The Study of Key Technology for Dynamic Resource Management in the Cloud Computing Environments

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***Abstract* — Storage resource scheduling is lack of flexibility, and user' demand for different data is vary. In cloud computing storage resource scheduling process, these data files to be equally are irrational, so it needs a dynamic storage resource scheduling mechanism to distinguish requirements of different data. For the file hot issues that a surge request results in the copy number of the current file is difficult to meet the demand of Cloud computing, we presented a cloud storage resources dynamic scheduling mechanism based on Hadoop distributed file system and genetic algorithm. We used tree structure to encode and decode chromosomes, used the spanning tree algorithm to generate the initial population of virtual machines. We designed the corresponding fitness function evaluation program. And according to the changes in chromosome structure we designed selection operator, crossover operator and mutation operator. Experimental results show that the algorithm compared with traditional algorithms, convergence time is faster, while effectively reducing the number of virtual machine migration.**

Keywords - Dynamic Resource; Resource Management; Cloud Computing

I. Introduction

With the popularity of the Internet and the proliferation of Internet users, amount of data shows explosive growth. Internet gradually enters the era of big data. The traditional method of calculation completely is unable to meet the dynamic needs of today's changing. So cloud computing emerged as the third wave of reforms following the personal computer revolution, the Internet revolution [1].

Since the nineteen sixties, academia and industry to take advantage of computing and storage resources to achieve large-scale collaboration and sharing of resources, to achieve high efficiency and low cost is calculated as the goal, we have made a lot of similar cloud computing concepts and models, such as "grid computing", "on-demand computing," "platform as a service" and so on. The concept of cloud computing is generally considered the start in 2001. As people search engines for access to the explosive growth of the amount, the initial design of Google server framework can not meet demand [2, 3]. So Jeff Dean redesigned the new server architecture, where the hundreds of thousands of computers are connected together to form a supercomputing pool. So the concept of cloud computing is generated. However, the launch of Amazon Elastic Compute Cloud (ElasticCompute Cloud, ECZ) is cloud computing really implemented and achieved great success in business. Since cloud computing in the industry and the business community universally recognized as one of the most talked about IT technologies [4].

Rsource Management scheme in Cloud Computing environment is a method to plan, distribute and regulate system resource according to the demand of users and the various parameters of system. It is a core technology, which has great influence on system performance. However, there are some problems to be solved in this area especially based on Hadoop architecture [5]. The first problem is the storage resource lacking of flexibility. Because user's demands for different data are also different, so that some of the data files could become "hot spots". It is unreasonable to threat all the data files as the same. Cloud computing needs dynamic storage scheduling scheme, which differentiates demands for different data [6]. The second, metadata is a key issue in Cloud Storage. Most of the current metadata management mechanism is master-slave architecture with only one central node.

And some Multi-Name Node metadata management mechanisms have inadequacies in metadata division, persistence and fault recovery [7]. Third, as the specification of resource provided by Cloud Computing Service Provider is different from user's demand, there will be some fragment resource in system [8]. The system resource utility would be improved if we could take some scheme to organize and allocate those fragment resource. This paper has three innovation points according to the problems discussed above or the "hot spots" problem caused by the number of replica could not satisfy the soaring request from users, we present a Cloud Computing orate resource replica dynamic scheduling scheme based on HDFS [9]. There are two sub algorithms which is the number of replica dynamic adjustment algorithm and replica placement algorithm. This scheme could improve system stability and file access throughput. The experiment result shows this optimized scheme lower the access delay obviously than the original scheme with some cost of storage resource and network workload.

For the problem of metadata management, this paper introduced a distributed metadata management scheme. This scheme distributed metadata into several Name Node according to their ability, and provides an efficient inquiry algorithm for metadata to improve system availability and reliability. More than that, this scheme takes a replica scheme based on group and a load-balance strategy to ensure system fault tolerance and scalability. The experiment result shows the multi-Name Nodes system with this metadata management scheme could improve the performance than the original system facing the huge metadata operation requests.

