Design and Key Techniques in Education Cloud Platforms for Teaching

LIU Chaofeng

Henan Institute of Science and Technology
Henan Xinxiang, 453003,China
liuchaofeng2008@163.com

Abstract — Since existing open source software functions cannot meet the design demands of education platform completely, part of the key technologies needs to be developed independently. In this paper, we focus on the overall design of educational cloud platforms, automatic monitoring technology of virtual machines, safety strategy for big data and remote desktop terminal technology. Our research deals with the demand for high education cloud computing platforms, with personalized needs. The new system adopts double layer virtual network architecture: the bottom is support layer, which establishes virtual machine carrier by real hardware device cluster. The top layer is the business layer composed of virtual machine cluster. The support layer only provides hardware resource support for the top layer and it does not offer external service. All work to complete various kinds of tasks are undertaken by the business layer. Then based on this architecture we study and design distributed storage, big data parallel computing and statistical analysis, etc. The test show that this technology and related theories have practical operability. It is based on open source software and can meet the demand of different regions and different levels for educational cloud.

Keywords - cloud computing; education; remote access; character; monitoring system

I. INTRODUCTION

In recent years, our country constantly exerts efforts for educational information so that infrastructure constructions get rapid development [1]. Digital learning resource covers most schools and digital application gains effects. School government information initially develops and information technology quickly popularizes in academic application. However, by comparison of these achievements and urgent demand of rapid development in our national cause on educational information, there still is huge difference. Thus, there constantly appear many problems such as uneven distribution of school infrastructure between city and village, digital information system incompatibility, excellent teaching resources scarcity, information technology talents shortage, information security system deficiency [2,3]. However, with appearance of cloud computing, it is significant for us to establish opened, flexible and safe cloud education information platform. Some developed nations, such as the United States, the Great Britain, etc, focus and study cloud environment-based educating big data as early as possible. Mature application products have merged in each aspect in social life. International cloud facilitators focusing on data analysis have been devoting themselves to develop and offer cloud platform. First-class universities in the United States and European countries have cooperated with some important cloud facilitators in globe and apply the service in their educating data analysis and processing [4]. In Oct 2007, Google and IBM collaboratively announce to promote "cloud computing" plan and some famous universities including Stanford University, Carnegie Mellon University, Massachusetts Institute of Technology, etc, all involve this plan [5]. In this cloud platform, teaching data resource can be downloaded and shared for students and then teachers can track and analyze students' scores through clod platform. Teaching method innovation deeply affects teaching education development. Along with big data and usage depth of education under cloud environment, its appearing security has been attached importance and various solutions have constantly appear to be improving [6].

The emphasis of this paper is learning cloud computing definition, characteristics, cloud computing three-layer framework, cloud computing advantage and key technology. Combining with our national situation of educating information, the new technology of cloud computing has been applied to our nationally basic education information to construct a cloud computing-based cloud education platform framework to realize resources sharing. We have discussed system design and deployment strategy of cloud platform in university network education including job rotation security technology, big data compression parallel technology, remote desktop terminal technology, etc. Finally, through practical environment establishment and test analysis, program feasibility in this paper has been proved and future prospect is put forward.

II. OVERALL STRUCTURE OF CLOUD EDUCATION PLATFORM

Cloud structure integrates various software and hardware resources through virtualization and offers terminal users services by means of internet. Classical cloud structure has basic infrastructure layer, platform layer and application layer and offers upper public cloud, private cloud and mixed cloud. In terms of cloud platform which faces teaching education, it is made up by infrastructure layer, platform service layer and educational application layer [7]. Each layer of cloud education platform provides various services for educational institute, teachers and students in the form of calculating resources.

Infrastructure layer is the bottom layer of cloud education platform which is basic service and infrastructure and provides calculating resources, storage resource and networked resource after virtualization as infrastructure for users. The infrastructure layer in cloud education platform is based on virtual technology, bottom layer server, storage and networked equipment to make up virtual resources pool with school as unit. After these physical environment preparations, the first thing which needs to be realized is abstract expression of resources in virtualization. Hardware resources virtualization adopts virtualization software and transforms physical resources into virtualization platform so as to integrate calculating resources. On this basis, through interface from virtualized platform, virtualized integration manager obtains various resources information to operate virtual machine on platform. That is, virtualized integration manager is management module at cloud educational platform infrastructure layer which mainly manages virtual machine and completes data management, resources monitoring, security management, and resources deployment. However, infrastructure layer services mainly contain mirror management, system management, system monitoring, user management and account billing. These characteristics match the functions offered by virtualized integration manager and is the interface for users to obtain infrastructure resource. Infrastructure layer of cloud education platform is shown as figure 1.

