

VIRTUALIZATION IN THE CLASSROOM

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ABSTRACT

This paper briefly describes the growth of computer virtualization and some of the reasons for that growth. The paper takes a quick look at Microsoft Virtual PC as one example of virtualization software and then examines how the benefits of virtualization apply to the classroom and computer lab. The paper describes how virtualization can help reduce the cost of classroom computing while offering students and staff a wider range of options than may currently be possible. The paper also describes how virtualization can help with classroom support functions, compatibility issues and safe and secure computing.

Keywords: Virtualization, Virtual Computer, Classroom, Computer Lab

INTRODUCTION

Virtualization is a hot topic in the IT industry. A recent report by IDC found 80% of surveyed companies plan to add virtual computers to their systems [1] while another survey predicted that 15% of all new servers will use virtualization in 2010 [2]. A paper from Dell quotes another IDC study predicting that worldwide spending on virtualization will be close to \$15 billion by 2009. The same paper says that Gartner labeled virtualization as a “megatrend” at the Gartner Symposium/ITxpo 2005 [3].

According to VMware, a leading vendor of x86 virtualization software, virtualization “describes the separation of a resource or request for a service from the underlying physical delivery of that service” [4]. Virtualization may involve the creation of virtual machines, virtual hard disks or other virtual resources. Some virtualization software takes a “hosted” approach with the virtualization service sitting on top of the normal operating system while other systems take a “hypervisor” approach where the virtualization service runs directly on the hardware without an intermediate operating system [4]. Approaches to virtualization may involve software only, software integration with the operating system or systems with direct processor support [5].

The potential business benefits of virtualization in business are many and include: [3, 4, 5, 6, 7, 8, 9]

- Partitioning
- Isolation
- Encapsulation
- Workload consolidation
- Increased server utilization
- Decreased hardware cost
- Legacy application support
- Secure and isolated execution
- Ability to run multiple operating systems simultaneously
- Test systems and software in a fault-tolerant, error contained environment
- Reduce support costs
- Support backup and recovery efforts

While many papers discuss the virtues of virtualization in the business world, few discuss the potential benefits for the classroom. This paper examines how the business benefits of virtualization apply to the classroom and makes suggestions for more flexible and cost effective classroom/computer lab environments. We specifically look at the use of Microsoft Virtual PC 2007 in a classroom/lab of Windows® based x86 computers.

MICROSOFT VIRTUAL PC 2007

Microsoft became a player in the virtualization marketplace when it acquired Virtual PC and Virtual Server from Connectix in 2003 [10]. Microsoft Virtual Server 2005 R2 is designed to facilitate testing and development of server applications, server consolidation and application migration [11]. It is not designed for desktop operating systems. Virtual PC 2007, on the other hand, is designed for desktop operating systems and has been optimized to work with both 32 and 64 bit versions of Windows Vista [9]. Both Virtual Server 2005 R2 and Virtual PC 2007 are available from Microsoft at no cost.

Execution of Virtual PC 2007 causes a small Virtual PC Console window to open on the desktop (Figure 1). The Console window shows all currently installed virtual machines and allows the user to start or manage each machine, create new machines and remove existing machines from the console. Figure 1 also shows the configuration settings available for each virtual machine, in this case a virtual Windows XP machine. Configuration settings are stored in a .vmc file with the name shown in the File Name property.

Each virtual machine has up to three virtual hard disks. Virtual hard disks are files with the .vhd extension that function exactly like physical hard disks. Virtual PC supports several different types of virtual hard disks including 1) dynamically expanding disks, 2) fixed sized disks, and 3) linked disks (the virtual disk links directly to a physical disk drive). Additionally, Virtual PC supports Undo disks (all disk changes are temporary until specifically merged with the original disk) and Differencing Disks (a shared common disk and a local disk containing only local changes)[9].

Virtual PC allows a virtual machine to attach to local optical drives or to use an .iso image directly (most Microsoft Academic Alliance software is downloaded as .iso images and can be read directly by a virtual machine). Virtual machines also support floppy disk drives, or images, com and lpt devices, sound, the mouse and the display. Each

virtual machine supports up to four network adaptors. These may be network adaptors physically present on the host computer, a local connection between virtual machines running on the host or a shared Network Address Translation adaptor that allows several virtual machines to connect to the Internet over a single dial-up service [9]. Finally, a virtual machine may share one or more folders with the host. Inside the virtual machine each shared folder is treated like a mapped shared drive.

