Based on Ant Colony Algorithm for Cloud Management Platform Resources Scheduling

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***Abstract*—With the development of Cloud Services, IaaS(Infrastructure as a Service) become a part of our daily life. And this paper is based on cloud management platform architecture which is in the testing phase. According to the experiment, we found a new way to solve the resources optimization problem about the resource scheduling of cloud management platform, and obtained satisfactory results. It indicated that ant colony algorithm could play a essential role in the problem about the resource scheduling of cloud management platform.**

Keywords-the cloud management platform; ant colony optimization; resource scheduling

I. INTRODUCTION

With the development of the data processing, storage, virtualization, information service, and so on, cloud computing arises at the historic moment. Cloud computing bring us a wide range of services, in which we are looking for our needs, bringing the great convenience for our life and study.

II. THE CLOUD-SERVICE

Cloud computing has brought us a lot of services and convenience, which can be divided into SaaS(Software-as-a-service), PaaS(Platform as a Service) and IaaS(Infrastructure as a Service) according to the types of service.[1]

As a kind of layout model of software, SaaS has become a newest tendency of software development. SaaS has a strong pertinence, which provides some certain application software to users through packing it as a service, in this way, users can save some investment of personnel and resources. CRM[2](Customer Relationship Management) provided by Salesforce is an example of SaaS.

In fact, Paas refers to taking the software development platform as a kind of service and giving to users in the model of SaaS. Therefore, PaaS also belongs to a application of SaaS, such as Googel App Engine[3].

Iaas provides some applications of basic resources for users, including processing, storage, network, etc. Users can arrange and operate any software on it, such as operating system and application program. Generally speaking, what IaaS provides for users is user-defined application program. For instance, Amazon EC2[4] (Amazon Elastic Compute Cloud) and Amazon S3[5] (Amazon Simple Storage Service) of Amazon Web Services.

In terms of the types of service, the cloud management platform belongs to IaaS. This platform provides relevant hardware support on the basis of user demand and offers them with operation rights of deployable software and selected operating system.

III. THE CLOUD MANAGEMENT PLATFORM

A. The Cloud Management Platform

Following are the difficulties of hardware and software management existed in domestic enterprises and universities at present:

1) Enterprises: Large inputs of hardware, it's not convenient to carry in the working atmosphere, recovery work is huge after breakdown of machine.

2) Universities: various equipments, dispersed distribution; experiment courses change so fast that the hardware cannot keep pace with it; life cycle management of the equipment has faults, and then it vanishes at last; the courses are changing everyday and preparation work of experiments is too heavy.

Above difficulties can be solved by the cloud management platform which integrates the environment again so as to realize a centralized and simplified management. Users can use the virtual machine operating system instead of physical servers so that it improves the flexibility, manageability and usability of the system.

B. The Realization Mechanism

Typical cloud platform[6] has interactive user interface which provides access interface in the way of Web Services aiming to obtain user demand. Moreover, this platform has service list for user's visit, management module which is used to manage and distribute all of the available resources, monitoring and statistical module which is used to monitor the running state of node, and configuration module used to do the configuration management to environment. We used a mature theory of cloud platform to make a cloud management platform which is fit for our own users. See the figure 1: the user can access the platform through the interface, user management provides registration, registration information maintenance and password retrieve; apply for resources through resource application module; monitor and distribute resources through resource management module.

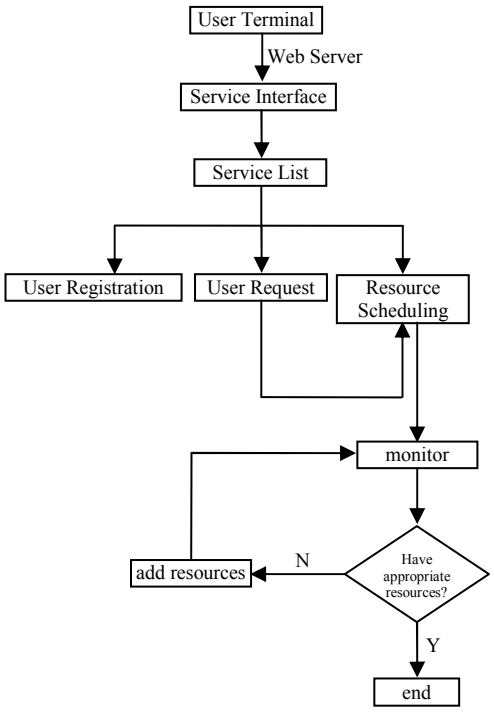

Figure 1. The cloud management platform

C. The System Virtualization

The system virtualization refers to taking a physical computer as one or several virtual computer system and each of that has its own CUP, memory and devices. Through the imitation of virtual layer which consists of VMM, the virtual machine will think its execution environment is independent so that it can provide users a independent virtual execution environment. We have employed the host computer model (see figure 2) which refers to taking the VMM[7] as a application program and run it in the operating system of host. During the period of virtualization, we suppose the physical resources into several virtual resource pools.

