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## Construction Research of University Data Centre of Cloud Computing Based on Virtualization Technology

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# Construction Research of University Data Centre of Cloud Computing Based on Virtualization Technology

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**Abstract:** University cloud computing data centre based on virtualization technology can integrate and distribute resources in computing, storage, network, security and other aspects on demand to improve the utilization ratio of resources. This paper analyses the drawbacks of traditional university data centre, gives the design scheme of university cloud computing data centre based on virtualization technology, and draws the architecture diagram of data centre after virtualization. The paper provides the key points of university cloud computing data centre implementation based on virtualization technology. Under high concurrency pressure, we compared the average CPU utilization and TTFB before and after virtualization. The results show that after virtualization, the performance of university data centre has been improved significantly.

## 1. Flaws of traditional university data centre

The traditional university data centre is generally the central computer room. In the early stage of construction, the main purpose is to ensure the stability and security of the system, which adopts the mode of running a system application on a server. With the popularization of automated office, the system application of various departments will also be popularized. This has led to a sudden increase in the number of servers, resulting in the number of cabinets insufficient, power supply insufficient, heat dissipation equipment processing capacity insufficient, machine room area insufficient and other related supporting facilities caused by the problem. The actual usage rate of each system application is not very high, or it is only intermittent peak in time. For example, in the course selection system, the annual course selection time is at the end of each semester. At the same time, the system can reach thousands of people instantaneously. This will lead to the server crash or even collapse after the time of course selection, the server is open every day, but nobody uses it. On the one hand, it wastes energy, on the other hand, it also damages the server's own hardware. For universities, it is composed of teachers, students and some facilities and places for teaching and living. However, for many data are their own set of statistical methods. This makes it difficult to share data. University does not have a unified platform, and servers do the same work, a function to be divided into several servers to do, which wastes resources and energy. These servers do not have a unified management software, and they will not find problems in real time. When they are used, they will go to the central computer room to check and debug manually. This requires a high level of professionalism of data centre personnel. Even if the problem is solved, it will take a long time. Traditional data centres are often characterized by redundancy in configuration, low utilization, inconsistent management and difficulty in adapting to new changes. The author proposes a solution to build university data centre based on virtualization technology, which overcomes the shortcomings of traditional data centre and provides a good foundation for the future development of university information.



## **2. Data centre of cloud computing and virtualization technology**

### *2.1. Data centre of cloud computing*

Cloud computing is a pay-per-use mode, which provides available, convenient and on-demand network access quickly through configurable computing resource sharing pools, requiring little management effort or little interaction with service providers. Virtualization is the underlying basic technology of cloud computing. It will virtualize the environment of user's needs on the hardware resources of the entity. Through virtualization technology, we can achieve the optimization of resource allocation. Cloud computing is composed of hundreds and thousands of computers. When a user's computer fails, it can be replaced by other computers. Cloud computing is composed of many servers in different places, so it can share the traffic situation that a single computer cannot bear. We can also add hardware facilities and expand the capacity of computing storage whenever necessary. When users need it, they can request it from the cloud, release it without need, and do not need to buy and maintain hard devices by themselves, so they do not need to spend a lot of money. The new generation of university data centre gathers computer resources, network resources and storage resources into a resource pool by virtualization technology through cloud computing software, deploys virtual machines according to teaching needs, and provides all-weather and uninterrupted application services for teachers and students. There is no need to equip a new server for every new application system, which greatly shortens the deployment time of the system, improves the utilization rate of resources, and saves the purchase cost and the power consumption cost of data centre. We realize the establishment of a new generation of data centre for data sharing. By further optimizing and integrating all kinds of application platforms, we can share data in each application system and reduce data redundancy. Distributed resource scheduling and security control in data centre can improve system performance, ensure system reliability and improve data security.

