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Regis University
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Final Project/Thesis

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Implementation of Microsoft's Virtual PC in Networking Curriculum

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This project submitted for fulfilling the partial requirements of
Master of Science in Computer Information Technology

School for Professional Studies
Regis University

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Abstract

Using Microsoft's Virtual PC software product as a virtual technology in the implementation of Network Specialist curriculum allows increased versatility and considerable hardware cost savings. Rather than purchasing individual computers or removable hard drives, using boot manager programs, or simulation software (including Computer Based Training programs), for student use in learning the administration of an operating system, one computer with hard drive, sufficient processor power, and RAM can be used to implement the effective hands-on learning approach of plan, implement and test, and then review. In addition, this software allows a non-dedicated (production) computer lab to be used. This is in contrast to a lab dedicated to the support of networking curriculum, as is typically done because of the fundamental testing involved including operating system rebuilds and service manipulation.

The successful result of this project is a curriculum including deliverables (student assessment guidelines, worksheets, and competency task list, and instructor procedures) that use Microsoft's Virtual PC software, Windows XP and Windows Server 2003. These software products will be used, and are currently being used, to demonstrate a subset of the tasks and competencies required for Mid-State Technical College's Network Specialist program course Network Administration-Intermediate.

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Chapter One, Introduction

Statement of the Problem

Effective learning at the technical college level involves a hands-on approach. The goal of technical colleges is to train a work force, and not necessarily to educate students on the principles or theories of a subject. Implementing computer networking concepts can have many constraints, because it is very hardware dependant and oriented. In developing and implementing computer networking curriculum, an environment must be created that will allow students to experiment. This project will allow an experimental environment to be implemented, while achieving economic feasibility across campuses.

In order for students in an academic networking program to effectively install, configure, and test various PC operating systems, the tasks must be accomplished in such a manner where the students are not hindered by a production network and operating system environment. To hinder the students would limit their exposure and learning to the intricacies, procedures, options, and limitations of that operating system. The students must be allowed to experiment, yet at the same time, not negatively affect the college network.

Project Goals

The ultimate goal of this project is to produce hands-on curriculum and to determine the feasibility of using a virtual technology software product in a non-dedicated computer lab to implement the curriculum instead of individual removable hard drives for each student. When taken together, these two items can be used to implement curriculum, including student assessment, with minimal cost to a college or any instructional organization. The deliverables of these goals are the documents found in the appendices.

In achieving the goals stated above, Microsoft's Virtual PC software product will be used to determine feasibility (see chapter three, Methodology). Virtual PC software allows operating

systems to be installed in a self-contained virtual environment, and therefore, it mimics physical computers. The actual functional implementation will be through XP, a client operating system, and Microsoft Windows Server 2003, a server operating system, and will be used to demonstrate the client/server relationship through directory services. To allow students to see the true client/server relationship between a server and a client, Virtual PC can be used to simulate individual physical computers or computers with a removable hard drive system. After installation, two virtual computers will be created on one host lab computer: one for the server and one for the client.

For Mid-State Technical College in particular, it is comprised of three campuses. Until the completion of this project, the full Network Specialist program was delivered only on the Wisconsin Rapids campus because of funding. Another campus located at Stevens Point (20 miles away), was able to offer 90% of the courses by using previous College production PCs (i.e., PCs considered too outdated to be used by employees and students in other labs). Through a piece meal approach, the networking lab on the Stevens Point campus has been assembled with current equipment. However, the constraint was and is still funding. Because of this situation, students drove to the Wisconsin Rapids campus for most of the courses involving network administration tasks (the courses Network Administration-Beginning and Network Administration-intermediate). This meant that during their third and fourth semesters, students drove twice a week for a course each semester. From the standpoint of student friendliness, having students drive this amount is unacceptable.

Shown in figure 1 is MSTC's Stevens Point Campus networking computer lab in which this project was implemented and tested. In this particular lab, there are 16 student workstations, yet only 10 PCs for students. Again, when this lab was designed, the funding for the additional PCs with a removable hard drive system (described in chapter 4, Project History) was not available, and therefore, even the sufficient number of PCs could not be purchased. Because of this fact, the full Network Specialist program could not be delivered on this campus. Microsoft's Virtual PC is installed on each of the 10 PCs.



Figure 1, MSTC's Stevens Point campus networking computer lab

In figure 2, the Wisconsin Rapids lab is shown. While this lab is not the room originally used when the Network Specialist program was implemented in 1999, and has been recently updated in the summer of 2005, it has 20 student workstations with 20 PCs available. Each PC has the removable hard drive system described in chapter 4, project History. The drives are stored in the room at the back of the lab.



Figure 2, MSTC's Wisconsin Rapids campus networking computer lab

As just stated, one of the goals of this project is to allow networking and other courses to be delivered in a non-dedicated lab on any campus. Through the use of a virtual technology, MSTC may no longer be constrained because of costs when delivering the Network Specialist program.

Main Question to be Answered

With the advent of a stable and reliable virtual technology software product (Microsoft's Virtual PC), is it possible that the removable hard drive system described in chapter four (Project History), is no longer needed? Could a production lab PC have an operating system installed, and

act as a host PC for other operating systems installed in a virtual environment, thus allowing mastery of the involved course's competencies? Finally, could this virtual system be used to support hands-on networking curriculum?

Limitations and Scope of the Project

Technically, this project is limited to Microsoft's Virtual PC software product. There are other virtual technology products available (VMware, for example). The virtual PC market has grown and matured over the past few years. An assumption can be made that the testing in this project can be achieved with other vendor's products. The main reason Microsoft's Virtual PC is used, is that it is available free for students if the educational institution subscribes to Microsoft's Developer Network Academic Alliance. For this project, this is relevant because cost savings are important to any educational organization.

This project specifically covers Microsoft's XP client operating system with service pack 2 and Microsoft's Windows Server 2003 operating system with service pack 1, running on an AMD platform. In addition, because of the time frame of this project, the usage of the document "Network Administration-Intermediate, Windows 2003 Competency #1" (appendix C) is limited to Domain Name System and Active Directory (resource and policy control).

A further extension of this project would be to cover Microsoft's Windows XP as the client operating system and Red Hat Linux Fedora core 4 operating systems as the server operating system running on any Intel/AMD platform. Usability on other hardware platforms or with other operating systems is unknown. The author, however, is currently working on this extension, yet the scope of this project needs to be limited. In addition, there is a version of VPC that runs on an Apple Macintosh (Virtual PC for Mac), that would allow for running of Window's operating systems.

This project does not address network devices such as switches, routers, print servers, etc. These devices have little to do with a computer's operating system. Under the premise that Microsoft's Virtual PC allows typical lab computers to be used for networking courses, the use of these network devices poses an issue if connected to a production network.

This project was developed and completed during MSTC's spring 2006 semester.

Terms and Abbreviations Used

ACL	Access Control List(s)
AD	Microsoft's Active Directory
ADUC	Active Directory Users and Computers, program used to access Microsoft's Active Directory
DC	Domain Controller, server used to store Microsoft's Active Directory database, and authenticate users.
DNS	Domain Name System
GPO	Group Policies Object(s)
MSDNAA	Microsoft's Developer Network Academic Alliance
MSTC	Mid-State Technical College
SDLC	System Development Life Cycle
IT	Information Technology
OU	Organizational Units, used in Microsoft's Active Directory to logically organize users and computers.
VPC	Microsoft's Virtual PC software
W2K3	Microsoft's Windows Server 2003 server operating system
WTCS	Wisconsin Technical College System
XP	Microsoft's XP client operating system

Summary

The goal of this project is to produce hands-on curriculum that will allow students to use a virtual technology software product rather than hardware in the implementation of client/server operating system and directory services concepts. In doing so, MSTC's course availability will be enhanced because a dedicated networking lab is optional. While the curriculum competencies have already been established, the method for implementation can vary. The result of this project are the deliverables, and the feasibility of using a software solution to implement curriculum.

Chapter Two, Literature Review and Research

Current Literature

Recent and relevant literature as it pertains to both VPC and its use in curriculum development and implementation is varied. Colleges are striving to find solutions to implement computer related curriculum that will allow experimentation and hands-on learning without the overhead and on-campus restrictions of a traditional dedicated lab. In the effort to deliver courses online (distance education), many have implemented a terminal emulation product such as Citrix (which could also be used on-campus). This implementation can be expensive. Some colleges have worked with simulation products to provide a "safe" environment for experimentation. While useful, the simulation products do not involve the intricacies of the software system being simulated. Lee J. Leitner and John W. Cane (12) discuss these issues as it relates to the delivery of hands-on Information Technology curriculum. They concluded that a virtual environment, with or without remote access, is viable for successful networking-oriented education. Other colleges have used a virtual type system, but usually it is VMware, as it is considered faster and more reliable, and not a Microsoft product. However, Microsoft's Virtual PC software is free to subscribers of Microsoft's Developer Network Academic Alliance.

However, the basic implementations that will be discussed in this project (chapter four, Project History), have been common throughout the educational field. Kimfong Lei and Phillip T. Rawles (11) discuss many of the same issues such as virtual machine technology and storage technology to meet the curriculum requirements of installing operating systems and applications, yet to provide an environment in a non-dedicated lab. They concluded virtual PC technology is a viable solution for laboratory-based courses concentrating on systems and network administration concepts, and provides scalability, manageability, and usability with affordable implementation costs.

The German publisher Haufe Mediengruppe (10) uses VPC to test software CDs that are mounted on the inside covers of its specialty publications. Rather than having numerous PCs configured with various types of operating systems (including versions, bugs fixes, etc.), and that need to have the operating system reinstalled (i.e., a clean install), they use a host PC with VPC installed. They then can create a virtual PC for each operating system. A feature of VPC is that rather than an operating system shutdown, any changes made to the virtual PC can be discarded. That virtual PC is then ready for the next test, just as if a clean install had been performed. Accordingly, the publisher has saved \$14,000 in hardware costs annually. While time savings were also reported, no amount was given.

Project Contribution to the Educational Information Technology Field

As stated in chapter one, this project's goals are academic networking program curriculum development and implementation using software rather than hardware. MSTC has been constrained in the offering of various computer related courses and programs, because dedicated hardware and computer labs are required. If this project is successful, this may eliminate some of these labs. For example, MSTC offers a course using a computerized accounting package. This package is still taught, because a local employer still uses the package. It, however, does not run well under Windows. We have, therefore, a group of older computers running DOS 6.22 set aside for this very package. If this project is successful, DOS 6.22 and the package could be loaded in VPC, while running on a current PC with the current version of Windows (the host computer), as is found in any of MSTC's labs.

In addition, MSTC offers network security courses. These courses also require various tasks and activities that involve experimentation, some of which could be detrimental to a host PC or campus network. These tasks include virus and spam introduction, testing non-patched operating system vulnerabilities, and many more. Attacking a production system could be catastrophic and even illegal. Because the virtual PC world can be self-contained, any issues will also be contained in that world and not allowed to "escape" if properly implemented.

What is Known and Unknown About the Project

All of the competency tasks covered in this project, and in the document “Network Administration-Intermediate, Windows 2003 Competency #1” (appendix C), function perfectly with individual computers and hard drives. While they *should* also work in a virtual implementation, there is only one way to find out, and that is to do it. Anyone familiar with the IT field knows that there is no such thing as a five-minute fix, or a “sure thing”.

Summary

While literature is varied on this project's topic, the use of virtual software to better utilize hardware is gaining ground in both the computing and academic fields. Products such as Microsoft's Virtual PC and VMware illustrate this fact. No matter the product, the issue often is whether actual software will operate and perform the same in a virtual environment as a physical one. In addition, using software that creates a virtual environment allows for safe testing without the laborious task of operating system reinstalls.

Chapter Three, Methodology

Research

As with most valid projects, this one resulted from a need to solve a problem. Research, therefore, has been two-fold: First, years of accumulated testing and knowledge gained over the author's work experience, most notably, the teaching experience. For this particular project, the goal is to transfer this knowledge and experience to a new level of implementation. As with any computer system, there is a huge difference between functional and high-level advertisements (the old term "vaporware" comes to mind) and the actual details of making a system function properly and repeatedly. The research, therefore, was to transfer tasks and knowledge to a new system and make sure that the new system (VPC) functions, while still achieving the criteria of meeting competencies, articulation to students, deliverables production, and cost measures to the College.