VIRTUAL PC IN THE CLASSROOM

Virtual PCs are easy to install in a computer lab setting. Computer settings and virtual hard disks can be configured once and then duplicated to any number of host computers. Our technical staff creates or copies virtual machines on a master system and then ghosts the images to other machines in the lab. This section looks at some of the ways IS classes can realize the benefits of virtualization.

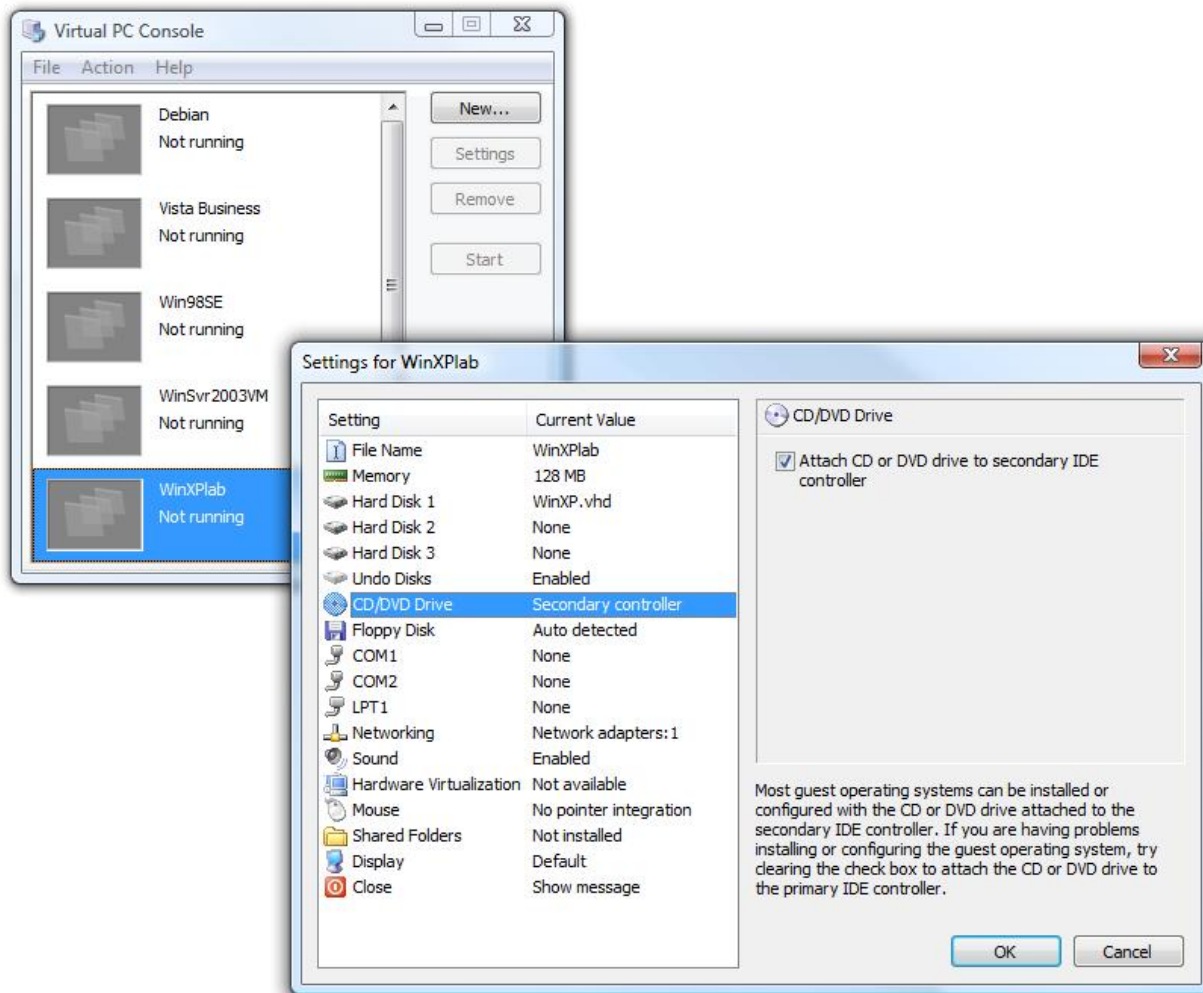


Figure 1. Virtual PC Console and Settings Window

Partitioning and the ability to run multiple operating systems simultaneously

Multiple operating systems can run on a single host at the same time. Figure 2 shows four virtual machines with four different operating systems (Windows 98 SE, Windows XP, Windows Server