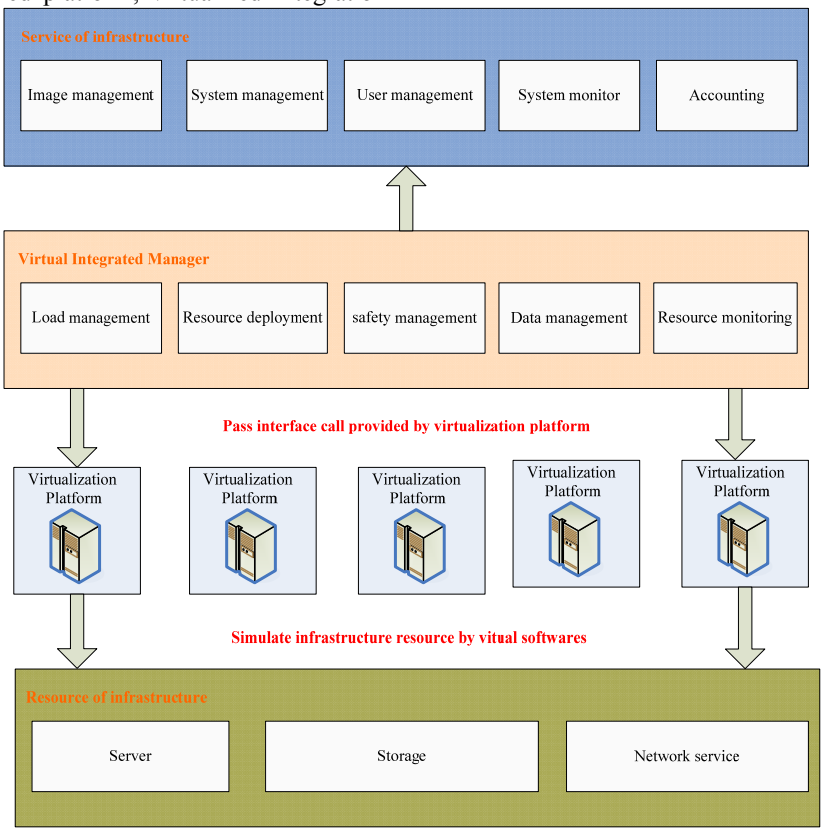

Fig.1. Basic infrastructure layer of cloud education platform

Platform service layer is constructed on infrastructure layer of cloud education platform. From common software life cycle, its development, operation and maintenance are the mainly key steps. However, platform layer completes these key steps and provides development, test and operation environment for educational application developers. Cloud service layer at cloud education platform is similar to traditional service of application platform but platform service layer at cloud education platform is the update of traditional application platform in theory and practice. Platform service layer operation is on the infrastructure of cloud education platform, provides SDK and integration development test environment which supports off-line development for many developers in educational application, realizes automatic deployment and expansion of application and offers user's the needed operating environment. Figure 2 is the basic structure of cloud education platform in platform service layer.

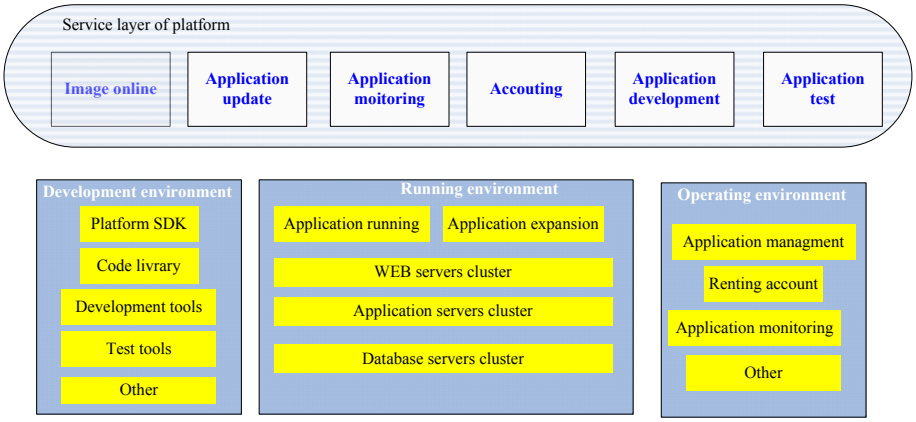

Fig.2. Service layer of cloud education platform

Platform adopts multi-renter system structure including these environments of operation, management and development with platform from environment. Development staff of educational application is divided into specific educational application developers and individuals. In developing environment, developers use SDK and integrating development environment application from platform service layer. Platform service layer also offers simulating operation environment at the same time. In this way, this can promote developers to simulate and apply the operation and debugging in cloud production environment. After development is completed, developers standardize and packet the completed application according to platform service layer and use SDK to offer applied upload service to deploy and activate application at platform layer. Operating environment provides the applied on-line, updating, maintenance and off-line management for users and offers applying monitor status surveillance and account billing. Operating environment offers application operating environment and guarantees its automatic, efficient and effective operation. Operating environment needs to consistently monitor the applying behavior and guarantees its isolation lies in its elasticity, operating resource control and distribution.

