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Classroom computing in graduate education continues to grow as more and more schools include the use of sophisticated software programs in their curriculums. Unfortunately many of these statistics and modeling applications are quite expensive and require significant processing power. The Graduate School of Business and Public Policy at the Naval Postgraduate School is using server-based computing to control software costs and improve the performance of applications. This paper describes the school's use of Microsoft's Remote Desktop Services to deliver applications to networked student computers. The virtual delivery of the software, which runs on a server, eliminates the need to install the software on every student computer. Depending on the software licensing structure, this can significantly reduce the required number of licenses. For some applications it can also dramatically improve performance.

Introduction

In 2004 the Graduate School of Business and Public Policy (GSBPP) at the Naval Postgraduate School built a prototype smart classroom seating 45 students with networked laptop PCs at every seat. Infusing computer technology into the traditional lecture based classroom proved to be a resounding success and that classroom quickly became the most frequently requested room every quarter. Faculty reported they could cover up to 20% more material in the same amount of time. The improved efficiency was the result of the professors being able to optimize classroom time by using computer based tools whenever it was appropriate rather than having to wait for a specific hour of the week when they had access to a computer lab. In the past, courses would be divided between lecture based classroom time and one or two hours per week of computer lab. Another instructional example is the use of the Internet to access on-line databases such as federal budget information in order to bring current budget issues into the classroom at the same time they are being addressed by the government. Thanks to the concurrency of access to the data and the issues at hand, the relevance of the materials becomes immediately apparent to the student (Doyle, 2010). Beyond the instructional advantages, research has also shown a significant increase in the level of student interaction when computer mediated communications are incorporated into the education process (Brinkley, 2003).

The success of the prototype project generated a demand to install computers for every student in as many classrooms as possible. GSBPP maintains approximately 200 computers spread across six classrooms and another 35 laptops in a mobile cart ready to deploy to any of the other classrooms as needed. The school tries to adhere to a three year lifecycle replacement plan to keep the systems up to date. Unfortunately budget constraints often preclude replacement of the systems exactly as planned. The high cost of analytical software competes directly with the purchase of new hardware when limited resources are available.

Setting

The Graduate School of Business and Public Policy is one of four academic schools that make up the Naval Postgraduate School (NPS). NPS is located in Monterey, California and was established in 1909 to serve the advanced educational needs of the United States Navy. It has since been expanded to support students from the other U.S. military services and foreign countries as well. The total student population consists of approximately 1,500 students coming from all branches of the U.S. defense community and the military services of more than 25 allied nations.

NPS is a well diversified, fully accredited graduate school with a proud history of academic excellence. This paper focuses on the classroom technologies employed by the Graduate School of Business and Public Policy (GSBPP). Classrooms within GSBPP are designed to accommodate an average of thirty to forty students. Continuously seeking to improve, GSBPP evaluates and considers the adoption of new technologies that can further improve teaching effectiveness and efficiency.

Client-Server Network Computing Environment

Naval Postgraduate School is fortunate to have a state of the art campus network with gigabit Ethernet connections to each end user station. This high speed connectivity supports data transmissions between the classroom computers and the GSBPP application server. Laptops are used in most of the GSBPP classrooms because of their small desktop footprint and their portability which facilitates a quick change out when necessary.

The mid-grade application server includes performance enhancing features such as solid state SSD hard drives, a six core Intel i7 processor, and 32 gigabytes of RAM. The server operating system is Windows Server 2008 R2. GSBPP began experimenting with application servers in 2006 when the school built a prototype client-server classroom using Wyse thin-clients. The goal of using the thin-clients was to save costs associated with the maintenance and administration of the student workstations. Research by the Gartner Group (1999) found that nearly 80% of the costs associated with end-user computing comes after the initial procurement and is associated with life-cycle support. The thin-clients used by GSBPP delivered a welcome reduction in the number of man-hours required to maintain the student workstations. Unfortunately some multimedia applications performed very poorly with the thin-client devices. In 2009 GSBPP switched back to the networked laptops but kept using application servers to achieve the benefits of centralized computing whenever possible. As of September 2014 the classroom laptops run some applications from their local hard drives and others from the application server.