II. Research Status of Cloud Computing

A. *Service type of Cloud Computing*

Cloud computing is not a new idea. It is an operating system developed CPU technology and the inevitable outcome. Wikipedia's definition of cloud computing is: a calculation based on the Internet, through this way, the hardware and software resources and information sharing may be provided to computers and other devices on demand [10].

According to the type of services provided in different, cloud computing services can be divided into three layers [11]: software as a service (SaaS), platform as a service (Platform as a Service, PaaS), Infrastructure as a Service (Infrastructure as aService, Iaas), shown in Figure 1.

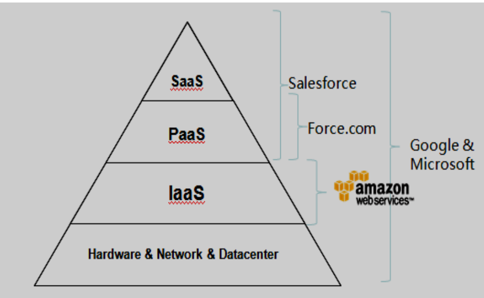

Fig. 1. Service type of Cloud Computing

IaaS refers to the underlying physical network connections and servers and other equipment as infrastructure, to provide resource lease and management services. In general, the use of virtualization technology to an organization's existing system CPU, memory and storage space and other IT resources. Computing and storage can be customized to do, easy to expand and robustness. laaS by abstraction of the underlying physical devices, information processing, storage and network resources to the user. Users can rent these resources to the Department related to operating systems and applications software. Users do not need to manage these physical resources - the work done by the system administrator - only need to control the operating system, storage, and application software deployment, but also possible to control the limited network components, such as firewalls and so on.

PaaS refers to a system software platform. Provide custom software on a cloud infrastructure deployment to users. The platform allows users to use several types of platforms supported programming language for software development, and provide the appropriate library services and tools supported by the service provider. Users do not need to manage or control, including network, servers, operating systems, and storage underlying cloud infrastructure, you may only need to control the application software deployment and support of environmental parameters may configure the application software. PaaS usually built on laaS, objects are often faced with application developers, rather than ordinary software users. PaaS provides a shield underlying platform infrastructure, so that developers do not need to worry about system deployment. Meanwhile, some PaaS also provides packaged SDK and runtime, even some sound common services for developers to use.

SaaS is a pointer to the user the ability to use cloud infrastructure runs on certain applications. Users can carry on a variety of client devices thin client interface (such as a web browser, etc.) or the program interface to access these applications. Users do not need to manage or control the underlying network, servers, operating systems, storage and other implementation details, you may only need to configure

