DESIGN AND IMPLEMENTATION OF A VIRTUAL COMPUTING ENVIRONMENT FOR SCHOOLS AND OFFICES

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Abstract

This Paper: "Design and implementation of a virtual computing environment for schools and offices" aims at solving issues that range from reducing information technology costs to making information technology as mobile as possible. Users want to be able to access their documents, use their important applications, and even their entire desktops on the go that is from anywhere, anytime with any device. These are just a part of the numerous issues this project aims at solving. Another issue is the problem of students and faculty having to source, purchase and install applications they need for study, work and leisure on their personal computers. These applications are very difficult and expensive to purchase. This hinders academic research and students' experience with applications that involve their courses' of study.

Yet another issue this project sets out to solve is for organizations. In small and medium enterprises, the high cost of IT is a huge problem. The project helps these enterprises to convert capital expenditure to operational expenditure. The large organizations require increased security, management, maintenance, and data redundancy. All of which the solutions from this paper takes care of.

In a single solution, a virtual computing environment is created via application and desktop virtualization. Applications and desktops are hosted in data centres on high resource servers and then delivered to users over a network. For demonstration in this project however, the hosting platform and delivery is scaled down to just one hardware server running logical servers hosting a couple of applications deployed to a select number of users.

Coupled with the positive results from a survey that aimed to find out the awareness and willingness of users towards the idea of the project, this project has been able to achieve the delivery of work and academic software packages to concurrent users on the following operating system platforms: Windows 7, Mac OS X Mavericks, Android 4.2.2 and iOS 7 while also solving the issues of security, management, maintenance and data redundancy for large organizations, high initial costs for SMEs, mobility for all types of users, and licensing, sourcing and installation in academic environments.

Keywords: Virtualization, Information Technology, Virtual computing environment.

1 INTRODUCTION

Virtualization can be referred to as an act of creating an abstract version of something be it storage, desktops, servers, or networks. It is basically the process of taking advantage of excess processing, memory storage, networking, and capacity to create several artificial environments each having different functions. [1]

Virtualization has led to several spin-offs, one of which is cloud computing. Cloud computing and virtualization help arising issues in schools and offices that range from reducing information technology costs to making information technology as mobile as possible. The computing world is rapidly transforming towards developing software for millions to consume as a service, instead of running them on their individual computers. Presently, users access content across the Internet independently without reference to the underlying hosting infrastructure. This infrastructure consists of servers that are monitored and maintained around the clock by service providers. Today, cloud computing allows individuals and businesses to use software and hardware that are managed by third parties. Also allowing access to information and computer resources from anywhere that a network connection is available; it provides a shared pool of resources, including storage, networks, corporate and user applications. More recently, entire systems are provided to customers for access. We hear terms like desktop as a service, infrastructure as a service, and even data centre as a service. Unlike earlier services like applications as a service, storage as a service whereby the user still owns a computer but uses the service provided by the cloud provider because of personal insufficiencies like

cost, redundancy, licensing, compatibility and resource availability, these services eliminate the need for a user to even own a computer to use a computer.

2   MOTIVATION

The issue of mobility of computers and the applications that run on them has become a prevalent issue in modern day computing. The demand for computing anywhere with anything is increasingly high. Users want to be able to access their documents, use their important applications, and even their entire desktops on the go. They want to be able to do these without having to carry their computer systems everywhere with them. Tablets and "super smart-phones" have done a lot to an extent to resolve some of these issues as they are very light and easy to carry around and can carry out a couple of the tasks that the normal computer system should carry. But still these devices are too small (in terms of memory) to be really able to carry the many applications a user needs, or let alone process them. Also because of flexibility users would like to access the same thing with any device, instead of being tied to one device.

3   INTRODUCTION

The aim in this project is to design and build a virtual computing environment that can provide software as a service, desktop as a service, and storage as a service for use in academic or work environments.

The major objectives are as follows:

- Maximization of computer resources such as memory, processor, and storage.

- Improve security, mobility, maintenance and management of computer resources.

- To be able to achieve the concept of using multiple logical servers on a single physical server via hypervisors

- To design and implement a virtual computing environment providing software as a service   and storage as a service in schools and offices

- Virtual desktop implementation to provide desktop as a service with the use of thin clients and diskless nodes.