The second research component was literature review. The literature review reinforces that the author and MSTC have faced the same issues in the area of hands-on networking curriculum development and deployment as other colleges, and includes the possible solutions of:

- Separate hard drive space controlled by boot manager programs
- Simulation software
- Individual student removable hard drives
- Virtual technologies

The virtual technologies are currently the option of choice because of the versatility and cost reducing attributes. The first three choices listed above are limited, cumbersome, or expensive.

Microsoft's Virtual PC in a Nutshell

Microsoft's Virtual PC (formerly Connectix's Virtual PC) is a software product that is installed on a host computer running a Microsoft or Macintosh operating system. It creates an environment for another Microsoft operating system (and sometimes non-Microsoft) to be installed. VPC runs an

operating system as another application to the host operating system, and this becomes the guest operating system. The guest operating system becomes a virtual PC running in its own window. The host operating system offers its and the PC's resources to VPC and its operating system. VPC creates virtual Network Interface Cards, video cards, etc. through emulation for the operating system installed in VPC to use. VPC then passes requests to the host operating system. For example, IP addresses can be completely different between the host operating system and the operating system installed in VPC. The host operating system allows VPC to use the NIC without interference, acting as merely a pass-through. Surfing the web, printing, etc., should work normally.

It is interesting to note that virtualization and emulation were developed years ago and have been successfully used in the mainframe/mini environment. IBM's I-series is a prime example where numerous operating systems can co-exist on the same physical computer and serve different users requiring different applications.

The VPC installed operating system is saved in a file stored (see figure 4) on the host PC, a network share, or even a portable drive. The latter was beneficial for some students as they could work in the lab, and then take their portable drive containing that classes work home for further experimentation. Once a virtual PC is created, it can be copied whenever needed. An original operating system install can be kept unaltered and then copied infinitely. In addition, VPC has the option of discarding any changes made during a session. For example, a virus could be introduced to the virtual operating system. If the virtual operating system is closed without saving changes, all record of the virus is gone.

Finally, given sufficient host PC hardware resources, more than one Virtual PC can be running on a host at one time. The deliverable "Instructor Procedures for Project Implementation" (appendix D) was created using this feature. Students also used this feature to learn the course competencies and for assessment. This is the ultimate reason for the logistical feasibility of this project.

Following are the minimum system requirements for the physical computer and the host operating system (8).

- An x86-based computer with one of the following processors: AMD Athlon/Duron family or Intel Celeron or Pentium II, III, or 4 family; 400 MHz minimum, 1.0 GHz or faster recommended. Virtual PC on a multi-processor computer, but it uses only one processor.
- CD-ROM or DVD drive.
- Super VGA (800 x 600) or higher resolution monitor recommended.
- Keyboard and Microsoft mouse or compatible pointing device.
- Host operating system: Windows© XP Professional, Windows 2000 Professional, or Windows XP.

As is always the case, the faster the PC, the better. For the minimum physical RAM requirement, add up the minimum RAM requirement for each virtual PC operating system to be run concurrently, plus the host operating system minimum RAM requirement. While RAM is virtualized to the virtual PC, following this method will reduce the amount of virtual memory (i.e., swap file) used by the host operating system. Again, consider this the minimum physical RAM requirement, as the more RAM, the better. Finally, because the actual virtual PC installations are stored in compressed files on the host PC hard drive, and the hard drive is virtualized to the virtual PC, it is difficult to determine the minimum physical hard drive size requirement. In examining figure 4, there are three virtual PCs configured and stored on a 40 GB hard drive, yet each virtual PC is configured to have access to approximately 20 GB. A 40 GB hard drive is considered minimum with current PCs sold, and therefore, can be considered the minimum physical hard drive requirement.

Illustrated in figure 3 is the console for Microsoft's Virtual PC software, along with the settings dialog box for Windows XP. The host operating system for this computer is XP. There are three virtual PCs configured on this host: Linux Fedora Core 4, Mandriva Linux, and Windows XP. Each has their own configurable settings, which are stored in separate files. Through the Settings dialog box, items such as the amount of RAM allocated to the virtual PC, file names, whether the host PC's communication ports are allowed to be used, which network interface cards to use, and other settings can be configured. While most of these settings are beyond the scope of this project, Figure 1 indicates the flexibility in VPC configuration.

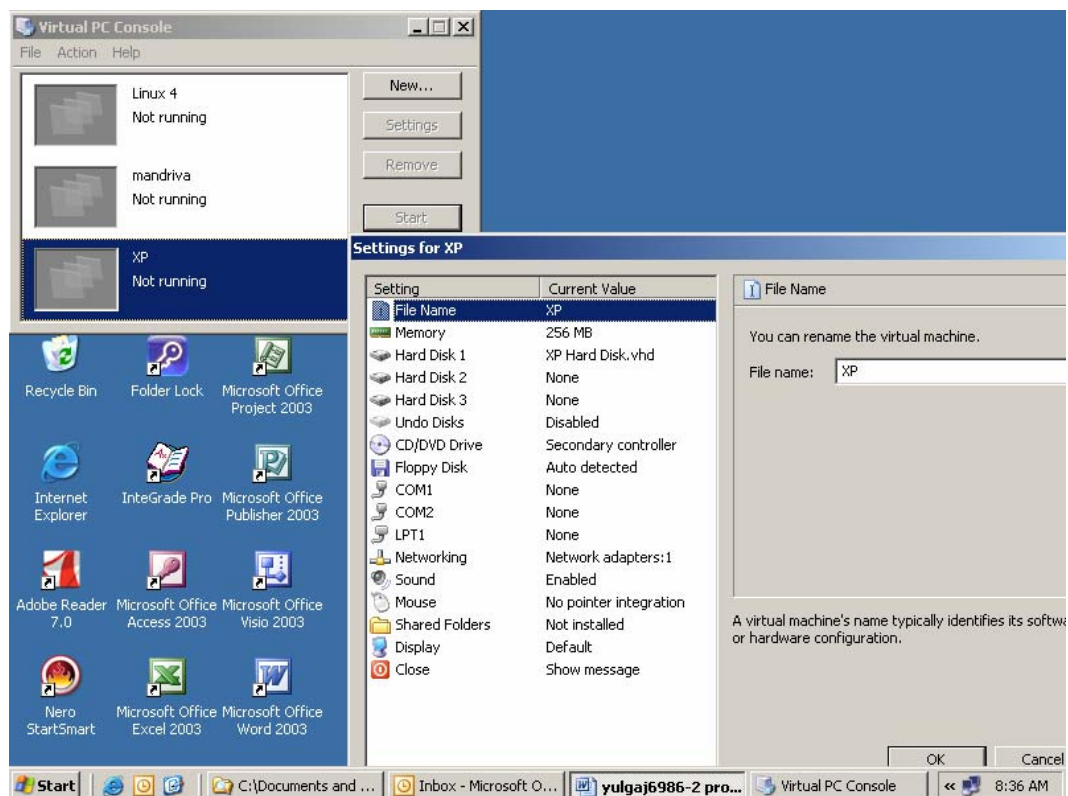


Figure 3, Microsoft's Virtual PC Console and settings

In figure 4, the files used by VPC are illustrated. For every virtual PC in the console window illustrated in figure 3, there are two associated files. The files with the .vmc extension contain the settings just described, and the file with the .vhd extension is the actual installation of an operating system.

Also notice that these files are stored in the host PC operating system (XP) user's profile (*C:\Documents and Settings*). For each XP user, these files are kept separate. While not immune from tampering, they are reasonably secure.

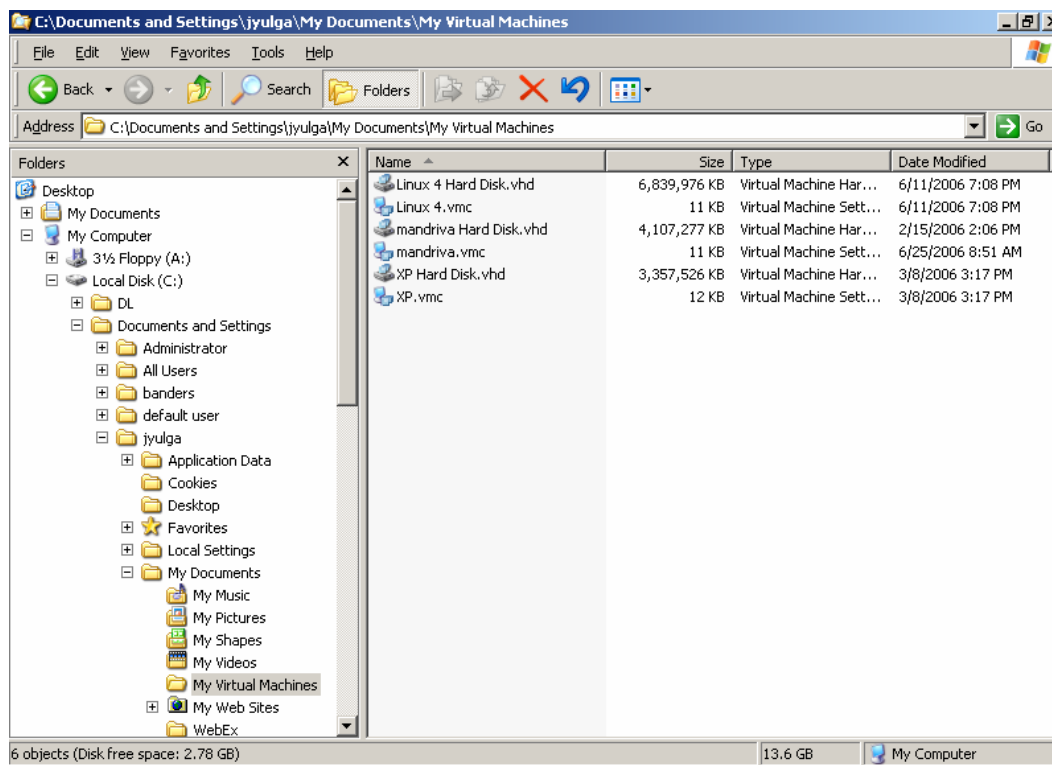


Figure 4, VPC files

Figure 5 illustrates one operating system running as a virtual PC within the host operating system. In this case, both operating systems are XP.