Educational application layer is the application set at platform service layer. Each application corresponds to specific requirements in educational teaching to realize a group of specific business logic. Different from infrastructure layer and platform service layer, the operating software types at application layer are so many with constantly appearing new applications. It is not very easy to define basic functions at application layer. Basic functions at educational application layer are for educational teaching management, share, development, application and service during educational information in order for services of educators and students.

III. RESEARCH ON KEY TECHNOLOGIES

A. *Automatic Monitoring System of Virtual Machine*

Virtualized computing can shield bottom layer equipment and structure difference. If it is effectively used, networked management can be simplified to improve networked security. Literature [8] puts forward virtual network-based next generation internet structure. It has definition of physical layer and user layer. Literature [9] puts forward virtualized technology-based processing monitor and literature [10] proposes to use virtual machine to realize automatic monitoring system without people to manage. Compared with double layer networked structure, automatic rotation design of post in virtual node has common features. Our improving thought is that normal operation in maintaining system is the system itself in this non-people controlling system. The only function of people is to change the equipment with hardware defect. Meanwhile, it does not necessarily change in time since the redundant mechanism in the system guarantees system operation and maintainers can simply change the normal hardware. For instance, in VMware virtualized computing environment, it designs network to be in two-layer which is helpful to make full use of virtual machine advantages. Figure 3 is the two-layer networked structure diagram in automatically monitoring system. In double-layer structure, the bottom layer is support layer which uses genuine hardware equipment group to be as virtual machine carrier. The upper layer is business layer which is made up by virtual machine cluster. It connects external network communication and its full jobs are totally completed by business layer. Support layer only plays a part in supporting business layer and it is separated from external network in logic. Virtual machine is similar to computer virus and it can perform self-replication, reduction and transference. Hardware at virtual machine is a document in essence and it can rapidly backup and return. Its effect is similar to hardware protection card in virtual machine. Thus, business layer at double-layer network has automatic restoration of software.

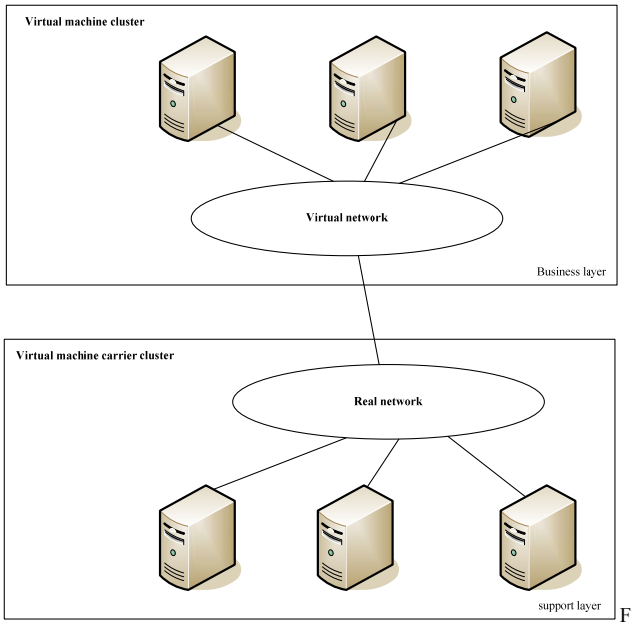

Fig.3. Double layer network architecture diagram

The system is divided into two layers which are respectively business layer of virtual machine and support layer by virtual machine carrier. Support layer operates virtual machine at business layer and offers business layer outside services. There are many virtual machines in business layer and they have same functions. However, virtual machine system and its setting can be different. There is only one virtual machine at front-ground at one time. The other virtual machines are at background which is performed automatic transference of virtual route. Virtual machine which is switched to the foreground and route connect external network but background virtual machine does not connect external network. The virtual machine shutdown, system recovery and restart operation will not affect normal operation of foreground virtual machine. After virtual machine takes back to background from foreground, above self-restoration operation will be performed to change into a totally new system and then rotate to foreground. Virtual machine carrier at support layer However, virtual machine status detection and route choice of virtual route are all completed by this virtual machine carrier. There are three kinds of status of each virtual machine and they are operation, recovery and readiness. Operating status demands virtual machine to be at foreground. Recovery and ready status demand virtual machine to be at background. Each virtual machine is periodically changing in recycle among these three status.

