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Cloud Computing Oriented Data Center Network Architecture Design

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Abstract:

With the rise of cloud computing technology, the traditional IT industry has been impacted. The network architecture design of traditional data center can not meet the requirements of high performance and high cost performance under the trend of cloud computing, nor can it support flexible bandwidth control in cloud computing environment. This paper analyzes and designs the data center network architecture for cloud computing, focusing on the fast and accurate data processing ability of cloud computing. This paper expounds the design principles and key points of cloud computing data center network system. The results are helpful for peers to design and build a more efficient, convenient and secure Cloud Computing Oriented Data Center network.

Keywords*: Cloud Computing, Data Center, Network Architecture, Bandwidth Control.*

I. INTRODUCTION

With the rapid development of cloud computing technology, the data center based on cloud computing has gradually become important and complex [1-2]. As the gathering place of high-performance computers, cloud computing data center includes tens of thousands of physical servers, physical storage and network equipment [3]. These resources are huge and heterogeneous, and the problem of low resource utilization of data center is becoming increasingly prominent. In the era of cloud computing, load balancing technology is an important aspect of improving equipment utilization and performance. It can effectively avoid the low performance caused by the high utilization of some resources. An efficient load sharing algorithm can greatly improve the quality of service [4-5]. In the cloud data center scheduling algorithm, a challenging task is to consider the migration after virtual machine allocation and reconfiguration. How to allocate resources and how to schedule in the data center has always been the focus of research. Therefore, the deployment and migration of virtual machines in the cloud computing data center is a hot issue in today's research [6]. The cloud computing technology will achieve a more flexible and efficient utilization of resources in the cloud computing center, and will save more unnecessary resource allocation and data center.

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II. VIRTUAL MACHINE PLACEMENT ALGORITHM BASED ON OPTIMIZED ANT COLONY ALGORITHM

In the cloud computing data center, virtualization makes the utilization of resources more improved than before. However, due to the different types of resources requested by various services and the heterogeneity of physical resources in the data center, it is difficult to make full use of the resources of each physical machine according to the traditional load balancing strategy when deploying virtual machines [7-9]. If we can consider the characteristics of each physical machine and deploy the corresponding job request on the physical machine, we can obtain higher resource utilization.

2.1 Virtual machine placement algorithm based on ant colony algorithm

Ant colony algorithm is a probabilistic algorithm used to find the optimal path in the graph. It was proposed by Marco Dorigo in his doctoral thesis in 1992. Its inspiration comes from the behavior of ants finding paths in the process of looking for food. Ant colony algorithm is a simulated evolutionary algorithm. All ants start searching for food without knowing where the food is in advance. After an ant searches for food, it will release a volatile secretion pheromone, called pheromone, to the outside world. Pheromone will gradually disappear with the passage of time. The concentration of pheromone represents the distance. Pheromone will attract other ants, so more and more ants will find food. Not all ants will always repeat the same path. Some will open up new roads. If the new roads are shorter than other roads before, gradually, more ants are attracted to this shorter road. Finally, after a period of time, the shortest path may be repeated by most ants.

After one iteration of ant anti, the pheromones of all paths are calculated according to formula (1) [10]:

$$\begin{aligned} \tau_{ij}(t+1) &= \rho \quad \tau_{ij}(t) + \Delta\tau_{ij}(t+1) \\ \Delta\tau_{ij}(t+1) &= \sum^{k} \Delta\tau_{kj}(t+1) \end{aligned} \tag{1}$$

Basic ant colony algorithm steps:

Stepl: initialization iteration times I = 0, initialization ant colony, τ_{ij} (t) = C (C is a constant), pheromone increment τ_{ij} = 0, K ant search from K virtual machines, and the tabu list of all ants is empty.

Step 2: establish a taboo table tabui for each ant.

Step 3: calculate the probability of selecting the next server m_j for each ant anti, select the server m_j based on this probability, and add the selected server to the taboo list of the ant.

Step 4: calculate the pheromone increment of each virtual machine and server combination.

Step5: calculate the combination with the minimum load imbalance in this cycle, and judge the number of iterations I < I_{max}. If it meets, clear all taboo tables, update pheromones, and jump to step 2, otherwise proceed to step 6.

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Step6: the algorithm ends and the virtual machine placement scheme f is output.

2.2 Simulation experiment and result analysis

Because the load of the server and the user's request are constantly changing in the cloud computing environment, it is difficult to evaluate the allocation and scheduling strategy of cloud computing resources, the load of the data center and the server performance in the actual cloud computing data center environment. Therefore, the cloud simulation platform cloudsim designed by Rajkumar Buyya and other scholars of the University of Melbourne solves these problems. Cloudsim can simulate the resource environment of cloud computing data center to realize the simulation and Simulation of cloud computing system and resource allocation and scheduling algorithm.

On the cloudsim platform, we set the parameters of the virtual machine and the server in the cloud computing center. The CPU, memory, network and other parameters of the virtual machine applied by the user are shown in Table 1, and the parameters of the server in the cloud data center are shown in Table 2. In this paper, CPU, memory and network bandwidth are selected as resource matching parameters.

