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Robust Grid Resource Broker Strategy for Economy Based Grid

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Abstract. In this paper, we propose a robust grid resource broker in an economy-based grid. The proposed strategy is meant to ensure grid system will be able to accommodate more jobs and deal with user more gracefully. The proposed strategy if broker is unable to execute the user job within the user deadline and budget parameters, it gives the options in terms of tentative budget and deadline to the user. Instead of giving discrete options of job accepted or not accepted to the user, broker is able to specify projected deadline and budget. User can choose the projected deadline and budget which its QoS requirements.
The proposed strategy can effectively increase the job submission rate by accepting more jobs that can be executed according to the user specified deadline and allotted budget. Hence, this helps in upholding trustworthiness of grid environment.

Keywords: Economy Based Grid, Grid Task Scheduling, Grid Resource Management, Distributed System.

1. Introduction

In early 1990s, the term Grid Computing[1-4], was coined by Ian Foster and Carl Kesselmen. They introduced grid computing as approach which enable the remote usage of idle workstation for the execution of computation hungry jobs. The idea was to do it in the same pervasive fashion, as we access the electric power grid [5-7]. According to the needs of the job submitted by the grid user, grid computing involves the runtime aggregation of idle computational power from different geographical places in the form of virtual organization (VO) [8, 10],

The economy based grid [11-13] is a user-centric resource management and job scheduling approach. It is the paradigm of grid computing which provide users a dynamic environment to maximize their gains by relaxing Quality of Service (QoS) requirements such as budget and deadline. It offers incentives to resource owners for contribution of their resource(s), and provides users a dynamic environment to maximize their gains by relaxing their QoS requirements such as budget and deadline. It thus provides a competitive environment to resource provider and resource consumer that can satisfy their needs. The availability of powerful PC and rapid growth of the Internet over the years has made it possible to visualize economic base grid as the technology for the future.

The motivation of this paper is to present a robust grid resource broker strategy for economy based grid system that can provide efficient QoS to the user in varying budget and deadline based on the available resource. This enables the economy grid environment to improve user satisfaction by efficiently fulfilling budget and deadline QoS requirement of the user(s). Furthermore, this also minimize the penalty paid [14] by the resource provider. In this way, it enables grid to uphold the faith of the user by not compromising its QoS requirements. Some of the main contributions of the paper:1

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1. We advocated the need for a robust grid broker strategy for economy base grid environment that can adapt to the varying resource availability over time and can provide the projected deadline and budget options to the user, if user specified deadline and budget can not be met. Hence, able to accept and execute more user jobs.
2. We proposed a heuristic of how to resource broker can give the projected budget and budget options be given to the users.
3. We presented a frame work how the economic based grid will perform with the inclusion of the proposed robust grid resource broker strategy.

The rest of this paper is organized as follows. Section 2 briefly explains different research efforts for providing different grid resource broker strategies. In Section 3, explanation of proposed robust grid resource broker strategy is given. The final section includes conclusions and suggests future work.

2. Related Work

In [11-13], economic based grid model was proposed. They mentioned four main players for economy grid and these are Grid Resource Provider, Grid User, Grid Resource Broker (GRB) and Grid Information Service (GIS). Grid users submit their jobs to the grid resource broker by specifying their QoS requirements i.e. deadline and budget. To find the list of available resources the GRB consults the GIS. GRB finds the best available resource by optimizing user required QoS requirement i.e deadline, budget. At the end, upon successful completion of user's job, result of the job was submitted to user.

In [11], time optimization strategy was proposed, which use time for the optimization. GRB consult the GIS to get the list of available resources which can execute user job within user defined deadline and budget. GRB then sort resource based on their processing capability. In the end, job was given to the fastest available resource, which can execute the job within deadline in minimum possible time. Time optimization is generally used in deadline constrained user application, where deadline can not be relaxed and the primary demand of user was to execute the job within hard deadline even at the expense of more budget.

In [15-17], cost optimization strategy was proposed, which use cost for the optimization. GRB consult the GIS to get the list of available resources which can execute user job within user defined deadline and budget. GRB then sort resource based on their processing cost. In the end, job was given to the cheapest available resource, which can execute the job within budget in minimum possible cost. Cost optimization is generally used in budget constrained user application, where budget can not be relaxed and the primary demand of user was to execute the job within hard budget even at the expense of more deadline time.

In [13], cost/time optimization strategy was proposed, which use cost as well as time for the optimization. GRB consult the GIS to get the list of available resource which can execute user job within user defined deadline and budget. GRB, then sort resources based on their processing cost. Further, the resources are sort based on their processing capability. In the end, job was given to the cheapest and fastest available resource, which can execute the job within budget and deadline, in minimum possible cost and time. Cost/time optimization is generally used in Deadline Budget Constrained (DBC) user application, where budget and deadline can not relaxed and the primary demand of user was to execute the job within hard deadline as well as budget constraints.