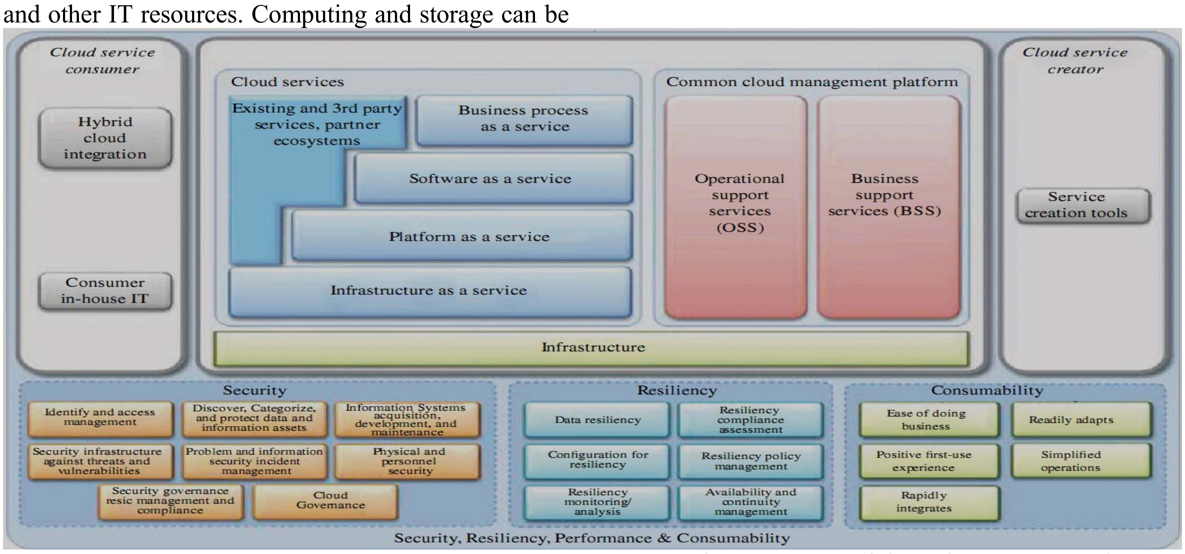

Fig. 2. Level Architecture of Cloud Computing

certain parameters of the software. SaaS refers to a more commercial model. SaaS operators to provide users with a number of built laaS the basis of applications. So that users do not need to buy software, without the need for software maintenance, as long as demand can be rented.

B. Brief introduction to System Architecture of Cloud Computing

System architecture is the foundation build a cloud environment [12], but also the prerequisite for good dynamic resource scheduling. Because cloud services are divided into three types, so there is no unified technical architecture. But large-scale distributed environment is mainly used in multi-level distributed architecture, shown in Figure 2.

Among them, the basic resource layers of the same type of resources that make up a large number of homogeneous or nearly homogeneous pool of resources, such as computing resource pool, resource pool data. Responsible for resource management middleware cloud computing management, task scheduling and numerous applications, so that resources can be efficiently and safely for the application to provide services. Build SOA layer cloud computing packaged into a standard Web Services service, and incorporated into the system for the management and use of SOA, including service registration, find, access and building services work flow, etc.

C. Typical cloud computing platform

With cloud computing technology matures, some of the more important and useful open source cloud computing framework gradually emerging in people's field of vision, such as Hadoop, Google cloud storage platform.

Google platform

Core Google cloud storage platform is Google File System (GFS). Its architecture is shown in Figure 1.3:

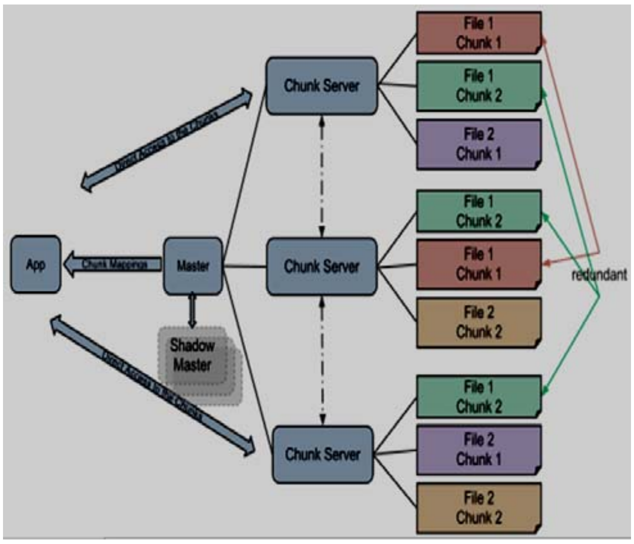

Fig. 3. Google File System

A GFS cluster consists of a server and a plurality Chunkserver Master server. Master main file system maintaining all metadata (metadata), including: namespace, access control information, the current location of the file to the block mapping, and blocks. It also controls the system-wide activities, such as block migration between Chunkserver.Chunkserver the file as a storage object. Each hunkserver can store multiple file blocks.

Although conventional GFS distributed file system is very similar. But for Google applications, GFS had made great progress in the effort and technical environment, mainly reflecting the earlier file systems have significantly different envisaged.