Microsoft Remote Desktop Services

Remote Desktop Services (RDS) makes it possible for end users to run a Windows based program on a remote server from their client workstation. Microsoft (2011) calls the server hosting the application a Remote Desktop Session Host server. Benefits of RDS include the following:

- Delivering applications to remote users where on-site end user support is limited or unavailable.
- Simplifying application management by reducing software installations to just a few RDS servers vice installing the same programs on hundreds of end-user computers.
- Reducing lifecycle technical support costs by eliminating the need to patch and update applications on end-user computers.
- Extending the service life of end-user computers by minimizing the hardware requirements necessary to run applications on the RDS server.
- Improving the performance of applications by running the programs on more powerful servers vice executing them on limited capacity end-user computers.
- Reducing overall costs for software by sharing applications through the use of concurrent licensing models vice purchasing licenses for each end-user computer.

The client-server model used by RDS has a lot in common with the mainframe environments of the past. Minasi (2010) explains that the historical shift away from centralized computing to personal computers and now back again to centralized computing is due to the advantages mainframes offered that PC-based networks do not. Specifically he cites the following benefits of the mainframe model:

- Grouping of computing resources to make sure none are wasted
- Centralized distribution and maintenance of applications
- Clients that do not need to run the most modern operating systems and the newest level of hardware necessary to support it

Of course there are also many differences between today's client-server models verses the old mainframe environments. PC-based application servers are much less expensive to purchase and operate than mainframes. The graphics capabilities of client computers also give a significantly higher degree of satisfaction to the end users verses the monochrome "green-screen" displays of yesterday's dumb terminals.

RDS Operation and Configuration

Remote Desktop Services is one of the optional features you can choose to install when configuring Windows Server 2008 R2. After installing this server role, RDS continuously listens for incoming client connection requests. When a client connection is established, the client's dedicated view of the RDS server is called a session. All of the client sessions are given a unique session ID. The server uses these session IDs to distinguish the processes running within different RDS sessions. The number of sessions an RDS server can support depends on factors such as server processor capability, memory, network bandwidth, and speed of disk access.

The RDS role can be added to any Windows Server 2008 R2 server using Server Manager. During the installation you will be asked which RDS licensing mode you want to use. This will determine which RDS Client Access Licenses (CALs) you will use. There are three configuration choices available:

- Per Device – A per-device CAL is assigned to a specific computer or device. This type of access is best for environments that share computers between many users, such as a computer lab. Many different users can share the same CAL because the license belongs to the computer and not the users.
- Per User – A per-user CAL is assigned to an individual user and grants that user the ability to connect to a RDS host server from any number of devices. This type of access would be a good choice for faculty who might need to use a combination of school owned and personally owned computers to connect to the RDS server.
- Configure Later – This option allows you to defer choosing one of the above permanent choices until you have completed your setup and testing. Microsoft is fairly generous with the terms of the postponement because they allow 120 days of operation and unlimited connections. You must configure the RDS Licensing server to install, issue, and track RDS CALs within the 120 day grace period. After that time RDS clients will not be allowed to connect to the RDS Session Host server if RDS CALs have not be added.

Another important step in the configuration of a RDS Host server is to add desired users into the local Remote Desktop Users group. They can be added during the RDS server role installation or later. The Administrators group is automatically added to the local Remote Desktop Users group when the RDS server role is added. Users not included in the local Remote Desktop Users group will not be allowed to connect even if there are RDS CALs available for issue.

After the RDS Host server operating system is installed and configured you must also install the desired applications. It is important to install the applications after configuring the RDS server role. Applications installed before configuring RDS may become inoperable. Applications can be installed through the use of an .msi (Windows Installer) file or with an Add Remove Program Wizard via the Control Panel.

Users connect to the RDS Host server by executing the mstsc.exe command. This can be done by entering the command directly into the Run Command Line or by double clicking on the Remote Desktop Connection shortcut located in the Start/Accessories group. Executing the program brings up the dialog box displayed in figure 1. Users can enter either the server's computer name or it's IP number in the Computer field. There are many configuration options available including the ability to have access to the local computer's hard drives while inside of a RDS session. This allows the user to execute the program on the server and be able to save the data to the local machine.