In [18], market grid's information asymmetry problem was addressed. The paper emphasis that this problem is critical and would result in dishonest trades and grid user loss. To rectify this problem, two mechanisms namely, reputation-aware aggregate mechanism and reputation-aware double auction were proposed. Further, a reputation value for each grid resource is maintained. Proposed strategies then use heuristic that involves resource price as well as resource reputation in making job scheduling decisions.

In [19], incentives for grid resource provider and for grid user were presented by objective functions. A QoS scheduling algorithm is proposed which aims to optimize the performance of each individual grid user and the performance of the grid resources. Using dynamic programming, QoS scheduling optimization was decomposed in two sub optimizations of grid user's cost and grid resource provider's profit.

3. Robust Grid Resource Broker Strategy for Economy Grid

This section explains the proposed strategy (see figure1) that enables the system to adapt to varying resource availability by giving the projected deadline and budget options to the user. Brief description is as follows:

We propose to give the deadline and budget options to the user based on the current resource availability. When user submit job to the grid resource broker, it lookup the GIS for the current resource availability. If finds the resource which can fulfill the QoS requirement of the user, the job is submitted. Otherwise, broker look for the resource which can complete the job in slight relaxation in the deadline and budget. Broker then make available these options with projected deadline and budget to the user. User can choose the deadline and budget option which suits him/her. Which help grid environment, in completing the user jobs in specified deadline and budget parameters. And gracefully handle the variance in resource performance and results in upholding the trustworthiness of the grid.

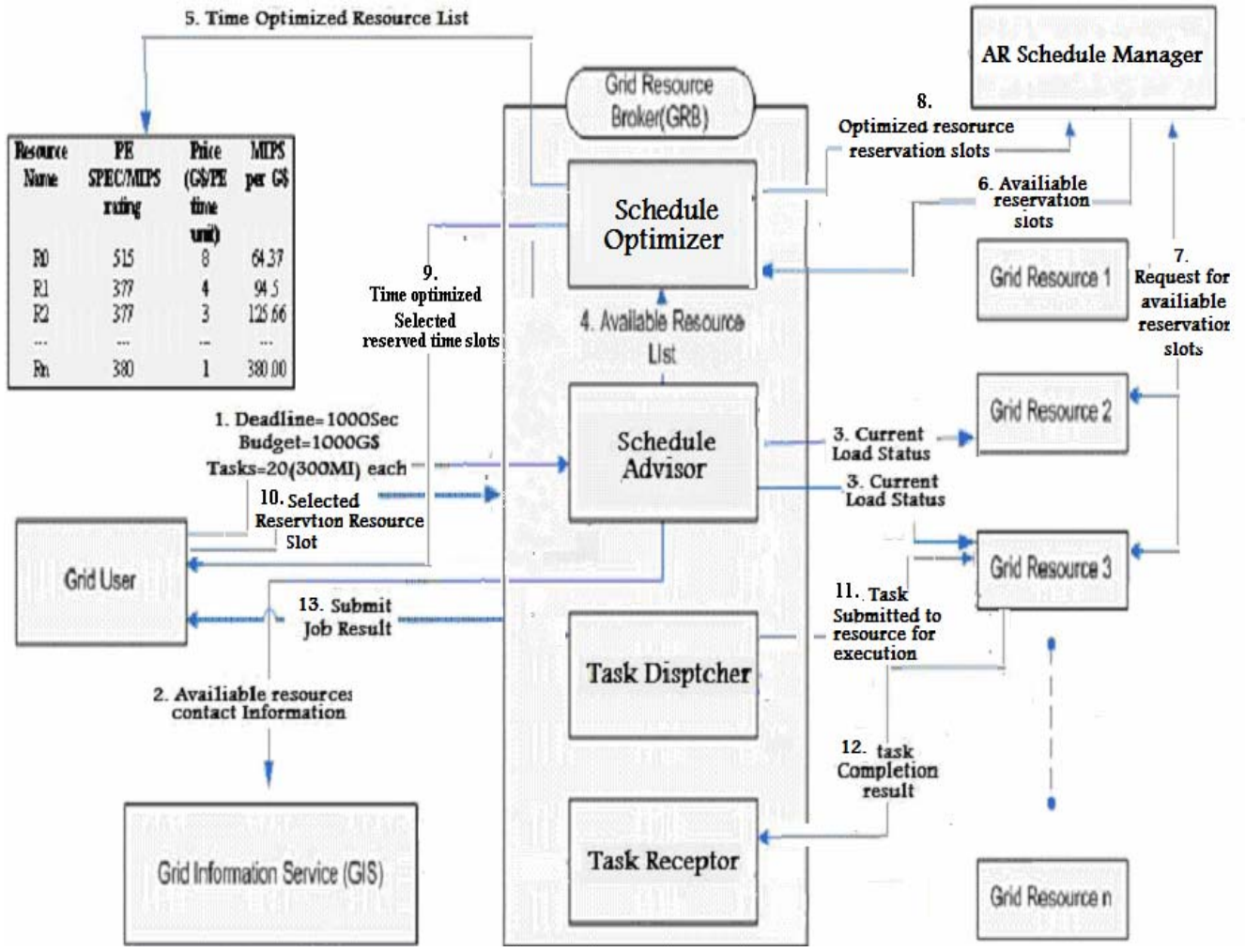

Figure 1 Interaction of different grid components in proposed grid resource broker strategy

3.1. Proposed Scheduling Strategy Framework

The interaction between different components of economy based grid in the proposed scheduling strategy (see figure1) is as follows:

Grid user submits jobs to the grid resource broker by specifying its characteristics i-e number of tasks and its length, scheduling time optimization strategy, deadline and budget etc. Grid user submits job and respond to different events while interaction with grid system using the following algorithm.