Hadoop platform

A large number of open-source software, Hadoop platform is the most famous. Its file storage system HDFS (Hadoop Distributed File System), the basic ideas are derived from the GFS. Its structure is shown in Figure 4. Hadoop framework allows users to use a simple parallel programming language for distributed processing of huge amounts of data in large-scale cluster system. Users may not understand the underlying details in the case of data manipulation. HDFS main features:

1) HDFS deployed on inexpensive hardware device that a hardware error is normal, that is, when some node fails, the entire system cannot stop working;

2) HDFS system data size is very large. Whether it is few GB file size or a few TB size, it can provide good support. Of course HDFS is more inclined to support large files;

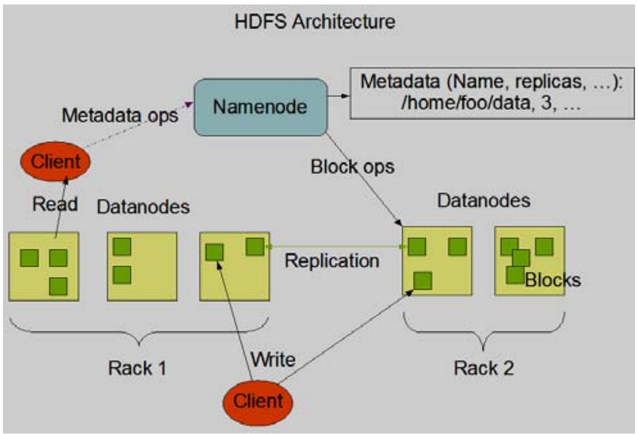

Fig.4. HDFC Architecture

3) HDFS use write-once read-many file access mode, which can not be changed once written, can only append;

4) HDFS has strong fault tolerance. HDFS file split in the form of block storage, and use full backup policy (the backup number> = 3). In the event of data corruption, can timely use of backup data to recovery;

5) HDFS has strong scalability, allowing dynamic addition and withdrawal of nodes, and is transparent to the user;

6) HDFS open source code at no cost, which will help the developers to discuss global research.

III. VIRTUAL MACHINE LOAD

As technology advances and hardware support, data center gradual transition to a virtual data center. You can run multiple virtual machines on one physical machine. Each virtual machine runs an application or a component application, virtual machine granularity share physical machine resources. And each application runs in its own independent operating system environment, the mutual interference and small. Cloud Data Center provides fine-grained resource allocation mechanism dynamic virtualization technology. And the more fine-grained resource allocation, the more close to the optimal allocation.

Virtual machine deployment / migration an issue is an important study based point cloud network dynamic resource management technologies. Both academia and industry to optimize virtual machine deployment / migration technology study based on a large number. Virtual Machine Deployment / Migration first face is based on resource requirements and physical capacity of the virtual machine, the virtual machines deployed on the physical machine. With the change of the applied load may occur virtual machine resource demand and capacity exceeds certain physical phenomena, requires the use of virtual machine migration mechanism design virtual machine migration strategy. The method of virtual machine deployment / migration strategy used may be summarized as two types of heuristic algorithms and optimization theory.

In a cloud environment, each physical host has more than one virtual machine server. We define a set of hosts

$$H=\{H_1,H_2,...,H_n\} \tag{1}$$

Of which, n represents the number of hosts, and H_i represents the host i. Set of its virtual machine is:

$$V_i=\{V_i^1,V_i^2,...,V_i^{m_i}\} \tag{2}$$

Of which, m_i represents the number of the virtual machine's on host i. Make $m=m_1+m_2+...+m_n$ represents the number of the virtual machine

$$D=\{D_1,D_2,...,D_n\} \tag{3}$$

It represents the virtual machine set which does not meet the rated load and is still can be deployed.

We will expressed load of physical hosts as the sum of running virtual machines. If the available resources of the host is d-dimensional (one-dimensional that is a resource) vector, then each virtual machine vector dimension is d, and the load is the sum of the load of each dimension. Suppose the virtual machine load in a unit time t is relatively stable. So that the virtual machine within the time period t i load is $D(i,t)$, then the server load period t is:

$$D=\{D(1,t),\ D(2,t),...,D(m,t)\} \tag{4}$$

The virtual machine D_i 's load:

$$D_i=\sum D(i,t) \tag{5}$$

The host load:

$$H(i,t)=\sum_{i=1}^{m_i} D_i \tag{6}$$

Because the cloud is heterogeneous, ie CPU, memory and bandwidth differences are very large, so the current approach is to use a broader use of resources as a measure of the load. In this paper, the main considerations in the server are CPU, memory and bandwidth of these three resources. So each virtual machine CPU utilization is ρ, the host CPU load indicators is :

$$H_c=\frac{\sum_{i=1}^{m}\rho}{C_t} \tag{7}$$

Host memory load indicators are:

$$H_r=\frac{\sum_{i=1}^{m}D_{ri}}{RAM} \tag{8}$$

Of which, D_{ri} is memory consumption of the i-th virtual machine, The total amount of RAM for the host memory. Bandwidth load index for the the host:

$$H_W=\frac{\sum_{i=1}^{m}D_{wi}}{W_t} \tag{9}$$

W_t is total system bandwidth, D_{wi} is the virtual machine i occupied bandwidth.