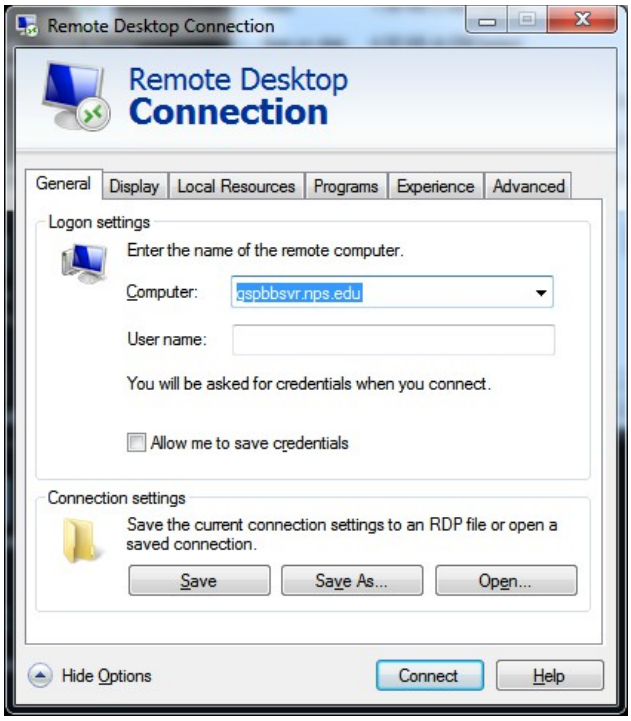

Figure 1: Remote Desktop Connection login display

After clicking the Connect button the user will be presented with a Windows Security screen and prompted to enter the requisite password. Depending on how the Remote Desktop Connection settings were configured, the connection will open as a window on the desktop or in full-screen mode. The appearance of the session windows will have the look and feel of a Windows 7 desktop similar to figure 2.

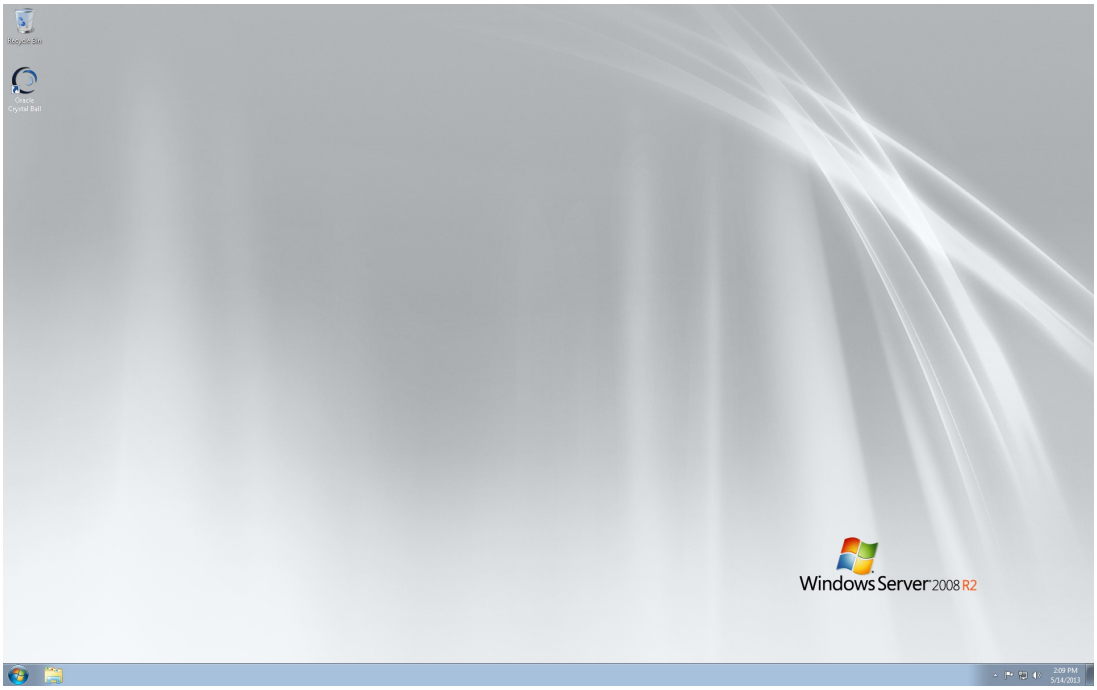

Figure 2: Session screen after connection to the RDS host server

Transferring the server output display to the client and uploading the users input to the server is handled by the display protocol. The display protocol used by RDS is called Remote Desktop Protocol (RDP). RDP uses a point-to-point connection over TCP/IP. One feature of RDP is client-side caching. This allows the client to retain images that have already been downloaded and thus only the changes need to be downloaded during image refreshes.

Results for GSBPP

As stated earlier, GSBPP maintains approximately 235 computer systems for use in the school's resident graduate programs. It is the school's policy to give as much autonomy as possible to professors choosing what software they wish to teach with. One benefit of this approach is that it ensures the professors are proficient and comfortable teaching their respective applications to their students. A disadvantage is that some programs are only used by a few professors for just a few courses. This makes it impractical to buy and install every application on every GSBPP computer system.

