

# Virtualization: Providing Better Computing To Universities

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## Abstract

This paper discusses computer virtualization and the benefits it can provide to universities, beginning with an explanation of virtualization and the information technology (IT) landscape needed to implement this technology. Additionally, a number of advantages are discussed that include benefits related to cost and power consumption that virtualization can bring to the university. Two examples are also presented to illustrate how virtualization has helped a university and a school district improve their computer labs and decrease their overall IT budget. Microsoft, Citrix, and VMware are discussed as solutions and the paper concludes with how different sized universities can benefit from each of these specific software solutions.

**Keywords:** Virtualization, Desktop, Power Consumption, Green Computing, Data Security

## 1. INTRODUCTION

Universities spend a great deal of money each year to maintain, patch, and upgrade computers within their educational institutions. The complexity of desktop computers is one of the reasons for the high cost of desktop infrastructure (Valovic, 2009). Although computers have become an indispensable tool in education, their complexity leads to a greater cost of maintenance from an IT perspective. Gartner Inc and IDC estimate the yearly per-desktop installation, patching and management cost in the range of \$4,000 to \$6,000 (Valovic, 2009). The solution to this dilemma is to utilize hosted virtualized desktops. Seventy-nine percent of Fortune 500 companies have or will (within a year) adopt server virtualization (Valovic, 2009).

The implementation model for virtualized desktops is very simple. This process moves the desktop to a central data center and provides a virtualized desktop image to the students. Each user is given access to the virtualized desktop image over a LAN or WAN connection using a display protocol (Remote Desktop Protocol). From the students' perspective, the computer will allow them to execute applications and display their personal settings as if the computer was physically located in front of them (Valovic, 2009).

In education, virtualization has been discussed as "education delivered through the internet or delivered via some other platform of information and telecommunication technologies. (Willoughby, 2003). The paper will provide additional information regarding desktop virtualization in the academic setting and discuss vari-

ous options for incorporating this into a university computer lab.

## 2. VIRTUALIZATION

In 1972, IBM introduced the concept of virtualization, which for several decades was only used in mainframe environments. Cheaper servers became available in the 1990s which led to a boom for organizations purchasing more servers. Mendel Rosenblum, a Stanford University researcher, found that this increase in servers became taxing on California's electrical grid because of the increase in cooling and power requirements (TCC, 2010). Rosenblum began his research to find a better solution to this problem, which led to the creation of VMware software. He found that by consolidating numerous servers into a larger one it reduced the power and cooling requirements. Virtualization has two components; server virtualization which collapses multiple servers on to a single server, and desktop virtualization which reduces the size and support of the desktop system.

A virtual computer is a desktop computer that is represented using only software (IBM, 2007). Virtualization provides better flexibility and increased utilization rate of the underlying physical hardware. Traditional computers provide one instance of the operating system that hosts various application programs. A virtualized environment utilizes a single physical computer (server) that runs software to extract the physical computer's resources so they can be shared among different virtual machines. Although multiple virtual computers are run from one server, each virtual computer can run different operating systems (TCC, 2010). If a virtual machine or a program on a specific virtual machine were to crash, it would not affect any of the virtual machines that are on the same server (IBM, 2007).

Students have the ability to customize their desktop environment with respect to their personal preferences and university policies. This customization includes but is not limited to storage of documents, modifications to background images and screen savers, and programs shortcuts / files stored on the desktop. In the virtualized environment, a student's desktop environment will be available from any computer that is part of the virtualized platform (classrooms, library, and labs) (IBM, 2007). This functionality allows students to

quickly and easily move to a different location if any of their workstation hardware were to fail. Additionally, software licenses costs can be reduced because software licenses can be shared with other students when the student's virtual desktop is not in use (IBM, 2007).

In difficult economic times, it is essential for universities to find cost cutting methods that are also effective. By virtualizing computer labs, universities are conserving financial resources, reducing the need for heating, cooling, electricity, and data center space (TCC, 2010). In addition, the university IT department will be able to provide more reliable and effective computers to students in classrooms, labs, and the library.