4   DESCRIPTION OF RESEARCH WORK

4.1   Implementation Details

4.1.1   Server Hardware

In the case of the full deployment the hardware used for the servers would be high-end production servers such as blade servers because of the amount of load in terms of concurrent users it will need to support. A factor of simultaneity of 0.7 can be assumed, bringing concurrent users to about 7000. Hence, a server farm that would be able to handle 7000 concurrent users would be required. A server farm is a collection of multiple servers maintained networked together to provide server needs far beyond the capacity or capability of one machine. Also, a blade enclosure or chassis is a physical enclosure which can hold multiple blade servers and provides services such as power (usually DC) and cooling, networking and various I/O ports for interconnection and management. In the case of the scaled deployment however, a desktop CPU with an Intel core2duo processor and a speed of 3.0GHZ will be used because of its flexibility, size, cost, and other advantages. It will be upgraded to have about 8GB of RAM and 160GB hard drive. It is believed that it will meet the scaled down requirements of the project. In Fig. 1 and 2 below pictures of the desktop CPU and Blade servers are shown.

Fig.1 (a) HP ProLiant BL465c-G7 Blade Server [3]. (b) Dell Optiplex 755 desktop CPU.

Fig. 2 An HP Blade Enclosure with 16 Blade Servers Installed and a Dedicated PSU at the Bottom [4]

4.1.2 Hypervisors

Blade servers are most cost-effective with virtualization. Blade servers and virtualization address the same issues: improving utilization of resources, consolidating to save space, reducing time to provision new servers, and improving manageability. Therefore, implementing them together as a hardware/software combination can provide the double benefits with a single implementation effort. Best practice requires that multiple instances of a server role be installed as virtual machines running on different blade servers boosting redundancy and efficiency much more. For example, there could be a situation where to exchange servers are running concurrently within the same blade enclosure or perhaps with the help of virtualization, within the same physical server. This is to provide redundancy and disaster recovery.

There are many different Type-1 hypervisors available, e.g. IBM z/VM, Oracle VM Server for SPARC (Scalable Processor Architecture), Oracle VM Server for x86, VMware ESX/ESXi, Microsoft Hyper-V, Proxmox VE, Xen Hypervisor, IBM Power VM, Parallels Server Bare Metal, Wind River Hypervisor, RTS Real Time Hypervisor.

The choice of the right hypervisor to use would depend on a lot of factors like cost, OEM supportability, features & capabilities, compatibility. Microsoft Hyper-V, VMware ESX/ESXi and Citrix Xen Server are the most common hypervisors used. For the full deployment any of the three would be sufficient. For the scaled deployment in this project, the Citrix Xen Server is the most ideal hypervisor Type-1 to be used on the desktop CPU because of its open source nature, the cost implications, integrated licensing, and seamless compatibility with the application virtualization software.

4.1.3 XenApp and XenDesktop

XenApp, an application virtualization software developed by Citrix systems. XenApp is a contender in the application hosting, application streaming and virtualization delivery market (alongside others like

VMware ThinApp, 2X Computing, and Microsoft App-V), allowing users from different platforms such as Windows, Linux, Mac, and also mobile devices to connect to and use their personal and business applications from anywhere in the world. It helps reduce the manpower, technology resources and costs for application distribution and management. With Citrix XenApp, an organization (academic or non-academic) can deploy secure applications quickly to thousands of users. Even users in the most remote locations of the world can have access to applications as long as internet access is available to such a user.

It is possible to publish entire desktops via XenApp, as if it were an application. But Citrix has a different package for desktop which according to them is easier in terms of management, configuration, and maintenance. The package is XenDesktop and XenDesktop is a suite that delivers Windows applications and desktops to any device. It makes the use of desktops very mobile, cost effective, controlled, and secure for personal and business use.