One example of the software used is a statistical analysis program called Crystal Ball. This program was requested by only one professor whose class size was normally less than 25. GSBPP could not install the software in just one classroom because the school's academic scheduling model is such that the classroom assignments change every quarter. GSBPP had no way of knowing which classroom Crystal Ball would be needed in advance of the quarter beginning. GSBPP could not afford to install the software on all 235 systems due to limited resources. The total annual cost for 235 licenses would have been approximately $22,000. The GSBPP solution was to purchase the needed 25 licenses, at a cost of only $3,000, and install the software on the RDS application server. This facilitated the virtual delivery of the software to whichever classroom it was required in. The only restriction was the limit of 25 concurrent users. In this case the use of the RDS application server meant the difference between approving the use of Crystal Ball or having to deny its use due to budget constraints.

Another important benefit to the RDS virtual delivery model is the reduced technical support man-hours needed to install, configure and maintain the software. GSBPP only needs to maintain the one instance of the software loaded on the server vice installing, configuring and updating the software on each end-user system.

Both the cost savings and reduced technical support man-hours were anticipated outcomes due to the known benefits of centralization and virtualization. Another unexpected benefit was realized during the post-installation testing phase. There was a significant increase in application performance. GSBPP developed a specific statistical model to evaluate and benchmark the performance of the software. The model was executed in several different usage scenarios in order to compare the performance under different situations. The first test was designed to establish the performance baseline of how the software ran in the old stand-alone environment. For this test the software was loaded and run on the local student computer hard drive. This represented what could be expected if GSBPP had purchased a license for each student computer instead of using the RDS application server. It took the standalone computer 33 seconds to finish the model's calculations. The next test used the RDS application server to run the software with only one client connection. This time the model was completed in just 19 seconds. The explanation for this 42% improvement is easily explained by the much higher grade of computer being used for the server compared to the student computers. The next test was designed to measure the performance with multiple client connections since the job of an RDS application server is to support many users. There would be times when the same model would be executed by multiple students simultaneously. To test this scenario several users were recruited to execute the model on seven different clients at exactly the same second. This instantaneous access would show GSBPP what to expect when a professor was teaching the software in a classroom environment. GSBPP expected some decrease in performance which would represent the sacrifice needed to achieve the many benefits of virtualization. Instead, there was yet another increase in performance and the model completed in just 11 seconds. The hypothesis for this additional improvement is that much of the software's program was still in the computer's cache memory when each subsequent client needed to access it. Having the needed software code available in cache memory saved the server from having to load it from the internal hard drive. Table 1 reiterates the results of each test.

Test Condition	Time to Complete Calculations	Percent Improvement Over Stand-Alone System
Stand-alone Computer	33	0%
RDS Server with Single User	19	42%
RDS Server with 7 Simultaneous Users	11	67%

Table 1: RDS server performance vice stand-alone computer

Conclusion and Findings

As of September 2014, the school's current iteration of the RDS application server had been operational for 22 months. During this time all of the RDS benefits listed above were confirmed. The primary goals of achieving cost savings and a more efficient centralized configuration management environment were clearly met. The added benefit of improved application performance was also sustained throughout the 22 months of real-world classroom teaching. GSBPP does not expect all applications to achieve the same performance benefits as measured for Crystal Ball. However the testing does show the RDS model offers significant benefits in the academic environment and should be considered as a part of an overall IT strategy.

References

Brinkley, D. (2003). The Effect of Computer-Mediated Communications on Graduate Student Interactions. In G. Richards (Ed.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, & Higher Education 2003*, (pp. 1536 – 1539). Chesapeake, VA: AACE.

Doyle, R. (2010). Asynchronous Online Graduate Public Policy Education: The Use of Public Databases to Engage Students and Advance Learning, *Proceedings of Global Learn Asia Pacific 2010 – Global Conference on Learning and Technology*, Chesapeake, VA: AACE

GartnerGroup (1999). *Thin-Client Desktops Cut Support Costs by 80 Percent*, [On-line]. Datapro Reports. Available: http://www.gartner.com/5_about/press_room/pr19990518a.html [2006, March].

Microsoft Corp. (2011). *Delivering Business Value with Remote Desktop Services*, [On-line]. White paper available at: http://download.microsoft.com/download/A/4/A/A4A9F533-6B4C-4D31-9262-3FA3AA67506B/WS2008%20R2%20RDS%20Business%20Value%20Whitepaper_SP1.pdf [2013, May].

Minasi, M. (2010). *Mastering Windows Server 2008 R2*. Indianapolis, IN: Wiley Publishing, Inc.