## 3. BENEFITS OF VIRTUALIZATION

### Power Reduction

Intel and Virtual Iron explained virtual servers are one way to circumvent escalating electricity costs of large data centers (Babcock, 2010). When universities virtualize their computers, they will eliminate much of the hardware we see today in the computer labs. The hardware reduction will lead to a reduction in power consumption (Norris, 2009). In addition, the university will see a reduction in cooling costs since there will not be as much hardware that needs to remain at specific temperature. In some larger environments, the cost savings in regard to cooling can be as great as 85% (Norris, 2009).

### Hardware Refresh Savings

Over a period of time, universities acquire computers for different classrooms, labs, or the library on campus. The university is then faced with a dilemma on how to spend their IT budget: replace older computers to support newer operating systems and applications or add additional computers to the campus so the students have additional computers to use. Depending on their decision, they will either lose out on expanding their computer workstations or retain older equipment that requires higher maintenance or may not function with desired applications.

Desktop virtualization provides an alternative for universities to increase the life of older computers. At the same time, this will reduce

the "cost-per-seat" of computer for students (IBM, 2007). Older computers can be converted to virtualized environments by installing virtual desktop software on them. Even though some of these older computers may not be capable of running newer operating systems and applications, the virtualization process will allow it to do so since application dependency is on the new physical computer that these older clients will connect to virtually. Additionally, universities can purchase less expensive thin clients workstations, instead of complete desktop computers, to add additional computer workstations on campus.

### **Effective Hardware Use**

Virtualization provides a uniform computing experience for students regardless of the computers' age. Although each computer may have different specifications (CPU, memory, hard drive, etc), it still provides a uniform experience since the desktop environment exists on a virtualized server and not on the individual computers (IBM, 2007). Each student's desktop environment will follow them regardless of which classroom or computer lab they choose to use. In some cases, this system can be extended so that students can utilize the desktop environment from their homes.

As technology changes, universities are now faced with supporting not only their technology devices but also student-owned devices (cell phones, smart phones, and PDAs). Virtualization allows universities to provide the student's desktop environment on a broad range of devices since the device merely needs to act as a thin client rather than a full desktop computer. Because of the additional security provided by virtualization, universities will be able to allow student-owned devices to connect to the school network without compromising the university's network security (IBM, 2007). With virtualization, it is no longer required that devices meet as strict of a standard to connect to the network.

### **Decreased Costs**

Virtualization can help lower the overall cost of ownership by minimizing the cost of operations and IT support (IBM, 2007). To better understand the cost savings, let's consider a university with 200 workstation computers. Assuming an average of 150 watts per computer, the university will need to consume 30,000 watts.

Since thin clients only consume about 20 watts on average, a total of 4,000 watts would be needed if all were thin clients. The virtualized server will consume 4,000 additional watts, assuming the use of an IBM BladeCenter server. Using virtualization saves us about 110 watts per computer. This process will save about \$20,000 per year in electricity and provides for a "greener" environment (IBM, 2007).

Virtual desktops provide additional software license savings over traditional computers. In a virtualized environment, universities only have to buy enough licenses equal to the peak usage. It is easier to control licensed software since it exists on virtual computers on the virtual server rather than on individual computers. It is easier to manage and limit licenses since the virtual computers are controlled by the server. Software licenses are optimized using virtual computer clients (IBM, 2007).

### **Disaster Recovery**

Using virtual servers can help improve the overall disaster recovery process regardless of what the failure is on the server. Virtualization will allow the university to quickly recover using a simple process. The IT staff would simply copy a virtual server file onto another server or computer in addition to installing a virtual machine player application to boot the virtual file (Norris, 2009). Within a very short time frame, possibly minutes, the university can have a fully functional system almost regardless of the hardware failure (Norris, 2009).