4.2   Installation

Before installation of XenServer on the CPU virtualization must be enabled from its BIOS. In this case the CPU processor is by Intel, so what would be enabled is VT-x. Below is an image of the management console of the XenServer hypervisor being managed from the Xen Centre software. The XenServer hypervisor is installed by booting the hardware from the installation media, in the case a bootable DVD drive. The Fig. 3 below shows the management console of the XenServer hypervisor showing its IP address and other details.
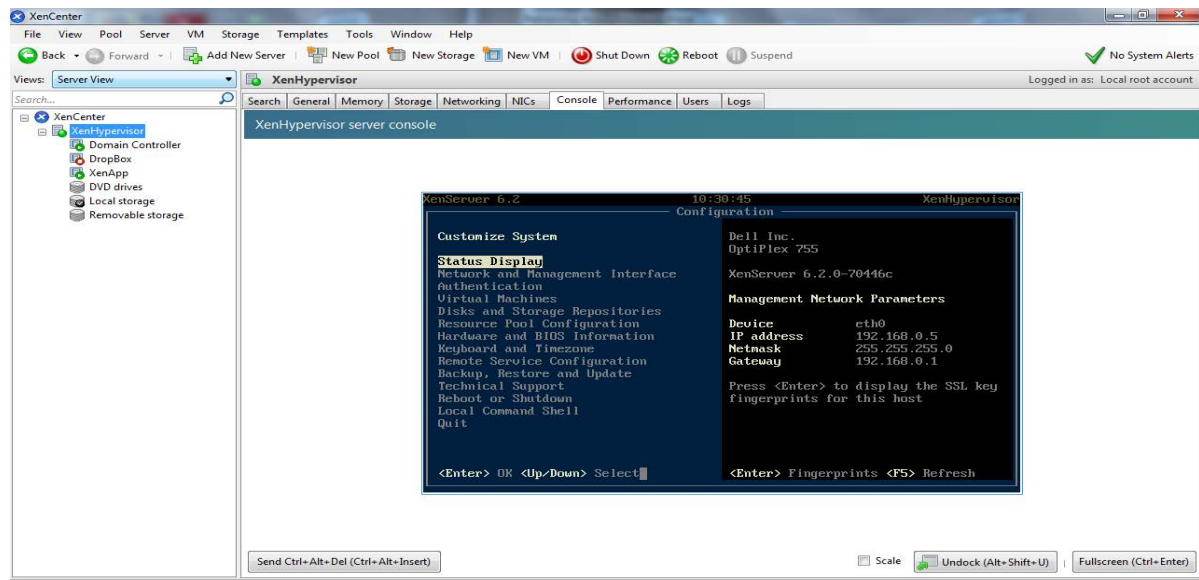

Fig. 3 XenServer Console from the Xen Centre software.

Further server consolidation would be achieved on the hardware by using just two virtual machines. The domain controller and active directory are in one VM and the remaining server roles in another VM (application, license, web and database servers). The domain controller would be installed on a different VM from the other server roles due to the incompatibility between the domain controller role and XenApp software when running on the same machine. The server hardware and its virtual machines are managed through a software called Xen Centre. The Xen Centre software is installed on a remote machine with network access to the XenServer. From the Xen Centre software, the server and its virtual machines can be fully managed and administered for installations and configuration. The XenServer is given an IP address for management and remote connections. The IP address given is: 192.168.0.5/24

The first VM is assigned with 1024 MB (1 GB) of memory, 24 GB of storage and 2 virtual CPUs. The VM is given a static IP of: 192.168.0.20/24 and the computer name: 'Domain-Ctrl'. This VM is assigned the role of the domain controller. Since no applications will be published over the internet or any server connected to the internet then a private domain can be used. The private domain given is: 'project.tobi'. Before setting a server as a domain controller, either .NET framework 3.5 or 4.0 must be turned on in the server feature manager; then the 'Active directory domain services' role must be

configured in the server role manager. The last stage would be then to run 'dcpromo.exe' in the command prompt interface of the server. This promotes a server to become a domain controller. The dialogue boxes thereafter then allow the administrator to set the domain name and other features. The computer name of the server would then become: 'Domain-Ctrl.project.tobi'.

The second virtual machineis assigned with 4096 MB (4 GB) of memory, 80 GB of storage and 2 virtual CPUs as well. The VM is given a static IP of 192.168.0.22/24 (Citrix recommends using a static IP) and computer name: 'Xen app Server'. This VM is assigned all other server roles in the XenApp infrastructure besides that of the domain controller and active directory. In this scaled-down deployment this virtual machine will play the following server roles:

- Application server,
- Web server (IIS),
- Database server, and
- License server,

The OS installed on this VM is Windows Server 2008 R2 standard edition, full installation. Note that the Web Server edition and core installation option of Windows server are not supported by XenApp 6.5.

