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Research on Resource Scheduling Technology Based on LB Algorithm and Belief Model for Cloud Computing

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Abstract

Aiming at the problem of resource scheduling in cloud computing, we constructed a new scheduling method based on trust model and LB algorithm. Firstly, on the basis of matching tasks and resources, we established three calculation modes on security requirements and reliable demand benefits. Secondly, based on the benefit function of security requirements and reliable demand, we built the trust benefit function of total. Finally, we got a cloud resource scheduling algorithm which combined with load balancing algorithm. The experimental results show that proposed method has obvious advantages comparing with the maximum and minimum trust driving method in the execution time span, load balancing performance and average waiting time, and this method can carry out fast and efficient resources scheduling for cloud computing.

Keywords*: cloud resource scheduling, trust model, load balancing, trust benefit function*

1. Introduction

Cloud computing is the result of the evolution of a variety of mixed technology, it has fast development speed, high maturity and vigorous promote of big companies, these make it become one of the most popular technology in today's computer industry[1].For the research field of cloud computing, we can get different classification from different angles. For example, from the view of service types, cloud computing can be divided into infrastructure cloud, platform and application of cloud[2], and according to different service mode, cloud computing can be divided into public cloud, private cloud and hybrid cloud[3]. Although a variety of cloud computing have differences in the system structure and service mode, general cloud computing architecture still needs hardware layer, resource virtualization layer and service layer [4]. Resource virtualization layer is established on the basis of the hardware, this layer can improve the utilization of hardware resources and utilize the software and hardware resources into multiple independent resources or let multiple independent resource virtualized as a unified resource, at the same time it provide rapid deployment, self replication and self migration business demand for third layer service [5]. Therefore, it is key to improve resource load balancing and task scheduling strategy. Only grasp task scheduling and improve the matching degree of tasks and resources, we can improve load balancing of resources. The existing scheduling algorithm in order to task execution time span (makespan), resource load balancing degree, the average waiting time of task and the complete efficiency of task as the optimization target[6].

Under a cloud environment, task scheduling based on trust driving is a NP problem, it need with the help of heuristic algorithm. Traditional batch job scheduling heuristic algorithm which have minimum task execution time include greedy algorithm, Sufferage, A *, Min-min and Max-min, genetic algorithm and so on [7-8]. Based on the trust driven mainly have TD_Min-min, the TD_Max-min, TD_Sufferage etc [9-10], these algorithms

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usually consider task execution time, load balancing and other factors; each one has his good points.

In this paper, on the basis of trust model, it combine LB algorithm together to construct a new cloud resource scheduling method, in order to better adapt to the demand of cloud computing.

2. Cloud Resource Scheduling Based On Trust Model and LB Algorithm

In scheduling algorithm for the study object of trust driven, its purpose is to meet task requirements, have a maximum value of trust benefit, but it not consider resource load balancing and scheduling time span of their own scheduling. While scheduling only consider the value of trust benefit, even if some resource load has big enough, but still the value of trust benefit meet the demands of current task, so go on this resource scheduling, it lead to extremely unbalanced load which some resources is heavy load and other resources is free. In view of this, this paper consider two elements of task requirements and load balance, and then construct a new method of cloud resource scheduling.The benefit of this method which based on resource and task value matching degree, is calculated the real-time load of each resource when scheduling, and then put the task scheduling to the lowest load degree of resources.

2.1. Trust Model

Trust is fuzzy concept, different scholars have different description. In this paper, we regard the trust model as a four dimensional body, it use (B_o, B_A, B_R, B_F) to show. Among them, Where B_o represents the set of service provider and service requester, it is a collection of resources and tasks in the algorithm; B_A represents the attributes of trust; B_R represents the set of trust relationship, it is trust needs in the algorithm; B_F represents a collection of benefit function based on different attributes and relationship.

In the trust attributes as described in B_A, this paper set up four attributes, they are security attributes of quantified resources and task, and reliable attributes of quantified resources and task with $S_{resource}$、 S_{task}、 $R_{resource}$ R_{task}。

Trust benefit function in this algorithm borrows the concept of benefit function from computed economic model. It is showed that the trust demand from task to resources in the process of scheduling. This trust demand can be divided into three cases: strong trust demand (Strong), weak trust demand (Weak) and non-trust demand (No).

When describing the trust remand, we can depend on the size of the original benefit remand to characterize the strength of the task demand resources. The degree of trust demand is divided into three cases that are strong, weak and no.

