Demystifying desktop virtualization

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Abstract: - This paper presents concepts of virtualization techniques. Both server virtualization and desktop virtualization are briefly presented, but desktop virtualization is discussed in more details. As the size of computer systems grows every day with new applications, and with new client and market requirements, it is obvious that something must be done to ease the administration and effectively secure data. Additionally, disaster recovery plans must be improved too. Virtualization has solved many of these requirements and has become more and more popular so that many companies decided to implement a virtual server, virtual storage or/and virtual desktops. The paper lists the reasons why to implement virtual desktops and servers and what are the main benefits of such implementations. Virtual environments the also have some downsides, which are presented, explained and compared to the advantages.

Key-Words: - desktop virtualization, virtual machine, infrastructure client, connection manager, thin client

1 Introduction

Manual administration of many separate computers is hard, tedious and time consuming job. A variety of choices exists for installing and reinstalling of different software and hardware by a user at a local computer. To avoid that, terminal servers are widely used as separate location for running applications which users can access and use, whilst the security of the applications is maintained at the servers. The desktop virtualization has a similar concept.

The idea of the desktop virtualization is to replace the user's computer with a virtual one. While the user's computer resides on a table, the virtual computer is located within security of a datacenter's server room. Users connect to their virtual machines using desktop-clients as a minimal resource. Desktop-clients can be devices without any preinstalled software, like operating system etc. Also, desktop-client can be a classic old PC having a small amount of RAM and slow processor; it can be a MAC PC or some special device such as the Pano or Wyse. Desktop-client is used only to connect to a virtual machine, like using a terminal server, but it gives the user much more flexibility and autonomy.

The main advantages of this centralization are lower costs and ease of administration. There are some advantages already introduced by virtual servers, also available within virtual computers – high reliability and availability of the system, flexibility of update, mobile access, etc.

In this paper we describe the concept of virtualization, use of desktop virtualization within leading companies, discuss reasons for its usage and give main advantages, along with some imperfections of virtual machines (virtual desktops).

2 Virtualization

In computer science, the word *virtualization* is used for abstraction of computer resources, such as memory, network, processor, application, etc [2], [5], [6]. When we talk about virtualization, we mean the platform virtualization, which in fact represents the computer virtualization or the virtualization of the operating system [2]. The core of the virtualization which handles virtual computers is called hypervisor. The virtualization can be categorized according to the level of virtualization and operating mode of the hypervisor. Based on the operating mode, we distinguish non-hosted hypervisor and hosted hypervisor. While the first one operates directly on hardware (e.g. Xen, ESX Server), the second one performs within another operation system (e.g. Microsoft Virtual PC and Vmware Workstation) [3], [12], [16]. The categorization based on the degree of virtualization is a bit more complicated. The main categories are as follows:

a) Full virtualization – implements the complete platform and enables the usage of a virtual operating system. The guest OS is fully abstracted from physical devices and it does not make difference for being virtualized. Representatives of full virtualization are: Qemu, Vmware ESX, Vmware Workstation, Virtual Box, etc.

b) Hardware assisted virtualization – the virtualization which is partly derived from the hardware. There are instructions in OS that have access to hardware directly, without any OS modification or emulation. The examples are: IBM POWER, Intel VT and AMD V instruction. In Linux there is KVM as the most advanced hardware assisted virtual system.

c) Partial virtualization implements only some specific parts of abstraction. This solution will allow the division of resources and the isolation of the processes but not starting of another operating system. For each and every process and user separate address space is used.

d) Para virtualization enables computer to run a separate operating systems. Those operating systems have to be changed for hyper calls of the host. Para virtualization involves modifying the OS kernel to replace non-virtualizable instructions with hyper calls that communicate directly with the virtualization layer. An example is Xen. Para virtual systems suffer limitations in combining different systems, migration of virtual computers from one platform to another because of platform itself, and of kernel dependence, but they have much better performance compared to partial and full virtual systems because of their dependence on the workload.

e) The virtualization of the operating system only – without virtualization of the hardware, which means that different instances of the same operating system can be run on the same hardware. The examples of this virtualization are OpenVZ and LinuxVserver.

There is plethora of forms of virtualization today. Virtualization of server infrastructure is the most dominant form today, but the latest one at the moment is the desktop virtualization. These forms are used: server virtualization, storage virtualization, network virtualization, application virtualization, desktop virtualization [10], [12], [13], [16].

The main reason for the usage of virtualization today is the variety of ways in which it can be used. One of them is consolidation of servers, whereby one can economize the server room. Virtualization has found its users among developers of operating systems and kernels. Facilities for debugging are also very good.

