

A Study on Architecture of Private Cloud Based on Virtual Technology

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Abstract—with the cloud service platform of National Science Library (NSL) as an example, this paper introduces how to build the open-source private cloud service architecture based on virtual technology, effectively increase the service capacity of information institutions and the use efficiency of network resources, and secure the applicability of services while preventing the server from spreading. It presents the key technical interfaces for building the private cloud infrastructure and the realization of major functional modules, including the management of virtual server, management of virtual application mapping template, monitoring and control of subcloud and overall virtual cloud environment.

Keywords- virtual technology; private cloud; architecture; subcloud; xenserver

I. INTRODUCTION

Due to its flexible, low-cost, green and energy-efficient, dynamic and elastic IT infrastructure, cloud computing becomes one of the major technical approaches for realization of scalized, centralized and specialized information services as well as a hot point of study for the business circle, academic circle and even governments. Naturally, today when trusted computing is not yet sophisticated, cloud computing architecture still shows obvious defects in terms of dependability, controllability and security of data. Thus, data security has always been the major concern for numerous cloud-computing users in using the cloud computing services. Then, can enterprises and institutions build, by themselves, the dynamic and elastic cloud architecture to provide their respective departments with cloud-like services? The answer is affirmative. With the cloud computing service plat of National Science Library, Chinese Academy of Sciences (hereinafter referred as NSL) as an example, this paper introduces in details the process of building the private cloud service platform based on open source technology.

The rest parts of paper are organized as follows. Section 2 describes the realization process of building private cloud computing service platform. Section 3 and section 4 gives the instances of application based on private cloud architecture and analysis its advantages. Section 5 gives conclusions of this paper.

II. BUILDING OF PRIVATE CLOUD COMPUTING SERVICE PLATFORM

In 2009, according to the project of “Digital Library Cloud Computing Application Study”, NSL undertook the study on application of cloud computing in construction of digital library information services to build the efficient, energy-efficient and green cloud computing service platform

supporting the personalized portal integration service and mass data computing and provide the capacity for simple, flexible and diversified information service allocation and migration.

A. Overall Architecture

Based on the above objective, NSL cloud service platform is designed and planned into two parts: resources management sub-system and service portal sub-system. The resources management sub-system allocated on all the physical devices in the environment of the cloud computing service is a system that manages and controls the network computing resources, which is invisible for the information service staff (end users), but with which the network administrator can carry out the dynamic integration of computing resources, including servers and storage devices, with various powerful functions such as centralized multi-node administration, multi-server resources sharing and real-time migration. The service portal sub-system allocated on the physical servers or virtual servers on one network segment with the resources management sub-system is a simple personalized and virtualized administration portal of information server provided for information service staffs, of which the functions include all the segments in the whole service lifecycle such as establishment, operation and unloading of the virtual server. The overall architecture is shown in Figure 1. :

B. Overall Technical Concept of NSL Cloud Service Platform

The overall technical concept for realization of NSL Cloud Service Platform is: the virtual server management software, Xenserver[1] is taken as the infrastructure and supporting platform of the cloud computing service platform and Xenserver console is used to realize the general monitoring and dynamic deployment of physical device resources, storage device resources and virtual device resources, to achieve the scalized and centralized management and integration of computing resources as well as to achieve such highly usable application as real-time migration of virtual host; Eclipse[2] integration and development environment is used to develop the simple the virtual server administration portal oriented for information service personnel, and, in combination Xenserver Api interface, PsExec[3] and Netsh[4] remote network configuration tool, Tomcat[5] information server and application template, to provide the information service personnel with the specialized easy-to-use interface of the virtual server, creating the capacity of simple, flexible and diversified information service allocation and migration; postgresDB[6] Database is used to save and synchronize the

operating status parameters of virtual devices between the resource layer and application user layer in the environment of the cloud computing service platform. According to such technical concept, in this section, this paper explains, in

details, the realization of NSL Cloud Service Platform by the processes of realizing the resources management sub-system and the service portal sub-system.