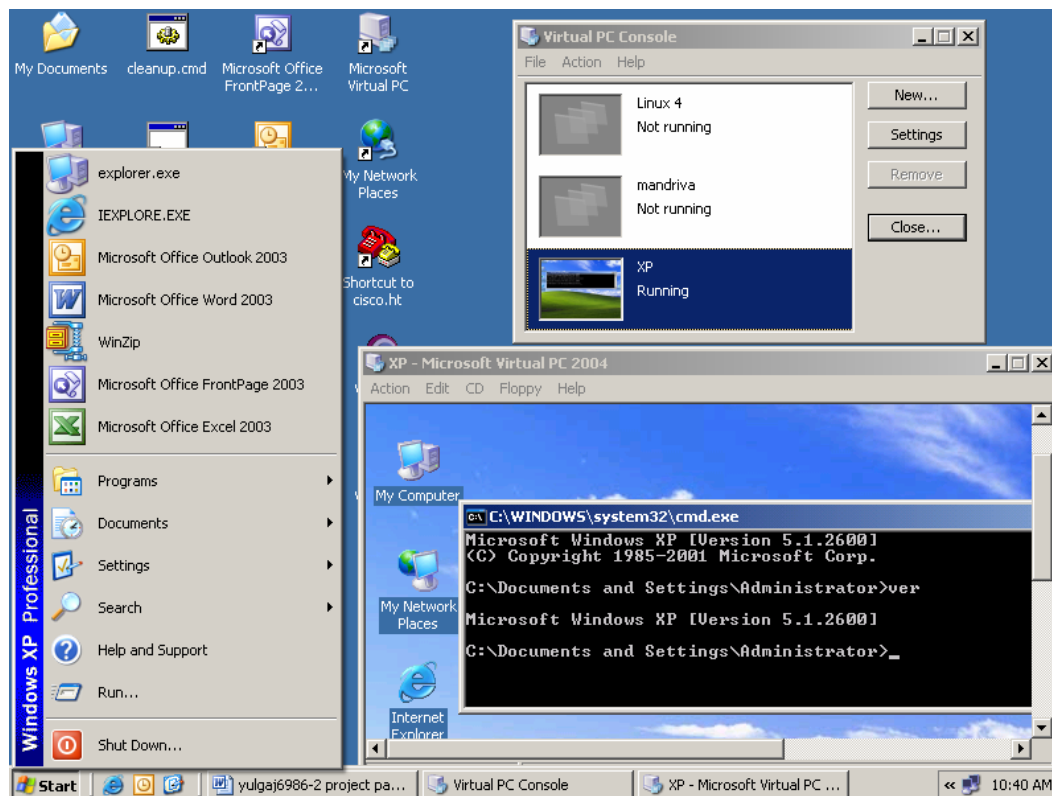


Figure 5, Windows XP running as a virtual PC

Curriculum Development

The competencies for this curriculum have been developed over the past seven years by local business advisors and instructors in support of the Network Specialist Applied Associate Degree taught at Mid-State Technical College. This is a two-year (four semesters) program. MSTC is part of the Wisconsin Technical College System. The Network Specialist program composition, including courses and competencies, are formally filed with the WTCS. The particular course covered in this project is Network Administration-Intermediate, a three-credit, fourth semester course. While the implementation of the competencies can be changed, the competencies themselves cannot be changed without approval. In other words, if a competency states, "Install and implement directory services", that could involve Microsoft's Active Directory or Novell's

Directory Services. The competency cannot change, but the actual type of system implemented can be.

Current Network Administration-Intermediate course competencies as related to Microsoft software (the focus of this project is DNS and Active Directory):

- Compare Windows Server 2003 and Windows XP Professional (review).
- Install and configure Windows Server 2003.
- Perform server monitoring and performance tuning.
- Monitor and analyze network traffic.
- Manage software licenses.
- Install and configure network devices.
- Install and configure DNS, FTP, and Web services.
- Install and implement Active Directory.
- Install, configure, and test software.
- Install and configure new hardware.
- Identify technology to meet needs.
- Other networking administration issues and tasks as time allows.

The definition of the word “curriculum” can be broad, and includes “an integrated course of academic studies” or “a plan for learning”. For the purposes of this project, this integrated course or plan is demonstrated in the deliverables found in the appendix and are the result of this project. Taken together, all of the deliverables can be used to assist in the instruction of MSTC’s Network Administration-Intermediate, or any course that uses Microsoft Windows operating systems to demonstrate the client/server relationship as illustrated using DNS and Active Directory.

From a student’s involvement, their task is to adhere to, and complete the documents found in the appendices. The testing of actual competence is explained in the document titled “Network Administration-Intermediate, Competency Guidelines and Expectations”. Briefly, students install and configure a system that conforms to the document titled “Network Administration-Intermediate, Windows 2003 Competency #1”. They perform these tasks without instructor assistance. Once completed, they practice the skills until they are mastered and then they arrange

a time for demonstration to the instructor. The instructor then checks off the items for completeness and accuracy. Often there are other tasks related to the competency that are assigned. Any tasks not completed, or inaccurate, are corrected and demonstrated again (for reduced grade point value). The goal here is mastery through repetition.

System Development Life Cycle

This project has followed the standard System Development Life Cycle, although some of the work to complete this project has been done so for other projects, other reasons, and other time frames. However, every project is driven by a need to fix a problem or find another and better way of accomplishing a set of tasks. This project is no different.

Planning Phase

The problem as stated previously is to determine the feasibility of VPC and producing networking curriculum, including deliverables. After an informal presentation to MSTC's management in December of 2005, approval was given to proceed. Having known the costs and comments from students concerning delivering the Network Specialist program at more than one campus, they were aware of the feasibility of such a concept. The schedule was set for MSTC spring 2006 semester, January-May.

Analysis Phase

The analysis of this project stems from the experience of all involved. The College's focus should be educating students so that they can be viable employees to any organization desiring an entry-level network specialist. While this may sound obtuse, an educational organization does produce a product, that being an educated and skilled person. While there is a greater human element present, the process can be equated to any production facility in that methods need to be found and used to increase efficiency and reduce cost. Based on previous experience, the limits of the existing hardware solution were known, as were the *possibilities* of VPC. The competencies were already developed and had been implemented using the hardware solution.

Design Phase

The author of this project has mastered the competencies covered in the Network Administration-Intermediate course years ago. The difference in the course as implemented in this project is the use of VPC. Therefore, through the author's experience and testing prior to delivery to students, a prototype implementation of XP/W2K3 (client/server) as it relates to DNS and Active Directory, was developed. Experimentation would be conducted with the client/server aspects of XP and W2K3, including DNS and AD, on the instructor's lab PC. In addition, the deliverables for student and instructor use were either modified or developed. The deliverables are the tangible results of this project.

Implementation Phase

After testing the procedures, students would be directed through the same steps as the instructor (the author). Through repetition, students performed the same steps (in ultimate preparation for assessment). Occasionally, there were differences between the author's testing and classroom implementation, but not enough that a bit of simple troubleshooting couldn't fix. Once the author was sure of the steps, they were incorporated into this project, or documented for future use.

Support Phase

This phase will involve updating the curriculum to include the use of VPC beyond the scope of DNS and Active Directory. In addition, while beyond the scope of this project, the use of VPC will extend to other operating systems and other courses both inside and outside of the Network Specialist program.

Project Participation

This project was developed, implemented, and documented solely by the author. Testing of the tasks involved, and the implementation of Virtual PC was accomplished by one section of MSTC's Network Administration-Intermediate course. This section was comprised of 10 students in their fourth of four semesters. As a prerequisite to this course, these students must have

successfully completed other courses dealing with programming logic, networking concepts, systems analysis and design, PC troubleshooting, and customer support.

The author has eight years of full-time teaching experience. In addition, the author has been employed as a network administrator, systems analyst, and programmer. Total career time in the field is 22 years.

Deliverables

The deliverables include (included in the appendices.):

- Appendix A, a document that defines how a student is graded, "Network Administration-Intermediate Competency Guidelines and Expectations".
- Appendix B, research documents (worksheets) the student must perform prior to beginning the tasks involved, "Network Administration-Intermediate ARP and DNS" and "Network Administration-Intermediate Active Directory"
- Appendix C, a checklist (competency) of the items that a student must follow, and subsequently demonstrate to an instructor, "Network Administration-Intermediate Windows Server 2003 Competency #1."
- Appendix D, a list of procedures an instructor can use to learn the tasks themselves and assist the students, "Instructor Procedures for Project Implementation".

Summary

The research for this project is a combination of culminated years of practical classroom implementation and literature review. The author's and MSTC's goals of curriculum implementation versatility are common among colleges. The hardware solution has been thoroughly tested and effectively implemented. Through continuing improvement of delivering courses, the System Development Life Cycle can be applied. The result is a method of course implementation and associated deliverables that uses software rather than hardware to increase versatility and feasibility of delivering courses and course tasks and competencies.

Chapter Four, Project History

Project History (i.e., How the Author got to the Project)

Eight years ago, the author designed and began teaching the Network Specialist Applied Associate Degree program at Mid-State Technical College. One of the goals of the program is to expose students to the installation, configuration, and management of different operating systems.

To be implemented effectively, each student requires his or her own controlled environment. This entails an individual computer, individual hard drive space, or an individual removable hard drive for operating system installations. Individual computers are too costly and space consuming. The author explored various boot manager (i.e., multi-boot) programs. In this case, up to four operating systems could be installed in their own partition on the hard drive and the boot manager program used to control which operating system was actually run. This proved unreliable, because a student could unintentionally (or intentionally) delete a partition used by another student. In addition, not all operating systems support this type of installation. At the time, simulation programs and Computer Based Training programs did not (and still do not) involve nor allow the intricacies of an operating system to be investigated. A hardware solution was then investigated which involved removable hard drives and an associated mounting system. Each student would have their own installation of an operating system on their own hard drive for the duration of a course. This system was evaluated and then purchased, and has proven to work wonderfully. One removable hard drive is used per student, per operating system (Windows 9x, 2000, XP, 2003, Netware, Linux, or whatever will work on the Intel i386 platform), per course. The control each student has over their own system has demonstrated ownership and responsibility. The removable hard drive mounting system including the frame/carrier system has performed flawlessly.

Standard IDE hard drives were used. The removable hard drive system is from StorCase, and model Data Express® DE90 was used. (It should be noted that this model has been discontinued, and a new version released.) A frame is mounted in the 5.25" drive bay of a PC. The hard drive mounts in a carrier, and slides in and out of the frame. The carrier/frame system is a simple electrical pass-through system.

Figure 6 and 7 displays the components of the StorCase Data Express® system. Figure 6 displays the carrier system. On the top (and from left to right) are the carrier cover, carrier, and a standard parallel IDE drive. Notice there are only two connections on the back of the carrier; one for power and the other for data signals. The bottom row displays the cover, the carrier with a hard drive installed and connected, and an assembled unit.



Figure 6, StorCase DE90 removable driver carrier

Figure 7 displays the white plastic receiving frame mounted in a PC in one of the 5.25 drive bays. As the removable drive is inserted, the door swings in. The drive is inserted until it connects on the back of the carrier and front of the rear portion of the frame. The key is then turned to lock the carrier with removable hard drive in place. The frame connects to one of the PC's IDE and power cables.



Figure 7, StorCase DE90 drive frame installed in PC

When a student started class for the period, they would retrieve their removable hard drive from a drawer and insert it into one of the 20 lab PCs. For the duration of that class period, the student would use the removable hard drive and PC combination. When class was over, the PC would be shutdown and the removable hard drive returned to the drawer.

When the systems were purchased in 1999, 23 frames and 94 hard drives and carriers were purchased at considerable cost. MSTC has three campuses approximately 25 miles apart.

Because of the cost, the program could only be implemented at one campus. Students would have preferred the program be available at all campuses.

In certain respects, this project began over a year ago when another MSTC instructor took a course on network security at an independent educational organization. The instruction included the use of VPC. The instructor returned from the training and began to implement VPC in the classroom. Having seen the possibilities, the author and the author's employing College began to wonder about the possibilities of implementing a software solution rather than hardware in network curriculum.

Because of the desire to implement the Network Specialist program on more than one campus, in the fall of 2005, the author suggested to MSTC's management a software implementation rather than hardware. Therefore, this idea and this project were timely, in that it brought together a valuable implementation for the College, and a project for the author to do for Regis' Master of Science in Computer Information Technology project requirement.

Project Management

As stated in the research portion (chapter three), this project has been initiated and managed by the author. Based upon experience, the overall result was known and hoped for. The success of achieving this result was the unknown.

Project management involved testing the interoperability of XP and W2K3 under VPC. Success of that procedure led to documentation including deliverables and then demonstration to students. For the specific tasks of DNS, and in particular, AD, this was accomplished in a two-week period.

Milestones were achieved when the process of instructor testing and documentation, and student completion of the DNS and AD tasks (as described in "Instructor Procedures for Project Implementation").

Results and Analysis

This project, and the overall usage of Virtual PC, has been a complete success. XP and W2K3 worked the same in VPC as it did on individual computers and hard drives with the StorCase system. In other words, the software solution mimicked the hardware solution. To some this may seem trivial, but to an experienced and seasoned IT specialist and instructor, it is not. In the IT field, interoperability among software and hardware are common. In the instructional arena, there is nothing more frustrating to a student than paying for courses in which the lab equipment is either outdated or inconsistent in its function, or the instructor perceived incompetent.

