International Journal of Computer Applications Technology and Research
Volume 3– Issue 6, 353 - 357, 2014, ISSN: 2319–8656

Propose a Method to Improve Performance in Grid Environment, Using Multi-Criteria Decision Making Techniques

Robabeh Parvaneh
Department of Computer Science and Research Branch
Khorasan Razavi،
Islamic Azad University،
Neyshabur،Iran

Ali Harounabadi
Islamic Azad University
Izeh Branch
Izeh، Iran

Abstract: The most important purpose of grid networks is resource subscription in a dynamic and heterogeneous environment. They are accessible through using various methods. Subscription has mainly computational, scientific and other implications. In order to reach grid purposes and to use available resources in grid environment, subtasks are distributed among resources and are scheduled by considering the quality of service. It has been tried to distribute subtasks between resources in a way that maximum QOS can be obtained. In this study, a method has been presented. In this method, three parameters; namely, sent and transferred time between RMS and resource, process time of subtask by the resource, and the load of available tasks in resources row, have been taken into account. In this way, multi-criteria decision is made by using TOPSIS method and this priority of the resources are determined to assign them to subtasks. Finally, time response, as an efficient parameter, has been improved and optimized by optimal assignment of the resources to subtasks.

Keywords: Grid network, multi-criteria decision making, response time, Petri net, TOPSIS

1. Introduction

Grid networks are composed of a set of heterogeneous computers. They have been non-exclusively connected to each other through connection protocol and grid management system. The main purpose of grid is using common resources such as processor power, band width and tec. Also, its purpose is to make it accessible for central computer. Currently, computing grid networks are widely used in developed countries in order to prevent waste of resources, and to use them optimally. Computing grid has been considered and used in order to prevent heavy expenditure paid to use computing power of network. The most important purpose of grid networks is resource subscription is a dynamic and heterogeneous environment. They are accessible by using various methods. This subscription has mainly computing, scientific and other applications [9]. Computing grid environment is suitable to solve those problems requiring long and complex computations [6]. The main purpose of grid networks is to provide services having high efficiency, reliability and fewer costs for many users. Also, its purpose is to support cooperative tasks. In grid, efficiency is important. In order to increase efficiency in grid, we need an efficient and proper scheduling. Dynamic nature of grid resources and various demands of users have made grid scheduling complex. The purpose of grid scheduling is to assign tasks to resources optimally [2]. In this paper, a method has been presented to decrease response time as an efficient parameter to increase efficiency. By considering multi-criteria decision making and Topsis method, resource priority is determined for subtasks. In this way, Makespan of the system is decreased. Decision making involves stating purposes, evaluating their possibility and the outcomes of executing each solution, selecting and executing them. In multi-criteria decision making method, several criteria can be used to select the better alternative, instead of using one optimality criterion [3]. The proposed method is evaluated and simulated by using CPN TOOLS.

2. Background

2.1 Grid Environment

Grid is “a wide network having high computing power and the ability to connect to Internet”. Grid has not been just composed of special and homogeneous computers. It has been composed of a set of computers distributed in various levels of internet or intranet. They are non-exclusively connected to each other through connection protocol and grid management system. In other words, grid decreases the execution time of those tasks and works lasting for several hours to just some seconds. Grid is a set of resources connected to each other. Also, it involves some applications to do works. Grid has been used in 1990 for the first time to point to computing ultra structure distributed in engineering and advanced sciences. Grid concepts and technologies have been considered and used to provide resource subscription between scientific units, and the aim is to use the resources of grid environment to solve complex and difficult problems [5]. In grid environment, tasks are not individually executed just in one system. Rather, these tasks are divided into subtasks. Each of them are sent to resources that are the member of grid. Available resources are connected to each other in a network by using connection links. The link provides connection information exchange between two computers. Link topology determines connection structure between computers. Various types of link topologies have been considered in grid systems such as star, tree, ring and combinational topologies [4]. In this paper, star topology has been taken into account. In grid, the procedure of this topology is that RMS is placed in the center of system, and all resources are connected to it by connection links [6]. After receiving the task from the user, RMS divides it into some subtasks. Redundancy technique is used in resources allocated to subtasks. Then, RMS assigns each subtask to more than one resource. In this way, each subtask is allocated to two or more resources, but each resource processes only one subtask [4]. Petri networks are appropriate tools for graphical modeling on the basis of mathematic logic. Although Petri net is graphical, its mathematical base is strong. Petri net has been considered as a method for formal modeling to analyze and describe the systems that have distributed simultaneous synchronous, parallel or random characteristics. One of the important characteristics of Petri net is that it is executable. Unlike UML, analysis and implementation is carried out simultaneously in Petri nets. This attribute can be used to evaluate the behavior and efficiency of a system simultaneously [1].