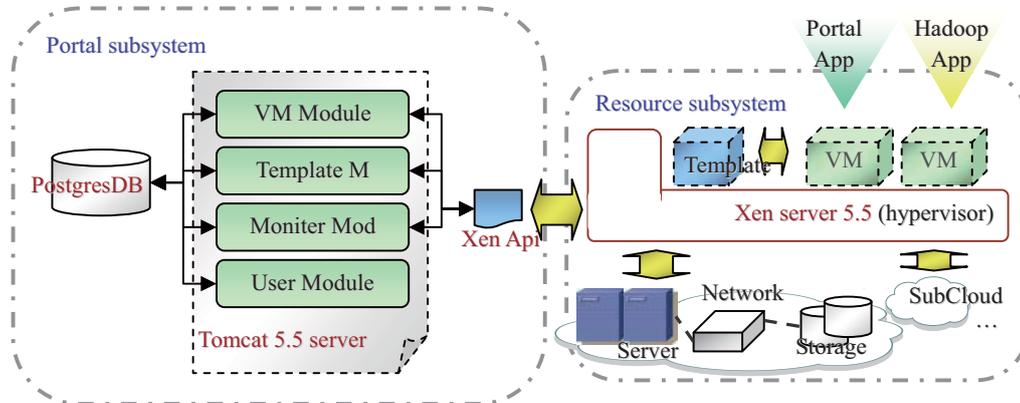


Figure 1. Overall Architecture of NSL Cloud Service Platform System

C. Realization of Resources Management Sub-system

The resources management sub-system is the infrastructure supporting system of NSL Cloud Service Platform, for which the access interface, data security, device compatibility and extendibility are critical. In the process of testing the building, consideration should be given mainly to the following aspects:

- Use 64-bit X86 server as the basic device of the resources management sub-system, support 32/64-bit virtual server, and support any new application while having the forward compatibility with the conventional information service platform.
- Installation path of Xencenter is recommended to be revised as “C:\Citrix\XenCenter\” so as to ensure the accuracy when the subsequent program calls Xenserver API interface, without any path pointing problem;
- The data in the whole cloud environment should be stored separately in the storage device, with the redundancy technique of which to ensure the data security. At present, there are mainly three types of storage devices Xenserver supports: storage pool based on NFS VHD, storage pool based on iSCSI, and storage pool based on Hardware HBA.

D. Realization of Service Portal Sub-system

The service portal sub-system of NSL Cloud Service Platform is a simple virtual application mapping template and virtual server administration portal, which be allocated on the physical or virtual server. With this sub-system, information service personnel can simply, flexible and quickly complete the creation and fast allocation of the personalized virtual server. Its main functions include: certification management of information service personnel, management of virtual server, management of virtual application mapping template, address management and

monitoring of virtual cloud environment. The main key interfaces and modules are introduced as follows:

1) Realization of major functional modules

a) Virtual server administration module

In the service portal sub-system of NSL Cloud Service Platform, users can, as per need, apply for and use multiple network resources/servers, just like using the local server. Obviously, virtual servers substitute the conventional physical server device and can control and manage such servers in an online way, as is a great change for the conventional working procedure. Users are not required to buy or move here and there any server, but can apply for creation merely through the explorer; it is not necessary to record particularly the use and network IP address of the server, while such information is already recorded automatically by the cloud service system upon creating the virtual server; it is not necessary to approach the server to check its operation status, but it can be done just in the explorer. The total process for online management of the whole virtual server lifecycle is shown in Figure 2. However, under the new mode, users need to as well as will gradually adapt to such operating procedures that are rare in the conventional working procedures as remote login and remote backup of data.

b) Realization of application template

The virtual host template in the private cloud environment is the key and precondition for flexible and quick allocation of virtual server and its application in the cloud environment. In the process of development, through exchange function between virtual host and template, we improve further the support of private cloud architecture to the application of virtual server and increase the usability and stability of the virtual server system. Through the templates, users not only can create quickly a virtual server, but also can, as per needs, promptly backup and restore a virtual server of different versions in different periods so as to increase the work efficiency as a whole. NSL Cloud