The end-users would use the virtualization mostly for the testing of new applications, new operating systems, etc. One of the most attractive ways in which we can put virtualization into good usage is the user's desktop. The paper further deals with desktop virtualization and its main characteristics.

3 Desktop virtualization

The term *desktop virtualization* describes two complementary technologies: server-based and client-hosted virtualization. In both of them, a standard desktop operating system is encapsulated in a virtual machine that can be accessed by the users. When client-hosted virtualization is concerned, a virtual machine resides and operates on a client itself. Client runs an operating system and an application for virtualization. Server-based desktop virtualization runs multiple virtual machines on a server and the user just get remote display at his/hers PC, thin client or specialized device such as the Pano or Wyse.

Which of these technologies one will use, depends on the requirements that must be met. For example, if one needs a solution to secure company data, the server-based solution is a good choice. On the other hand, if one needs to provide a corporate desktop and a set of applications to the laptop of an employee who travels a lot and who needs to work offline or over a limited-bandwidth network connection, the client-hosted solution would be the right choice.

3.1 Understanding virtual desktop infrastructure

Virtual Desktop Infrastructure (VDI) is a new architectural model for desktop virtualization that allows client operating system to run in server-based virtual machines. Client desktops can run on both thin client and desktop PC. Storage, execution and management of virtual desktops are placed at the datacenter. A typical implementation of Virtual Desktop Infrastructure has the following components:

a) Hypervisor – software that enables virtualization and hosts desktop images. As we have already mentioned, there are two types of hypervisor. The first one is a software system that runs directly on the host's hardware. Operating system runs on another level above hypervisor. Often, we can find names like bare-metal and native for this type of virtualization. The second type is software that runs within an operating system. The guest operating system runs at the third level above the hardware.

b) Virtual Machine Manager – application aimed to manage virtual machines. User can create, start and stop virtual machines. The users can also view and control each virtual machine console, preview performance statistics and status of some other things.

c) Connection Broker – software installed on a separate virtual server. There can be one or more servers in the same network. Connection broker manages requests from thin clients or software clients, connecting these requests to the pools of the virtual desktop. Usually, terms *connection manager* or *virtual desktop manager* are used for connection broker.

d) Virtual Machine – software implementation of a computer that executes programs like a real one. This virtual machine is isolated from any hardware. There are two types of virtual machines: process and system virtual machines. *Process virtual machines* are designed to run a single program, as opposed to *system virtual machines* which are running complete operating system. For the system virtual machine we can find also the term *hardware virtual machine*.
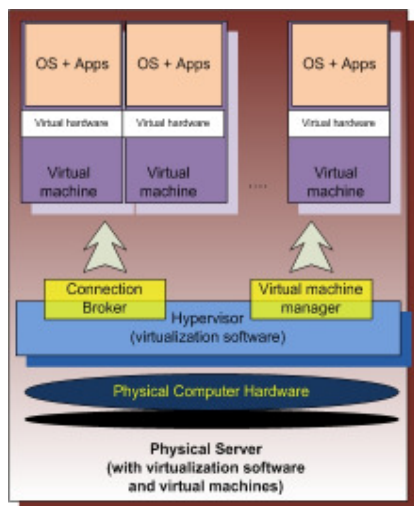

Figure 1. Virtual desktop infrastructure (VDI)

3.2   VDI - Implementation

There are two core architectures of **VDI** – static and dynamic. Which architecture option will one choose depends on the needs of the company. If one wants to have for each user a unique VM, a static mode will be chosen. In the static (or *persistent*) architecture option, one-to-one mapping exists between users and virtual machines. Each user has his or her virtual machine, so the more users are needed, the more virtual machines must be created and managed. The virtual machines usually are stored on a storage area network (SAN) or network-attached storage (NAS). Virtual desktops are presented via VDI to standard desktop PC or thin client.

In the dynamic architecture option (*non-persistent* option), single master virtual machine image is residing on the hypervisor and VDI system automatically replicates this image as needed for users. Application for users are distributed based on user profiles and profile rights, and user data are stored centrally on the server via Folder Redirection. Having only a single virtual machine

image to maintain, the management overhead and support costs are significantly reduced, while dynamic provisioning of desktop environments is enabled on demand.

3.3   Benefits of VDI

Virtualization brings many advantages and some of them are presented in this section.

Data are more secure with virtualization. One can prevent users to copy files from virtual machines or lock down image from external device. Sensitive data are stored on server at the data center, not on remote devices like notebooks. In this case, if a device is stolen, the information is protected.