Students quickly adapted to the concept of two virtual PCs running on one host computer. The author used VPC to support two courses – Network Administration-Intermediate, and Network Operating Systems. While most of the competencies for these courses were outside the scope of this project, they were courses the author taught during the spring 2006 semester. Network Operating Systems, in particular, was a pleasant surprise, as this course is dedicated to the installation, configuration, and use of Red Hat Linux Fedora core 4 (and its associated interaction with a client operating system such as XP). Despite a few minor issues, this version of Linux also performed perfectly. Here too, students did not have any usage issues.

Figure 8 illustrates Linux Fedora core 4 running as a virtual PC under the host XP operating system.

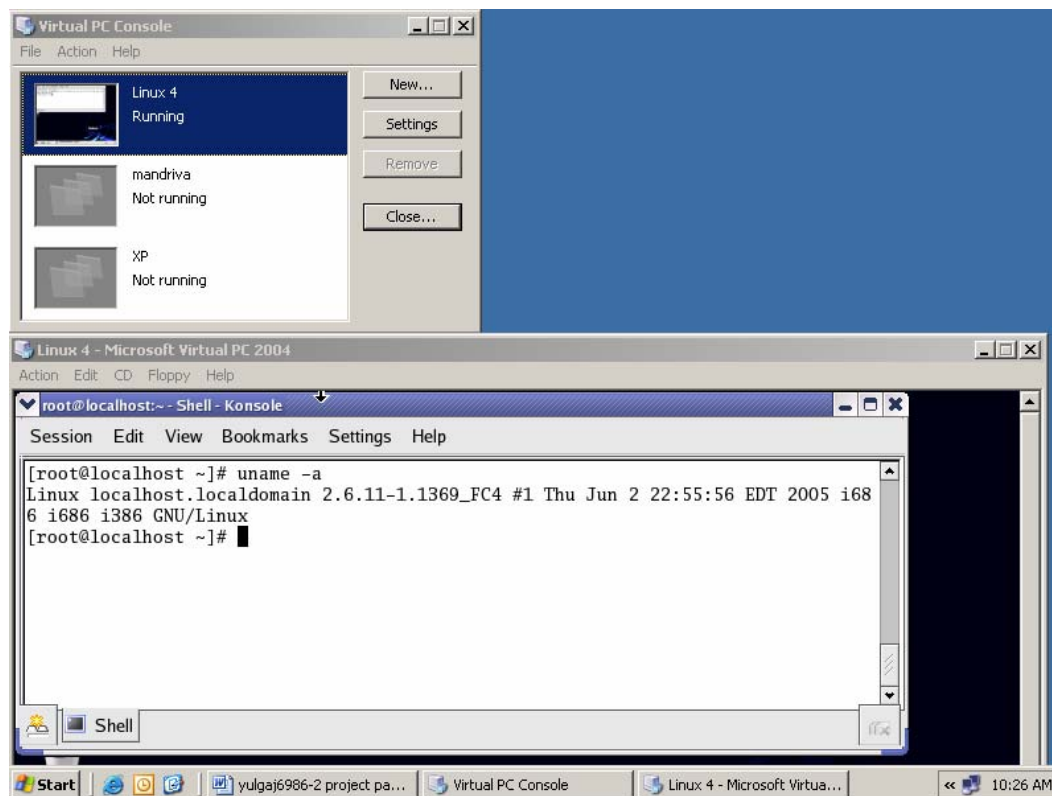


Figure 8, Linux Fedora core 4 running as a virtual PC

Deliverable Development

The deliverables found in the appendix are the tangible results of this project. As stated previously, this project is centered on curriculum development. While the documents existed before this project started (except for appendix D, "Instructor Procedures for Project Implementation"), they were modified to be used with VPC *and* still include the hardware solution of individual removable hard drives. This is important, because flexibility is required in the implementation of course delivery. If the deliverables are examined, there is no mention of VPC. This is because, ultimately, it is the competencies developed for the course that are important to the student and the success of that student, not how they are delivered. That delivery is a function of the College system and its exercised right to control courses and budgets.

Student Assessment

Further proof of project success came during student assessment of the tasks covered in this project (DNS and AD). As explained previously, the deliverable, "Network Administration-Intermediate Windows 2003 Competency #1" (appendix C), is a document that students formally receive when a series of topics have been covered in class. The student's task is to create an XP and W2K3 "mini network" from scratch. Using individual removable hard drives, this involves reformatting, followed by operating system installation and configuration using two hard drives and two physical computers. Using VPC, this involves creating new virtual PCs using VPC running on one host PC, and then operating system installation and configuration.

Watching each student demonstrate the tasks (competencies) in XP and W2K3 showed to the author that the tasks listed could be successfully completed using VPC. Students were able to demonstrate the tasks in the same amount of time, and with similar success as has been demonstrated for years using the hardware solution to delivering the course. Ultimately, the students had demonstrated knowledge and skill in the concepts of client/server relationship as implemented through DNS and AD. The fact that both XP and W2K3 were running as virtual PC did not hinder the students at all.

Finally, the ultimate test as to the completeness and usefulness of curriculum is assessment. If after all of the time and work performed on curriculum development, the students are unable to perform the tasks properly, effort was probably wasted. No one wants the wrong solution to the right problem.

Summary

This project met its stated goals – test the feasibility of a virtual technology (Microsoft's Virtual PC) in implementing curriculum including assessment, and producing supporting documentation (deliverables). Students in the courses the author taught successfully demonstrated skill and competence, and solved any issues that arose. The use of Microsoft's Virtual PC will be a benefit

to MSTC in its delivery option for networking curriculum, as well the possibility of courses and programs outside of that scope. Having this option available will increase course offerings at all of its campuses, which is a positive benefit for students. From a practical standpoint, this option will increase MSTC's return on investment for the money it spends on lab resources. In addition, the knowledge and information collected here will be shared with other instructors.

Chapter Five, Lessons Learned and Project Extensions

Lessons Learned

This has been a very interesting project. There have been a number of aspects to this project – whether VPC, XP, and W2K3 would work properly together, and whether the tasks and competencies that have been accomplished via hardware would work similarly when implemented via software, and whether a subset of the course and competencies could be assembled together for this document. The author believes he has successfully accomplished all of those aspects.

As has been previously stated, VPC was also successfully used in teaching a course using Linux. When the semester began in January, the author had serious doubts whether VPC, W2K3, XP, and Linux would peacefully coexist. They have, and the interoperability has been a boon to students. For example, Linux Samba is implemented, which “turns” a computer running Linux into a “Windows server” with the implementation of the SMB protocol. XP can then be used as a client to Linux. Students were able to understand the parallels between all three operating systems running on one host computer. Given this, a recommendation is to use the fastest processors that can be afforded, and at least 512MB RAM for each Virtual machine that is to be running at any given time.

One section each of Network Administration-Intermediate and Network Operating Systems were successfully taught using VPC (on the Stevens Point campus). As a control, another section of each was taught (on the Wisconsin Rapids campus) using the hardware solution (of course, past success of these courses also plays a role for comparison.). All tasks and competencies were implemented successfully with minimal issues. Given these facts, the author believes that this project is a 100% success and met the initial expectations. Curriculum deliverables were updated

to reflect the flexibility of implementing the course using either VPC or the individual removable hard drives.

Project Changes

The author considers this project a success because:

- The curriculum was updated, and knowledge was gained for future use that will increase the option of delivering courses at MSTC. This will have far reaching impact to MSTC.
- All computer systems performed acceptably.
- Virtual technology such as Microsoft's Virtual PC is a viable solution for implementing curriculum.
- The appropriate topics (competencies) were covered in the course.
- Students learned the material, and were successfully assessed.
- The deliverables were updated or developed.
- VPC issues were minor. Little, if any, student confusion resulted from using VPC.

There is, however, one change that the author would make to this project. The focus of this project was to be curriculum development, and more specially DNS and AD. This focus was too narrow. A more applicable concept focus, or title, would have been "Using virtual technologies to support a broad range of operating systems and tasks when implementing networking curriculum", or "Using virtual technologies to support Information Technology courses". Having said that, the author also believes that at project inception, these concepts were beyond the scope of the project course requirement for Regis' Master of Science in Computer Information Technology.

Project Evolution

The next step in this project will be to take other courses such as PC Troubleshooting-Beginning and Intermediate, and Introduction to Security and implement those using VPC. In doing so, instructors will be introducing Virtual PC and its concepts earlier in a student's academic career.

In reality, that is already occurring, as course and curriculum development is dynamic. Students will be able to edit the registry or introduce a virus in an unprotected virtual installation of Windows 98, for example. When done experimenting (cause and effect again), students will be able to close VPC without saving changes, and the 98 virtual machine will be the same as it was before testing. The result is wonderful flexibility and cost savings. The result of these endeavors will be additional curriculum that can be used to support courses, and assist instructors and students. All of this can be performed in a non-dedicated and non-isolated lab; in other words, a production lab.

In addition, as previously mentioned, use VPC to instruct a course on Linux. This too, is occurring.

As of May 2006, no decision has been made by the MSTC's management to discontinue the hardware (removable hard drive) solution. However, given the success of this project, any further such purchases are unlikely, preferring instead the software solution.

Summary

Given the success of this project, the options available to MSTC or any educational organization are quite broad. This project was a valuable and productive learning experience for both the author and MSTC. While the scope of this project could have been broader and covered the concept of implementing virtual technology in Information Technology courses in general, it nonetheless served its purpose by demonstrating that Microsoft's Virtual PC software product is functional, stable, usable, and cost effective. This virtual technology is an effective method to implement networking courses and associated hands-on curriculum.

References

- (1) Microsoft Virtual PC information: <http://www.microsoft.com/windows/virtualpc/default.aspx>
- (2) StorCase drive systems: <http://www.storcase.com/>
- (3) VMware information: <http://www.vmware.com/>
- (4) Microsoft's Developer Network Academic Alliance (MSDNAA):
<http://msdn.microsoft.com/academic/>
- (5) Current course syllabus: <http://instructor.mstc.edu/instructor/jyulga/150-121/Syllabus.doc>
- (6) MSTC Network Specialist program:
<http://www.mstc.edu/academics/CISNetworkSpecialist.pdf>
- (7) Wikipedia's entry for Microsoft Virtual PC: http://en.wikipedia.org/wiki/Virtual_PC

Annotated Bibliography

- (8) Honeycutt, Jerry. (November 2003). Microsoft Virtual PC 2004 Technical Overview.
<http://www.microsoft.com/windows/virtualpc/evaluation/techoverview.mspx>. Accessed 5/22/2006.

This white paper provides a technical overview of Virtual PC, including minimum requirements and operation between the host and virtual operating system.
- (9) Honeycutt, Jerry. (May 2006). Microsoft Virtual PC 2004 Deployment.
<http://www.microsoft.com/windows/virtualpc/techinfo/deploy.mspx>. Microsoft Corporation.
Accessed 5/22/2006.

This white paper describes how to deploy Microsoft Windows 9X, Windows NT Workstation 4.0, Windows 2000 Professional, and Windows XP Professional on virtual hard disk images by using Virtual PC. While the details of Virtual PC are explained, which are assumed in this project, it nonetheless has background on the use, implementation, and deployment of VPC.
- (10)Haufe Mediengruppe, one of the top 10 publishers in Germany, uses VPC for software testing.

<http://members.microsoft.com/CustomerEvidence/Search/EvidenceDetails.aspx?EvidenceID=2661&LanguageID=1>. Microsoft Corporation. 2003. Accessed 5/22/2006.

Haufe Mediengruppe editors use VPC to test various software products. In doing so, they are not required to reinstall an operating system after testing a product. They simply install the product, configure, and test it. When completed, they do not save the VPC environment. The result is an unchanged base operating system ready for the next product. As a result, the editors are able to test more products using different operating systems without individual computers for each, and without constant reinstallations.

- (11) Lei, Kimfong & Rawles, Phillip T. (2003). Strategic decisions on technology selections for facilitating a network/systems laboratory using real options & total cost of ownership theories <http://portal.acm.org.dml.regis.edu/citation.cfm?id=1047508&coll=Portal&dl=GUIDE&CFID=77705242&CFTOKEN=76337615>. ACM Press. Accessed 6/6/2006.