### *2.2. Virtualization technology*

As the core technology of cloud computing, virtualization builds a virtual computing environment on the basis of open network infrastructure. Virtualization technology is essentially a resource management technology. By introducing virtual machine monitor and other mid-tier software, the entity resources such as computing, network and storage are abstracted and transformed, and the heterogeneity, distribution and dynamics of hardware platform are shielded, providing users with independent, isolated and secure computing or running environment on demand. Virtualization technology breaks the geographical and physical constraints of resources, supports efficient reuse and transparent sharing of resources, and achieves ubiquitous access and centralized management of hardware and software resources. As the core technology of virtualization, VMM (Virtual Machine Monitor) is used to shield the details of the underlying hardware and provide a virtual environment or interface for the upper system or application. VM (Virtual Machine) can be divided into hardware abstraction layer virtual machine, operating system layer virtual machine application programming interface layer virtual machine and programming language layer virtual machine according to the location of its middle layer. In order to build a private cloud based on IaaS and realize cloud computing virtualization, a hardware abstraction layer virtual machine with intermediate software approaching the bottom layer is adopted. The overall performance and operation efficiency of the virtual machine are high, and the isolation and transparency of the software are good. In order to realize hardware abstraction layer virtual machine, VMM captures the instructions of client operating system to access system resources, simulates instructions and redistributes system resources, maps virtual resources to physical resources, and realizes isolation and protection of operating environment of client operating system.

## **3. Solution design of university data centre of cloud computing based on virtualization technology**

The data centre uses virtualization technology in cloud computing management platform to load a series of hardware such as network and storage into the resource pool, providing basic architecture resources to all teachers and students. The system architecture after virtualization is shown in Figure 1.

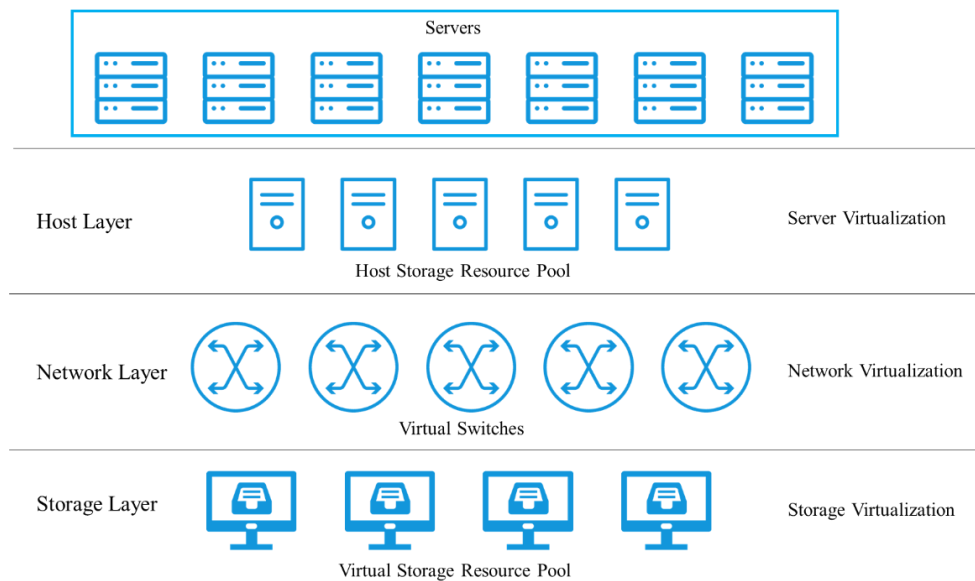


Figure 1. Architecture diagram of data centre after virtualization

### 3.1. Server virtualization

Server virtualization is mainly based on the existing hardware, adding new devices appropriately, and using H3C CAS cloud computing management software to integrate and redistribute server resources. We use virtualization technology to load x86 servers with the same configuration and better system performance into the host pool. As required, a designated server virtualization host pool HNSW-IT-POOL01 is established at the beginning, and then the business servers in the same network layer are loaded into the same host pool. A shared file system is built in the host pool, and the work of mobile and dynamic resource scheduling is accomplished by using network storage as a specific mapping. At the same time, in order to obtain better system performance and higher availability, the host cannot be directly loaded into the host pool. We build several clusters in the host pool, and then turn on the cluster's high availability and dynamic resource scheduling functions. Host planning mainly includes the planning of host name and password. According to the unified requirements of the school, host name includes uppercase and lowercase letters, numbers and connectors. It cannot contain underscores or begin with numbers. To enhance security, root user passwords require at least eight bits in length, including at least three characters: uppercase and lowercase letters, numbers and special characters.