The computer name given to this VM is: 'XenAppServer' and when added to the domain it becomes: 'XenAppServer.project.tobi'. Before the installation of XenApp server roles can begin on the machine, a few things must be done to prepare it. One of which is to ensure the .NET framework 3.5 & 4.0 are installed on the server. The .NET framework 3.5 can be turned on in the features console of the server manager, while version 4.0 is contained in the installation pack of XenApp 6.5.

The web interface server role needs to be configured. The web interface is configured by creating a XenApp website in the Citrix Web Interface Management console. User point of authentication is specified to be at the web interface. The farm name is specified and the servers to use this website are added also. The URL of the website is then: 'http://XenAppServer.project.tobi/Citrix/XenApp'. This URL can be entered into the web browsers of client devices to gain access to the applications being published by the application servers in the XenApp infrastructure. A services website is also configured on the Citrix Web Interface Management console so as to allow applications be accessed on user devices via the Citrix Online Plug-in and Citrix Receiver (mobile devices). The URL of the services website is: 'http://XenAppServer.project.tobi/Citrix/PNAgent'.

The next stage in the installation process is to run server farm discovery within the domain using the discovery tool in the Citrix AppCenter console. This discovery tool will add all servers within the server farm running XenApp 6.5 to be managed centrally for application delivery. It is on this console that applications are published.

Before an application is published on the Citrix AppCenter console using the hosted application model, it must first be installed on the application server. This installation isn't the native installation process, but installation using the remote desktop application installer in the control panel of the server. This kind of installation prepares the application to be used over RDP connections. The applications installed through this process to be delivered in the streamed model are:

- Foxit PDF Reader,
- Proteus Design Suite 7.7,
- Microsoft Office 2013.
- Video Lan Client
- GNS3
- E Sword

Once the applications have been installed using the RDP installer they must published from the XenApp infrastructure. The applications are published using the 'Publish Applications' wizard in the Applications pane of the XenApp Centre software on the application server. In the process of publishing an application the administrator must specify some details such as; whether the application is to be streamed or hosted, the executable file to launch the application, the servers in the server farm on which the application is to run when being delivered via ICA, the users allowed to use the application, the application icon to use, and whether or not to add the application to the client's start

menu. Fig. 4 below shows the applications presently published on the applications pane of the XenAppCenter software.
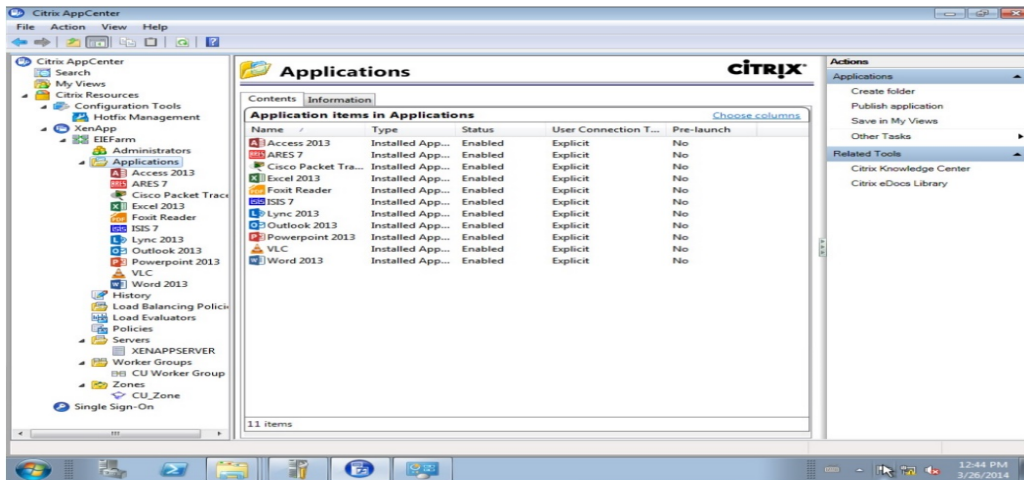

Fig. 4 Published Applications on Citrix XenCenter.