1. IF a grid user receive executed job result from the grid broker THEN
   a. Store the result of the executed job.
   END IF
2. IF a grid user receives a list of reserved slots from the broker to choose the one that suits the user THEN

a. IF user preference strategy is time optimization THEN
   i. Reserve the slot with minimum deadline
   END IF
b. IF user preference strategy is cost optimization THEN
   i. Reserve the slot with minimum budget
   END IF
c. IF user preference strategy is cost optimization THEN
   i. Reserve the slot with minimum budget/deadline
   END IF

END IF

3. IF none of the reservation options suits user deadline and budget preferences.
   THEN
   a. Cancel the job and not interested in any of the reservation slot options.
   END IF
4. EXIT

A grid resource is a member of a grid and it offers computing services to grid users. On joining the grid system it register themselves to Grid Information Server (GIS) of a grid by specifying the QoS requirements such as the cost of computation, deadline to complete the execution, the number of processors, speed of processing, internal scheduling policy, and time zone. A grid resource executes the grid tasks and other request sent to it by the broker and/or AR Schedule Manager using the following algorithm:

Grid Information Server (GIS) contains information about all available grid resources with their computing capacity and cost at which they offer their services to grid users. All grid resources that join and leave the grid are monitored by GIS. Whenever a grid broker has jobs to execute, it consults GIS to give information about available grid resource.

Advance Reservation Schedule Manager (AR Schedule Manager) arranges the reservation on the resources for the task on the request of different components. Depending on the request received by different components of the grid system AR Schedule Manager implements following algorithm to take appropriate decision.

1. IF AR Schedule Manager receives a request for reservation from broker THEN
   a. The AR Schedule Manager sends the message to resource to reserved slot according to time, cost or time/cost optimization.
   b. Based on the response received from the resource make following decision:
      i. IF AR Schedule Manager receives reservation slot confirmation from a resource
         THEN
         (1) Send the list of resource on which reservation slot is confirmed to the broker
         END IF
      ii. IF AR Schedule Manager receives reservation slot cancellation from a resource
            THEN
         (1) Send reservation slot cancellation message to the broker
         END IF

   END IF
2. IF AR Schedule Manager receives a reservation cancellation message from a broker
   THEN
      i. Send the message to one or more resource(s) to cancel booking of reservation slot.
   END IF
3. EXIT

Grid Resource Broker (GRB) is an important entity of a grid. A grid resource broker is connected to an instance of a user. Each grid job (composed of tasks) is first submitted to its broker, which then schedules the grid job according to the user's scheduling policy. A grid resource broker schedules the grid jobs sent to it by the user using the following algorithm:

1. IF broker receives a job for execution from the grid user THEN
   a. The Schedule Advisor prepares a list of resources with the help of GIS.
   b. Schedule Optimizer apply time, cost or cost/time optimization on the resource list receives from GIS
   c. IF any available resource can execute the task satisfying the QoS requirements like budget and deadline
      THEN
      i. Assign the job to the selected resource.
      ELSE
      i. Send the message to the AR Schedule Manager to arrange reservation on available resources.
      ii. Receive the reservation slots from the AR Schedule Manager
      iii. Check available reservation slots, apply time, cost or time/cost optimization on the available reservation slots.
      iv. Calculate the project deadline and budget first three reservation slots.
      v. Send the first three reservation slots that projected deadline and budget options to the user.
      END IF

   END IF.
2. IF broker receives reservation slot agreement message from the user
   THEN
   c. Send the message to the AR Schedule Manager to confirm reservation to the selected reservation slot.
   d. Send the message to the AR Schedule Manager to cancel reservation to the reservation slot that are not selected.
   END IF
3. IF broker receives a job cancellation message from a user a job for execution from the grid user
   THEN
   c. Send the message to the AR Schedule Manager to cancel reservation to all the reservation slot that are not selected.
   END IF
4. EXIT

Grid Dispatcher dispatches the tasks one by one to the respective grid resource as specified by GRB. Task Receptor receives the task execution result from the grid resource where the task is dispatched by the dispatcher.

4. Conclusion

In this paper, we propose an robust grid resource broker in an economy-based grid. The proposed strategy is meant to ensure grid system able to accommodate more jobs and deal with user more gracefully. In proposed strategy instead of discrete options of job accepted or not accepted, broker is able to send projected deadline and budget to the user. User can choice the projected deadline and budget which suits it to further continue the job submission.

The proposed strategy can effectively get more user job and deal with them more gracefully. As such, more jobs can be executed according to the user specified deadline and allotted budget.

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