Service Platform includes two types of template pools: system template pool and user's personal template pool. The system administrator creates and manages the system template pool; through the system template, common users create the virtual host, configure the particular information application program and release service, and convert, as per need, the virtual host integrated with new information application program into the user template, thus creating a user template pool. The user templates can be shared with other users and can further create a virtual host integrating new information service platform with more application functions. The logic structure of the application template is shown in Figure 3. :

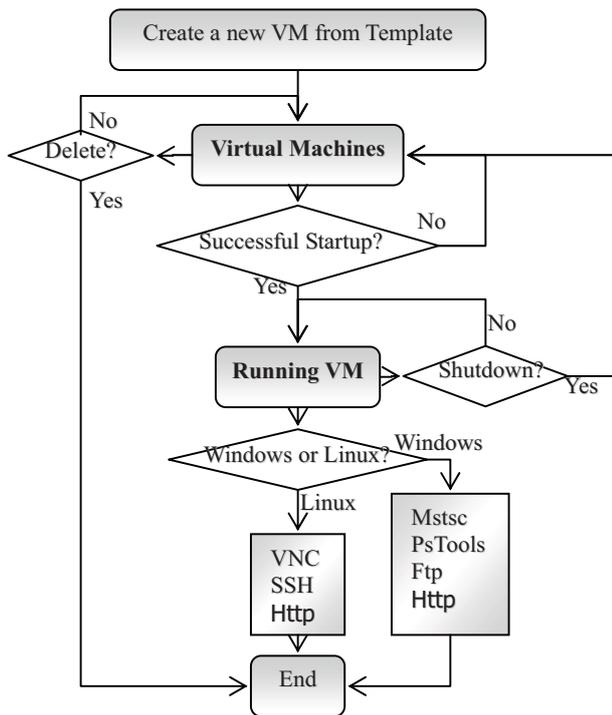


Figure 2. Logic Diagram of Virtual Server Lifecycle Management

In the process of conversion between the virtual server and the template, attention should be given to the following:

- Conversion from virtual server to application template cannot be in a reverse way. Therefore, the application templates in the private cloud architecture can clone a virtual server, but in a different way from the clone of conventional IT architecture, with the original system existing no longer. In order to securing the sustainability of information service capacity, upon converting the virtual server into templates, it is necessary to create another virtual server, based on the new template, so as to complete really the clone of the system in virtual cloud environment and promptly check the service interface status of the new server and assure the service accessibility.
- Except for the customized application templates, network configuration of general application

templates should be made in DHCP mode so as to ensure the new server can be accessible as well as the network address of the new server will not cause any impact on other systems.