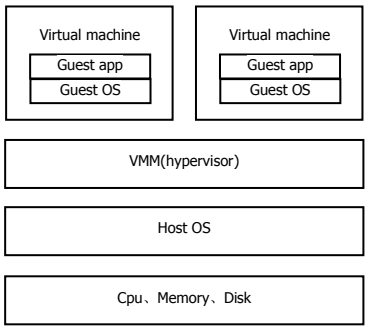

Figure 2. The host computer model

IV. Based on The Cloud Management Platform Resources Scheduling

A. The Cloud Management Platform Resources Scheduling

The resource scheduling of cloud management platform can be divided into four steps: resource request, resource detection, resource selection and resource monitoring.

Resource request: we established an independent module for the resource request when we designed the module. Resource restrictions exist in the resource request.

Resource detection: in this section, we detected all of the resource pools and collected all of the useful information, so as to form a candidate list. During the process of resource detection, we used the ant colony algorithm, searching available resources from plentiful resources.

Resource selection: select proper resource from candidate list, the strategy is to define utility function and apply algorithm to evaluate the detection results.

Resource monitoring: in this stage, system provided the optimal resources for users who applied for this resource and monitored the resource. It can redistribute or remove when the usage is abnormal aiming to guarantee the usage, it can retrieve the resource when the period of use is over.

Resource selection should be the core of the whole resource scheduling after it received the request and done the resource detection. In the whole process of resource selection, it employed ant colony algorithm.

B. Ant Colony Algorithm

Ant colony algorithm[8], proposed by Italian scholars such as Colorni A, Dorigo M and Maniezzo V in 1992, is a new simulated evolutionary algorithm which solves some optimal problems existed in discrete system through the search ability reflected in the process of searching food resource of ant. It has been widely used in traveling salesman problem[9], weapon-target assignment[10], clustering[11] and scheduling problem[12]; moreover, it has gotten a preferable experimental result. In this paper, we applied ant colony algorithm to solve the optimization problems existed in the resource scheduling.

C. The Problem description

We have given a description about the resource scheduling problems on the cloud management platform. There were n node in the whole cloud management platform, each node is connected by network between each other, each node is with own load information on the current condition. In the each stage, the algorithm will being m ant.

D. The Ant Path Selection

In the initial stages, the algorithm has being m ant in 1 node, then, with the pheromone about the path and stimulating factor, each ant selected anther node as the next station. In ‘t’ moment, the probability for the ant k(k = 1, 2,..., m) from node i (i = 1, 2,..., n) moving to node i+1 is

$$P_{ij}^{k}(t)=\begin{cases}\dfrac{[\tau_{ij}(t)]^{\alpha}\bullet[\eta_{ij}(t)]^{\beta}}{\sum_{s\in J_k(i)}[\tau_{is}(t)]^{\alpha}\bullet[\eta_{is}(t)]^{\beta}}, & j\in J_k(i)\\ 0, & j\notin J_k(i)\end{cases} \quad (1)$$

$$\eta_{ij}\underset{M_1<L_j<M_2}{=}\frac{l_j}{M_2} \quad (2)$$

Among them:

$\tau_{ij}(t)$ —— In 't' moment, the pheromone is between node i and j, in the initial time, $\tau_{ij}(0)=C$ (C is smaller positive integer).

l_j —— The load value at node j.

M_1 and M_2 ——the threshold value of l_j, M_1 is the minimum load value, M_2 is the maximum load value. The role is that when the cloud management platform received the user application, at first, to allocate the resources from the resource pool which the load value is higher than anther, in order to achieve the purpose of saving resources. At the same time, in order to ensure that resources can be used, the load value is lower than M_2.

η_{ij} —— the stimulating factor(the expected value), when the ant at i selected node j as the next station. When a node through which the load closer to M_2, η_{ij} the greater the choice of the nodes may be greater.

$J_k(i)$ —— The node set which Ants can reach at i node, among them, the $tabu_k$ shows the taboo list of ant, every ant has themselves' taboo list storage all the passing node, We use $tabu_k$ to control the ant walking routes. Unless the first cycle end (ants traverse all nodes), ants can't again through the node in $tabu_k$. $J_k(i)$={all the nodes}—$tabu_k$, $tabu_k$ is the taboo list about k.

α and β —— express Respectively, when the k-th ant selects the next node as the direction of movement, the current pheromone and inspired factors relative importance.

The ant death when all nodes have been gone. Then we statistics the elements of the $tabu_k$, we conclude the k-th solution:

$$tabu_k=\{h,i,j,....,t,n\}\subseteq\{1,2,...,n\}$$

$$L_k=p_{hi}+p_{ij}+...+p_{tn} \quad (3)$$

Among them:

L_k —— Obtained K-th ant the solution in this iteration.