Published applications would be accessible over the switched network to configured users from the active directory of the domain controller. Users would be able to use applications and desktops via desktops, personal laptops and other mobile devices.

4.3   Testing

Published applications were tested on two operating system platforms (Windows and Macintosh) and two mobile device platforms (iOS and Android) using Citrix Online Plug-in Citrix Receiver as the client software. The client devices were connected to a wireless network on which the hardware server was connected as well.

For the Windows 7 test, the Citrix Online Plug-in was used. Fig. 5 below shows the published applications shown in the 'Citrix Applications' folder in the start menu of a Windows 7 laptop with Cisco Packet Tracer executed.
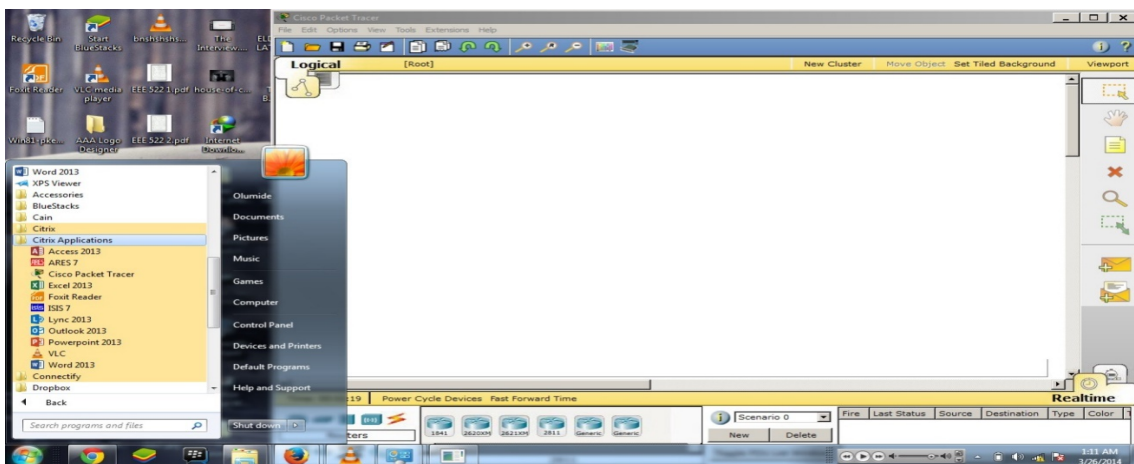

Fig.5 Windows 7 laptop showing published applications; Cisco Packet Tracer executed.

For the Macintosh test, the Citrix Receiver client software was used. Fig. 6 below shows the published applications in Citrix Receiver with ISIS 7 executed on a Macintosh laptop running Max OS X Mavericks.
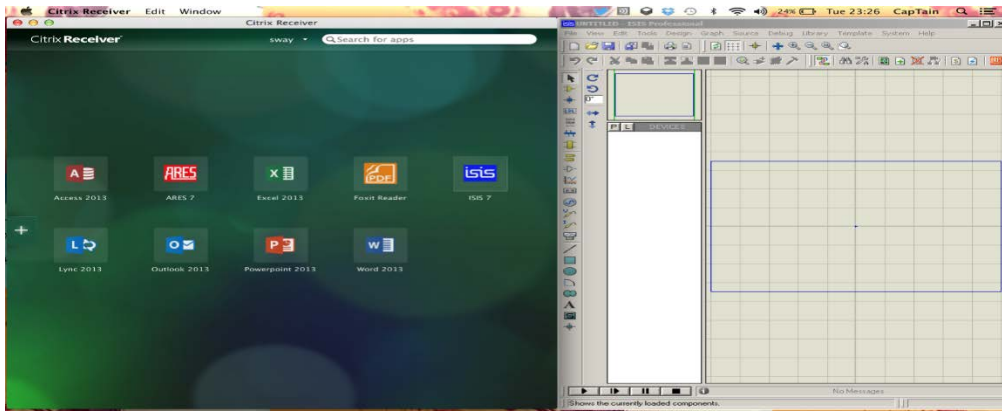
Fig. 6 Macintosh laptop showing published applications with ISIS 7 executed.