Discusses different combinations of enabling technologies and approaches, such as virtual machine technology, storage technology, and host operating system used in a laboratory environment.

- (12) Leitner, Lee J & Cane, John W. (2005). A virtual laboratory environment for online IT education <http://portal.acm.org.dml.regis.edu/citation.cfm?id=1095780&coll=Portal&dl=GUIDE&CFID=77705242&CFTOKEN=76337615>. ACM Press. Accessed 6/6/2006.

Discusses issues with creating hands-on lab experiences for online (distance education) students.

- (13) Nieh, Jason, & Vaill, Chris. (2005). Experiences teaching operating systems using virtual platforms and linux. <http://portal.acm.org.dml.regis.edu/citation.cfm?id=1047508&coll=Portal&dl=GUIDE&CFID=77705242&CFTOKEN=76337615>. ACM Press. Accessed 6/6/2006.

Discusses Linux kernel-level programming projects using VMware running on a host PC, leaving the host unaffected.

(14)Satzinger, John W, Jackson, Robert B, & Burd, Stephen D. (2004). System Analysis and Design in a Changing World, Third Edition. Boston: Course Technology.

The chapter titled "Approaches to System Development" covers the System Development Life Cycle. Every systems project should follow this life cycle comprised of planning, analysis, design, implementation, and support phases. This chapter is helpful for keeping on track and achieving the project goals.

Appendices

Appendix A, Competency Guidelines and Expectations

This appendix includes the guidelines for assessing a student for the hands-on portion of the course. It is to be printed as is, except for the headings added for inclusion in this document.

Network Administration-Intermediate, Competency Guidelines and Expectations

Network Administration-Intermediate Competency Guidelines and Expectations

Throughout this course, there will be competencies to assess your mastery of the hands-on portion of network administration. This mastery is defined as knowledge, skills, confidence, preparation, accuracy and of course, competence. In essence, a competency is a hands-on exam. This document outlines the guidelines and expectations for these competencies.

The majority of the competencies will involve installing and configuring a Network Operating System per the competency specifications in preparation for demonstration to the instructor. All of the tasks in a competency have been covered in class.

While it is desirable to have all students work collaboratively, the work must ultimately be individual. Assistance from other students must be limited. In other words, during your preparation you may ask others questions, but you must implement their answers. Other students must **not** be at the controls. In addition, because this is a hands-on exam, the instructor will **not** assist unless a situation has occurred beyond your control or you need instructions clarified.

Given these conditions, either receiving or giving excessive student assistance will be considered a breach of the Academic Integrity Policy as stated on the syllabus. While a demonstration is ongoing, assistance is prohibited.

Any test installations must occur before you begin your actual competency installation. During such an installation, the instructor will provide assistance. All test installations must be deleted before proceeding with the competency.

Grading competencies will be graded based on the number of attempts needed to complete as follows:

# of attempts	Percent given
1	95-100
2	85
3	75
4	60
5	10% reduction from 60% per attempt

One or more of the following conditions will be considered an attempt:

- Lack of preparation
- Lack of skills and knowledge needed for demonstration
- Incompleteness – missing item(s) from the competency documentation
- Inaccurately implementing item(s) from the competency documentation
- Duration of demonstration – while time is given to show/prove the competency items, constantly searching and thus taking an inordinate amount time will be considered a lack a of preparation.

In addition, there will be a 10% reduction for lateness per late period. A late period is defined as a day, or signing up for a competency demonstration time and not being able to meet that time.

Your notes may be used during the demonstration, but timeliness of completion is a factor.

The flow of the competency demonstration will be as follows:

- 1) The demonstration will begin. Questions by the instructor will be asked to verify the items of the documentation. Additional tasks will be asked to prove abilities contained in the competency.
- 2) Item(s) that are missing/incorrect will be noted.
- 3) If any of the other conditions that are considered an attempt apply, they will be noted also.
- 4) This will be considered an attempt.
- 5) When the demonstration is complete, time will be given to correct any items.
- 6) The correction(s) will then be demonstrated. (If this demonstration goes beyond a late period, the final grade will be reduced 10% per late period.)
- 7) If there are still missing/incorrect item(s), time will be given to correct them.
- 8) If any of the other conditions that are considered an attempt apply, they will be noted also.
- 9) This will be considered another attempt.
- 10) This process will continue until all of the items have been corrected and demonstrated.

Appendix B, Student Worksheets

This appendix includes worksheets for students to complete. These are to be printed as is, except for the headings added for inclusion in this document.

Network Administration-Intermediate, ARP and DNS

Network Administration-Intermediate ARP and DNS

Copy this document and complete the outline.

Related web site links:

http://en.wikipedia.org/wiki/Main_Page

<http://www.howstuffworks.com/>

<http://www.microsoft.com/>

<http://www.networkdictionary.com/>

<http://www.webopedia.com>

<http://support.microsoft.com/default.aspx?scid=kb;en-us;814591>

http://www.microsoft.com/resources/documentation/windows/xp/all/proddocs/en-us/tcpip_utils.mspx

Research using the above sites, the textbook, and any additional sites:

- 1) Define the following terms:
 - a) Address Resolution Protocol (ARP)
 - b) Berkeley Internet Name Domain (BIND)
 - c) Domain Name System (or Service or Server) (DNS)
 - d) DNS domain namespace or DNS hierarchical tree or logical organization of the Internet
 - e) Windows Internet Naming Service (WINS)
 - f) NetBIOS over TCP/IP (NBT)
 - g) Fully Qualified Domain Name (FQDN)
 - h) Loop back address
 - i) Replication (non computer related definition)
 - j) Duplication (non computer related definition)
- 2) Research the following commands found in Microsoft operating systems. Include links.
 - a) arp
 - b) ipconfig
 - c) nslookup
 - d) nbtstat

Commands are indicated using Times New Roman font.

Network Administration-Intermediate, Active Directory

Network Administration-Intermediate Active Directory

Copy this document and complete the outline.

Related web site links:

http://en.wikipedia.org/wiki/Main_Page

<http://www.microsoft.com/>

<http://www.networkdictionary.com/>

<http://www.webopedia.com>

Research using the above sites, the textbook, and any additional sites:

- 1) Define the following terms:
 - a) Lightweight Directory Access Protocol (LDAP)
 - b) Directory service
 - c) X.500
 - d) Active Directory
 - e) Netware Directory Service (NDS)
 - f) Domain (non computer definition)
 - g) Domain Controller
 - h) Fully Qualified Domain Name (FQDN)
 - i) Best practice
 - j) AGDLP
 - k) Organizational unit
 - l) Replication (non-computer related definition)
 - m) Duplication (non-computer related definition)
- 2) What program is run to install AD on Windows Server 2003?
- 3) Research the command gpupdate. Include links.
- 4) Review NTFS permissions.

Commands are indicated using Times New Roman font.

Appendix C, Windows Server 2003 Competency

This appendix includes a competency checklist for students to complete and latter are assessed on. It is to be printed as is, except for the headings added for inclusion in this document.

Network Administration-Intermediate, Windows 2003 Competency #1

Network Administration-Intermediate Windows Server 2003 Competency #1

This is a review Windows Server 2003 exercise. Do all of the tasks below.

What: Install Windows Server 2003 as outlined below.
 Who: Each student working independently.
 When: TBA
 Grading: See Net Admin competency guidelines.doc

- 1) Completely install Windows Server 2003.
 - a) There can be no other NOS/OS on the hard drive, i.e. re-partition the drive.
 - b) Create two primary partitions:
 - i) Partition one is 20 GB
 - (1) NTFS, C:
 - ii) Partition two is 20 GB (or what remains)
 - (1) NTFS, D:
 - c) CD-ROM is E:.
 - d) Product key is: _____
 - e) Licensing is "Per user or per device"
 - f) Enter a meaningful computer name, i.e. not "workstation" _____
 - g) Enter an Administrator password _____
 - h) Time zone will be set to Central time (GMT -06:00).
 - i) Set the time to MSTC time.
 - j) Installation will be the "typical setup".
 - k) Enter a meaningful temporary workgroup name, i.e. not "workgroup"

- 2) Windows Server 2003 communication.
 - a) Install the driver for the Marvell Yukon 88E8050 PCI-E ASF Gigabit Ethernet Controller.
 - b) Configure the TCP/IP network protocol only:
 - (1) IP is 172.17.10.nnn
 - (2) Use the following IP addresses:
 - (a) MW 8:00:
 - (b) IP: _____
 - (3) SM is 255.255.0.0
 - (4) Default gateway is the same as the IP
 - (5) Preferred DNS server is 172.17.10.11
 - (6) Primary DNS suffix is NETLAB.COM.
 - c) The workstation will communicate with the rest of the network, both at the network layer (ping), and the application layer (Microsoft Windows Network).

- 3) Windows Server 2003 startup configuration.
 - a) Show the Startup list for 5 seconds.

- 4) Windows Server 2003 enhancements.
 - a) For the Administrator user:
 - i) Create Desktop icons (do not use programs from C:\WINNT\SYSTEM32\DLLCACHE) for:
 - (1) Control Panel
 - (2) Administrative Tools folder
 - (3) Windows Explorer
 - (4) Windows 2003 Diagnostics (system information)
 - (5) Windows 2003 IP configuration displaying all info
 - (6) Windows 2003 Command prompt
 - (7) DNS
 - (8) ADUC.
 - ii) Enable these settings (these are not policy settings):
 - (1) Display file extensions
 - (2) Display hidden files
 - (3) Display Operating System files.
 - b) Create a folder structure for management of downloaded/zipped/compressed updates such as service packs, NIC, printer, video drivers, etc on D:\.
 - i) Access \\NLSVR1\PROGRAMS (do not reconnect to this drive at logon) and copy to this structure:
 - (1) Service pack 1
 - (2) Mass storage (Adaptec PCI IDE controller) update
 - (3) Trusted Platform Module update
 - (4) Printer driver (HP 4050 PCL 6)
 - c) Install the following updates
 - i) Service pack 1
 - ii) Mass storage (Adaptec PCI IDE controller)
 - iii) Trusted Platform Module
 - iv) Printer driver (HP 4050 PCL 6)
 - d) Install and automatically start Print services for UNIX.
- 5) Norton Anti-Virus 7.6 Server version
 - a) Copy to a folder on D:\.
 - b) Do not install AMS.
 - c) Password: _____
 - d) Install to C:\PROGRAM FILES\NAV.
 - e) Enable Realtime virus checking.
 - f) Update the virus definitions. For further information and directions, see "Copying a .vdb file from another location" in the document: http://service1.symantec.com/SUPPORT/ent-security.nsf/docid/2000041710560048?Open&src=&docid=2000010708230148&nsf=ent-security.nsf&view=docid&dtype=&prod=&ver=&osv=&osv_lv/

- 6) Windows Server 2003 Domain users. ***Do not use spaces in usernames!**
 a) Create two new administrator users, with full name and description, and add them to the Domain Administrators group.

Username*	Password
_____	_____
_____	_____

- b) Create two Organizational Units (OU) to contain the following user accounts:
 i) Unrestricted desktop OU: _____

(1) Create two users, with full name and description

	<u>Username*</u>	<u>Password</u>
(a) User #1	_____	_____
(b) User #2	_____	_____

- ii) Restricted desktop OU: _____

(1) Create two users, with full name and description

	<u>Username*</u>	<u>Password</u>
(a) User #3	_____	_____
(b) User #4	_____	_____

- c) Create an OU that will contain the global groups: _____

- i) Within this, create two global groups based on type of users
 (1) Group #1 _____
 (2) Group #2 _____

- ii) Appropriately modify the member list of these groups to include the users created in (6) (b) (i) and (6) (b) (ii).

- d) Create an OU that will contain the domain local groups:

- i) Within this, create two domain local groups based on resource restrictions for the common folder
 (1) Group #1 _____
 (2) Group #2 _____

- ii) Modify the member list of domain local group #1 to include the members the global group #1.

- iii) Modify the member list of domain local group #2 to include the members the global group #2.

- e) Provide a diagram of the OU organization. Use Visio/Word/Excel.

