An Energy Efficiency Optimization Method Based on Decoupling in Cloud Computing

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Abstract. The cloud resource is becoming a key infrastructure carrying the various types of applications, and providing basic support for emerging areas such as artificial intelligence, big data, and internet of things. It is an important driving force for the development of science and technology. Cloud computing has laid the development direction and foundation for future computing. Because cloud is composed of large-scale distributed resources, resource allocation and optimization of computing efficiency in cloud computing is a very important task. In order to adapt to the complex use environment of multi-load parallel in cloud computing, this paper proposes a decoupling method in virtualization environment, which can optimize the energy allocation strategy of distributed systems and effectively improve the efficiency of cloud resources.

1. Introduction
Cloud computing is a new computing model developed following distributed computing, parallel computing and grid computing. It not only has the advantages of distributed and parallel computing, but also has the advantages of easy maintenance, load balancing and resource sharing. Based on these characteristics, cloud computing technology is becoming more and more important, and provides support for large data and artificial intelligence technology. Cloud computing products have also been commercialized, and play an important role in education, health care, intelligent manufacturing and smart cities. Because virtualization technology shields the connection between application layer and hardware, if we want to better develop cloud computing technology, we need to analyze the underlying technology of virtualization. Generally speaking, the system architecture of cloud computing can be divided into four layers: infrastructure layer, platform layer, service layer and application layer. Virtualization environment exists in platform layer, which can also be called resource layer, including computing, storage, network and other infrastructure environment. However, with the development of this technology, the energy consumption of cloud resources has gradually attracted attention. For example, Fig. 1 shows the energy consumption of cloud computing in a country and the energy efficiency of cloud computing. This paper will propose a solution to this problem.
2. **Virtualization in cloud computing**

The core principle of virtualization is to provide abstract underlying resources in a transparent way. As the function of computer system becomes more and more powerful, its management becomes more and more difficult, and users are more concerned about how to get more functions through interfaces and services. Virtualization technology can flexibly organize various computing resources, unbind and restrain the upper and lower resources, and improve the efficiency of resource utilization. Using this technology can effectively integrate servers, storage, network and other infrastructure. These physical infrastructures abstract through the underlying virtualization technology to form a pool of unified management resources, and provide a dynamic, scalable and flexible infrastructure platform for the upper application through funny management and scheduling, so as to meet the needs of cloud computing to expand, deploy on demand and use on demand. However, different virtualization technologies have their own advantages and disadvantages. For example, some virtualization technologies consume less extra CPU performance in their virtual management, but the performance loss of memory is relatively large. If CPU-intensive applications are running, they can migrate to virtualization platform very well. On the contrary, I/O-intensive applications will cause big problems. Therefore, how to optimize the virtualization advantages, dynamically share and flexibly configure various resources according to the application requirements, so that the computing system has the ability to build on demand, are the problems that need to be studied in depth in cloud computing.

3. **The development of decoupling in virtualization**

With regard to the social value and significance of cloud computing, we often use a sentence to express the goal of cloud computing: "Let people use cloud computing like electricity in the future". Here, people regard cloud computing as an indispensable basic resource in the daily production and life of human society. From the evolution of technology structure, cloud computing is absolutely an important change since the emergence of computer architecture. For a long time since the birth of computers, mainframes and minimal machine with highly centralized computing and multi-user and multi-task support have been the mainstream form of computer use. Thus, in the 1980s, the birth of personal micro-computer system marked the transition from a fully enclosed hardware and software environment to a multi-level hierarchical architecture. The standardization of interface between layers greatly simplified the technical complexity of each layer. However, when the hierarchical structure develops to a certain stage, the drawbacks gradually emerge. Because of too many system layers, the difficulty of integration between layers becomes more and more serious, which makes the integrated management configuration and on-demand supply of servers, storage and network resources in infrastructure layer become the constraints affecting the rapid response of computer systems to demand. At the same time, although the
development of hardware and software layers achieves decoupling, the deployment and operation state are still the relationship of hardware and software coupling binding. Therefore, when resources across servers are unevenly busy, it is still unable to effectively utilize computing resources. Therefore, the flexibility of computing, storage and network hardware supply and the insufficiency of their coordination are becoming more and more restrictive factors for the improvement of computing power. So, is there any way to effectively solve the above problems without major changes in the current hardware and software structure? The answer is yes. This is virtualization decoupling technology. For example, Figure 2 illustrates the principle of decoupling. Through virtualization and cloud scheduling management technology, computing, storage and network devices from different regions are integrated into a "super cloud computing machine" to provide flexible resources for the upper software. In this way, the decoupling between hardware and software deployment process and running state can be realized, the differences and complexity of hardware and software can be shielded, and the rational allocation of computing resources can be realized.