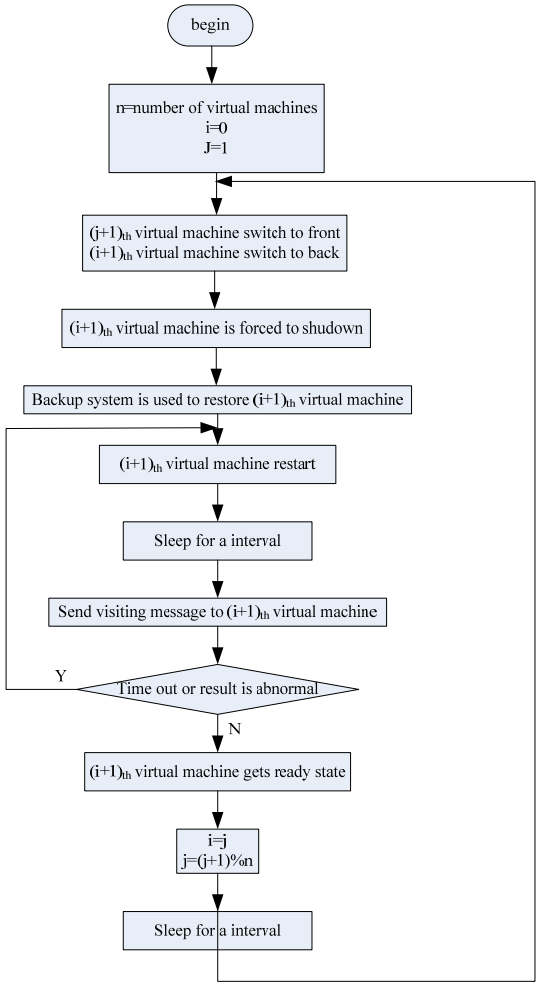

Fig.4. Control flowchart of virtual carrier

Figure 4 is the controlling process of virtual machine carrier at support layer. Virtual machine carrier is at certain period, and it can select virtual machine under ready state in recycle. It will be switched to foreground through virtual route, switch off original foreground virtual machine and complete system recovery at background. The virtual machine after recovery and restart needs the test of virtual machine carrier and performs normally external service to be in ready state. There is only one virtual machine in operating status at one time and virtual machine quantity at other status is not limited.

B. Security Strategy of Big Data

When users operate cloud-terminal educational big data, data storage security, identity authentication security, trust access control security and security measures of virtual security start to work [11]. A set of complete solutions guarantee reasonable users to operate educational big data under cloud environment, educational big data security is also improved.

(1) Data backup

Educational data which uploads to cloud platform for backup and performs aiming backup towards data in different clusters. According to different secretes degree, public data, common data, important data, key data and core data can adopt following backup strategies.

- Public data: complete protection and routine backup. For instance, some data such as multi-media resources in routine teaching, teaching exercises, electronic note, these data do not have secrete degree with large routine download quantity. They provide routine teaching assistance for teachers and students with complete protection without destruction.
- General data: Necessary protection and important backup. Teachers' routine teaching plan has usage value and it will be in loss if this data is destroyed and leaked.
- Important data: important protection and redundant backup. Testing questions in stages and answers. Except those teachers relating to teaching, the other materials cannot be corrected and downloaded.
- Key data: specific protection, redundant backup and remote place storage, teachers' individual information and students' roll information.
- Core data: absolute protection, multiple copies, remote place storage and routine backup for journal. Schools independently study data resources with commercial secret quality with other institutions.

(2) Disaster restoration

Cloud platform facilitator formulate specific and aiming data disaster restoration strategy towards the rented specific service items in the school. When cloud environment is attacked and suffers from accident such as power off and fire or natural disaster such as earthquake and floods, it can restore system to the largest degree, guarantee continuous usage of cloud platform and ensure educational data security in this school. Under normal condition, the most important measure is power off, fire off, defending thunder, water sinking, etc. Therefore, the school lies that when cloud facilitator is signs with cloud platform renting protocol, data disaster restoration must be clearly proposed and feasible solutions must be offered by cloud facilitators.

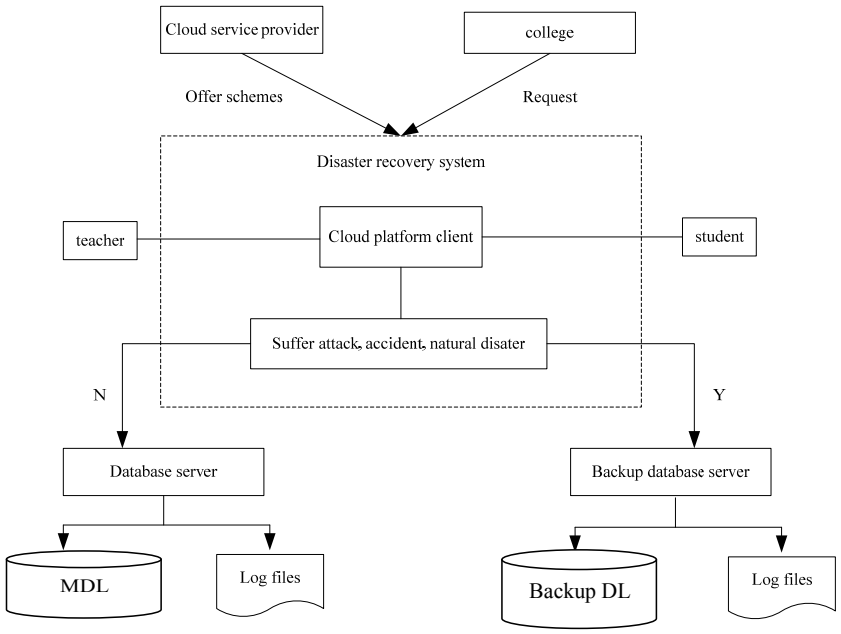

Fig.5. Disaster recovery system of educational data

(3) Authority assignment

Since educational data at cloud platform can be randomly corrected, clear authority division can assist to standardize authority of users at various degrees and realizing functions. It is helpful to protect data. This mainly contains school, user, cloud platform management and evaluative institute in the third part. Authority division and the classified data can be realized by touching-cloud and corresponding operations.