If we use T_i to represent ith task and R_j to represent jth resource, $S^i_{resource}$ shows safety coefficient of i resource, S^i_{task} shows safety coefficient of ith task, so three kinds of demand intensities that the safety efficiency executed on the j resource by the i task requires, they can be calculated according to the following formula:

$$\begin{cases} F^{s}_{strong}(i,j)=\begin{cases}0 & S^{i}_{task}\le S^{i}_{resource}\\ 1 & S^{i}_{task}>S^{i}_{resource}\end{cases} \\ F^{s}_{weak}(i,j)=\begin{cases}1 & S^{i}_{task}\le S^{i}_{resource}\\ 1-\dfrac{S^{i}_{task}-S^{i}_{resource}}{T_{\max}-S^{i}_{resource}} & S^{i}_{task}>S^{i}_{resource}\end{cases} \\ F^{s}_{no}(i,j)=\dfrac{S^{i}_{task}}{T_{\max}} \end{cases} \tag{1}$$

Similarly, the reliable efficiency demands on the j resource by the ith task also have three kinds of demand intensities. $R^{i}_{resource}$ Shows reliable coefficient of ith resources, R^{i}_{task} shows reliable coefficient of ith task, then the reliable efficiency function of three kinds of demand intensity can be calculated according to the following formula:

$$\begin{cases} F^{r}_{strong}(i,j)=\begin{cases}1 & R^{i}_{task}\le R^{j}_{resource}\\ 0 & R^{i}_{task}>R^{j}_{resource}\end{cases} \\ F^{r}_{weak}(i,j)=\begin{cases}1 & R^{i}_{task}\le R^{j}_{resource}\\ \dfrac{1-e^{-TR_{ij}-1+R^{j}_{task}}}{e^{-1+R^{i}_{task}}}\Big/\dfrac{1-e^{-1}}{e^{-1+R^{i}_{task}}} & R^{i}_{task}>R^{j}_{resource}\end{cases} \\ F^{r}_{no}(i,j)=\dfrac{1-e^{-TR_{ij}}}{1-e^{-1}} \end{cases} \tag{2}$$

The range of R^{i}_{task} is (0, 1), and TR_{ij} is a joint decision according to the ith task and jth resource. We must set inherent failure rate R_{fail} of all computing resources at the beginning of scheduling. With the increase of operation time, the probability of resource failure also increases and reliability decreases. If executed time on the jth resource by the ith task is t_{ij} , resource reliability TR_{ij} is:

$$TR_{ij}=e^{-(t_{ij}\times R_{fail})} \tag{3}$$

Accordingly, we can deduce the executed trust efficiency function on the jth resource by the ith task, the function as follows:

$$F_{trust}(i,j)=w_1F^{s}(i,j)+w_2F^{r}(i,j) \tag{4}$$

In this function, w_1 represents the important degree of security, w_2 represents the important degree of the reliability, the relationship between them is $w_1+w_2=1$.We can get that the greater values of trust efficiency function, the more stable after the task mapping is performed, and the execution results with higher credibility.

If there are m tasks in the resource pool, the average of trust efficiency function for this resource pool is:

$$\overline{F}_{trust} = \frac{\sum_{j=1}^{m} F_{trust}(i, j)}{m} \tag{5}$$

2.2. Load Balancing Evaluation Function

In the cloud computing resource scheduling, time span function can be used to express the length of time which the task completed, its calculation as shown in formula (6):

$$t_{spare} = Max(t_{end} - t_{start})_{m(j)} \tag{6}$$

The time length of time span function depends on the last task completed time on the resources. When some task completed, they need to m resources, time span is that tasks on the m resources have completed the longest time, the smaller the time span indicated that scheduling algorithm performance of cloud computing resource is better. Thus, cloud resource scheduling algorithm is excellent, it becomes whether time span have the minimum problem.

The average waiting time is an important factor to measure cloud resource scheduling algorithm, the calculation formula is shown as (7):

$$\bar{t}_{wait} = \frac{\sum_{i=1}^{n} t_{wait}}{n} \tag{7}$$

Calculation method of average waiting time is that calculated all task waiting time and then divided by the number of tasks. A single task waiting time, that is present task executed time plus former task completed time. The smaller is the average waiting time, the better is the effect of cloud computing scheduling algorithm.

If we want to get the minimum average waiting time, we need to balance load scheduling. The standard deviation of each load as shown in formula (8) :

$$\sigma_L = \sqrt{\frac{1}{m}\sum_{j=1}^{m}(L_j - \mu_L)} \tag{8}$$

2.3. Construction of the Cloud Resource Scheduling Algorithm

In this paper, we combine trust model with LB algorithm to construct a new cloud resource scheduling algorithm. Firstly, we calculate maximum value of the trust efficiency function for every task in each computing resource, and choose the maximum trust efficiency task-resource to match. Then calculate average efficiency value for each task T_i in the resource pool, count the number of tasks-resources which is larger than average efficiency value, this number is represented by N_a, filter out larger than average efficiency value and arrange them in descending order. Meanwhile, figure out all the number of the tasks - resources which is greater than average value of trust efficiency and the average value is N_b. If N_a is greater than N_b, then in this task take N_b task - resources to calculate the minimum time span, and schedule this task to perform on the resource. If N_a is less than N_b, then in this task take N_a task-resources to calculate the minimum time span, and schedule this task to perform on the resource.