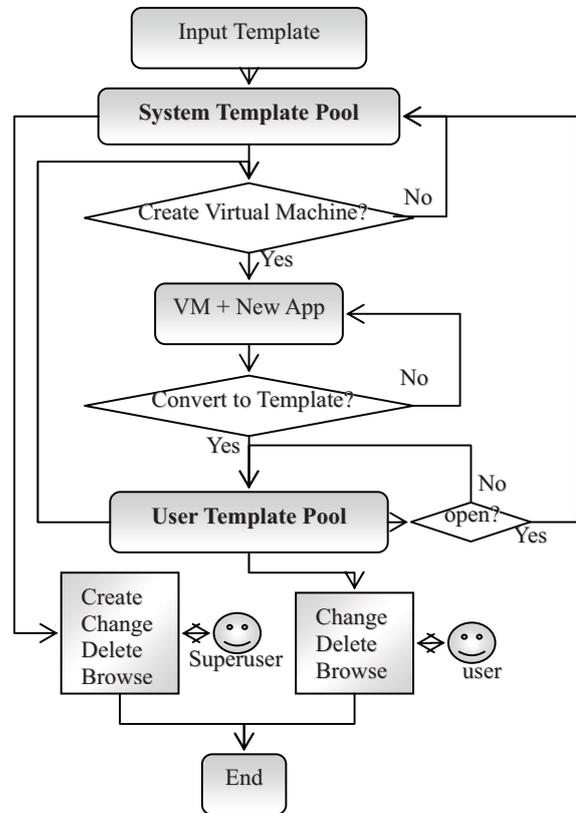


Figure 3. Logic Diagram of Template Lifecycle Management

c) Monitoring of private cloud environment

Since the virtual technology-based private cloud computing environment and the virtual hosts in the cloud environment cannot be infinitely extended, effect monitoring of cloud environment can massively increase user's experience in online use of private cloud computing. At present, the cloud environment monitoring of NSL Cloud Service Platform mainly focuses on the lifecycle management of the virtual host including mainly: monitoring of spatial use of cloud environment and monitoring of virtual server status, as shown in Figure 4.

d) Management of multi-subcloud architecture

The multi-subcloud architecture management solution is extremely important in the management of WEB-based virtual servers and can effectively avoid any time delay due to creation of new virtual servers in cross-storage space as well as achieve flexibly, in a multi-subcloud way, the classification and grading management of storage or service application: e.g., it may be considered to integrate similar information service applications into several subclouds of different types and different importance, which are in turn grouped into complete private cloud computing service environment. In combination with the resource pool and

dynamic migration technique, the multi-subcloud architecture management solution can also achieve the need-based migration of network computing resources

(physical server) between subclouds so as to effectively increase the use efficiency and flexibility of such resources.

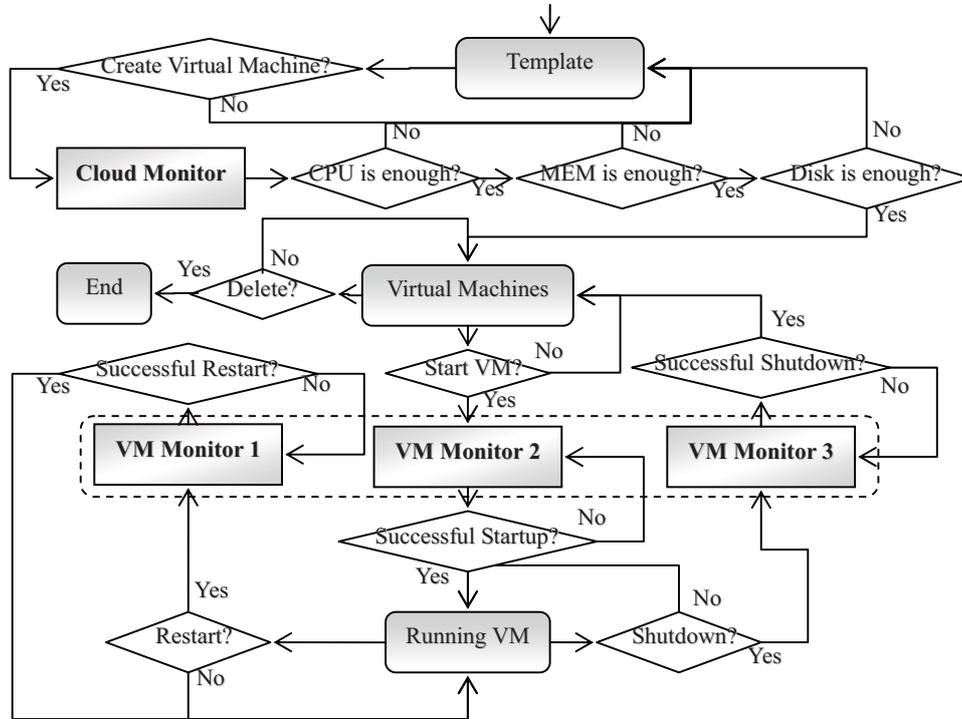


Figure 4. Logic Diagram for Monitoring of Private Cloud Environment

2) Realization of key technical interfaces

a) api interface of XENServer

With api interface of XENServer, NSL Cloud Service Platform links seamlessly the service portal sub-system and the resources management sub-system, and, in combination with Runtime.getRuntime().exec method, executes the interface command, shield the complex server resources management and provides the capacity of simple and flexible application allocations.