E. The Pheromone Update Strategy

When the best solution of this iteration is better than the current best solution, we use this solution instead of the current iteration of the best optimal solution, and the k-th ant through the nodes which the pheromone will update:

$$\tau_{ij}(t+1)=(1-\rho)*\tau_{ij}(t)+\Delta\tau_{ij} \quad (4)$$

$$\Delta\tau_{ij}=\sum_{k=1}^{m}\Delta\tau_{ij}^{k} \quad (5)$$

$$\Delta\tau_{ij}^{k}=\begin{cases}\dfrac{L_k}{Q}, if\ the\ k-th\ ant\ from\ i\ to\ j\\ 0, else\end{cases} \quad (6)$$

Among them:

ρ —— The evaporation coefficient between nodes.

$\Delta\tau_{ij}$ —— The iteration's pheromone increment between nodes i and j.

$\Delta\tau_{ij}^{k}$ —— the amount of pheromone between node i and node j left by the k-th ant.

Q ——A positive constant.

F. The Algorithm Description

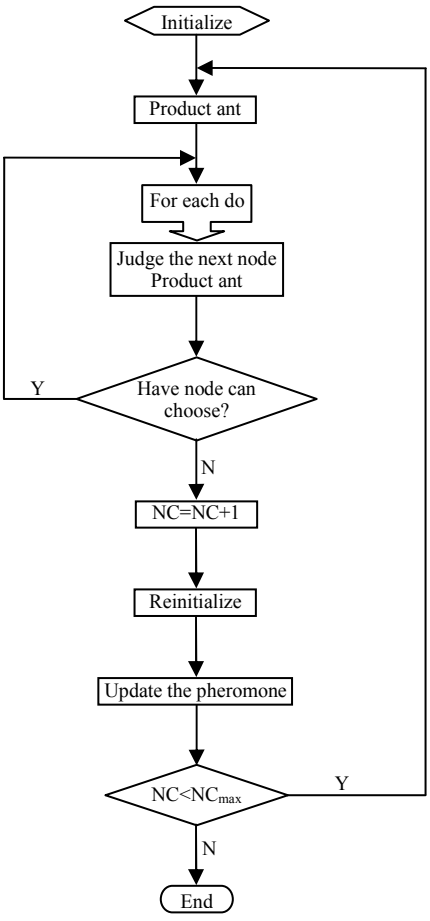

Figure 3. The algorithm flow chart

The main steps:

- Initialization parameters
- Product m ant on node 1
- According to the formula (1) to judge the next node.
- Record the passed node to the taboo list of the k-th ant.
- After all the ant death, calculate this iteration's the best solution, if this iteration's the best solution is better than the current, use the best solution instead of the current optimal solution.

- Judging whether the cycling times beyond the NC_{max}.
- According to the formula (2) update the pheromone on the path, clear all data from the ant taboo list, and $\Delta\tau_{ij} = 0$.

V. THE TEST RESULT

In the experiment, there are 30 nodes, parameters test value for: Q={1,10,100,1000,10000}, α ={0.1,0.2,0.5,1.0,2.0,3.0}, β ={1.0,2.0,3.0,4.0,5.0}, ρ ={0.1,0.2,0.3,0.4,0.5,0.6}. When we test a parameter, other parameters take the default value (the default value of each parameter for: Q=10, α =1.0, β =2.0, ρ =0.5). We run the ant colony algorithm with a certain parameters value. Among them, the avg in the table is the number of average with running the ant colony algorithm, in the tests, we run the 20 times.

TABLE I. PARAMETER Q OF ANT COLONY ALGORITHM INFLUENCE

Q	avg	Effective(%)
1	13337	0.65
10	13354	0.70
100	13352.2	0.69
1000	13351.8	0.70
10000	13335	0.53

TABLE II. PARAMETER α OF ANT COLONY ALGORITHM INFLUENCE

α	avg	Effective(%)
0.1	13375	0.96
0.2	13383.2	0.98
0.5	13379.1	0.90
1.0	13350.3	0.72
2.0	13280	0.30
3.0	12290	0.41

TABLE III. PARAMETER β OF ANT COLONY ALGORITHM INFLUENCE

β	avg	Effective(%)
1.0	13351.2	0.7
2.0	13370.9	0.89
3.0	13380.3	0.91
4.0	13381.1	0.91
5.0	13383.6	0.92

TABLE Ⅳ. PARAMETER ρ OF ANT COLONY ALGORITHM INFLUENCE

ρ	avg	Effective(%)
0.1	13373.2	0.89
0.2	133374	0.91
0.3	13353.7	0.76
0.4	13352.9	0.78
0.5	13357.1	0.72
0.6	13347	0.74

From the table, it is known that the Q of the algorithm is the impact is not big, as α =0.2, β =1.0, ρ =0.2, The validity of the algorithm is high.

VI. CONCLUSION

In the article, we described the cloud computing management platform framework, identified the resource scheduling strategy through analysis the platform implementation processes, suggested that apply the ant colony optimization to search for the available resources within the resource scheduling. Finally, through the experiment got good results.

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