2003 and Debian Linux) all running in Microsoft Vista on a 2.16GHz Centrino® Duo notebook with 2 GBytes of RAM. As shown in this figure, Microsoft Virtual Server 2007 supports a wide range of Windows operating systems from Windows 98 SE through Windows Vista and some non-Windows systems including several variations of Linux.

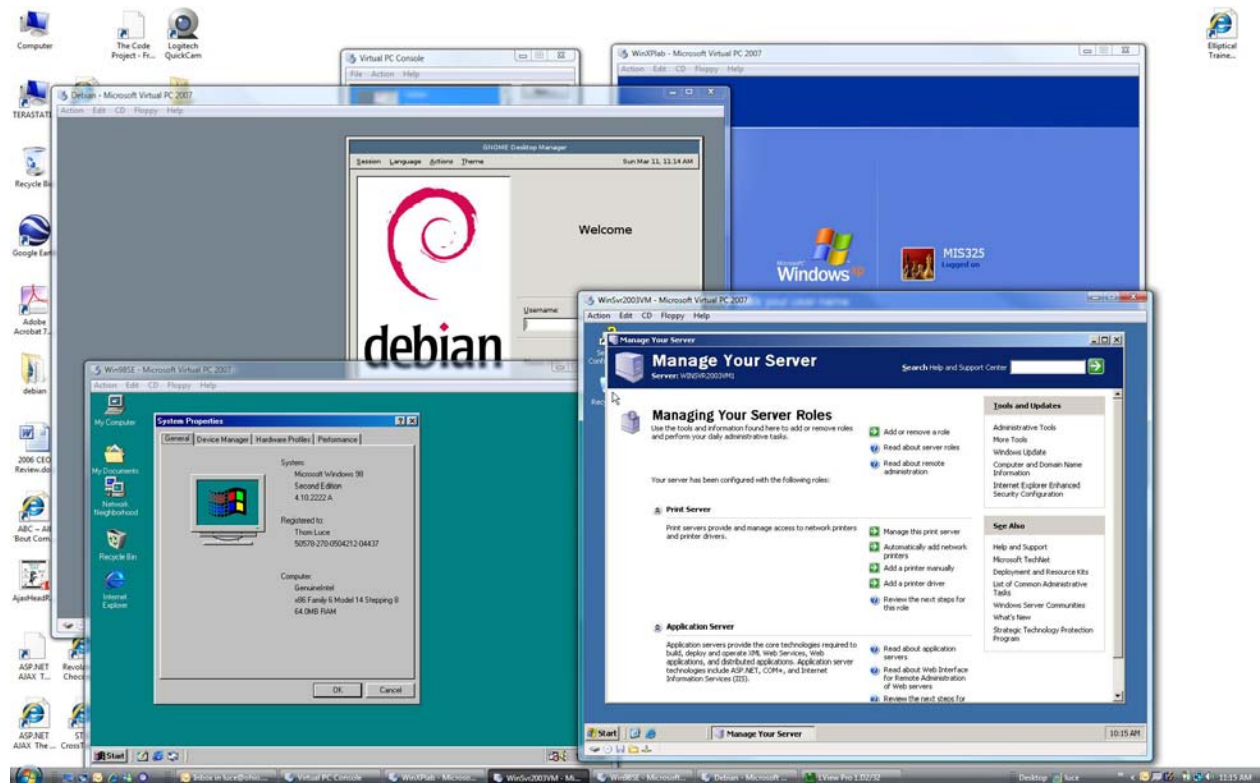


Figure 2. Multiple virtual machines running on a Microsoft Vista host

Partitioning facilitates more efficient use of classroom computers. For example, the same computers could be used to teach Linux operations in one class, Windows Server 2003 networking in another class and still support general office applications in Windows XP during open lab hours. Alternatively, virtual machines running Internet Information Server (IIS), SQL Server, SharePoint Server and Exchange Server could all be hosted on a single physical system thus reducing the classroom hardware cost.