3. Literature review

Azghomi and his colleagues [4] presented their paper entitled modeling of tasks distribution and computing reliability in grid networks having star topology. They considered time and colored Petri nets in investigations and implementation. Tasks scheduling is important in grid networks environment in order to reach to desired quality level. In this study, grid networks are based on resource management system. This system receives tasks from the users and divides them into subtasks. Then, each subtask is transferred and sent to one or more available resources (redundancy technique). After executing subtasks, each set of resources processing the same subtask sends and transfers the results to one location. Among the resources that are randomly selected, the resource that executes the related task as quickly as possible is identified and transferred to another location. Finally, the maximum degree is computed so that total time of the task is obtained. Above mentioned operations are simulated by using time and colored Petri nets, and reliability is computed.

Parsa and his colleagues [10] proposed the scheduling algorithm called RASA. This algorithm is based on two well-known algorithms, namely, Max-min and Min-min scheduling. RASA has the advantages of this algorithm, and it has removed disadvantages of them. RASA alternatively uses these two algorithms on the basis of estimating the end time of doing works. At first, algorithm presents a matrix of end time of t_i on R_j resource. If the number of accessible resources is odd, then Min-min strategy is used; otherwise, Max-min strategy is applied. Other works are alternatively transferred to resources by one of these strategies. One of the advantages of this method is to provide the better load balance compared to these two algorithms. RASA algorithm has better performance in comparison with algorithms in distributed systems.

Kokilavani and his colleagues [7] improved Min-min algorithm. When the number of small tasks and works is lesser that the number of large works and tasks in meta-task, this algorithm does not operate well, and it increases makespan of the system. Also, it does not create any loads in the system. They presented an algorithm called LBBM. This method has been presented in two phases. In the first phase, Min-min algorithm is presented, while in the second phase, works and tasks are scheduled to reuse the resources effectively. Their algorithm has decreased makespan, and has increased the efficiency of the resources.

Meibody and his colleagues [8] presented a scheme for resource scheduling in order to optimize resource scheduling in computing grid. On the basis of demands classification, three levels (home, local, logical) are considered. Each level has its own function to receive and deliver the subtasks to lower or higher layers. In scheduling scheme, three levels have been presented, and resources have been connected to each other by a hierarchical network involving three levels.

Saadi and his colleagues [13] proposed an algorithm for scheduling of independent tasks in computing grid. They presented weighted objective function for this scheduler, and they considered the importance of time and cost of the works done by the users.

Parsa and his colleagues [11] proposed a new category to estimate reliability of service and whet they expect from computing the time of providing service when there are some defects in grid system.

4. proposed Method

The purpose of scheduling in grid environment is to reach to maximum quality of service. Quality has various concepts. The most important parameter of service quality are efficiency, load balance, reliability, cost, time and etc, or a combination of them. In order to optimize and improve response time in presented model, three parameters are considered. These parameters are transferred and sent time between RMS and j resource to execute i subtask, processing time of i subtask by j resource, and available load in the row of each resource. They are placed in decision making matrix. After unscaling, weighting and making decision among them, the priority of resources are separately obtained for each subtask. Assuming that the subtask having smaller data has more priority in selecting the resource (because it has less time to execute it), we allocate the resource to subtasks. The result is that minimum response time is obtained.