IT management is simplified. Excellent management tools can be found for administration and control over VDI. It is really demanding and highly inefficient to administer hundreds or more physical devices. With virtual technology, deployment of virtual desktop and software is very simple and fast. Also, administrator can remotely start, stop and get control over a virtual machine.

With easy managed VDI system, based on templates of virtual machines, we can ensure that users are forced to comply with relevant laws and company regulations.

With the cost of VDI deployment of only 40-50$ per workplace, there is no need for hardware upgrade. Of course, this depends on the purchased product and requirements of company. One can choose freeware and use old physical PCs as desktop clients or can use environment that will cost 1000$ per workplace with specialized devices such Pano and Wyse. Even so, the cost of maintenance of a workplace based on virtual machines is still lower.

Each virtual machine is an image that can be simply copied or moved. Also, with VDI technology and snapshots there is a possibility to roll back desktops to different states. This gives a lot of flexibility to end users and the administrator can quickly recover data or/and the whole virtual machine.

Using VDI and thin clients, there is a reduced carbon footprint on our planet [14]. A thin client consumes less electricity than a desktop computer. There are thin client devices that use less electricity in normal work than a physical computer in "stand by" mode.

One can use any device for connection to a virtual desktop. Also, if one has a DSL connection there are no limits where to connect from. All that one needs, is a VPN account and a configured and assigned virtual desktop.

There can be several (different) virtual machines (desktops) residing on a single physical server. By consolidating servers, we maximize utilization; the same is with virtual desktops.

Integration is highly simplified with VDI, which can be integrated with almost any hardware, being that a processor with only 300 MHz and just 128 MB of RAM or even weaker. There is no need to buy more expensive hardware in order to implement the VDI technology.

3.4 Advantages vs. Disadvantages

In this chapter the VDI advantages are compared to VDI disadvantages. Most problems arise from poor support. Regarding performance, virtual machines are somewhat slower because of an application that runs and manage the VM. Decoupling from physical hardware means access to the device through the virtualization solution we have chosen, and this may not always be possible. Problems with poor video and audio support as well as peripheral devices support like PCMCIA are frequently encountered. Many graphics or processor-intensive desktop applications work over physical infrastructure much better than over VDI. Problems arise when all desktops share the host server's processor and memory. Regarding graphics and audio too, all the execution takes place at the server and is presented to the user via a RDP. It is well-known that RDP is not optimized for streaming.

Another downside of desktop virtual machines is impossibility of offline work. When the problem with network occurs, the user's work is interrupted and they have to wait for network to become serviceable again. VDI cannot be used in tunnels or in a plane.

Also, the storage can be a source of problems if one hosts many VMs on an expensive SAN or NAS while trying to use virtualization desktop to lower the cost; storage at a reasonable price needs to be found.

Other problems on the host can cause all VMs to stop working, but this problem can be partially solved with host redundancy. There are no real standards in virtualization. Virtualization implies big changes to the whole system, certainly causing new kinds of problems. It can be very complex to provide a solution for this new problem, and it may require new tools and know-how to be implemented at the IT center.

Also, there is a problem with old applications that are dependent of MAC address of some hardware components, applications that use COM+, applications that install system drivers or boot-time services. Of course, the list of problems is far from being complete. It does not mean that it is impossible to virtualize some of the applications using above specified features, but problems can be expected in that area.

Advantages	Disadvantages
Utilization increased	Performances degraded
Live Backup and migrations	No real standards
Cloning and snapshots	storage
Energy saving	Complex root cause analysis
Administration is easier	New concepts and tools
-	Low graphics
Go green	Multimedia performance - poor
Manage and monitor regulatory compliance	-
Flexibility and mobility	Peripheral support - poor
Reduced costs	Cannot work offline
Disaster recovery	Single point of failure (SPOF)
Data security	can't virtualize just everything
Lower noise	

Table 1.

3.5 VDI – Trends and statistics

Virtualization grows rapidly [7], [9], [17], [18]., as showed by the results of a survey conducted in 2008 (IDG - (International Data Group[1]). Reasons are mostly found in cost reduction. Also, interest for desktop computers grows because of secured and manageable desktop environment with centralized administration/provisioning capabilities that are created

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[1] IDG – research service company (www.idgresearch.com)

within the last few years. Generally, desktop virtualization is favorable. IDG's survey shows that over 50% of the companies who deployed VDI, report that it has met their expectations.