Finally, the flow chart of cloud resource scheduling algorithm is constructed as shown in figure 1.

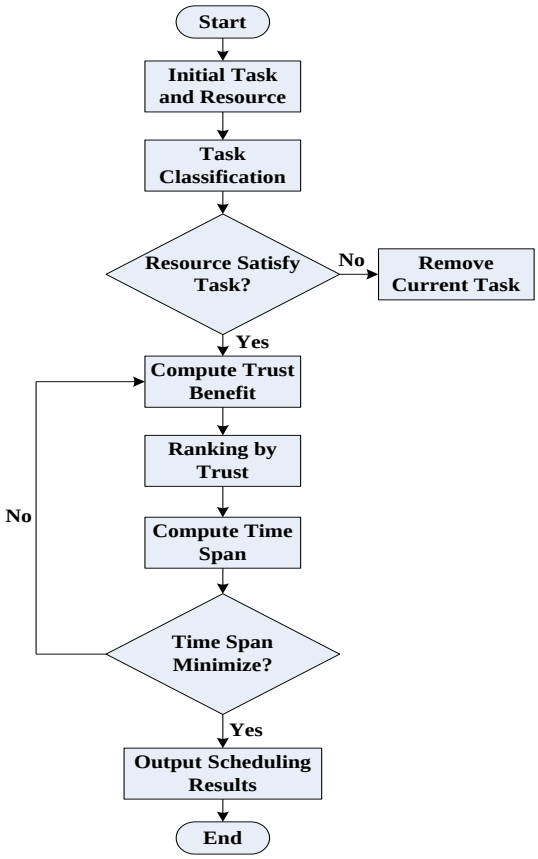

Figure 1. Algorithm Flow Chart

3. Experiment and Experimental Analysis

3.1. Experimental Design

In order to verify the effectiveness of the method for cloud resource scheduling, we design the following experiments.

In the CloudSim environment, we set up the total of cloud resources which is 100, the computing tasks change from 10 to 40, the number of tasks change spacing is 5. Each security level of computing resources have four types with high, medium, low and poor, these four levels are randomly generated, the corresponding value is set to 0.8, 0.6, 0.4, and 0.2. Each computing resource efficiency loss [0.002, 0.003] on the interval randomly generated. The failure rate of each computing resources randomly generated in [0.002, 0.003] this interval.

Randomizer can control reliability and safety requirements of every computing tasks, its scope is [0.2, 0.2]. The strength of trust relationship between tasks and resources are also controlled through randomizer on [0, 1] interval. Trust efficiency function is used to control the safety and reliability, its weight is set to $w_1 = 0.6$ and $w_2 = 0.4$, it shows that we emphasize the safety more.

3.2. The Result of the Experiment

In order to form a more intuitive comparison, this paper select the maxinum trust driven method and minimum trust driven method, as reference method in this paper, at the same time, this method execute the scheduling experiments of the cloud resource. Comparing the effect of three methods, this article start an experiment from the time span, load balancing, task average time to make a comparison.

When computing task gradually increased from 10 to 40, execute time span of three methods are shown in figure 2.

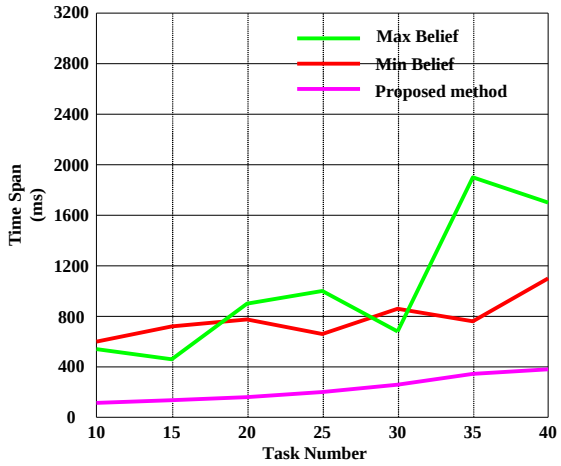

Figure 2. Time Span Ratio of the Three Methods

As can be seen from the figure, the cloud resource scheduling algorithm on the executed time span is superior to the maximum trust driven method and minimum trust driven method. Because the algorithm considers the trust requirements of the user, it always chooses the resource which completed execution first to match, so that the time span is much lower than the other two methods.

When computing task gradually increased from 10 to 40, load balancing of three methods are shown in figure 3.