TABLE I. Parameter list of virtual machine template applied by user

Number of CPUs / piece	Computing power / MIPS	Memory / GB	Network bandwidth / maps	Resource demand characteristics
1	200	1	100	ordinary
1	300	1	100	Computational type
1	200	2	100	Storage type
1	200	1	200	Network type
2	200	1	200	ordinary
2	300	1	200	Computational type
2	200	2	200	Storage type
2	200	1	400	Network type

TABLE II. Server parameter list

Number of CPUs / piece	Computing power / MIPS	Memory / GB	Network bandwidth / maps
8	2000	16	750
8	3000	8	1000
4	1000	8	750
4	2000	12	1500

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2	2000	4	1500
2	1000	8	1000

In order to verify the superiority of virtual machine placement algorithm based on optimized ant colony algorithm, in this experiment, this paper implements the greedy scheduling (GS), basic ant colony algorithm (AC) and ant colony optimization algorithm for virtualmachina p1agreement (acovp) on cloudsim, and carries out simulation experiments.

In order to verify that the algorithm can play a good effect on the load balancing of the system, this paper randomly generates the number of virtual machines, which are 45, 23, 51, 21, 8, 26, 2L and 29 respectively according to the template type, and the number of servers are 20, 2L, 13, 21, 12 and 21 respectively. Using CPU, memory and network bandwidth as the measurement standard of system state, the load imbalance degree of data center is calculated, and the experimental results of the three algorithms are compared.

The load imbalance degree of the three resources obtained by the greedy placement algorithm is high, and the load imbalance degree of each resource is also different. Therefore, it can be inferred that the resource utilization rate after using the greedy placement algorithm is not high; The load imbalance of the three resources after using the basic ant colony placement algorithm is lower than that of the greedy placement algorithm, but there is still a big gap in the load of different resources; After using the virtual machine placement algorithm based on optimized ant colony algorithm, the load imbalance of the three resources is low and the difference is small.

With the change of the scale of cloud computing data center, the change of load imbalance. The lower the load imbalance, the better the load balancing effect. It can be seen that the load imbalance of data center servers is from high to low, and the algorithms used are greedy placement algorithm, basic ant colony placement algorithm and virtual machine placement algorithm based on optimized ant colony algorithm. After using the greedy placement algorithm, the load imbalance of the data center is very high, indicating that the load of resources varies greatly among servers. Both the basic ant colony algorithm and the virtual machine placement algorithm based on the optimized ant colony algorithm reduce the load imbalance of the data center, which shows that the resource load difference between each server is small after using the two algorithms. The experimental data show that the virtual machine placement algorithm based on optimized ant colony algorithm is better than greedy placement algorithm and basic ant colony placement algorithm.

III. DESIGN AND SIMULATION OF LOAD BALANCING SYSTEM

3.1 Design of load balancing system

Through the demand analysis of the load balancing system, it can be seen that the load balancing system needs four modules. The load collection module is located in the infrastructure layer of the cloud platform and is responsible for collecting the load data of the server and business; The load monitoring

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module is located in the platform management layer of the cloud platform and is responsible for receiving the information transmitted by the load collection module, judging whether it is overloaded, and then making decisions; The policy control module is located in the platform management layer of the cloud platform and is responsible for dynamically applying the load balancing strategy according to the server load condition: the overload adjustment module is located in the platform management layer of the cloud platform and is responsible for dynamically migrating resources according to the overload condition; The load balancing module is also equipped with a special API interface, which is responsible for interacting with other external modules. In addition, the heartbeat management module, alarm module and configuration management module are located at the platform management layer of the cloud platform and are respectively responsible for heartbeat management and log alarm amount configuration management.

3.2 Implementation of load balancing system

Since we need to regularly count the load of each virtual server, different services may be deployed on a virtual server, and a service may also be deployed on multiple servers, we need to deploy a load monitoring module in the middle of each server in the virtual resource layer to collect the load data of the server. In the same period of time, the load of different services is different. The load of the same service is also different due to different visits. The CPU and memory load can be counted, but the network load is not easy to obtain. We estimate the network load of the service on a virtual resource according to the proportion of the traffic of a single service in the total traffic of the resource. This method is based on the assumption that the load occupied by processing each request is equal, so it is not accurate and needs further research.

In the process of data processing, the load of a resource and the load occupation of a business on a virtual resource can be used directly, while another kind of data can be obtained only after statistical calculation. Therefore, the design of the database storing these data is very key. Table 3 is the database table we designed.

TABLE III. Design of database table of load monitoring module

Header	Data type	Describe
AppID	String	Unique business ID
Adress	String	Virtual resource address
Time	TimeStamp	Reporting time
cupHours	double	CPU usage
memoryInm	double	Memory usage
diskInG	double	Disk usage
DatabaseUsed	double	Database usage
Requests	Int	User access requests
O_Requests	Int	Outbound access requests

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In the above database table, the total load of the specified business can be obtained by statistical summation according to the unique business ID and reporting time. Because long-term data accumulation will cause the burden of the database, we set up a database maintenance thread to regularly check whether the data in the database is expired when starting the server, and clean it if it is expired.

The load collection module is represented by the loadcollect interface, and the createregistration() function implements the registration of the load collection module entity. Loadcollecthnpl is a specific implementation class of the loadcollect interface, in which settimer() function implements timer setting, collectdata() function collects the load of the specified server, and getpreappdata() is responsible for obtaining the load of a single business on the specified resources. The load control module is represented by the loadlistener interface, and the reportloaddata() function receives the data reported by the load collection module. Loadlistenerimpl is the specific implementation class of loadlistener interface. Processdata() function is used to count the data obtained by processing, and storagedata() function is used to store useful data into the database.

IV. CONCLUSION

The data center based on cloud computing in the same city is a development trend of the data center of power companies. In order to solve the problems of low resource utilization and unbalanced load in the data center. This paper proposes a virtual machine placement algorithm based on ant colony optimization algorithm and a load balancing algorithm based on virtual machine dynamic migration, designs and implements a load balancing system on cloud platform, and verifies the performance of the algorithm and system through experiments.

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