Table 1. Plan of host names and user passwords

Server name	Host name	root user password	Remark
Management server	HNSW-SRV-ADMIN	Compliance with safety	Already existing
Business server 1	HNSW-SRV-CVK 01	Compliance with safety	Newly purchased
Business server 2	HNSW-SRV-CVK 02	Compliance with safety	Newly purchased
Business server 3	HNSW-SRV-CVK 03	Compliance with safety	Newly purchased
Business server 4	HNSW-SRV-CVK 04	Compliance with safety	Plan to purchase

### 3.2. Network virtualization

We adopt network virtualization technology to prepare a well-functioning network encapsulated in software container for users. The underlying hardware or network topology has no direct impact on its deployment and matching. The exchange and transformation of information between VM and external

network and VM itself are mainly carried out on the switch inside the virtual machine. According to different purposes, network types can be divided into management, business and storage. Different types of networks also bear different data streams - management, storage and business. Cloud computing data centre needs flexible, flexible and efficient information exchange environment. Through network virtualization, users are provided with a fully functional network encapsulated in software containers, whose deployment is independent of the underlying hardware or network topology. The network planning of cloud computing management platform mainly includes the planning of management address, business address and storage address. In order to separate all kinds of data traffic, increase security and improve performance, it is necessary to create three virtual switches, which carry management data flow, storage data flow and business data flow respectively. In order to improve the reliability of the system, creating a cluster will add multiple hosts to the cluster, and keep the virtual switch names of all hosts in the cluster consistent, otherwise there will be problems in business migration. In order to increase link redundancy and improve performance, it is required to allocate two storage network cards and two service network cards to the host, bind two storage network cards to the vswitch-storage virtual switch, bind two service network cards to the vswitch-app virtual switch, and do port static or dynamic port aggregation for the service dual network cards and storage dual network cards.

### *3.3. Storage virtualization*

The cornerstone of cloud computing data centre implementation is storage virtualization. Storage virtualization is a technology that simplifies complex underlying infrastructure. By mapping physical storage devices and user-oriented logical storage devices through the middle layer, users need not worry about how to implement storage hardware, and through centralized management, it is convenient to add storage resources of various hardware platforms to the storage pool and realize dynamic expansion. Storage virtualization integrates one or more target services or functions with other additional functions to shield the complexity of the system and provide unified storage resources or services. Virtual storage space, like water in a flowing pool, can be allocated arbitrarily according to need. Comprehensive comparison schools adopt SAN storage devices. H3CCAS system supports IPSAN and FCSAN storage devices. From the performance point of view, FCSAN has good performance. It can provide 4 GB or 8 GB storage network bandwidth for servers, but the price is high and the cost of IPSAN is low. It can provide high performance-cost block-based storage, easy deployment, scalable and mature hardware and software implementation solutions. Based on this, schools use IPSAN storage. Previously, as a test, the server that was eliminated from the data centre was selected through open source Open Filer. Software builds storage server, provides iSCSI-based shared storage resources to H3C CAS host pool, and provides data storage for virtual machines. In order to improve the availability of H3C CAS system, RAID5 or RAID6 are needed for storage devices. H3C CAS system supports 16T shared file system, and can plan 16T disk volume when planning storage devices.