- 7) Windows Server 2003 Group Policies.
 - a) Apply the following to the Domain OU (Default Domain Policy):
 - i) Password Policies:

(1) Enforce password history	3 passwords
(2) Maximum password age:	30 days
(3) Minimum password age:	1 day
(4) Minimum password length:	4 characters.
 - ii) Lockout Account Policies:

(1) Lockout duration:	60 minutes
(2) Lockout threshold:	3 bad attempts
(3) Reset lockout counter after:	15 minutes.
 - iii) Security Options:
 - (1) Remove the requirement to press Ctrl-Alt-Delete at logon
 - (2) Do not display the last user name in the logon screen
 - (3) Start prompting users for password change 5 days before it expires.
 - iv) Administrative templates:
 - (1) Add logoff to Start Menu.
 - b) Apply the following to the Domain Controller OU (Default Domain Controller Policy):
 - i) Allow your global groups to logon locally.
 - c) Create a new Group Policy Object (GPO) for the restrictive desktop OU ((6) (b) (ii) and apply the following:
 - i) Administrative templates:
 - (1) Remove Run menu from Start menu
 - (2) Disable Add/Remove programs
 - (3) Disable deletion of printers.
 - ii) Five additional restrictions of your choosing.

- 8) Windows Server 2003 user data storage.
 - a) The second partition (D:) will be used for user's home folder. (While home folders may be created via the profile tab in the user's dialog box, the NTFS security will be not set appropriately.)
 - b) Invoke the following security on D:\
 - i) Set the NTFS permissions for D:\ as follows:
 - (1) Full Control for the group Administrators
 - (2) List Folder contents for the group Everyone
 - c) Create a \USERS folder and invoke the following security:
 - i) Verify the NTFS permissions as follows:
 - (1) Full Control for the group Administrators
 - (2) List Folder contents for the group Everyone
 - d) In the \USERS folder, create individual user home folders based on username and invoke the following security:
 - i) Set the NTFS permissions as follows:
 - (1) Full Control for the group Administrators
 - (2) All permissions except Full Control for that user
 - e) In the \USERS folder, create a folder to act as a common area for your new users and invoke the following security:
 - i) Set the NTFS permissions as follows:
 - (1) Full Control for the Administrators group
 - (2) Modify for domain local group #1.
 - (3) All permissions except Full Control and Modify for domain local group #2
- 9) Microsoft Office XP.
 - a) Copy to a folder on D:\.
 - b) Install to C:\PROGRAM FILES.
 - c) Install Word and FrontPage.
 - d) Product key is _____
 - e) Install Microsoft Office XP service pack #3.
- 10) Adobe Acrobat 7.x.
 - a) Copy to a folder on D:\.
 - b) Install to C:\ PROGRAM FILES.

11) Windows XP "server" printing.

- a) Add standard TCP/IP ports:
 - i) HP Jetdirect 172.17.10.22
 - ii) HP Jetdirect 172.17.10.24
- b) Add LPR ports:
 - i) Lantronix 172.17.10.27:eps_XXXXXX_p1
- c) Create the following printer objects:

<u>Port/type</u>	<u>Driver</u>	<u>Printer name</u>	<u>Share name</u>
i) TCP/IP to .10.22	HP 4050 PCL 6		
ii) TCP/IP to .10.24	HP 4 Si mx		
iii) LPR to .10.27:eps_XXXXXX_p1	HP 4050 PCL 6		

- d) Give your unrestricted global group Manage Documents permission over (c) (i) (keep all other default permissions). In the real world, you would create a new domain local group for this function.

Please recycle all paper used from testing your printers. Place the paper printed side down onto tray 1 on the laser printer.

- 12) Windows Server 2003 System (Performance) monitoring.
 - i) Configure and start separate alerts for:
 - (1) Logical Disk % Free Space on C: < 30%
 - (2) Logical Disk % Free Space on D: < 20%
 - ii) Log event in Application log for both alerts.

- 13) Windows Server 2003 License Services.
 - a) Add 100 licenses of Windows Server 2003. Maintain per seat.

- 14) Windows Server 2003 DNS. **DNS must be installed and functioning correctly before installing Active Directory.**
 - a) Install, configure, and test DNS services. Make sure the computer name and second-level domain are not the same, i.e. use PC1.PC.COM, and not PC.PC.COM.
 - b) Create primary forward and reverse lookup zones
 - i) Enable dynamic updates.
 - c) Create primary and secondary lookup zones.
 - d) Create new alias records.
 - e) Create new host records.

- 15) Windows Server 2003 client DNS.
 - a) Disable NBT.
 - b) Configure the server as a DNS client to the DNS Server (itself).

- 16) Windows Server 2003 Active Directory (AD).
 - a) Install and configure AD
 - i) Create a new domain controller, tree and forest.
 - b) Modify DNS primary forward and reverse lookup zones to be AD integrated.

- 17) Windows Server 2003 FTP server.
 - a) Install, configure, and test FTP services per Microsoft [323384](#)
 - b) Store files in the appropriate FTP location.

- 18) Windows Server 2003 Web server.
 - a) Install, configure, and test Web services per Microsoft [324742](#)
 - b) Create a simple index.htm file and store it in the WWW appropriate location.

Further testing on the following items:

1. DNS
2. AD
3. FTP
4. Web
5. NAV

Appendix D, Instructor Procedures

This appendix consists of the steps an instructor would use to implement this project using Microsoft XP and Windows server 2003 in a client/server relationship while running in VPC. This procedure is limited to DNS and AD. These procedures are not proprietary.

Instructor Procedures for Project Implementation

The premise behind effective hands-on instruction are the results of cause and effect. Making changes to the server configuration and seeing the results on the client is invaluable. This setup works well with a dual monitor and single computer configuration – one monitor can display W2K3, the other XP for side-by-side comparison.

While there are many ways to see the interaction between a server and a client, for the purposes of this project, DNS and basic Active Directory operability will be demonstrated. This combination works well, because proper DNS functionality is required for proper AD operation, yet DNS is a separate service from AD, and its functionality is largely based on computer and domain names, which it uses DNS to resolve into IP addresses. AD in its simplest terms is a logical representation of a network and its resources. It is also a method to implement through software, an organization's structure (hierarchy).

To perform the tasks outlined below, a student **must** be familiar with the following:

- Windows operations (right clicking, copying files, etc.).
- NTFS permissions (ACL) and share permission ACLs.
- Mapping network drives.
- Group Policies Objects.
- Basic DNS terminology and functionality.
- DNS installation, configuration, and testing.
- The concepts of domains, namespace, and Active Directory.
- Active Directory installation.
- Completed worksheets titled “Network Administration-Intermediate, ARP and DNS” and “Network Administration-Intermediate, Active Directory” (appendix B).

This project covers the following tasks found in the document “Network Administration-Intermediate, Windows Server 2003 Competency #1” (see appendices):

- #6 Windows Server 2003 Domain users
- #7 Windows Server 2003 Group Policies
- #8 Windows Server 2003 user data storage
- #14 Windows Server 2003 DNS
- #15 Windows Server 2003 client DNS
- #16 Windows Server 2003 Active Directory

For the purposes of this exercise, computers should be named using the format “initials-w2k3” (i.e., *jy-w2k3*) for the server, and “initials-xp” (i.e., *jy-xp*) for the client. Zone and domain names are in the format “firstname.net” (i.e., *jim.net*). While this is not “real world” naming, The author has found that personalizing naming keeps student’s interest and aids in their understanding of the configuration through system ownership (from their perspective). From an instructor standpoint, it is easy to track a rogue configuration, because it will point directly back to a particular student.

(For the following screen images, relevant information has been highlighted with red ellipses or rectangles.)

Server DNS Configuration

The first step is to install and configure DNS on the server. If this installation fails, or the server cannot resolve its own name, then the issue must be investigated and corrected before proceeding further.

The following must be accomplished: The server must have a static IP address (*172.27.55.73*), install DNS., create a forward and reverse lookup zone in DNS (*jim.net*, and *172.27.55.x*, respectively).

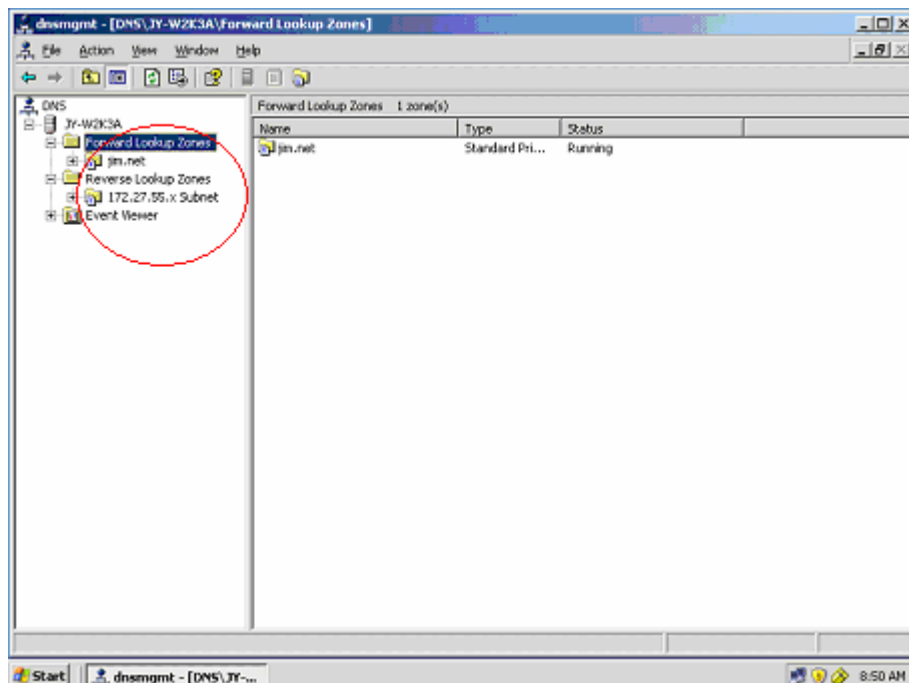


Figure 9 Server DNS with forward and reverse lookup zones

Next, the DNS client settings need to be changed on the server. Change the Preferred DNS server IP to that of the server itself.

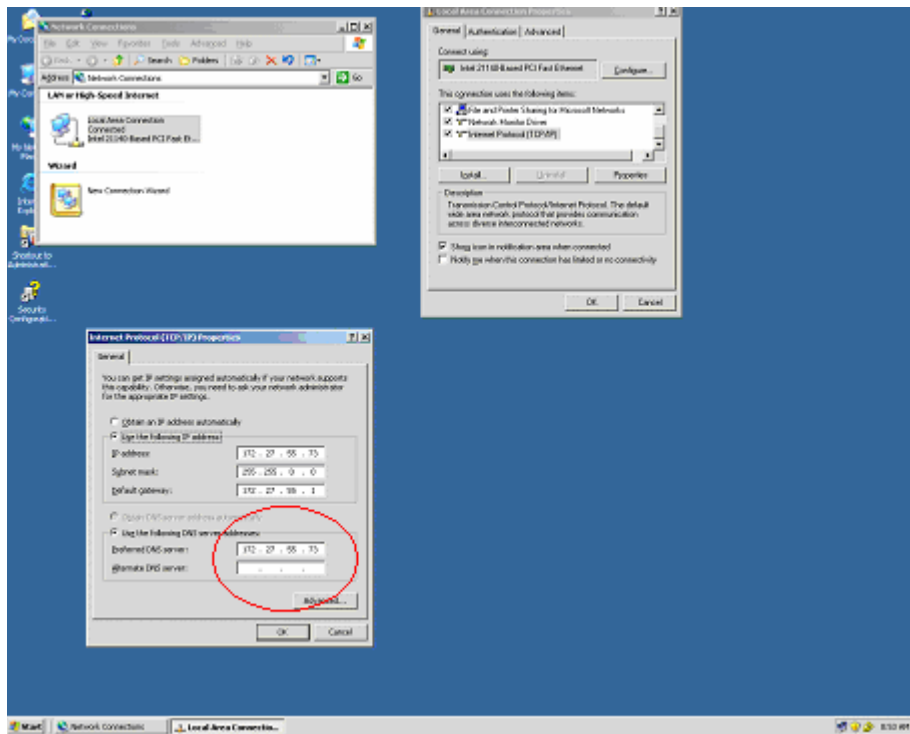


Figure 10 Server preferred DNS server IP address
Change the suffix to that of the forward lookup zone.