Based on importance division of the classified degree of educational data on educational data on cloud platform, usage authority of staff will be regulated. Since school is the provider part of educational data, it has the largest authority to process data. As main users, teachers and students have usage authority of this cloud platform education data. However, due to the realizing operation difference, the specifically realizing operations are different. Cloud platform facilitator is the escrow side and only has management authority of data. However, the main function of the third part evaluation institute is to monitor specific management behavior of cloud facilitator with different authorities.

(4) Identity authentication

Single sign-on and uniform identity authentication are user's registering cloud platform. They operate according to data on educational data to realize functions and guarantee important technology assurance of data security. Teachers and students in this school use their\own teaching number and students' number to register on this cloud platform. After successful registration, cloud platform automatically recognizes users and functional authority division. After users singly log in system, uniform identity authentication realizes user's identity. Users can also realize access among various application systems and browse as well as download without repeated log-in. However, uniform identity authentication can guarantee users' realizing data operation within their reasonable authority scope and avoid correction and delete educational data of cloud platform without authority.

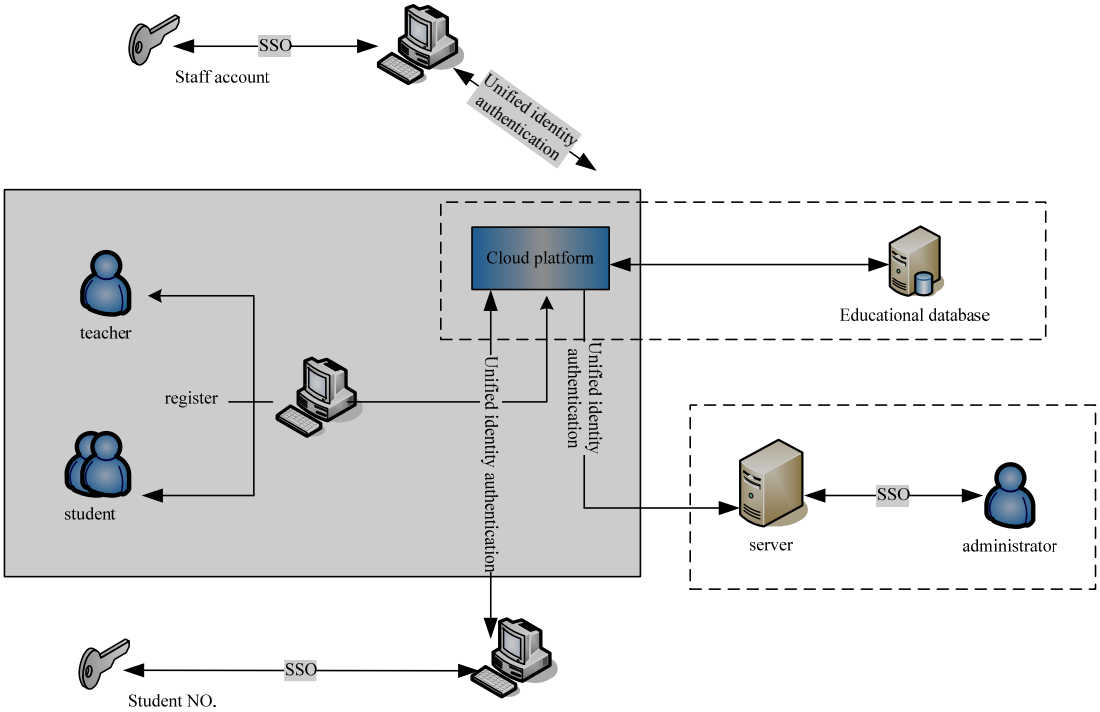

Fig.6. Multi-layer distributed architecture of system

C. *Remote Access of Virtual Cloud Desktop*

Virtual cloud desktop system is C/S structure in totality and its service terminal is cloud desktop management center which is used for user management, desktop pool management and image management. Client is the touch-cloud client which is the entrance of terminal user to access to cloud desktop. It offers functions such as user verification, cloud desktop connection, etc. Management center and touch-cloud client of cloud desktop is communicated through HTTP request and response. System structure is shown as figure 7. In addition, as additional functions in this system, structure location of remote printing has been noted in the figure. The printer VinzorPrinter is installed on operating system of cloud desktop. PrinterChannelClient is a dynamic link base and applied by touch-cloud client and obtains printing data through monitoring VirtualChannel. Because touch-cloud client needs cloud desktop from public network connecting to internal network, RD gateway needs to transfer communicating data between touch-cloud client and cloud desktop.