For the iOS test, the Citrix Receiver client software was used (installed from the Apple App Store). Fig. 7 below shows the published applications in Citrix Receiver with ISIS 7 Executed on an iPad (running on iOS 7.0.6).
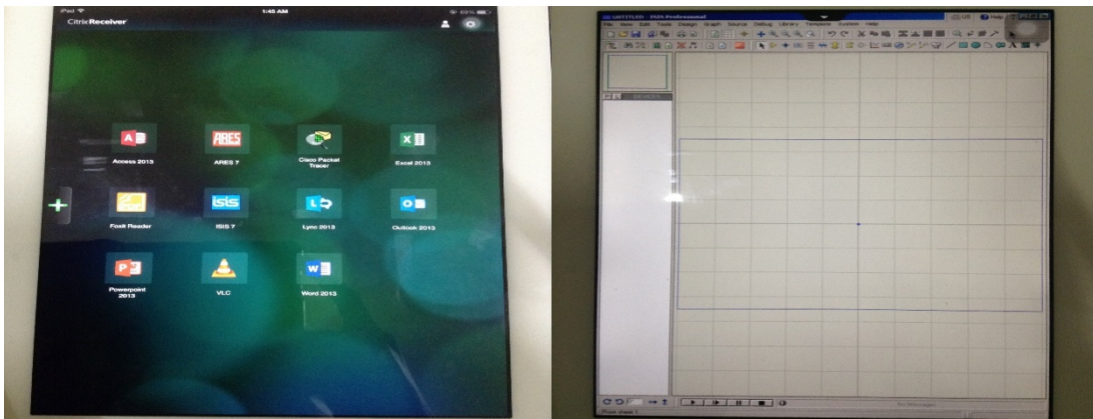

Fig. 7 iPad showing published applications and ISIS 7 executed.

For the Android test, the Citrix Receiver client software was installed from the Google Play Store. Fig. 8 below shows the published applications in Citrix Receiver with Excel 2013 executed on a Lenovo Android device (running Android 4.2.2).
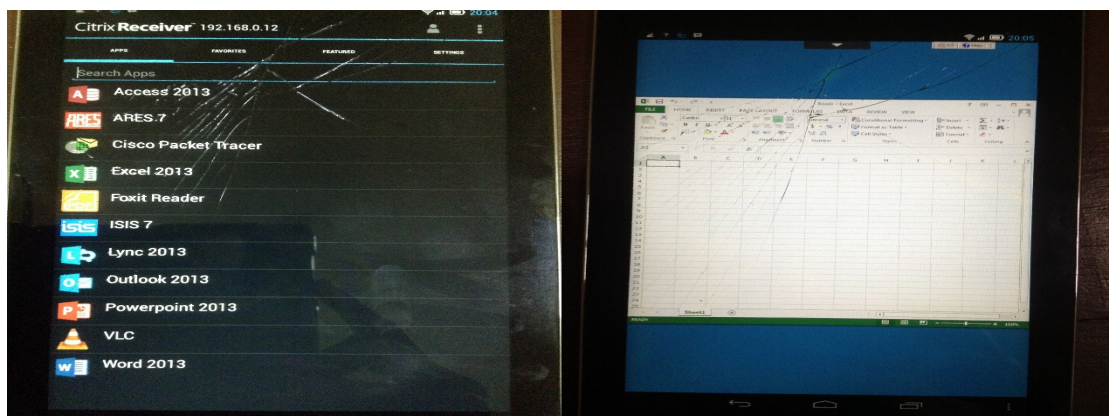

Fig. 8 Android device showing published applications with Excel 2013 executed.

5   CONCLUSION

In conclusion, this project has proven that it is in fact possible to deploy applications and desktops from the cloud, providing solutions to the issues of mobility and compatibility that users encounter.

Users are now able to access their documents, use their important applications, and even their entire desktops on the go. They are able to do these without having to carry their computer systems everywhere with them. For organizations, we see how easier data recovery, data redundancy and also maintenance and management of information technology can become. This project is also able to help reduce cost of information technology, especially for consumers and small enterprises. For instance, for small enterprises virtual computing helps convert capital costs to operational costs.

However the requirements for these deployments if not outsourced to a third-party is very large and initially will cost a whole lot of money. Organisations will have to go through lot of planning and budgeting to be able to back the huge decision of moving to the "cloud".

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