IV. EXPERIMENTS AND RESULTS ANALYSIS

A. *Load balancing test*

Measuring the load balancing algorithm has two important evaluation indicators: throughput and average response time. Comparative test algorithm chosen are in CloudSim Weighted Round Robin (Weighted Round Robin, WRR) and currently the most popular method of weighted least connections (Weighted Least Connections, WLC). The algorithm expressed herein PPLB-UF.

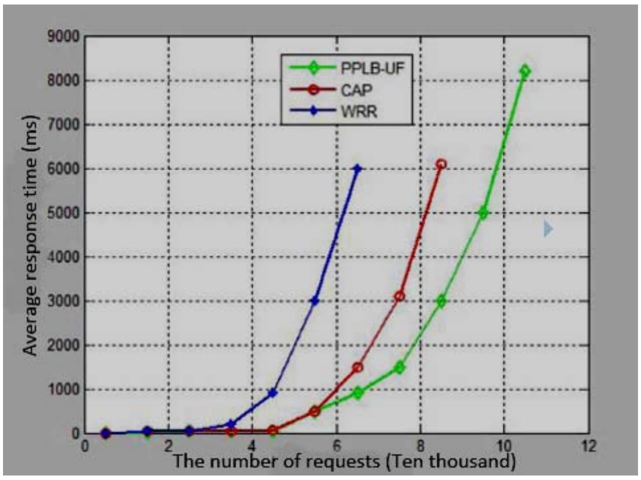

Fig. 5. The comparison of average response time of the cluster

Figure 5 shows the average response time of the algorithm. For all methods, the initial response time curve is relatively flat first, then began to increase. At the same time a client requests a certain number, the slope of the curve began to significantly increase, is a server bottleneck value.

Throughput typically shows an inverted U-shaped, as shown in Figure 35 is displayed. As early increase in the number of requests, a corresponding increase in throughput. Once the CPU in the queue exceeds a certain value, throughput begins to decline. U-shaped peak is the bottleneck CPU resources. In contrast, based on throughput PPLB-UF system is clearly higher than the other two systems.

As can be seen from the test results, this algorithm in terms of average throughput and average response times are better than the other two comparison algorithms to achieve a better load balancing effect, can effectively improve the overall performance of the cluster.

B. Algorithm Comparative Experiment

In this study, we assumed that the number of tasks from 50-100, the computing resources of nodes is eight. In order to distinguish between the various algorithms here, we specially set up property relatively large gap between the quality of service of resource nodes. Selected indicators include cpu, memory, network bandwidth. According to the ant colony algorithm and particle swarm optimization algorithm fusion algorithm and its processes, do test simulation, perform 10 times and calculate the average.

For comparison fusion algorithm, where the ant colony algorithm and particle swarm optimization comparative tests were carried out, were executed 10 times. Three parameters except for a few different algorithms, the other take the same values, the specific parameter is set to:

Particle swarm optimization, set the particle size is 50; the number of iterations set the particle population was 100.

In ACO and PSO algorithm, part of ant colony algorithm parameters $\partial = 0.5$, $\beta = 0.5$, $\rho = 0.9$ and 20 iteration is 20.

Some parameters of ant colony algorithm and ant colony and particle swarm optimization algorithm same set of iterations is 50.

The simulation task execution time spent is contrast Figure 6.