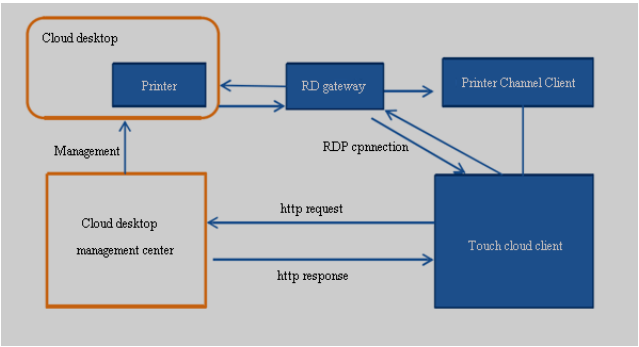

Fig.7. System structure

RD gateway is web application which operates on Linux. It is communicating transfer station between touch-cloud client in external network and cloud desktop in internal network. After it receives connecting request of touch-cloud client, it will set up bidirection communication

channel for them so as to re-transmit communication data. The key graph of RD gateway is shown as figure 8.:

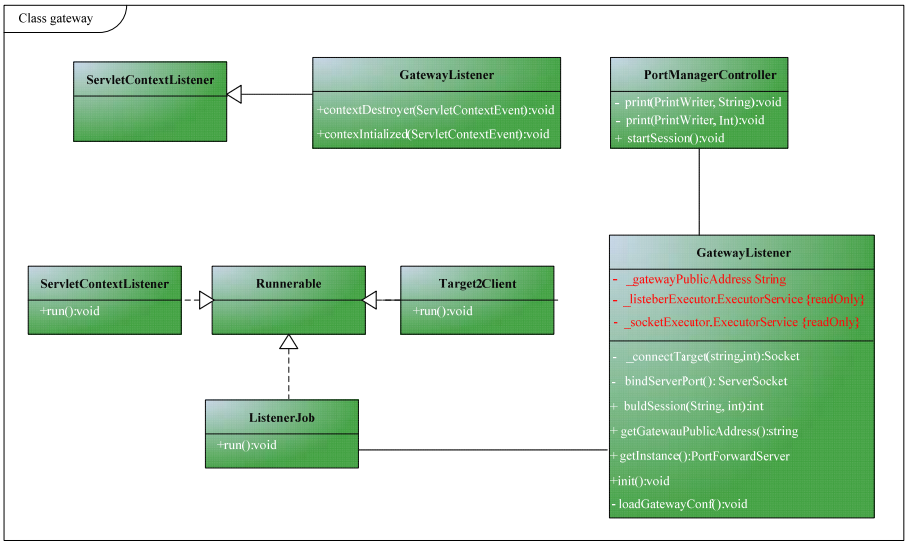

Fig.8. Key classes of RD gateway

RD gateway is based on Spring Web MVC framework to design. However, since gateway only receives connecting request and socket between re-transmitting cloud desktop and local desktop, RD gateway only realizes business logic between Controller layer and Model layer. The connecting cloud desktop is the last one key case of terminal user to log in touching-cloud terminal. After it logs in cloud desktop, it can instantly realize remote office and obtains traditional PC usage experience. The following figure is the sequence chart of this case.