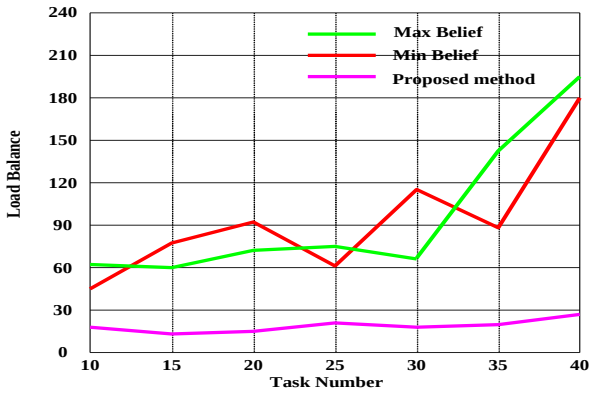

Figure 3. Load Balancing Ratio of the Three Methods

As can be seen from the figure, the algorithm of load balancing degree still has obvious advantage. Because the algorithm in this paper choose the task-resource matching with high credibility, and also schedule tasks to resources as small as possible when scheduling, it can improve the load balancing degree.

When computing task gradually increased from 10 to 40, task average time of three methods are shown in figure 4

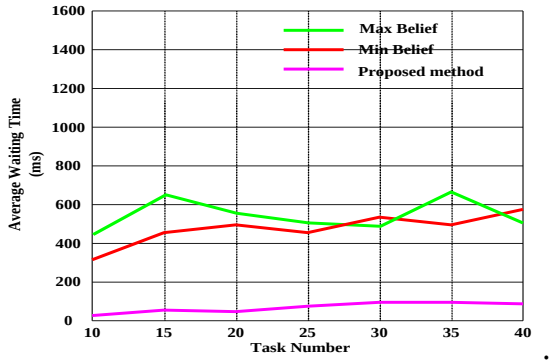

Figure 4. Task Average Time Ratio Of The Three Methods

As can be seen from the figure, with the number of tasks increase the total of resources do not change, and average waiting time of maximum trust driven method and minimum trust driven method increase, the proposed method in this paper is only a minor increase.

4. Conclusions

The dynamic and uncertainty of resources makes the task scheduling is very complex under the cloud environment. High reliability of cloud computing and meet the demand of user becomes more complicated. Aiming at the shortcomings of the previous task-resource matching problem, we introduce trust mechanism under the cloud environment, at the same time, we introduce load balancing mechanism in the scheduling process, we always choose the minimum balancing resources to schedule which meet trust demand, it reduces the waiting time of tasks and improve the load balancing degree and reduce the total time which task executed.

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References

[1] H. R Faragardi, A. Rajabi, R. Shojaee and T. Nolte, "Towards energy-aware resource scheduling to maximize reliability in cloud computing systems", Proceedings IEEE International Conference on High Performance Computing and Communications, **(2014)**, pp. 1469-1479.
[2] W. Q. Gao and F. J. Kang, "Cloud simulation resource scheduling algorithm based on multi-dimension quality of service", Information Technology Journal, vol. 1, **(2012)**, pp. 94-101.
[3] H. H. Chang and X. H. Tang, "A load-balance based resource-scheduling algorithm under cloud computing environment", Lecture Notes in Computer Scinece, vol. 37, **(2011)**, pp. 85-90.
[4] P. D. Kaur and I. Chana, "Enhancing grid resource scheduling algorithms for cloud environments", Communications in Computer and Information Science, vol. 169, **(2011)**, pp. 140-144.
[5] H. J. Moon, Y. Chi and H. Hacigumus, "SLA-aware profit optimization in cloud services via resource scheduling", Proceedings 6th World Congress on Services, **(2010)**, pp. 152-153.
[6] J. Wood, B. Romoser, I. Zecena and Z. Zong, "B-Maps: a self-adaptive resource scheduling framework for heterogeneous cloud systems", ACM International Conference Proceeding Series, **(2013)**, pp. 353-357.
[7] S. M. Abu, A. Ouda and A. Shami, "A resource scheduling model for cloud computing data centers", 2013 9th International Wireless Communications and Mobile Computing Conference, **(2013)**, pp. 213-218.
[8] I. M. Abbadi and A. B. Ruan, "Towards trustworthy resource scheduling in clouds", IEEE Transactions on Information Forensics and Security, vol. 6, **(2013)**, pp. 973-984.
[9] V. Popov, "Particle swarm optimization technique for task-resource scheduling for robotic clouds", Applied Mechanics and Materials, **(2014)**, vol. 565, pp. 243-246.
[10] D. Adami, C. Callegar, S. Giordano and M. Pagano, "A hybrid multidimensional algorithm for network-aware resource scheduling in clouds and grids", IEEE International Conference on Communications, **(2012)**, pp. 1297-1301.

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