The Virtual Desktop and Application Sharing System for Cloud Computing

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ABSTRACT

The cloud computing technology is developed rapidly in recent years, in which the remote software is delivered as a service and accessed by users using a thin client over the Internet. In order to share the software resources, virtualization technology plays an important role in the cloud computing environment. In this paper our main goal is to provide the basic knowledge about the virtualization technology of desktop and application sharing, and proposed the virtual desktop and application sharing system to provide an efficient, reliable and elastic service platform for cloud computing environment. By developing the virtual desktop and application sharing technology with the cloud cluster platform, it will realize the VDaaS (Virtual Desktop as a Service) and VAaaS (Virtual Application as a Service) for users, and it will also provide more innovative application services for users in the cloud computing environment.

Keywords: Virtualization, Desktop, Application, Cloud, Sharing

I. INTRODUCTION

In the last few years, cloud computing has evolved from a promising technology into a popular service for boosting the efficiency of business, education and IT functions. With the development of computing technology, cloud computing has become a core technology of computing platform for next generational networks. Cloud computing is an emerging model of business computing derived from distributed computing, parallel computing and grid computing. It provides a computing paradigm that enables a shared pool of virtualized, dynamically configurable, and managed computing resources to be delivered on demand to customers over the Internet. The software resources sharing in the cloud is also delivered as a service and becomes more popular in recent years. There are many companies such as Amazon and Google have promoted the relative simplicity of the software as service concept. The cloud computing paradigms provide simple and transparent approaches to enable effective sharing and utilization of applications over the Internet [1, 2, 3].

The virtualization technology has a long history, starting in the mainframe environment and arising from the need to provide isolation between users and companies. It reduces the costs for server installation, operation, and maintenance and it will make the building of distributed systems simply and easily. The virtualization technology for cloud computing can be divided into several parts: hardware virtualization, operating system virtualization and application virtualization. Hardware virtualization gives different operating systems the ability to share resources by emulating the underlying hardware using a layer of software. Operating system virtualization works at the kernel level of a single operating system instance, creating discrete isolated virtual machines. Application virtualization draws out applications from the operating system, allowing them to run as network services. Virtualization is not a single, specific solution; it is rather a collection of approaches and specific tools that vary greatly. It also provides a useful tool for introducing operating systems and offers some potential opportunities and benefits for innovative applications.

In this paper, the main goal is to develop a virtual desktop and application sharing system which is scalable, efficient, and independent of the operating system. The virtual desktop and application sharing system provides an open architecture to deliver desktops and applications with the heterogeneous operating systems to any client device of users. Users can easily use the operating system environment or applications to develop software projects in the cloud through the web browsers over Internet.

In a cloud computing environment, users can utilize SaaS (software as a service) subscriptions instead of traditional software licenses. In a traditional computing environment, users need to locally install operating systems and applications under a granted license. Users may be burdened with many complex tasks in terms of software installation, configuration, updating and even troubleshooting issues. With the cloud computing concept, users may access software on demand through the Internet without any installation and maintenance issues. For the system providers, there are two alternative methods of making the SaaS software available. One is to develop software based on web technologies. This not only requires significant work, but may also encounter compatibility problems with the numerous browsers. The second approach is based on the remote virtual desktop and applications, which separates the presentation and execution of operating systems and software. This provides a transparent way to deliver software resources based on the virtualization technologies. By utilizing the virtualization technologies, all cluster severs and the software which are maintained by the cloud providers and the users just pay as they go. Cloud service providers provide the resources sharing system for accessing virtual desktop and applications, so users develop their programs and execute in the cloud environment provided by the cloud service providers.

The system technology is discussed in section II, and system design and implementation of the system is discussed in section III. Conclusion of this paper will be in section IV.