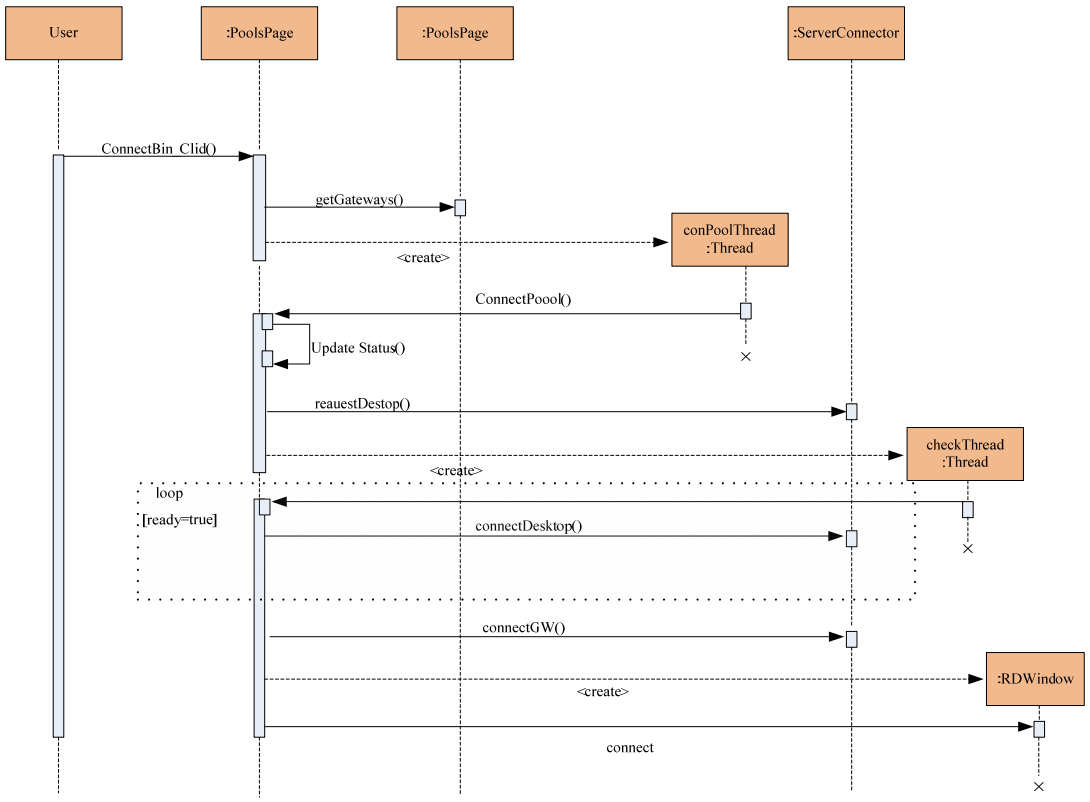

Fig.9. Sequence chart of cloud desktop connection

IV. APPLICATION AND TEST RESULTS ANALYSIS

A. Automatic Monitoring Technology of Virtual Machine

We simulate SQL injecting attack experiment on Web net server which deploys post shift system under lab environment. The experiment systems include: one real PC machine to be the support layer but business layer has 3 Linux virtual machines as Web server and one Linux virtual machine as virtual router. 3 virtual Web servers will shift at one time each 5 minutes. From outside network, the whole experiment system expresses one website. We left one same SQL to inject attacking vulnerability in 3 virtual Web servers of experiment system and implement SQL to inject, attack and tamper main page of internet at external network. Meanwhile, it accesses main page one time in each 3 seconds at external network. The experiment results show that this system can be consistently and normally operated and effectively eliminated invasion attack:

(1) All testing and accessing main pages will be opened less than 8 seconds. It indicates that shift switching has not affected normal Web Foreign Service.

(2) After SQL injecting attack is carried out each time, it will instantly access to the main page within 3 seconds. If it is discovered to tamper, it indicates attack is successful.

(3) After attack is successful within 5 minutes, main page will be automatically normal. It indicates attacking effect has been eliminated.

Above experiments are different in essence with traditional webpage which defends tampering technology. The reason is this system is the reduction of the whole virtual machine rather than any specific security attack. In other words, various unknown attacks including zero-day attack and various malicious codes including transmutation virus and shell adding Trojan will be automatically eliminated in indifference.

B. Control Strategy Realization

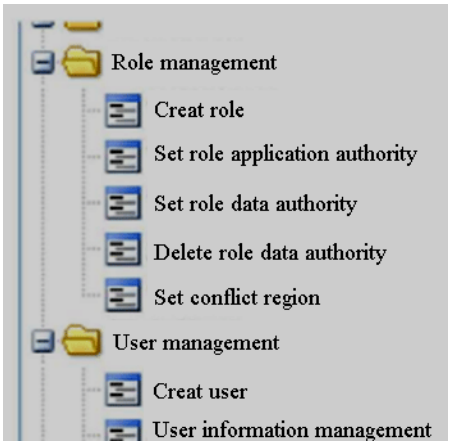

Fig.10. Accessing control directory tree

The distribution relationship among various characters, users and authorities in center management system adopts the improved character-based access control strategy of double authority of "character-authority" and "user-authority" to realize accessing control of information management system. Figure 10 describes involved application operation in accessing control strategy.

During accessing control, one character will be created at first. When creating character, there should fill some blanks such as character name, information description, and whether character setting inherits other characters. One character only inherits one basic character and inherits application authority and data authority of this character during inheriting. There is collision between authorities, that is, collision authority cannot be distributed to the same character. Therefore, collision domain of authority should be set. One collision domain can contain many different authorities. One authority can be distributed into different collision domains. There has many-to-many relationship between collision domain and authority. In this application, collision domain can be created, checked, deleted, etc.

After character creation, character authority will be distributed from application and data. When distributing application authority of character, one character should be selected at first and application group will be chosen. Some applications of this application group will then be selected. Meanwhile, this application can correct authority towards those characters which have been distributed authorities. However, towards those characters which inherit characters, they cannot correct their authorities. During the process of distributing authorities, whether the distributed authority is in one collision domain will be checked at first. If authority cannot be distributed in one collision domain, specific operations are shown as figure 11.