4.1 Modeling and Scheduling Subtasks

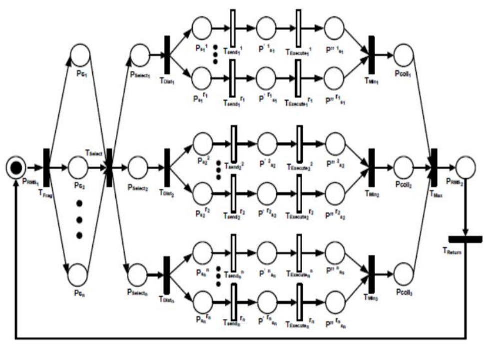

Figure1.Modeling on the basis of Petri nets

According to [4] and Fig1, at first, token is placed in P_{RMS} location. This token, that is considered as a task, is divided into subtasks after passing through frag ($T_{frag)\ route.}$ Then, tokens (subtasks) are allocated to several resources on the basis of redundancy technique. These subtasks select the optimal resource on the basis of three parameters such as transferred and sent time of data between RMS and resource, processing time of subtask by the resource and load of available works in resource row, and multi-criteria decision making. According to [4], if resources are randomly made accessible for subtasks, then after passing the selection route (T_{select}) and selecting the appropriate resources for subtasks, these resources are sent and transferred to subtasks by passing through distribution route. Then, tokens are placed in P_{si} location.

4.2 Allocating subtasks to resources by using the model of multi-criteria decision making

Decision making model is divided into two groups: multi-objectives model and multi-criteria model.

Multi-objectives models have been used for designing, while multi-criteria model are used to select the better alternative. In this method, multi-criteria models have been used to select the appropriate resource. We have taken into account Topsis method among the methods of multi-criteria models. According to [3], unscaling should be considered in order to compare different measurement scales and measures. In this way, the elements of indexes (n_{ij}) are measured without any dimension. In some cases such as MCDM, especially MADM, we should know the relation importance of available indexes (objectives). The sum of them equals one (they are normalized). The relation importance of priority of each index (objective) is measured against other for making decision. In this study, we considered entropy technique to weigh the indexes, and selected Topsis method to select the suitable resource. In this method, we considered the distance of A_i from the ideal point. Its distance from negative ideal points has been also taken into account. It means that the selected alternative should have minimum distance from the ideal solution, and it should have maximum distance from negative ideal solution. We used this method to prioritize the resources in each subtask. After converting decision making matrix to an unscaled matrix and providing an unscaled matrix, we determine ideal solution as well as negative-ideal solution.

Afterwards, we compute the distance. Distance of ith alternative from ideals can be obtained by Euclidean method.

for Ideal option (A^+) and negative ideal (A^-) defined:

Ideal Option =
$$A^{+} = \{(\max V_{ij} | j \in J)\ And\ (min\ V_{ij} | j \in J' | i = 1,2,\dots m)\} = \{V_1^{+}, V_2^{+}, \dots\dots, V_j^{+}, \dots\dots, V_n^{+}\}$$

Negative Ideal Option =
$$A^{-} = \{(\min V_{ij} | j \in J)\ And\ (max\ V_{ij} | j \in J' | i = 1,2,\dots m)\}$$

$$=\{V_1^{-}, V_2^{-}, \dots\dots, V_j^{-}, \dots\dots, V_n^{-}\}$$

Then calculate the size of separation (distance), the choice between the i-th to the ideal use of Euclidean method:

$$\text{the i-th to the ideal},\ d_{i+} = \{\textstyle\sum_{j=1}^{n}(V_{ij} - V^{+}j)^2\}^{0/5} \quad ; \quad i = 1,2,\dots\dots m$$

$$\text{the i-th to the negetive ideal},\ d_{i-} =$$

$$\{\textstyle\sum_{j=1}^{n}(V_{ij} - V^{-}{}_j)^2\}^{0/5};\ i = 1,2,\dots\dots m$$

Finally, we compute the closeness of A_i to an ideal solution.

$$cl_{i+} = \frac{d_{i-}}{(d_{i+} + d_{i-})}\ ;\ 0 \le cl_{i+} \le 1;\ i = 1,2,\dots\dots m$$

Eventually, we can rank the alternatives in the supposed problem.