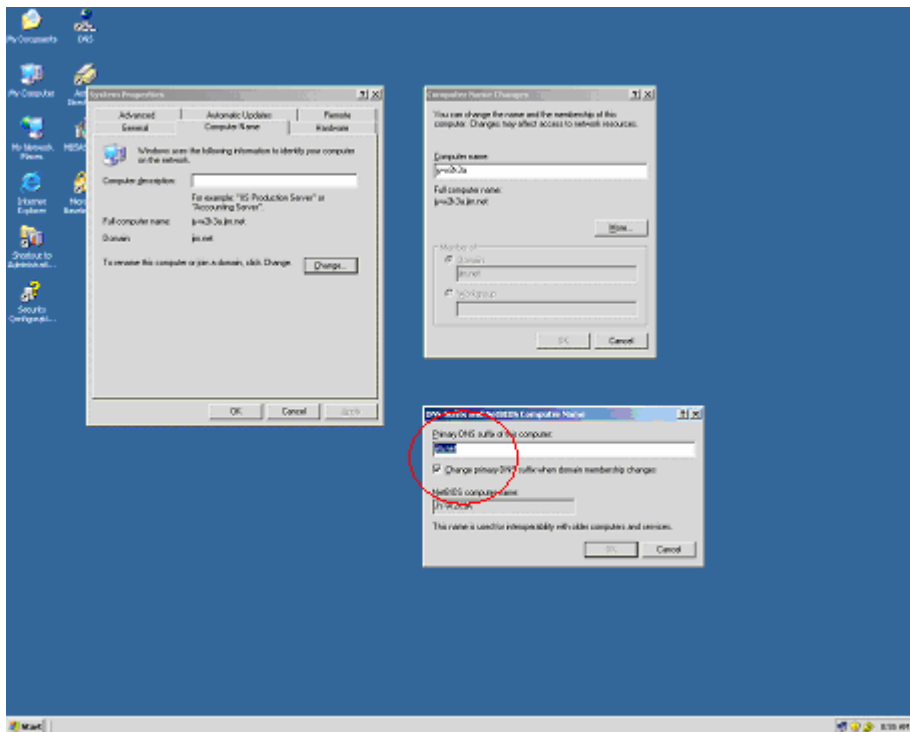
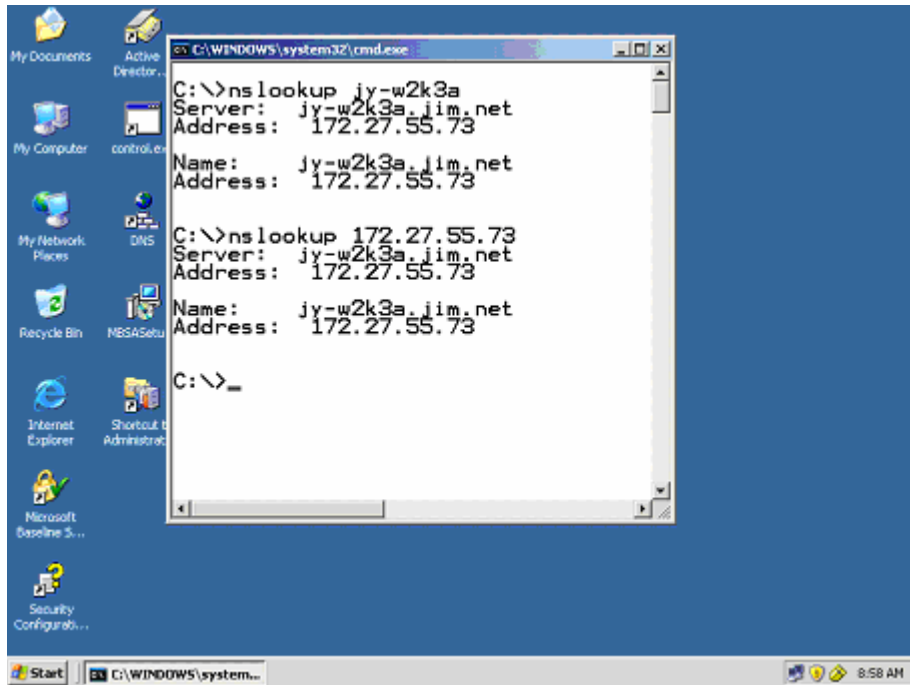


Figure 11 Server primary DNS suffix

Making the suffix change will require the server to be rebooted. When rebooted, test both forward and reverse DNS lookups. The server should resolve its own name and address. If it does not, the problem is probably with one of the above client settings being inaccurate, or a server zone setting (such as enabling updates).



```
C:\>nslookup jy-w2k3a
Server: jy-w2k3a.jim.net
Address: 172.27.55.73

Name: jy-w2k3a.jim.net
Address: 172.27.55.73

C:\>nslookup 172.27.55.73
Server: jy-w2k3a.jim.net
Address: 172.27.55.73

Name: jy-w2k3a.jim.net
Address: 172.27.55.73

C:\>_
```

Figure 12 Server lookup test

Client DNS Configuration

After W2K3 DNS is configured and properly operating, XP can be configured to point to the server.

Point the preferred DNS server to the IP of the server.

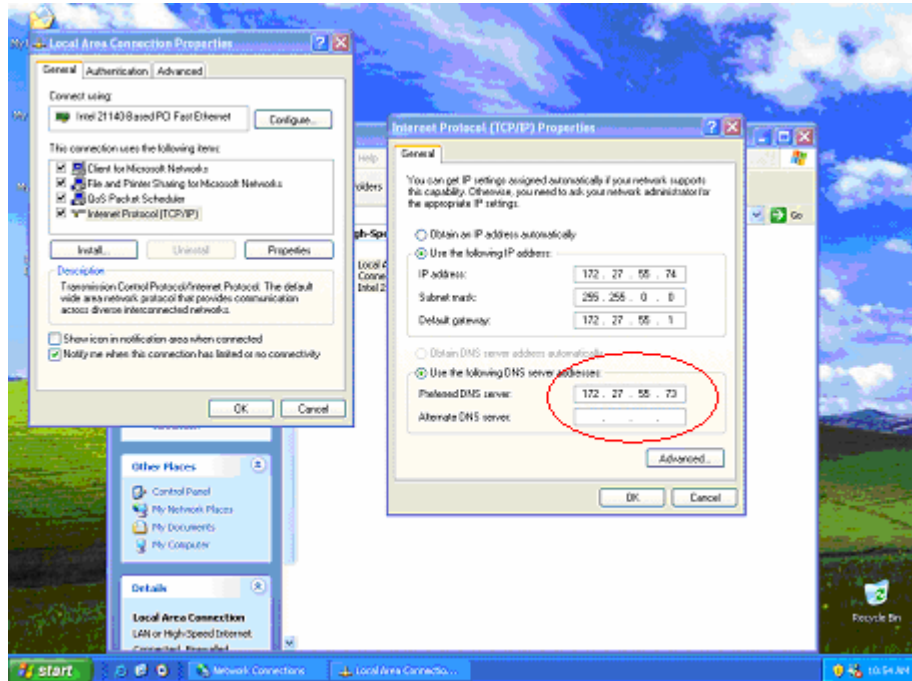


Figure 13 Client preferred DNS server IP

And the suffix to point to the forward zone.

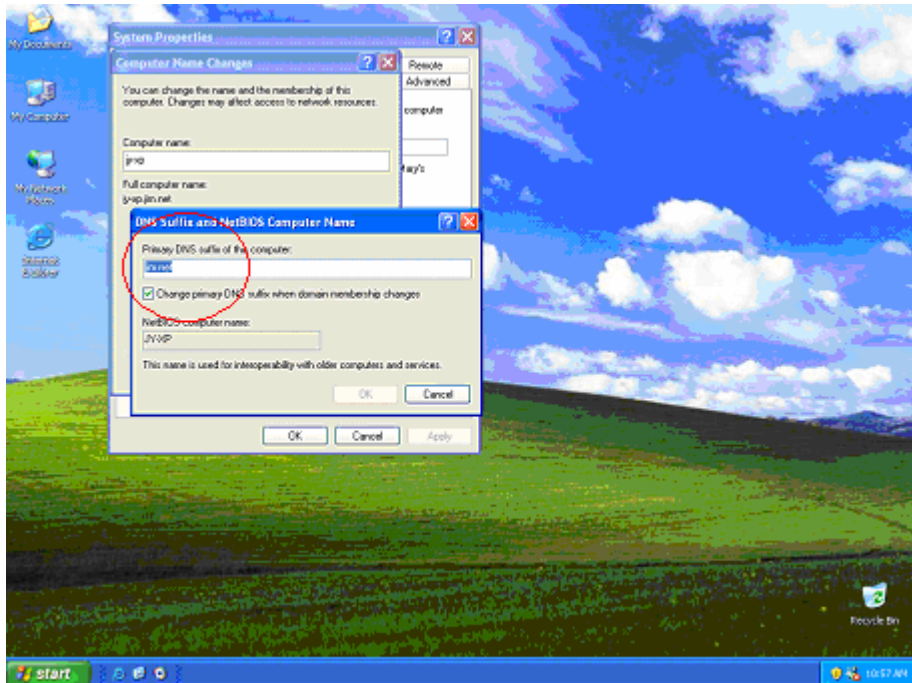


Figure 14 Client primary DNS suffix

Reboot and test resolution on the client.

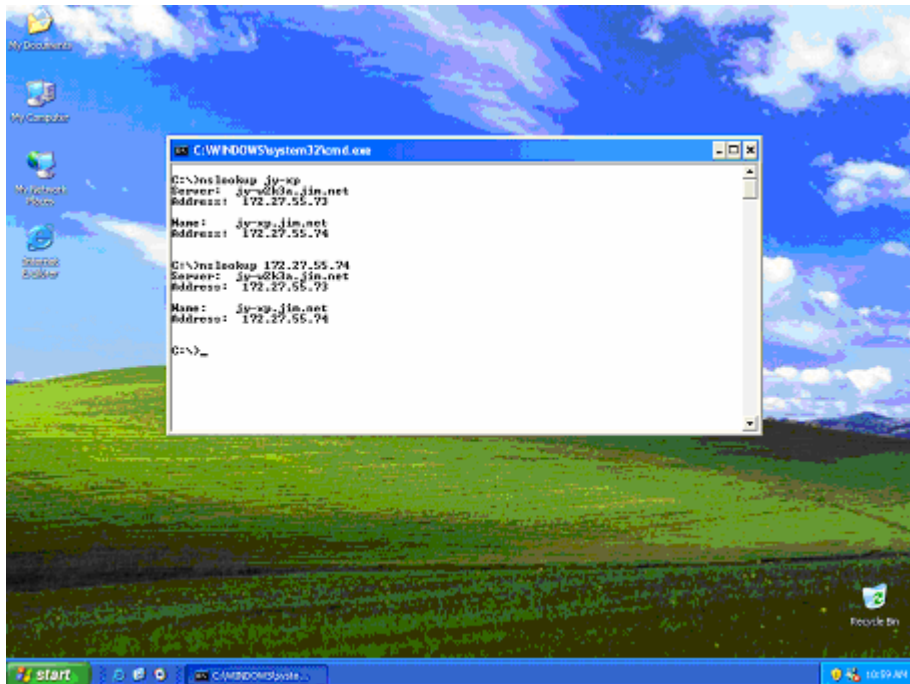


Figure 15 Client lookup test

Active Directory Installation

Once DNS is properly functioning on both the client and the server, AD can be installed. The install is straightforward, accepting all default settings. For the domain name, the forward zone/suffix must be used (*jim.net*). Once completed, the server will act as a Domain Controller.

After installation, the domain name can be tested for a forward lookup resolution. Next, the XP client can be configured to join the domain.