### **Data Security**

In the university setting, it is essential that the university protect its data (student information, grades, financials, etc.) from hackers and external threats. The process of virtualization can alleviate this concern and allow students and faculty access to university related content off-campus. In a virtualized environment, most of the data resides in the data center instead of on a laptop or desktop computer. This centralizes the data to the universities data center which can be protected from external threats. Teachers and students can work on university owned laptops or their personal computers without the risk of infecting the university network with virus filled computers (IBM, 2007).

#### 4. VIRTUALIZATION IN EDUCATION

##### Arizona State University

In the past, Arizona State University (ASU) professors would return each fall semester with a list of applications that they would need for their classroom activities. However, each professor was told that it would take weeks to fulfill their requests which caused delays in their course schedules. ASU has a central IT department with 300+ employees. The majority of this department is primarily focused on supporting the desktop computers. Because of their complex IT environment, the university assessed various vendors until they chose and implemented a system by Citrix Systems Inc.

Approximately four years ago, the university began to virtualize their applications using Citrix XenaApp. Prior to this, the IT process for new software requests was to determine the impact on the application on the existing systems, create a new image for the computers, and distribute it to approximately 1,600 machines. This process could take anywhere from two weeks to a month leaving professors "out of luck" if they waited until the last minute for their request (IDG, 2010). However, with the XenApp environment, the IT staff can upload the application to the virtual environment and each client machine can access the application from it, which significantly reduced the amount of time to install and distribute a new application.

ASU has also found a number of other benefits from switching to a virtualized environment. This environment allows students to access applications from any place in the world (IDG, 2010). This becomes an excellent marketing tool since students can access many of the universities resources from their home or other off-campus location. Utilizing a single platform allows the IT staff to spend less time maintaining applications, desktops, and servers allowing ASU to reallocate these resources to effectively deliver business benefits (IDG, 2010).

##### Brick Township School District

The Brick Township School District, located in Brick, New Jersey, upgraded their entire server infrastructure by June 2008 by switching from a Novell Based system to the Windows Server 2003 platform with Active Directory for their

domain services. This was done to reduce the overall costs related to their IT infrastructure. Using a Dell application to gauge energy costs, they found that each server had annual costs of \$2,600 to power and cool (Microsoft, 2010). After analyzing the results of this analysis, the Board of Education approved an initiative to move towards a virtualized environment to further reduce these costs and better allocate the IT support they receive from their 5.5 full time employees (Microsoft, 2010).

The School District's new virtualized infrastructure utilized Microsoft Server 2008, since it required a very minimal learning curve, and Hyper-V technology for its virtualization since it was significantly less expensive and built-in to the Microsoft Server 2008 software package. Currently, the School District has saved about \$30,000 in electrical costs after switching 90 percent of their servers to a virtual environment. In the future, the district estimates it will save approximately \$52,000 in electrical costs and another \$80,000 in hardware replacement costs (Microsoft, 2010). Additionally, traditional servers depreciate about 93 percent over a four year period and according to Microsoft (2010) "virtual servers never depreciate." The new system allows the IT staff to monitor and support the virtualized environments better by consolidating various applications on one virtual server, dynamic disk space allocation, and improved reporting for better visibility of each physical and virtual machine across the network.

#### 5. DISCUSSION

The concept of virtualization has become a hot topic in the IT industry. IDC (2007) reported that 80 percent of companies are planning to add virtual computers to their IT environment while it was predicted that another 15 percent of all new servers in 2010 will use virtualization. Many virtualization software packages exist from vendors such as VMWare, Microsoft, and Citrix. However, choosing the right combination of Hardware and Software depends heavily on a university's budget and IT resources.