5. Case Study

In this section, the results of two proposed methods are simulated and analyzed. At first, these methods are modeled by colored Petri nets; then, they are simulated ny CPN TOOLS. The results of these simulations are compared with [1] and [4]. Suppose that, in grid environment, the task entered by RMS is divided into two tasks having complex computing characteristics and required data volume. Also, suppose that although there are four resources having some characteristics such as processing speed, band width and lack of any failure in processing (P), it is possible that there is lack of failure in connection lines during transferring (q). In this method, redundancy technique is followed. This means that subtasks should be fewer than accessible resources. Therefore, after allocating the task to subtasks, each subtask is allocated to one resource, but each resource only processes one subtask. In order to improve the response time, we considered three parameters such as transferring time of data between RMS and R_j resource to execute S_i subtask (T_{ij}), processing time of S_i subtask by R_j resource (T_{ij}), and execution time in the row of each resource (q). They are computed by following equations [4].

$$\tau_{ij} = \frac{a_i}{b_{wj}}$$

$$T_{ij} = \frac{c_i}{P_{sj}}$$

A balance is provided between three parameters by using multi-criteria decision making and TOPSIS, and they are weighted. After placing them in decision making matrix, we obtain resource priority for S1 and S2. Since subtask of S2 has fewer data, selection priority is allocated to it. In this way, R2 and R3 are selected for S1 and R1, and R1 and R4 are selected for S2; hence, the selected scenario has the minimum response time (6/4). This time is the best one. As it was already mentioned, according to [4], firstly resources are randomly selected. Secondly, available load in resources is not considered. Thirdly, it does not result in a scenario with optimized response time. It has been tried by [1] to improve reliability. A method for improving response time has not been presented. It should be mentioned that, in the proposed method, reliability is high. Through using the method proposed by [4], there are different scenarios to allocate subtasks and resources. Since they are selected randomly, different modes can be observed. In this method, we analyze six scenarios.

The first scenario: in this scenario, subtask of S1 selects R_2 and R_4 resources, and subtask of S2 selects R_1 and R_3 resources.

The second scenario: subtask of S1 selects R_1 and R_4 resources, and subtask of S2 selects R_2 and R_3 resources.

The third scenario: subtask of S1 selects R_1 and R_3 resources, and subtask of S2 selects R_2 and R_4 resources.

The fourth scenario: subtask of S1 selects R_3 and R_4 resources, and subtask of S2 selects R_1 and R_2 resources.

The fifth scenario: subtask of S1 selects R_1 and R_2 resources, and subtask of S2 selects R_3 and R_4 resources.

The sixth scenario: subtask of S1 selects R_2 and R_3 resources, and subtask of S2 selects R_1 and R_4 resources.

Comparison diagram of response time in the above mentioned scenarios in the proposed and previous method has been shown in figure 2.

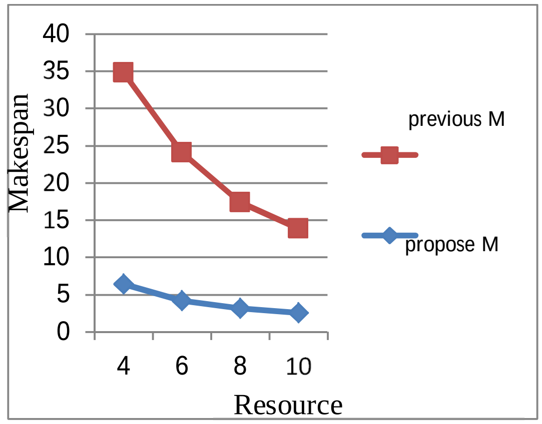

Figure 2. Comparison diagram

After determining parameters subtasks, we have simulated CPN TOOLS software. The result of this simulation has been demonstrated in figure 3,4.

