resources in Grid computing environment.

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