A Study on Resource Innovation in Grid Computing using Fuzzy Logic

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Abstract

Resource Innovation is a very important task in Grid environments. Grid technologies enable us to share the scattered resources. For using these resources what will be needed are the resource management systems. The resource management discovers the resources to obtain some information about the resources and therefore, because of the complex and dynamic nature of the Grid resources, the issue of resource Innovation and sharing has been emerged out. In this paper, an approach has been introduced for the resource Innovation with implications for searching efficient resources using fuzzy logic and taboo table. The resource Innovation starts with the network request to find appropriate resources in the Grid. The Innovation process is very vital and critical in the management and allocation of resources. Proposed approach has been simulated in Matlab environment and the comparison of obtained results to other approaches indicates the efficiency of proposed resource Innovation.

KEYWORDS: Resource Innovation, Resource Sharing, Efficient Resources, the Fuzzy Logic

1. Introduction

The computational Grid system is a hardware and software infrastructure that provides reliable, stable, universal and cheap access to the facilities of other people. The Grid computing system is linked with a collection of heterogeneous resources such as personal computers, work stations, clusters, etc. in a wide-scale scenario. In recent years, Grid computational systems have emerged out as an alternative in increasing the memory and processing capacity of integrated resources through sharing their resources. Grid computational systems make possible the integration of computers and resources such as software packages, data and peripheral devices through an inter-related network. On a computational Grid system a collection of computational resources appear in the form of a virtual powerful computer system. So the resource Innovation in modern distributed systems plays a critical role. The resource Innovation allows the system to be aware of what resources are added to the system as well as the situation, features and the capabilities of available resources [1].

Resources can be computers, computer clusters, direct devices, storage space, data, and applications. In a Grid computing network, the existence of several different operating systems and different management areas and the lack of portability among database-dependent approaches make resource Innovation even harder. Hence, implementing a suitable resource Innovation is an important aspect of Grid environments. The success of a computational Grid network mainly depends on locating suitable resources for a particular task. In fact, Grid computing is a way toward distributed processing which considers not only the geographical position but also the architecture of machines struggling with software constraints. Hereby it provides any connected person to the Grid with an unlimited computational power. A Grid computational system consists of a group of machines and a communicational network among these machines. As mentioned before, each machine can be a personal computer, computational resource, database, etc.

With the development of computational Grid systems and the importance of finding different resources for users, time and space saving will be more critical which in turn highlights the great importance of resource Innovation algorithms. Nowadays, with the development of Grid environments and the increased number of resources as well as the geographical distribution of resources implementing a resource Innovation algorithm which could provide the required resources of users in a very short time is one of the main tasks in Grid environments [2]. Therefore, in order to achieve this aim in finding the appropriate resources for Grid users, in this paper, a new Grid resource Innovation mechanism is proposed. In the proposed mechanism, fuzzy logic (multi-criterion decision making) and taboo table for optimum Innovation and scheduling of resources are used.

The multi-criterion decision making is the most common modeling method in the decision making issues and it tries to model a decision making problem while the number of goals or decision making attributes are more than one. The multi-criterion decision making is considered as a rule-based structure of preferential relations for evaluating a set of options in the presence of several indicators. The resource Innovation acts as a connector between the resource holder and the resource requester and as a support for the scheduling operations. In the rest of this paper, in section 2, previous works for resource Innovation in Grid environments are introduced. In section 3 the proposed mechanism is outlined and the simulation results are evaluated in section 4. Finally, section 5 concludes the paper.

2. Related Works

In [4] a new algorithm with the help of a weighted tree to discover resources and a bitmap is used for studying some of resources that locate in special positions. In fact, in each node of the tree there will be signs or tracks of existing resources in the generated children of the node. So when the user sends his/her request for each node if these requests exist in the associated children of that node, then direct access to the request-holding nodes will be possible without any reference to additional nodes and creating extra traffic. This algorithm implies that the number of nodes met in resource Innovation algorithm is less than those of other algorithms .With the notable increase in the number of nodes the updating cost will reduce as well [4].