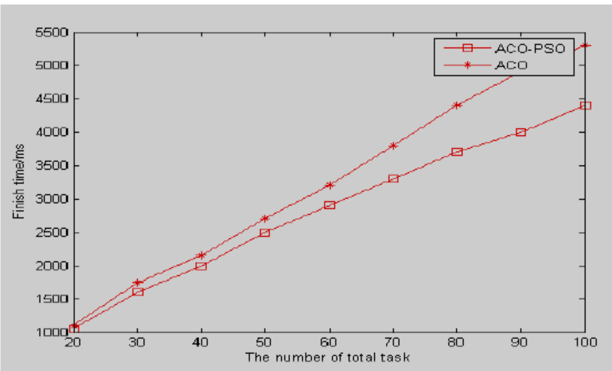

Fig. 6. Completion Time Comparison Chart between ACO-PSO and ACO

From Figure 6 and 7, we can get to the conclusion that: With the increasing amount of tasks, ant colony and particle swarm optimization algorithm execution time spent on assignments less compared to the single algorithm. Thus proving that: within a certain range, amount to a certain number of tasks, ant colony and particle swarm optimization with a single algorithm (ant colony or particle swarm optimization algorithm) allocation of resources and the time gap between the cost of executing the task will becomes large.

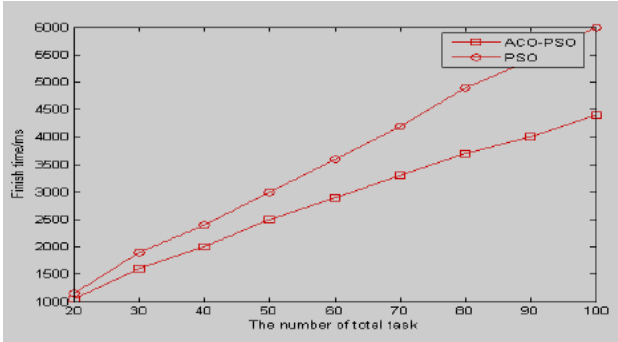

Fig. 7. Completion Time Comparison Chart between ACO-PSO and PSO

Ant colony and particle swarm optimization in the cloud resource scheduling correct. The relative standard deviation algorithm reflects the degree of load balancing algorithms. Deviation value is smaller, the better load balancing algorithm. Here we compare the ant colony algorithm, ant colony and particle swarm optimization and ant colony algorithm difference in terms of load balancing.

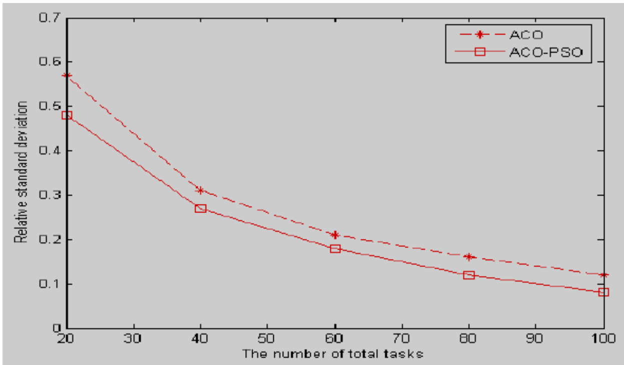

Fig. 8. The relative standard deviation of resource nodes task allocation results

From Figure 8, we can see that the ant colony and particle swarm optimization algorithm standard deviation compared to a single colony algorithm to be smaller. And with the number of tasks increases, the offset value is smaller. The above analysis shows, the load balancing of the algorithm is relatively good, suitable for application in the cloud.

V. CONCLUSION

Storage resource scheduling is lack of flexibility, and user' demand for different data is vary. In cloud computing storage resource scheduling process, these data files to be equally are irrational, so it needs a dynamic storage resource scheduling mechanism to distinguish requirements of different data. for the file hot issues that a surge request results in the copy number of the current file is difficult to meet the demand, Cloud computing we presented a cloud storage resources dynamic scheduling mechanism based on hadoop distributed file system and genetic algorithm. We used tree structure to encode and decode chromosomes, used the spanning tree algorithm to generate the initial population of virtual machines. We designed the corresponding fitness function evaluation program. And according to the changes in chromosome structure we designed selection operator, crossover operator and mutation operator. Experimental results show that the algorithm compared with traditional algorithms, convergence time is faster, while effectively reducing the number of virtual machine migration.

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