II. TECHNOLOGY DESCRIPTION

The key technology of the virtual desktop and application sharing system is virtualizing and sharing of desktops and applications. The virtualization software is installed with the cluster server and its virtual machines. Each virtual desktop and application shares the computing resources of the cluster server. The cluster server is one of the important infrastructures in the cloud computing technology, and it is one of the important resources in the Internet. The main purpose of the cluster server is to formulate the responses which are sending by the clients, it also performs the several load balancing activities while the tasks access to make the system reliable.

The virtual desktop and application sharing system allows more than one person to collaborate or develop on a single document at the same time. Currently virtual desktops are delivered using RFB (remote framebuffer) protocols such as VNC (Virtual Network Computing) and RDP (Remote Desktop Protocol) [13, 14]. These protocols generally provide methods for accessing a remote virtual desktop or application, and users can login to a system server and work on the desktop. The virtual desktop and application sharing system is also presenting some innovative scenarios for application sharing in single or multiple virtual machines. In a single virtual machine, collaboration scenarios can be supported based on a shared desktop. For example, desktop sharing enables the instructor and students to work on the same view in a remote teaching system.

A. Virtualization of Desktop

The desktop virtualization is a software technology, which transfers the desktop of operating system to the cloud environment. With the virtualization of desktop technology, the physical machine becomes a simple access point into the virtual desktop. Traditional local desktops have a particular operating system installed, and they store user settings and applications on each individual machine. Desktop virtualization replaces this static structure with a flexible approach in which each machine exists in the cloud and the local hardware becomes the access point. With all machines centrally located within the same virtual network, the time and cost of administration is greatly reduced. Besides, there is also the benefit of increased accessibility.

The implementation of desktop virtualization is classified based on where the virtual desktop runs and whether or not the virtual desktop persists between sessions. The virtual desktop and application sharing system is developed to provide the most appropriate implementation to support specific requirements. Neither approach explicitly requires the use of virtual machines; however, in practice most desktop virtualization implementations do incorporate a virtual machine component [4, 5].

Remote desktop virtualization implementations operate as client-server computing architectures [6, 7, 8, 9]. Application execution takes place on a remote operating system which is linked to the local client device over a network using a remote display protocol through which the user interacts with the application. All applications and data used remain on the remote system with only display, keyboard, and mouse information communicated with the local client device. A common implementation is to host multiple desktop operating system instances on a server hardware platform running a virtual machine. This is generally referred to as VDI (Virtual Desktop Infrastructure). VDI is a virtualization technique enabling access to a virtualized desktop, which is hosted on a remote service over the Internet. It refers to the software, hardware and other resources required for the virtualization of a standard desktop system. VDI is also a desktop-centric service that hosts users' desktop environments in cloud computing environment, which are accessed over a network using a remote framebuffer protocol. VDI solutions normally include some kind of connection broker to connect users to available virtual machines. Connection brokers are a part of a rapidly developing suite of management tools that can help minimize the support overhead of a VDI solution. A connection brokering service is used to connect users to their assigned desktop sessions. For users, this means they can access their desktop from any location, without being tied to a single client device. Since the resources are centralized, users moving between work locations can still access the same desktop environment with their applications and data. For system administrators, this means a more centralized, efficient client environment that is easier to maintain and able to respond more quickly to the changing needs of the user and business. The connection brokers and management tools is development rapidly over the last year, and makes the desktop virtualization field mature and maximize the return on investment in desktop virtualization solutions [27].

With the desktop virtualization, multiple client operating systems can run on the same hardware at the same time where each operating system is running in its own virtual machine. Remote desktop virtualization can also be provided via a cloud computing similar to that provided using a SaaS (Software as a Service) model. The desktop virtualization can also be provided via a cloud computing similar to that provided using software as a service model. This approach is usually referred to as VDaaS (Virtual Desktop as a Service). The VDaaS provider typically takes full responsibility for hosting and maintaining the compute, storage and access infrastructure, as well as applications and software licenses needed to provide the desktop service in return for a fixed fee. VDaaS can be implemented using both VDI and remote desktop services based systems. VDaaS can be implemented through public cloud, private cloud, or hybrid cloud platforms [10, 11, 12].