Key codes are as follows:

- Process process = Runtime.getRuntime().exec("vm-start vm="+str_vmuuid.trim()+""") //start server.

XENServer api interface command relating to the virtual server lifecycle management:

- xe vm-install new-name-label=vmname template-uuid= tem_uuid Storage_uuid //create virtual server based on template;
- xe -s vmserverip -u root -pw password vm-list uuid=vm_uuid params= uuid,networks //get relevant information of virtual host;
- xe -s vmserverip -u root -pw password vm-shutdown uuid= vm_uuid params= uuid,networks //close virtual server.

XENServer api interface command relating to monitoring of computing resources (when resources are tight, the portal

platform will popup the prompting of “failing to create a new virtual server”):

- xe -s vmserverip -u root -pw password host-list params= uuid,memory-total,memory-free //monitor memory usage;
- xe -s vmserverip -u root -pw password sr-list uuid=sr_uuid params=physical-utilisation //monitor storage space usage.

b) Remote network configuration interface

The remote network configuration interface is the function of changing, by simple configuration in the system, directly the network configuration of the remote target server. Through this interface, NSL Cloud Service Platform mainly completes the network configuration of the created virtual server. Here, we mainly use two configuration tools: PsExec and Netsh.

PsExec is a light Telnet alternative tool, with which user can execute the process on other systems, without the need to install the client software, and can obtain the total interaction equal to the application program of the console. Through PsExec, NSL Cloud Service Platform uploads the encapsulated netsh network configuration document to the remote virtual server and executes the same for remote server network configuration.

Netsh is a practical tool of command line script provided with Windows 2000/XP/2003 operating system, which allows the user to carry out the local or remote display or

change of the network configuration of a computer in operation. To file, backup or configure other servers, Netsh can also save the configuration script in the text document. It is extremely simple and convenient as well as fast and effective to backup the server network configuration through Netsh command, without any need for the assistance of other software.

Items needing attention: Since PsTools has problem in Chinese identification, its address names are generally “local area connection” in Chinese by default. If the remote “cmd” is executed with PsExec, it will be impossible to correctly execute the command of Netsh, unless the value of address name is English. Therefore, the network connection names of all the mapping templates of NSL Cloud Service Platform are changed as “local” in English.

c) *Parameter configuration of Tomcat information server*

For the convenient allocation, development, multi-language support and use by end-users of NSL Cloud Service Platform, the parameters are changed as follows: change the default root directory of Tomcat as the system development directory and the port number as 80, and add the support to the language code utf-8-character set common in the world. All parameters are changed in server.xml configuration document under conf directory below Tomcat installation directory.

III. EXAMPLES OF APPLICATION BASED ON PRIVATE CLOUD ARCHITECTURE

A. Portal Application Integration

Through the cloud computing service built as above, by typical and cloud-sharing architecture and service mode

similar to AMAZON EC2[7], the project team, achieved the application of private cloud service within the library, making a helpful trial for the library to migrate and allocate the conventional information service items in the dynamic and elastic green computing resources pool. With the NSL Cloud Service Portal Platform, users can follow the prompting of the system to select appropriate information service application template and promptly achieve the creation of a virtual server and allocation and release of the portal application. Currently, the application mapping templates used by NSL Cloud Service Platform are mainly Portal and wiki. Simply by linking such system functions as system resources configuration, template conversion, turn-off, re-start, Web remote desk, FTP data loading, URL, achieve the multi-layer management the created virtual servers over their total service life. For instance, by clicking “power” icon link, turn on and off the virtual server; by clicking “configuration” icon link, configure the virtual server cpu/mem to increase the computing capacity and achieve the dynamic resources configuration; by ftp connection, achieve the remote backup of data; with the templates, achieve the clone of the whole application system as well as, on the basis of templates, create new portal integration application virtual server for embedding new service applications. The virtual server management interface of NSL Cloud Service Platform is shown in Figure 5.