Isolation:

Programs running in a virtual machine are completely isolated from other virtual machines and the host computer. Data can only pass between a virtual machine and its host computer via shared folders, a linked disk or a network connection. Beta

software and software of unknown origin can be installed and tested on a virtual machine without concern for damage to the host system. For example, a virtual machine could be used to check downloaded software for malware or to test known buggy software. If the software does harm the computer or disk, by intent or accident, only the virtual equipment is affected. If an Undo disk was used the changes can be instantly removed. If an Undo disk wasn't used it may be necessary to rebuild the virtual disk but in neither case should the underlying hardware be damaged.

Isolation means that an entire class can install an operating system or other software, configure software, create users accounts and groups, set security policies, and configure software firewalls, etc. without destroying the computer lab. At the end of the exercise all the changes can be quickly

removed and the pristine systems made available for the next class.

Encapsulation

Entire operating systems with installed software are stored in a single file which can easily be copied, moved from one host to another and backed up. And, once a virtual hard disk is created and duplicated you have a consistent environment across all copies. This means you can create systems with consistent configurations, or even known problems, for student use.

Workload consolidation and increased server utilization

Virtual machines allow you to run several stand alone server systems on one physical computer. This means less hardware, smaller electric bills, fewer uninterruptable power supplies, lower air conditioning requirements, fewer machines to secure, etc. It also means an easier migration path when more power is needed because the virtual machines can easily be moved to newer, faster, hosts with little or no compatibility concerns.

Decrease hardware cost

With virtual machines you may be able to replace three or four servers, each running at 5%-20% capacity with one server running at 50-80% capacity. Instead of a Linux lab, a Windows desktop lab and several Windows server machines you could have one lab with a Windows desktop host and virtual machines for Linux and one or more Windows Servers. In this configuration one lab can serve the needs of two, three or four labs and all machines will experience higher utilization than in the multilab scenario.

Legacy application support

This may be one of the most important points for the academic environment. Consider some of the major questions faced by schools in 2007 – Should we upgrade to Windows Vista? Will our existing

applications run in Vista? How will we retrain the staff? Our instructors? Our students? Virtualization can help with these problems because Virtual PC 2007 is designed for Vista and can easily support virtual machines running Windows XP or another version of Windows and your current applications can be installed in the virtual machine.

Secure and isolated execution and test systems and software in a fault-tolerant, error contained environment

Each virtual machine runs in its own virtual memory and has its own virtual disks (unless linked disks are used). Because of this, each machine is completely separate from every other machine and any errors or problems that occur in a virtual machine are completely isolated in that machine. This provides a secure resource for testing unknown or buggy software, checking for compatibility issues, experimenting with beta versions of software and operating systems, etc.

Our computer labs are locked down. Students can't see the C drive. They can't open a Command window or change desktop properties. They can't configure network connections or do most other computer management activities. However, students in the virtual environment can see the C drive. They can examine and configure network connections. They can set desktop properties and manage the computer. They can play with firewalls and IP Security policies. They can do these things without risk to the host computer system. Figure 3 shows the disk and share configuration of a Windows Vista host computer. The insert shows the same information for a Windows XP virtual machine running on the host. As shown in the figure, the host computer has multiple hard disk partitions, two optical devices, several removable devices and access to a number of shares on the Terastation network storage device. The virtual computer, running on the host, has its own C drive, one optical device, one folder shared with the host (Z) and access to the same Terastation shares.