B. Virtualization of Application

Application virtualization is layered on top of virtualization technologies. Application virtualization is the separation of an installation of an application from the client computer that is accessing it. Application virtualization can be divided into two types: remote and streaming. Remote applications run on a server. End users view and interact with their applications over a network via a remote display protocol [28]. The remote applications can be completely integrated with the user's desktop so that they appear and behave the same as local applications. The remote applications can be shared with other users, or the application can be running on its own operating system instance on the server. With streaming applications, the

virtualized application is executed on the end user's local computer. When an application is requested, components are downloaded to the local computer on demand. Once completely downloaded, a streamed application can work without a network connection. Both forms of application virtualization have benefits from centralized management. Applications can be installed, patched, and upgraded once for an entire environment. Application virtualization typically is combined with application streaming, so the software is not installed in the usual sense. Application virtualization allows software to be run without being installed on the machine and without interacting directly with the original operating system for which it was designed. Application streaming is an on-demand software distribution system. With application streaming, users receive only applications that they request from a master server. In addition, clients are given only the portion of the application that they need to launch the software and use its basic functions [15, 16, 17].

The virtual application sharing is different from the virtual desktop sharing. In virtual desktop sharing, a server distributes any screen update. In virtual application sharing, the server distributes screen updates if they belong to the shared application's windows. Client users receive screen updates from the server and send keyboard and mouse events to the server. Application virtualization is also a software technology that encapsulates applications from the underlying operating system on which it is executed. With application virtualization, users can store and manage applications centrally, integrate with third party computer lifecycle management and software distribution systems. Application virtualization also enhances organizations' ability to control access to applications, track usage of virtual applications, and quickly test, deploy and update applications.

Full application virtualization requires a virtualization layer. The application virtualization layers are used to substitute part of the runtime environment which is provided by the operating system. The layer acquires registry operations of virtualized applications and transparently redirects them to a virtualized location. It makes the real application remaining to access the virtual resources. The pieces of the application's code, data, and settings are delivered when first used, and the application streaming are usually delivered over a protocol such as HTTP (Hypertext Transfer Protocol), CIFS (Common Internet File System) or RTSP (Real Time Streaming Protocol) [18, 19, 20]. Deploying and maintaining desktop and application level virtualization poses many challenges, but there are opportunities for improvements at the application and server layers to achieve the high-level of computing performance and scalability [25, 26].

III. System Design and Implementation

The virtual desktop and application sharing system can be developed under the personal computer or cluster servers to provide more application services and reduce the software maintenance costs. The virtual desktop service is built based on the VDI framework, and the main components of VDI framework are: VDI Infrastructure, VDI Desktops and VDI Middleware, which is shown as Figure 1. VDI Infrastructure is responsibility for creation, deletion or migration of virtual desktop. VDI Middleware is responsibility for connection management and desktop control. Applications and shared data can be installed on the cluster server and its hypervisors, and users can request for some specific applications or data on demand from the server. The requested virtual desktops and applications will be delivered with dynamic streaming technologies to the client devices.

Virtual desktop infrastructure is the practice of hosting a desktop operating system within a virtual machine running on a centralized server. VDI is a variation on the client/server computing model, sometimes referred to as server-based computing.

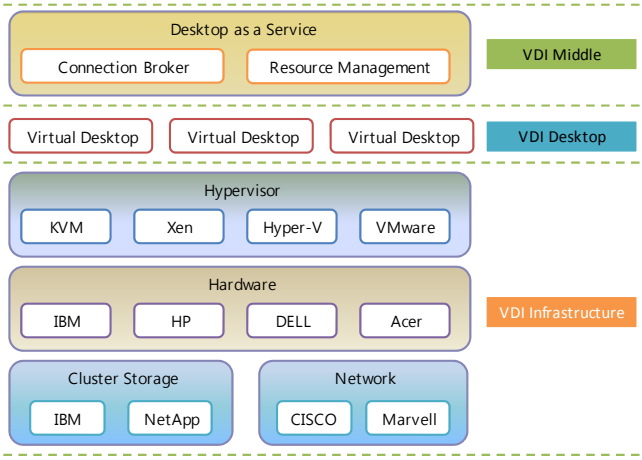

Figure 1. Virtual Desktop Infrastructure Framework

There are two ways to execute the virtual desktop and applications on the client devices:

1) Native mode: The remote control and streaming display software will be installed on the client device to execute the virtual desktops and applications. It is suitable for the homogeneous operating system between the server and clients.

2) Web-based mode: Only need a web browser with Java applet to install on the client device. It is suitable for the heterogeneous operating system between the server and clients.

The virtual desktop and application sharing system architecture is shown as Figure 2. This system has a session server to perform in the role of virtualization controller, and to manage user's connections and accountings information. The session server can be implemented with Linux or Windows operating system, and it maintains the virtualization, session and application manager functions. It is responsible for virtualizing the desktop and applications and sends them to the proper sessions for the application servers. The session server also communicates with application servers to deliver the virtual desktop or application streaming to client devices by RDP technology. Besides, the session server uses the HTTP server to provide the single web-based portal for user login. It also enhances the system security and elasticity by applying the centralized control of applications and files on the server cluster.

When a user requests the application which installed on the Linux application server, the session server will manage the user account and its session, and communicate with Linux application servers. When the Linux application server receives the request from session server, it will start RDP service and make the application virtualize to streaming data, and then delivers the data for the client user. The session server can also apply the context-aware service to fit the requirements of user's client device and the network bandwidth, which can enhance qualities of the virtualization services.

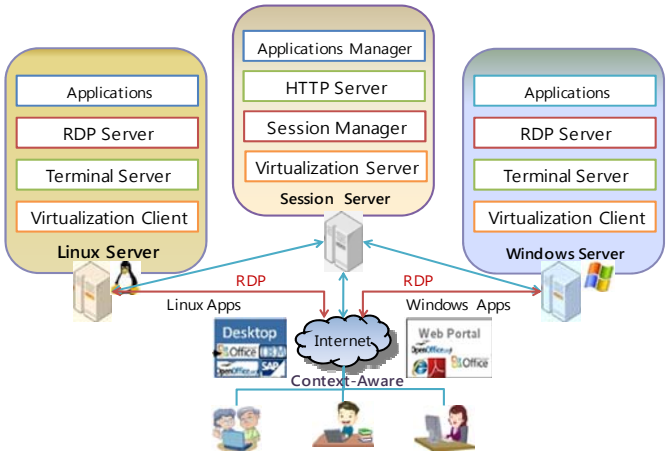

Figure 2. The virtual desktop and application sharing system architecture

The virtual desktop and application sharing system is composed of several modules: Desktop Virtualization Manager, Application Virtualization Manager, User Session Manager and Data Synchronization Manager. The software modules of the system are shown as Figure 3. The functions of each module are described as follows:

1) Desktop Virtualization Manager: This module provides virtualization of operating system and customization of remote desktop environment. The development of this module is based on the open virtual desktop software, and designed according to the user requirements. It is responsible for allocating computing resources of cluster server and hypervisors dynamically.

2) Application Virtualization Manager: This module provides virtualization of applications and software resources. The development of this module is based on the open virtual application software, and designed according to the user requirements. The Full application virtualization also requires a virtualization layer with the operating system. Application virtualization layers replace part of the runtime environment normally provided by the operating system. The layer intercepts all file and registry operations of virtualized applications and transparently redirects them to a virtualized location.

3) User Session Manager: This module is responsible for managing user connection sessions and authenticating accounts information. The user session begins when the user accesses the virtual desktop or application and ends when the user quits the virtual desktop or application from the web browser. It also plays a role of bridge between application servers and client devices. It applied the SSH (Secure Shell) and HTTP (Hyper Text Transfer Protocol) protocol to provide the single entry website.