##### Cost Savings

Anticipated cost savings in a virtualized environment are twofold and will occur after the initial investment in software, hardware, support staff training, and infrastructure. Savings

will include reduced power consumption, longer life span of the end nodes for virtualized desktops, and fewer physical servers. End nodes will have a longer life span since less system resources (CPU, RAM, and storage) are required to support the virtual desktop. Less powerful end nodes can also be deployed further reducing the environmental requirements. Intangible cost savings include, less hands-on support needed for upgrades and deployment of applications. Upgrades occur on the server and are pushed to the end nodes instead of someone needing to visit each end node. This will require less desk top support hence less staff. Staff can then be trained and repositioned to support the core virtual infrastructure. Another advantage is a quicker repair of failed systems equating to less down time. In a diskless environment there is no longer a need to ghost an image each time a system fails therefore time to repair or replace is reduced. Diskless systems capable of supporting a virtual end node environment are more secure as there is no operating system or hard drive to compromise.

### **Faculty and Student Benefits**

From an instructor student perspective, all parties will benefit from a virtualized environment by a quicker recovery time for failed systems and a more rapid deployment of applications. Images for specialized lab environments can be customized and loaded as needed. This model is also very scalable in that the number of lab systems can be increased or decreased based on the instructors need and availability of systems. Virtualization will play an important role in mobile computing initiatives. Consider the pad technologies and their ability to run a virtualized Windows environment. This provides full windows functionality in a lightweight mobile platform enabling access to the virtual desktop and applications anywhere. In essence, a true game changer for educators and students.

### **Microsoft, VMware, and Citrix**

Microsoft joined the virtualization marketplace after their acquisition in 2003 of Virtual PC and Virtual Server from Connectix (Luce, 2007). Since the acquisition, Microsoft has released various Virtualization applications including Microsoft Virtual Server 2005 (designed for server consolidation and application migration) and Virtual PC 2007 which is designed for use

with Windows Vista (Luce). Both applications are available at no cost. However, Microsoft has introduced a new virtualization application, Hyper-V, with their Windows Server 2008 package. While Microsoft has limitations on providing advanced features such as Citrix and VMware, it is perfect for a university with a small IT support staff and high financial constraints. While not as advanced or well established like VMware, Microsoft can provide a low cost solution since their virtualization software is included in their software packages or offered at no extra cost (Bednarz, 2010). Lastly, it is ideal for smaller universities since it requires minimal learning for those that already utilize Microsoft applications.

While not as cost effective as Microsoft, VMware and Citrix can offer much more with reporting and automation. Each of these companies has developed partnerships with popular vendors to provide better and more effective solutions for their customers (VMware with Cisco and Citrix with Microsoft). Pricing becomes a big factor for which universities adopt which applications. Citrix's partnership with Microsoft allows them to offer similar technology for free, however, they do charge their customers for a maintenance agreement and in comparison to VMware, they will not have the "latest and greatest features" (Bednerz, 2010). VMware is the market leader for virtualization because they began earlier in 2001 and became much more widespread. Although you will pay quite a bit more for their application, the return is a more well developed environment, with many years of experience, and functionality that surpasses Citrix and Microsoft.

## **6. CONCLUSIONS**

There is no doubt that virtualization can provide a number of benefits to the university that will help the students, faculty, and the IT department. Virtualization allows the university to offer students and faculty a variety of operating systems and applications while reducing the overall number of computers needed. Reducing the number of computers will lower the equipment and support costs budgeted each year. Virtualization also allows the university to offer the latest applications and operating systems while maintaining compatibility with older applications and operating systems (Luce, 2007).

Virtualization has gained a lot of popularity with fortune 500 companies and its growth has caught the attention of universities as a solution to more effectively and efficiently use information technology. However, if virtualization is not planned properly and if the university does not choose the solution that best fits their landscape, the effort will have a high probability of failure. Lastly, universities must recognize that virtualization will require a large amount of initial capitol, but the long-term effect will cut overall IT costs allowing universities to more effectively use their IT staff.

## 7. FUTURE RESEARCH

The university under study has planned to implement their first virtualized computer lab by the end of this year. As a follow-up to this study, the authors have planned to conduct future research on the effects of virtualization from the perspectives of the students and faculty. This assessment will provide to the body of knowledge in the area of computer lab virtualization as well as help the university evaluate its effort of converting their traditional computer labs to virtualized ones.

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