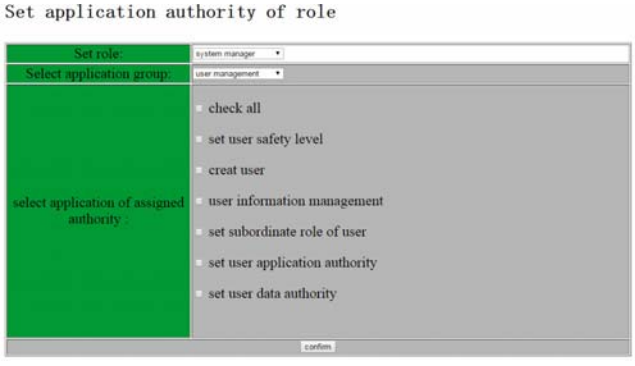

Fig.11. Role-application authority assignment

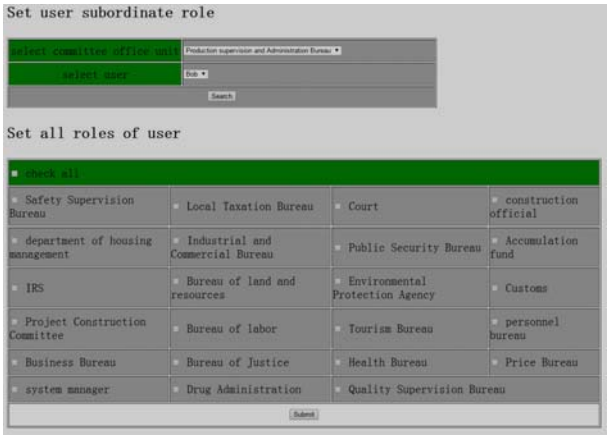

Fig.12. User-role assignment

After character creation and authority distribution, if sponsor committee user will be created, character will be distributed to users. During users' character distribution, sponsor committee will be selected at first and one user in sponsor committee will be selected. Then, the created characters will be distributed to this user. If many characters are distributed to users, there may have character collision in order that the distributing users' characters do not have collision. The detailed users' distributing character page is shown as figure 12.

C. 4.3 Remote Desktop Application Test

Install Android system remote desktop client software Remote Desktop, Linux remote desktop control open-source software XRDP, realize cross-platform intercommunication with Windows remote desktop and verify remote education application of ADSL, WiFi, 3G, etc, under networked condition. Figure 13 is the test image of Android terminal accessing Windows virtual machine. It proves that it can be normally visited.

Remote desktop application tests verifies the cross system compatibility of the educational cloud platform, and confirms the wide adaptability of this platform to urban and rural education information development from a certain point of view.

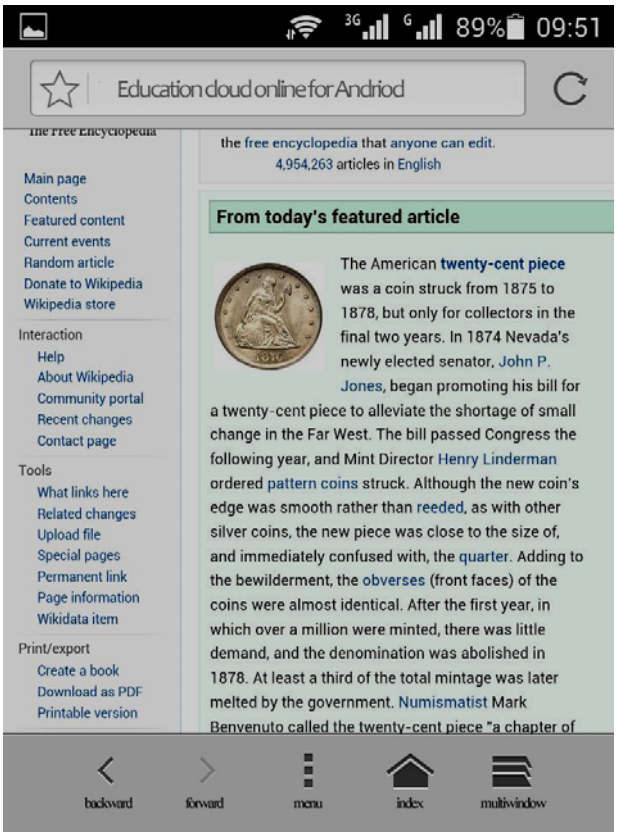

Fig.13. Web page of cloud platform accessed by Android

V. CONCLUSION

Cloud computing is future development tendency of education information platform but there has special requirement of individualized quality education for educating cloud. The generally universal cloud platform is not very appropriate. For individualized requirement in education field, this paper's author involves in cloud platform design and implementation of education in team. Our platform adopts two-layer virtual network framework and has advantages in expansibility, flexibility, security, efficiency, etc, so it has various big data processing ability of educating cloud. This paper mainly completes 3 key technology studies: automatic monitoring technology of virtual machine, big data security strategy and remote desktop terminal technology. Research achievement in this paper plays a part in directing educational information development and actively promoting optimizing educational structure, rationally allocating educational resource, narrowing the educational gap between city and village, improving educational teaching management and information education.

It is a long-term job in educational cloud platform study and there still has lots of studies in application development and key technology development. Based on overall structure of cloud platform, current cloud computing

resources virtualization has been completed with resources over-consumption. In the future, resources usage method and structure need to be further deepened, resources utilization needs to be maximized with minimal risk.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

ACKNOWLEDGMENT

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