The resource Innovation algorithm which uses flooding-based and random methods in order to explore the resources in the Grid environment lowers the system performance due to the transmitted user request to unnecessary routes and generated traffic. The tree algorithm of resource Innovation [5] drastically eliminates many disadvantages of the previous methods which were related to additional traffic and heavy loads and reduces the updating cost. But still the user's renewed requests pass through unnecessary and create extra traffic which in turn reduces the system performance in a Grid environment with a lot of nodes. In this method a weighted tree structure "Footprint Resource Tree" is introduced. In this way [5] one bitmap with different content named as the "route bitmap "will replace several bitmaps. For updating, a super bitmap "bitmap counter" will be used. In the current method to any type of resources two bitmap states (one of the counter type and the other of footprint type) are dedicated therefore the user's request should change according to this. When sending requests to the nodes, if the target node contains the requested resources it means that the desired node is found, and if it is not within its resources the query will be sent to the parent node. So if the node does not contain the requested resource it is understood that it would be found inside one of the children of this node. The mentioned node can be directly found without reference to additional nodes using the information stored in the nodes and edge weights.

So in this algorithm unnecessary referrals to other nodes, creation of additional traffic and increase of extra loads are all prevented. Thereafter the time is saved, the resource discovering ability is improved and updating cost is reduced. In the algorithm [6] resource Innovation in dynamic Grid is investigated on the basis of re-routing table. With the resource Innovation problem checked in a dynamic Grid model based on a Grid routing model it shows that the Grid is seen as a formed environment by the router and resources in which each router is responsible for its local resources.

The problem of discovering resources on the Grid is seen as a problem of finding suitable resources for a particular request in that environment. Efforts for solving the resource Innovation problem are currently ongoing .Various mechanisms have been introduced so far. One of these mechanisms is the routing table which can guarantee that appropriate solutions are found for a particular request in a static Grid environment in which the resources are always online and connected to the Grid. In this method the effect of the mechanism of routing table is checked, which in turn can guarantee that the appropriate resources are found in a Grid dynamic environment where resources can be disconnected and therefore become offline. In the paper [7] a resource Innovation algorithm in the Grid context uses methods based on flooding or random sampling methods to send the requests of users. In this case a request may pass many unnecessary routes causing additional traffic and reducing system performance.

In this method the tree structure is introduced for discovering resources and it shows all resource specifications by using bitmap format. The user's request for finding the appropriate resources is sent to the server (indicator). If the server finds the under-request resources in the node, the request will be sent to the children of that node. If the desired resources do not exist, the search in the tree is carried on until reaching the root. Hence using the tree structure can reduce the unnecessary traffic and improve the efficiency of resource Innovation.

3. The proposed algorithm

In multi criteria decision making procedures which have found popularity among researchers in recent decades, instead of using a measure of optimality several measures are used. The Multi Criteria Decision Making (MCDM) models are divided into two major categories: Multi Objective Decision Making (MODM) models and Multi Attribute Decision Making (MADM) models. Generally speaking, the Multi Objective Decision Making models are used for design purposes while the Multi Attribute Decision Making models are used for the selection of superior options. The main difference of the Multi Objective Decision Making models with the Multi Attribute Decision Making models is that the first type is defined in continuous space while the latter one is defined in discrete space respectively. Generally in the mentioned problems, three tasks must be done over the engaged criteria:

- Converting qualitative criteria to quantitative ones
- Normalizing criteria
- Determining the relative weights of criteria

The multi criteria decision making is the most common method in decision making problems and tries to model a decision making problem while the number of decision's objectives or attributes are more than unity. The multi criteria decision making can be seen as a rule-based structure of preferential relations for evaluating a set of options in the presence of several indicators. The aim from MCDM techniques is to design and to help the decision making in finding the most appropriate solution from the decision maker's viewpoint toward the problem. MCDM problems are usually divided into two categories, the Multi Attribute Decision Making (MADM) and the Multi Objective Decision Making (MODM). In the Multi Attribute Decision Making the concern of decision maker is to prioritize and choose from among several available options and generally the number of options is limited and known, and the operation is done in discrete space while multi objective problems are engaged for designing purposes, they have a structure of mathematical programming and their goal is the simultaneous optimization [8].