4) Data Synchronization Manager: This module is responsible for managing the process of establishing consistency among data from cluster servers to client devices and the continuous harmonization of the data over time. Users and project developers can collaborate or develop on a single file without installing any relative application on their own client device. It also backups and shares the user's data to make the system reliable and elastic.

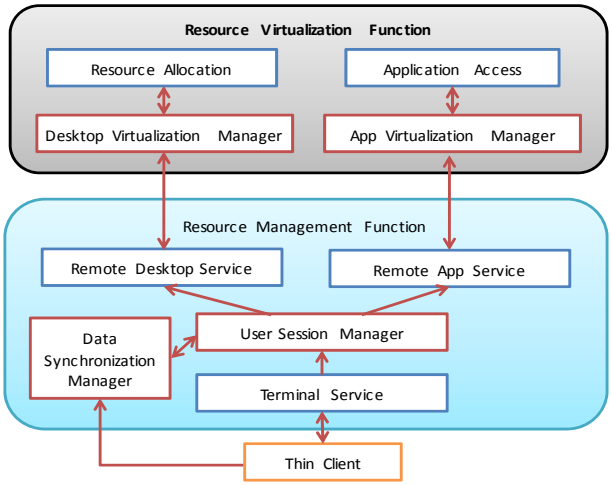

Figure 3. The software modules of the virtual desktop and application sharing system

To enable collaborations among multiple virtual machines, an application sharing and migration mechanism will be applied. Through presentation streaming redirection and virtual machine cloning technology, an application can be easily shared or migrated. To realize remote application access in a cloud, RFB protocol is used to transfer the virtual desktop or application of a remote virtual machine. The RFB protocol works at the buffer frame layer and supports the remote access to graphical user interfaces, and the mouse or keyboard inputs can be transferred to the remote application, thus achieving a transparent access to the applications. In such a presentation streaming based software delivery mode, when a client wants to migrate or share an application to another client, the presentation streaming of this application should be redirected and the corresponding virtual machine will be cloned in case of application sharing [21, 22, 23].

The virtual desktop and application sharing system supports both multicast and unicast transmissions. For unicast connections, either UDP or TCP can be used. Since TCP provides reliable communication and flow control, it is more suitable for unicast sessions. Multiple TCP clients sharing a single application may have different bandwidths, so an algorithm which sends the updates at the link speed of each client will be developed. For UDP clients, the system controls the transmission rate because UDP does not provide flow and

congestion control. Several simultaneous multicast sessions with different transmission rates can be created at the system. The system can share an application to TCP clients, UDP clients, and several multicast addresses in the same sharing session.

The desktop and application virtualization technology enables operating system environments and applications to be streamed from a centralized location into an isolation environment on the target device where they will execute. The desktop and application files, configuration, and settings are transmitted to the target device and the application execution at run time is controlled by the user session manager and virtualization layer. The virtual desktop and application sharing system enables collaborative works, and provides an efficient, reliable and elastic service platform for cloud-based computing environment.

IV. CONCLUSIONS

In recent years, virtualization technologies have attracted attention to solve the problem of the decreasing efficiency of hardware and software. In order to share the software resources, virtualization technology plays an important role in the cloud computing environment. The development of the virtual desktop and application sharing system will integrate the relative technologies of IaaS, PaaS and SaaS with Cloud computing to provide the innovative application services and realize the VDaaS (Virtual Desktop as a Service) and VAaaS(Virtual Application as a Service). Users no longer need to burden the costs of software license and maintainace, and they only need some simple operations to get the various software resources on demand and pay per use. By developing the virtual desktop and application sharing technology, we can provide more innovative application services of Cloud computing for users and make the cluster server as a high economic benefits platform. Furthermore, the relative technologies will also push forward the development of Cloud computing field.

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