4. The application of tuple space in decoupling

Therefore, decoupling is a key technology for virtualization in cloud computing. In virtualized resource management, how to decouple resources and separate hardware devices, software applications and computational data, break the boundaries of hardware, software and data distribution, achieve centralized resource management, and enable applications to use resources dynamically. The tuple space(s) model provides a possibility for us.

A tuple space is an implementation of the associative memory paradigm for parallel/distributed computing and providing a coherent-addressable shared memory abstraction. The tuple space provides a logically shared address space and enables data sharing. It also enables distributed programming and is decoupled in space and time. Moreover, tuple space is a popular coordination model for concurrent, distributed and mobile computing paradigms. Its popularity is due to its ability to provide multidimensional decoupling in the coordination process of interaction parties. In order to use the tuple space model as decoupling medium, we can locate the tuple space model in multiple locations according to the nature of the computing paradigm. These interactive data are converted into tuples and stored in the tuple space. Users can extract these data from tuples to find these tuples in the tuple space. So the tuple space(s) have been used as decoupling media. For example, Fig 3 is a diagram of tuple space in a cloud computing environment.
Tuple space will be organically combined with cloud services to form a new architecture. In this architecture, cloud resources can be accessed in various ways. In such a cloud computing architecture, both static and dynamic environments are included. Because cloud computing is essentially decentralized and distributed, multiple tuple spaces can be distributed as decoupling media in the cloud computing virtualization environment. These tuple spaces are tailored to carry out the decoupling functionalities efficiently. The advantage of this cloud computing system structure is that in the process of using resources, the uncertainty is obviously alleviated, the system resources are fully utilized, giving full play to the advantages of resource decoupling of tuple space, and facilitating the realization and expansion.

5. Analysis of Energy Efficiency Optimization Effect
The purpose of decoupling in cloud computing is to balance system power consumption, data throughput and system response time. If we want to verify whether the above methods can improve the energy efficiency of cloud resources, we need to observe the power consumption of the system under certain conditions of data throughput and system response time. Assume that the number of computing center sites in the current cloud computing environment is N. At time t, the system energy consumption of the first computing center is \( p_i(t) \) (0 ≤ i ≤ N), and the resource utilization frequency is \( f_i(t) \) (0 ≤ i ≤ N). In this way, the calculation formula of system power consumption in a specific time T is as follows:

\[
E(t) = \sum_{i=0}^{N} \int_0^T f_i(t)p_i(t)\,dt
\]  

It can be seen from (1) that the power consumption and power of the system are related to the frequency of use. In order to evaluate the effect of this decoupling method on energy efficiency as much as possible, virtual simulation experiments were carried out with the parallel number of 0 to 400 according to the formula. The results are shown in Fig. 4.

![Figure 4. The power consumption of the system compared with two cases](image)

6. Conclusion
Overall, the results show that this decoupling method can effectively improve the efficiency of system resources in cloud computing virtualization environment. Especially, it has played an active role in solving the problem of huge energy consumption of Internet terminal applications. It provides a new way of thinking for solving such problems and has a certain application prospect.
References

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