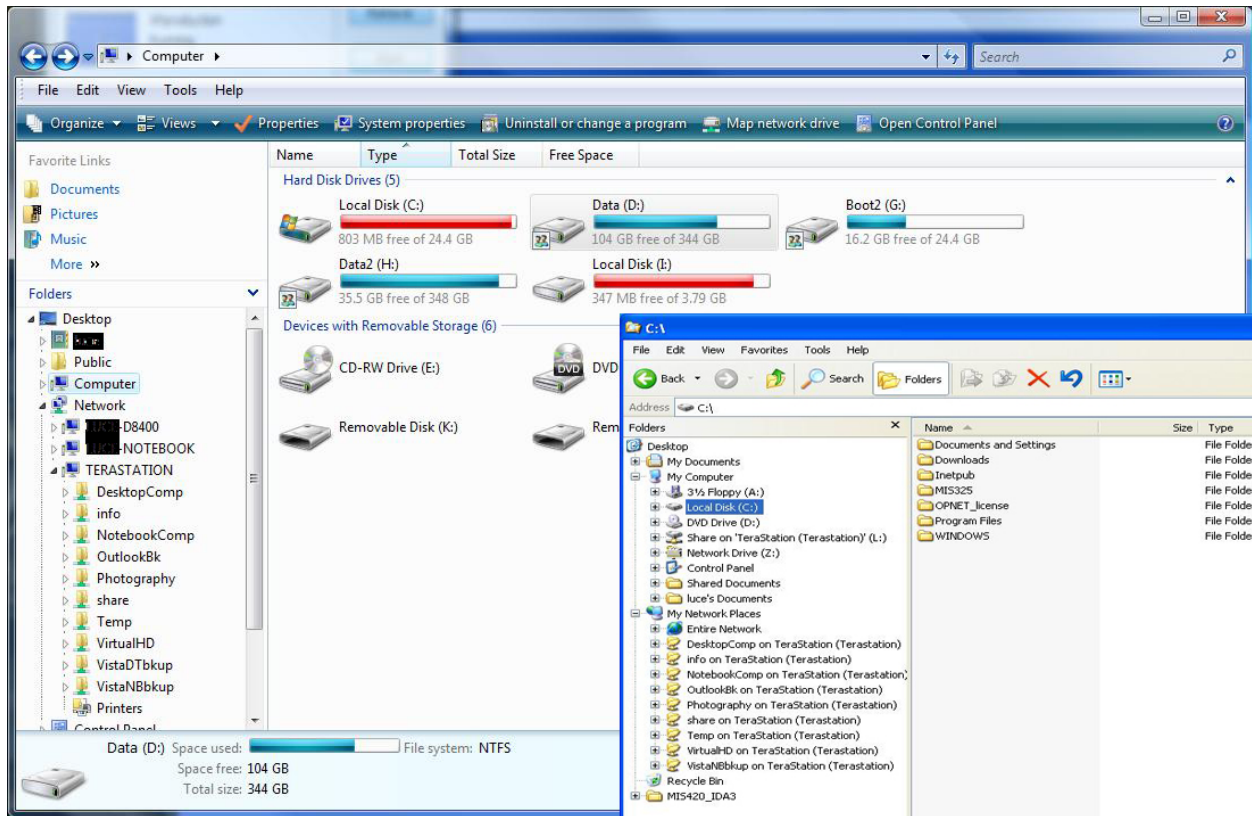


Figure 3. Host and virtual computer configurations.

Reduce support costs

Classroom support cost may be lower because fewer machines are required. Costs are also lower because most disasters that would normally require rebuilding, or re-ghosting a computer can be prevented by simply discarding the Undo disk. In the event that the Undo disk is merged into the original image the changes can still be undone by copying a backup version of the virtual disk on to the computer.

Support backup and recovery efforts

Backup and recovery are easy with virtual machines. Virtual disks are backed up by copying them to another hard disk, optical device or other storage device. Virtual machine .vmc files are very small and can be backed up on any storage device, including a flash drive (virtual hard disks can also be copied to flash drives if they are small enough).

SUMMARY

Virtualization offers numerous benefits for the classroom and computer lab. Virtualization allows you to offer students a variety of operating systems and applications while reducing the total number of computers required. Fewer computers mean lower equipment and support cost. Virtualization provides

a safe environment for students to install operating systems, server and application software and configure systems. It provides a safe environment for network configuration experimentation. Virtualization provides a way to have the latest software and operating systems while maintaining compatibility with older systems and software. Virtualization provides a secure environment for testing buggy software and software of questionable origin.

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