## **4. Implementation points of university data centre of cloud computing based on virtualization technology**

Cloud computing data centre must ensure the stability and reliability of system application and solve the problem of service interruption caused by single physical server downtime. H3C CAS solves these problems by enabling cluster High Availability (HA) functionality. In order to achieve high availability, CVM (Cloud Virtual Machine) joins several hosts into a cluster with shared resource pool, and continuously monitors the operation of all hosts and virtual machines in the cluster by opening HA function. Once a host or virtual machine fails, CVM responds immediately and activates the affected virtual machine on other available hosts in the cluster according to the scheduling strategy, thus minimizing the time of server failure and service interruption caused by hardware system failures. The server host CPU uses the same vendor. The best migration compatibility can be achieved by using a cluster composed of server hosts of the same CPU manufacturer, the same product family and the same generation of processors; in the cluster, all virtual machine image files are stored in shared storage to ensure the smooth migration of virtual machines between nodes in the cluster; after the virtual machine

uses the physical CD-ROM on the host, it cancels the virtual machine. The connection with the physical CD-ROM on the host in order to avoid the failure of the virtual machine migration because the destination host has no physical CD-ROM. The configuration of virtual switches on each business host in the cluster is consistent and the configuration of shared storage on each business host is consistent.

Automatic migration is a key technology to achieve optimal scheduling of server resources. Automatic migration can be realized by dynamic resource scheduling. A running virtual machine can be transferred from one physical machine to another in real time. The mapping of virtual machine to business host can be dynamically optimized in real time within the same cluster, which greatly improves the utilization and flexibility of physical servers. Automatic migration is often used for planned downtime or server overload enablement. Dynamic resource scheduling of H3C CAS provides an automatic migration mechanism. Through continuous monitoring system, virtual machines are migrated online to hosts with more available resources to ensure that each virtual machine can call corresponding resources in time at any node. By fully automated resource allocation and load balancing functions, the cost and operation cost of data centre can be significantly reduced. The implementation of H3C CAS dynamic resource scheduling is to monitor the CPU and memory utilization of hosts in cluster in real time through heartbeat mechanism, and judge whether online migration is necessary according to user-defined rules. The virtual machine running on the host with resource bottleneck will be migrated to another host with more suitable resources if the utilization rate of the host resource is still higher than that of the other host. When a threshold is specified, the other virtual machines on the host are migrated one by one until the resource utilization of the host is below the threshold.

## 5. Performance testing and results analysis

### 5.1. Performance testing

Now, we introduce the background of system performance testing. According to the university teaching arrangement, at the beginning of each semester, students will choose their own courses through the educational administration management system. For course selection, as the students want to choose a good course at the first time, before virtualization of servers by deploying cloud computing management platform, the server carrying educational administration management system will have a high utilization rate of resources in a short time, and students will fail in course selection or even be unable to log in. To solve this problem, the Educational Administration Management System is migrated to the cloud computing management platform, deployed to a virtual server located in the host pool and enabled cluster. This performance test environment uses B/S architecture, and tests the educational administration management system before and after the cloud computing virtualization platform. In order to simulate the simultaneous access of a large number of students to the educational administration management system, the Web Application Stress Tool is run on a test client computer with Windows 7 operating system. The simultaneous access of a large number of users is simulated by setting different high concurrent connection numbers. The test period is 10 minutes each time, in order to send out enough access requests and avoid generating them. Distortion test results. Referring to the average utilization of CPU and the value of Time To First Byte (TTFB), this paper compares the performance of educational administration management system before and after virtualization using cloud computing management platform software. TTFB refers to the time taken by the test end to receive the first packet of the real server to respond to the request.

### 5.2. Results analysis

The average utilization of CPU under different concurrent accesses is shown in Table 2 and Figure 2.