The architecture used in the proposed method has a hierarchical structure that its details are as follows: The architecture is hierarchical and consists of several clusters so that each cluster has a large number of sites. In this model, there is a central coordinator and local coordinators interact with the central coordinators for allocating data to the requesters. In the case that the requested resource does not exist inside the own cluster, the request is transmitted to the central coordinator. Figure 1 displays the architecture of proposed method with three clusters.

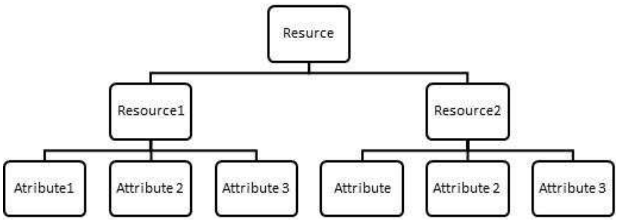

Fig1: The hierarchical architecture of the proposed approach

In the proposed architecture, each cluster consists of many resources and also an efficiency super-factor monitors all machines to assure from the proper operating of them. Of course, for having a comprehensive and overall view from the entire system, the remote surveillance of the required parameters of all operations must be possible. When monitoring is possible, the applied policies should guarantee the system in reaching at its maximum value of efficiency .As each resource has its own features, all these features must be heeded duly. The resource factor acts as a local coordinator and in the hierarchal model these local coordinators interact with a central coordinator (resource requester) for allocating resources. If the requested resource does not exist inside the own cluster, the request is transmitted to the central coordinator and the central coordinator replies to this request.

The multi criteria decision making indicates a resource evaluation process which should be assessed by a few criteria and can be divided into two classes of the Multi Attribute Decision Making and the Multi Objective Decision Making. In this paper according to the terms of decision making, the Multi Attribute Decision Making method was engaged for the selection of widely used data .Its stages are as follows:

- Identification and selection of effective criteria in resources (the resource features should be studied as each resource may have several features).

- Determining the weight of resource features inside the Grid by using the peer comparisons method.

Ranking the available options and procuring the fitness of each resource and specifying the best resource, and if the best resource is not found, suggesting a resource with adequate weight.

First, based on the studies and research done in the field the determinant criteria for the stage “the identification and selection of effective criteria “are identified and selected and then the weights of the criteria are determined. One of the what-computing methods is the method of Professor Saati in the form of paired comparisons.

This method starts with peer-to-peer comparisons between decision elements and through the allocation of quantified scores which represent the preference or importance between the two decisions. After the peer comparisons matrix has been formed, several methods may be applied for calculating of the relative weight and in the proposed method we used the arithmetic mean method from the approximate methods. In this case the procedure is as follows: In the resulted matrix the sum of figures in each column is calculated, and then each column entry is divided by the sum of the figures in that column. The new obtained matrix is called the normalized comparisons matrix.

After selecting resources in the central coordinator, the options should be ranked and the resources should be scheduled, after sending information from resources to resource requesters the final data is sorted in an ascending manner. Now the most appropriate source must be selected. Therefore first the obtained values should be normalized. A simple normalization method which often researchers prefer it is the division of all figures of each column by the largest figure in that column. Following this we face with a kind of normalization in which the largest value in each column will be converted into 1. After normalization, according to the normalized values and resource weights the decision value is calculated for each resource. Worth noting that the weight of factors bearing negative impact is used in the complement form of ;that is ;in such a problem like this the data size criterion has a negative impact on the decision

Finally, the data are ranked based on the decision values and starting from the highest ranks. One-third of the total data items are marked or starred as the best selection. The same number of lowest ranks is marked too in order to be removed.

The pseudo code of proposed algorithm

- Initialized to the number of tasks (processes)
- create tasks with Exponential
- Initialized process time
- Time service to any business or process

Loop (When the service to be provided to any work completed)

4. Evaluation and comparison of simulation results

In this section, we compare the results of our simulation with the recommended algorithm [5], the flooding method, the proposed algorithm in [8,9]. In the first simulation experiment 400 requests were tested. In our proposed algorithm, as each system executes a process fitted with its performance and powerful systems are dedicated to very complex processes and any process is run on a proper machine or system, therefore little traffic will appear and the processes not only will wait short time in the queue but also their run time will be proportional. And the experiments were repeated with 300 and 1000 requests as well. As mentioned before the traffic caused by the Fuzzy algorithm is better than those of other techniques.