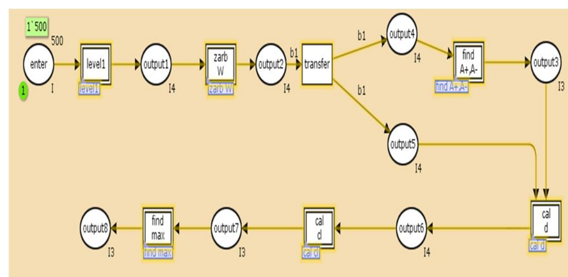

Figure 3. System simulation

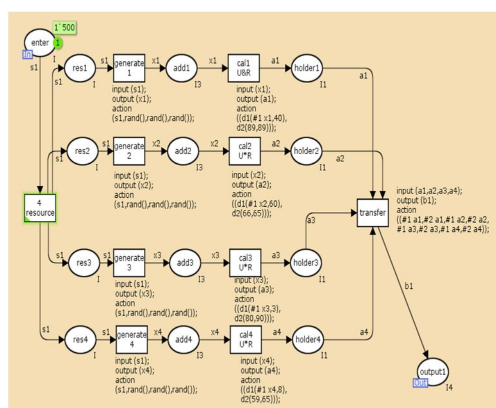

Figure 4. Subsystem simulation of allocating resources to subtask

6. CONCLUSION

In grid, various types of computers having different abilities and operating systems can be found. Open environments such as grid have independent and heterogeneous computing nodes, and their accessibility changes over time. There are some problems due to this dynamic environment. In this study, we proposed a method by preventing the random allocation of resources, considering above mentioned parameters and using multi-criteria decision making for prioritization. In this method, we improved response time to increase the efficiency considerably. Since colored Petri nets have a strong mathematical basis to evaluate software systems, we used CPN TOOLS simulator to simulate the proposed method, and we compared our method with the method proposed by [1] and [4]. The results indicate that the priority of this method in comparison to other presented methods. The results show that this method has minimum response time compared to the methods that have been already presented.

7. SUGGESTIONS

In this Paper, the following Suggestions have been Proposed:
Considering data dependency among subtasks and expecting some sub-tasks to receive required data from sub-tasks. Also due to BandWidth and etc.

8. REFERENCES

[1] Alishahi M, Abroshan V, Harounabadi A, 1391, Modeling and optimal resource selection for the subtasks aimed at improving reliability of grid network using colored Petri Nets, The second Conference on Soft Computing and Information Technology.

[2]Arora. M, Biswas. R, Das. S, Aug .2002, "A Decentralized Scheduling and Load Balancing Algorithm for Heterogeneous Grid Environments", Proceeding of International Conference on parallel processing workshops, pp. 499-505.

[3] Asgharpour MJ,1389, Multi Criteria Decision Making, Tehran University Press.

[4]Azghomi.M.A, Entezari-maleki. R, October 2010, "Task scheduling modeling and reliability evalution of grid services using colored petri net ", Future Generation Computer Systems, Vol .26, pp 1141-1150.

[5] Dastgheybifar G, Ansari S, Lotfi S, 1386, " A new Scheduling Algorithm for Computational Grid, Thirteenth Annual Conference of Computer Society of Iran".

[6] Fathi M, Shahriari F, 1388, Concepts of grid computing technology and its applications in various Fields.

[7] Kokilavani. T, George Amalarethinam. D.I, April 2011, "Load Balance Min-Min Algorithm for Static Meta-Task Scheduling in Grid Computing", International Jornal of Computer Applications, Vol.20- No.2, pp.43-49.

[8] Meibodi. M, Shojafar. M, Barzegar. S, 2010, "A New Method on Recourse Scheduling in Grid Systems Based on Hierarchical Stochastic Petri Net", 3th International Conference on Computer and Engineering,pp.175-180.

[9] Mohammad Khanli Leyli ،Etminan Far Maryam ، Ghaffari Ali. 2010 ، Reliable Job Scheduler using RFOH in Grid Computing ، Journal of Emerging Trends in Computing and Information Sciences ،©2009-2010 CIS Journal. All rights reserved. VOL. 1.

[10] Parsa. S, Entezari-maleki. R, Dec.2009,"RASA: A New Task Scheduling Algorithm in Grid Environment", International Journal of Digital Content Technology and its Applications Vol.3,9.4,pp. 152-160.

[11] Parsa. S, Azadi Parand. F, 2012," Estimation of service reliability and performance in grid environment", Journal of King Saud University – Engineering Sciences 24, 151–157.

[12] Rongfei. Zeng, Yixin. Jiang, Chuang. Lin, and Xuemin (Sherman) Shen, 2012 ,"Dependability Analysis of Control Center Networks in Smart Grid using Stochastic Petri Nets" , Electrical and Computer Engineering Sept. (vol. 23 no. 9) pp. 1721-1730.

[13] Saadi H, Habibi G,Mohammadi H,1386, "design of a scheduler for grid computing using genetic algorithms", Thirteenth National Conference of Iranian Society, Kish Island, Iran.