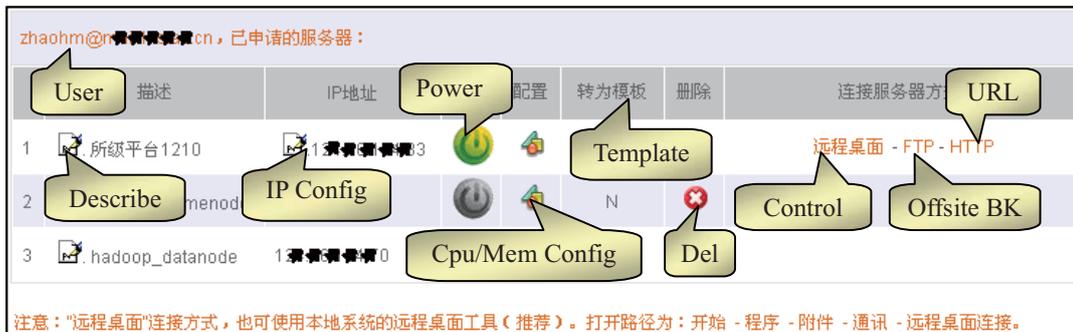


Figure 5. Virtual Server Administration Interface

B. Mass Data Processing

According to the needs for actual data-processing scale, with reference to Cloudera[8] and Cloudera Desktop[9] application templates, in the cloud service platform, the user can carry out the quick creation and dynamic management HADOOP[10]virtual server nodes, flexibly build the appropriate distribution network computing environment, as well as effectively save the building time of mass data computing environment and focus the building of HADOOP distribution environment on SSH security data transmission

connection configuration, parameter synchronization, distribution environment allocation and deployment.

IV. ANALYSIS ON ADVANTAGES OF PRIVATE CLOUD ARCHITECTURE

Then, what has the application of the private cloud architecture brought about for libraries or information institutions? As a whole, in addition to the data security, it has properly resolved the following issues:

A. Effectively increase the use rate of resource

Using the private cloud architecture, the administrator can carry out, with the visual monitoring interface, dynamic configuration, regulation and deployment of servers and storage devices, efficiently integrate resources, integrate the existing multi-server applications on to one physical server, effectively limiting the number of servers from increasing and spreading sharply; additionally, private cloud architecture based on virtual technology will also lead to the separation and encapsulation of virtual server, without affecting the usability and performance of the existing service[11][12].

B. Effectively promote the applicability of services and accelerate the personalized information service and release capacity.

With the encapsulated operating system and application virtual image, the user can simply and flexible create the virtual server with basic application software and reduce the installation and configuration time of the conventional operation systems and relevant software so that information service personnel can be more devoted to the personalized business innovation construction and service release, creating the capacity for rapid, simple, flexible and diversified information release and services.

C. Effectively reduce the management difficulty of applications.

Using the features of abstract separation between application platform and base physical environment, the administrator can generalize the basic configuration of the virtual, increase the compatibility of application and hide the complexity of isomeric resources. In building the computing environment of distribution data mining, the user can, according to the task and scale of data mining, simply and flexibly create and add/delete HADOOP server nodes, creating the HADOOP clusters with appropriate scale and high tolerance and completing the data mining rapidly at a low cost. Upon completion of the task, the user can also promptly recover the computing resources for use in other applications and mine profoundly the available space of the computing resources.

V. CONCLUSIONS

Based on the process of developing an actual digital library cloud service platform, the author has introduced in details the overall concept and solution for how to build the private cloud service platform within libraries and information agencies, with the hope to provide certain reference and recommendation for the counterparts with the same demand and help to guide in resolving the problems relating the cloud computing application in digital libraries. The subsequent work concept of the author is to enrich the application of mapping templates to support more application in information service, optimize the functions of administrating and monitoring the virtual server, and constantly enhance the applicability, flexibility and stability of NSL Cloud Service Platform.

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