To a question associated with desktop virtualization benefits, most respondents answered with cost reduction (54% of respondents), more manageable desktop environments (54%) and ability to provision PCs and other client devices with software from a central location (52%).

The normal investment in VDI is between $600 and

$900 per desktop whereas the desktop client costs about $300. One can fare better, but offten this is not good enough. It is also necessary to invest in adequate hypervisor. Hypervisors (such as Vmware ESX, Microsoft Hyper-V, Citrix XenServer, and the other) differ among themselves in connection broker. [1],[2], [4], [6] Many of them use Microsoft's RDP (Remote Data Potocol) to hande client-server connection, and the other use proprietary protocols to apply compression and other optimization techniques [2]. Qumranet has a rendering protocol called Simple Protocol for Independent Computing Environments. This protocol is aimed to multimedia support. Citrix uses ICA – Independent Computing Arhcitecture communications protocol and has its own metod for optimization.

Today, many solutions can be found at the market, but until now, none has been found that can replace the classic physical infrastructure completely.
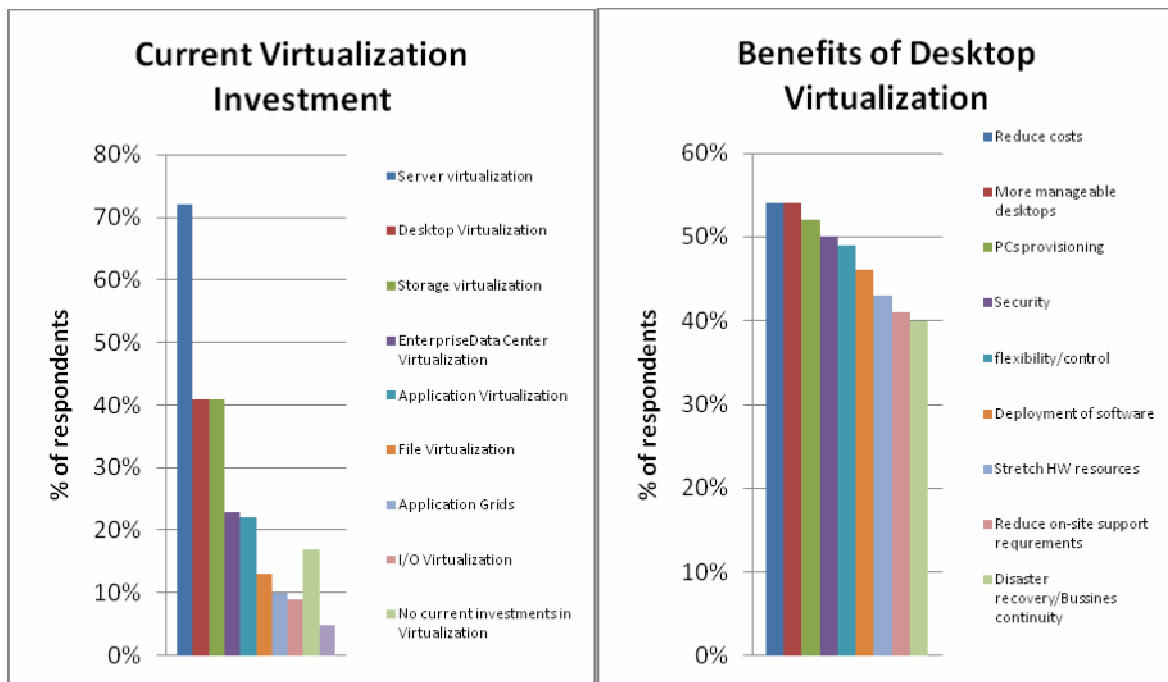

Fig 2. Trends in Virtualization

4 Conclusion

Desktop virtualization requires hypervisor running on a data center server to host the desktop virtual machine. No real standards are set up until now. In a company, more than one hypervisor can be set up , but for some jobs it is still better to use classic desktop computers. Having more than one different hypervisor, more than one management software is required so far. In last several months, software capable to administrate simuntaneously more hypervisors and physical computers arrived at the market.

There is no general recipy, a lot depends of someone's needs. If one needs security and flexibility, also better performance and independence from always-on network connection, s/he will choose a vendor who offers something like MokaFive's Live PC. With them, one can use the best of server-based and client-hosted desktop virtualization technologies.

Local virtualization makes sense for mobile workers, who can use separate operating systems, one or more for business use and one for personal use.

Desktop virtualization technologies offer many advantages, but attention must be paid what is the main goal and accordingly which technology to implement – to follow the trends, to reduce costs, to make administration easier, to achieve user flexibility or something else.

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