The simulation was performed at MATLAB environment and the simulation characters are expressed in the following table. Figure 5 shows the number of met nodes in 180 requests. As seen , in the proposed algorithm since all the criteria are of a certain degree of importance and their fitness amount are calculated from Fuzzy computations , so the number of met nodes is less and less this value is , lower the traffic will be in Grid. Also this test has been performed with limited number of servers.

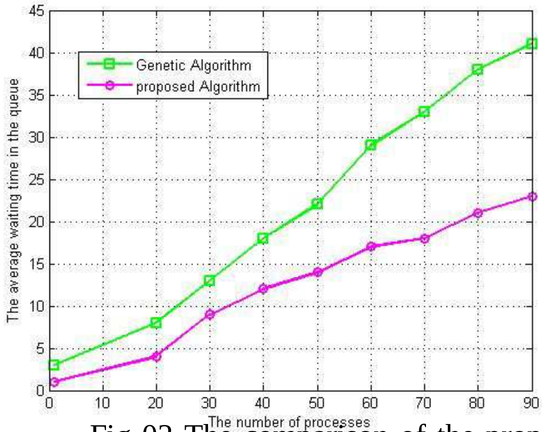

Fig 02 The comparison of the proposed algorithm with the genetic algorithm regarding the average waiting time in queue

The proposed algorithm was compared with the genetic algorithm. In Figure 10 with increase in the number of servers, we examined the number of met nodes. As shown with increasing the number of servers the number of nodes has been incremented too but in the proposed algorithm according to the fact that all parameters have certain weights and if the process needs be not met, the Grid aggregation is utilized so the number of nodes is not incremented drastically. But in the genetic algorithm as cross-over and mutation operations are used it may be trapped in local optimality and may not satisfy the required fitness level. Therefore it has lower efficiency than the proposed algorithm.

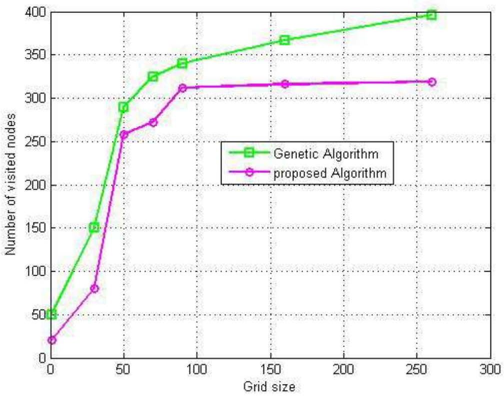

Fig 03: The comparison of the proposed algorithm with the genetic algorithm regarding the number of met nodes in the query

Figure 03 shows the average waiting time in the queue and it is the mean time duration each process waits in the queue to get service. As in our algorithm it endeavors to assign a system to a process which has a close fitness to the required process fitness so the waiting time in queue has been decreased in quantity.

Conclusions

In tree methods all nodes should be met but surface scanning is time-consuming. In our method, a Fuzzy Logic is introduced for discovering resources. Peer to peer comparisons turns out that what state is the best one and it prioritizes the parameters i.e. which feature is more important and it per se selects the best state which is closer to our request. In our algorithm we find the good resource simply by adding some figures without any need for a long scan. Our algorithm is better because the weighting and attributes are important, it is of Fuzzy type, it has detection power and it is intelligent. In our algorithm the number of integrated nodes with together is almost identical, because we have made a system Grid which matches our requests and criteria. The simulations showed that the number of nodes and links met in resource Innovation algorithm after the resource Innovation is much less than other algorithms and it is anticipated that in the near future this algorithm will be evaluated and developed to cover the security edge of Grids or to mix our algorithm with the imperialistic algorithm or to combine the genetic algorithm which can be implemented on very modern servers and albeit with much higher techniques.

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