Table 2. Comparison of average utilization rate of CPU

Concurrency	100	200	500	1000	2000	5000	6000
Average utilization rate of CPU before virtualization	23	27	33	68	81	100	100

Average utilization rate of CPU after virtualization	25	29	32	41	51	64	69
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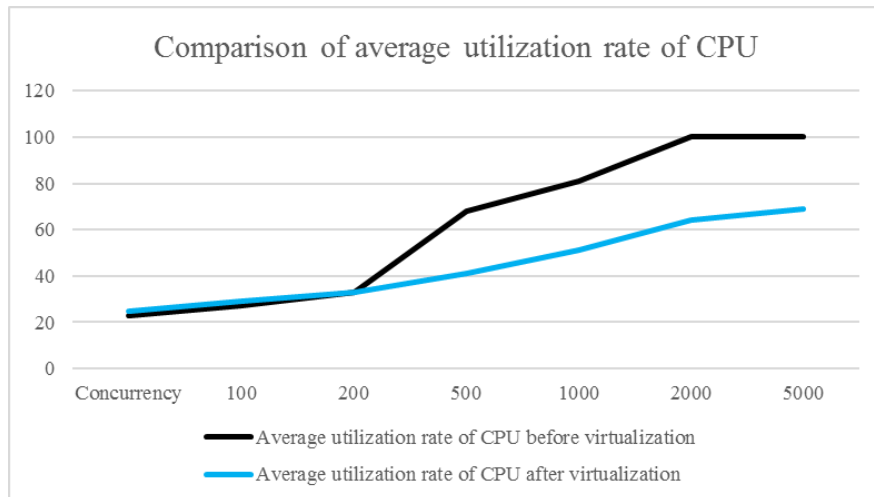


Figure 2. Comparison of average utilization rate of CPU before and after virtualization  
TTFB in different concurrent access cases are shown in Table 3 and Figure 3.

Table 3. Comparison of TTFB

Concurrency	100	200	500	1000	2000	5000	6000
TTFB before virtualization (ms)	16.14	16.25	17.51	22.61	44.97	194.22	No response
TTFB after virtualization (ms)	16.23	16.31	17.35	19.46	30.17	66.38	79.51

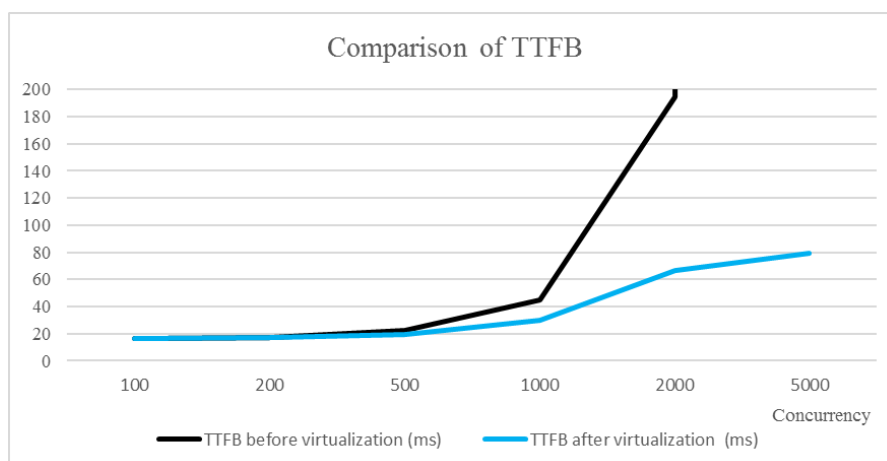


Figure 3. Comparison of TTFB before and after virtualization

Before virtualization, the CPU usage rate of educational administration system reached 100% under the condition of more than 5000 concurrent visits, and the phenomenon of discontinuation of service appeared. After virtualization, the CPU utilization of educational administration management system has been within the acceptable range, and there is no denial of service phenomenon under high concurrent access. It shows that the system performance has been greatly improved compared with before virtualization.

## 6. Conclusions

The wide application of university cloud computing data centre based on virtualization technology can effectively improve the university informatization. The data centre of traditional university has the shortcomings of low utilization rate of equipment, inability to share resources and heavy maintenance workload. The scheme design of cloud computing data centre based on virtualization technology mainly includes the virtualizations of server, network and storage. The system performance test shows that under high concurrency pressure, the average CPU utilization and TFFB value after virtualization are much lower than those before virtualization. Virtualization technology enables university data centres to achieve effective management and flexible allocation.

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