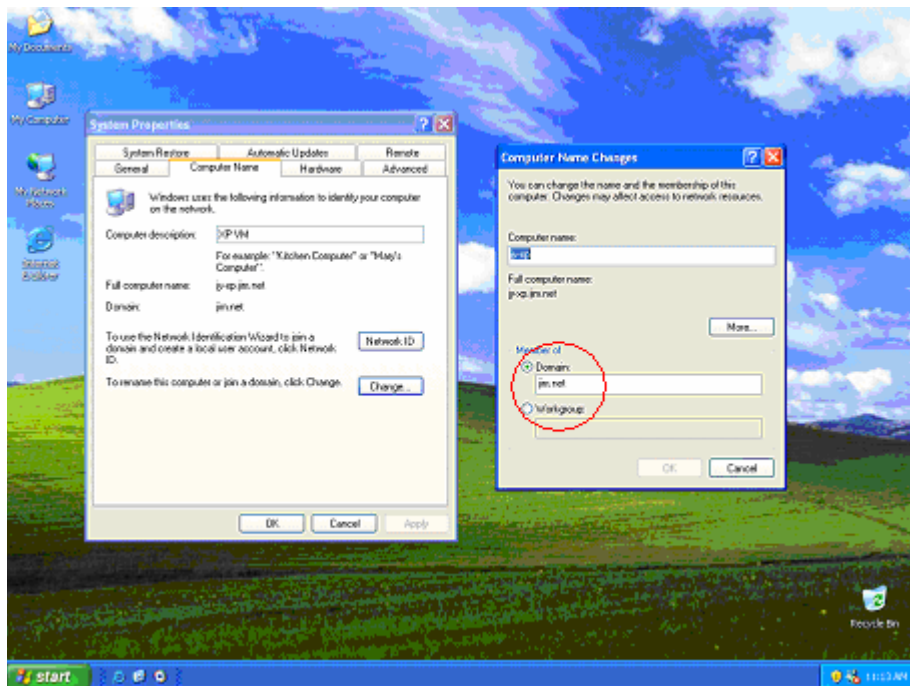


Figure 16 Joining the client to the domain

The client will need to authenticate with AD on the DC using a server's administrator user account. Once completed, the client will be a member of the domain's "Computers" Organizational Unit.

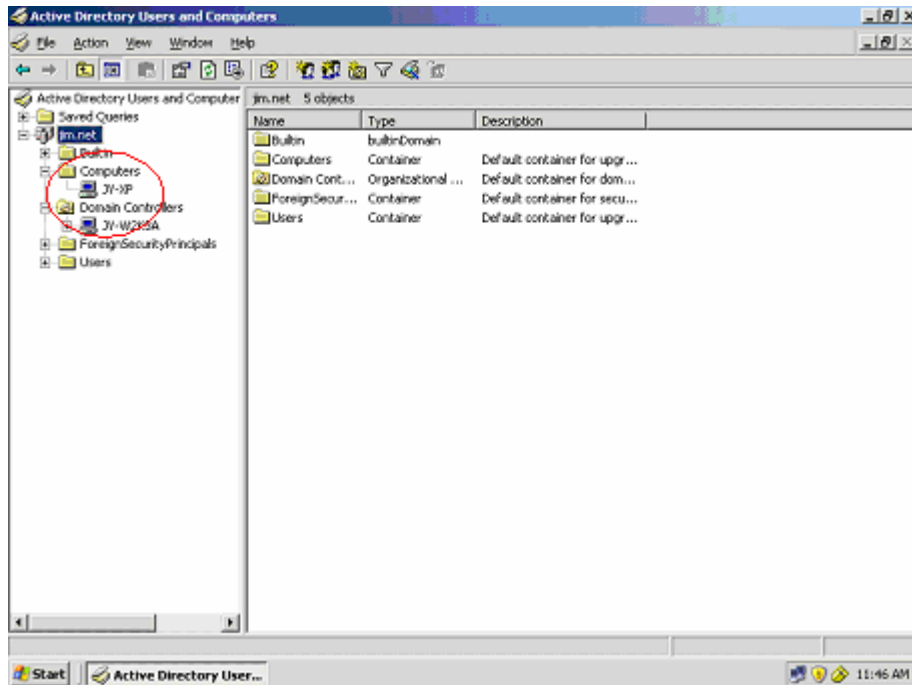


Figure 17 Server proof the client was added to AD

AGDLP

The next task to be mastered is the implementation of Microsoft's best practice of AGDLP. AGDLP is a method to implement NTFS file ACLs, and GPOs. While not necessarily the easiest to learn, it is widely used and supported by Microsoft.

A – User **A**ccounts

G – **G**lobal groups

DL – **D**omain **L**ocal groups

P – **P**ermissions

It is also written as A -> G -> DL <- P. User accounts are placed in Account OUs; those users are also placed in Global groups, the Global groups are then placed in Domain Local groups, which are then attached to NTFS file Permissions.

When a user logs onto the domain client, the server will authenticate the user. These credentials will be used to allow access to resources.

For this project, the goal is to create two types of users – instructors and students. Basically, instructors will have unrestricted policies and ACLs, while students will have restricted policies and ACLs. In addition, a folder for student net submissions will be created on the DC. This folder will allow a student to submit an assignment, but once there, not change it. Other students will be prevented from seeing the assignment as well.

“Active Directory Users and Computers”, is the typical program used to access and manage the AD database.

A – User Accounts

AD can be used to logically implement an organization’s hierarchy through software. For this example, an educational setting will be used. Create new Organizational Units following the format “*accounts – functional group name*”. For example, *accounts – students* and *accounts – instructors*.

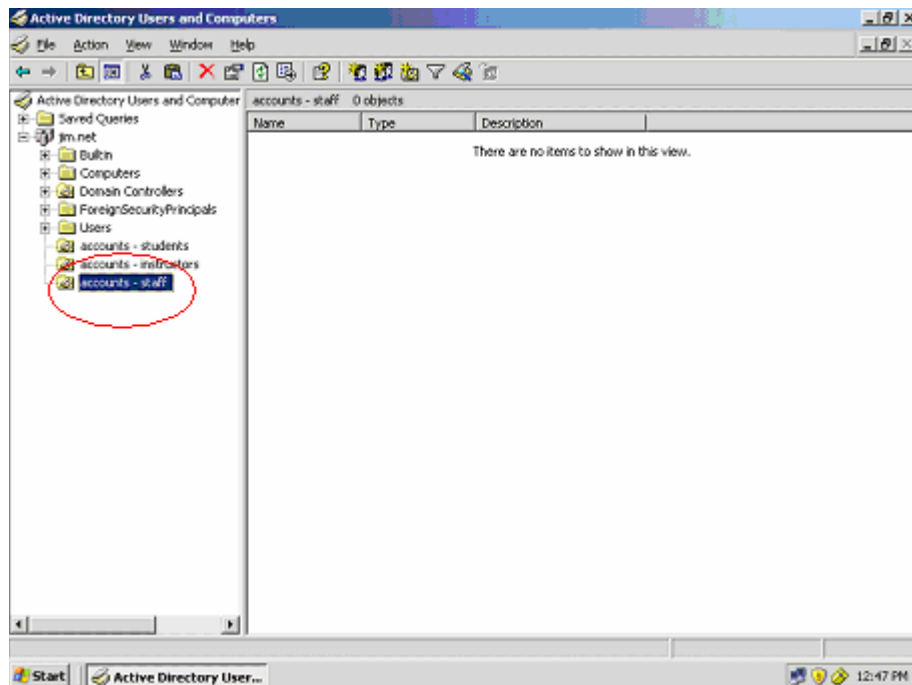


Figure 18 AGDLP, user accounts

Within each OU, create a few users.

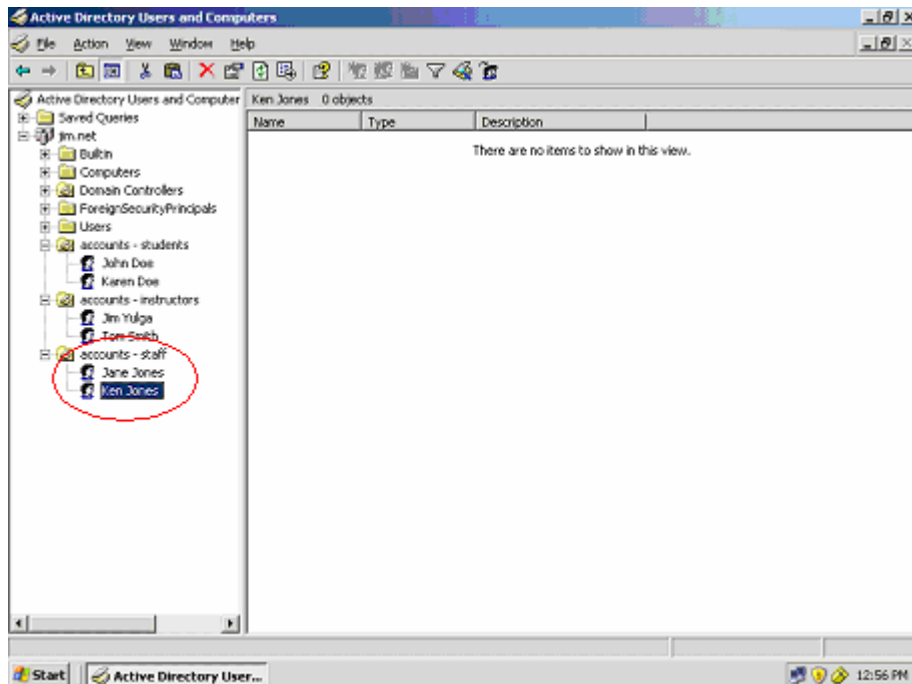


Figure 19 AGDLP, users

G – Global Groups

Global groups are used to define logical groups users fall into. Typically, this will be the same as the accounts OU names just created. While this might seem redundant, there is a reason - an OU can have a GPO assigned to it, whereas a group can not.

Create an OU to contain the Global groups (this is merely good housekeeping practice):

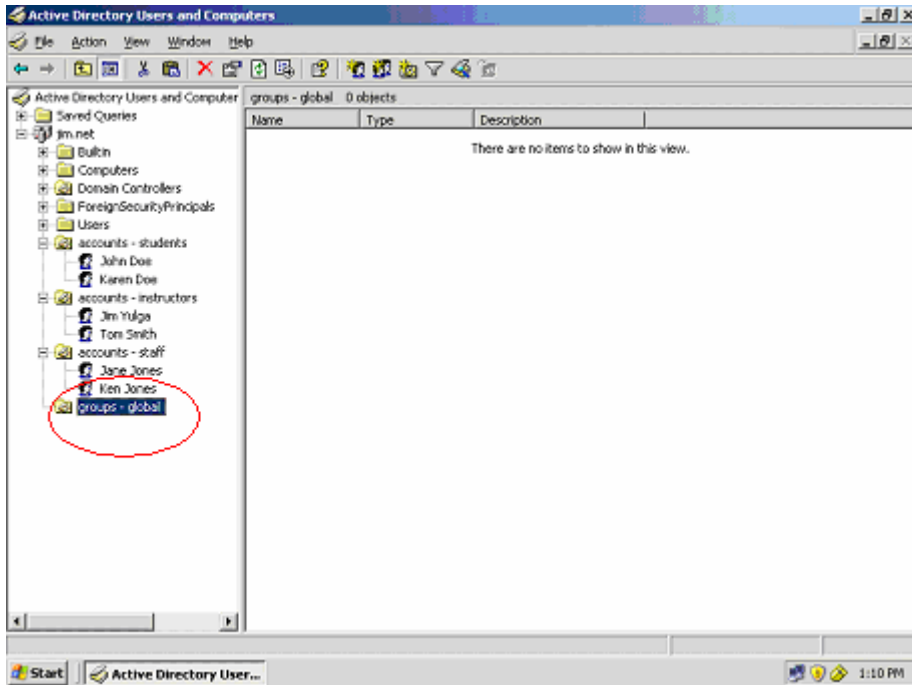


Figure 20 AGDLP, OU for Global groups

Create a new Global Security group for each account's OU:

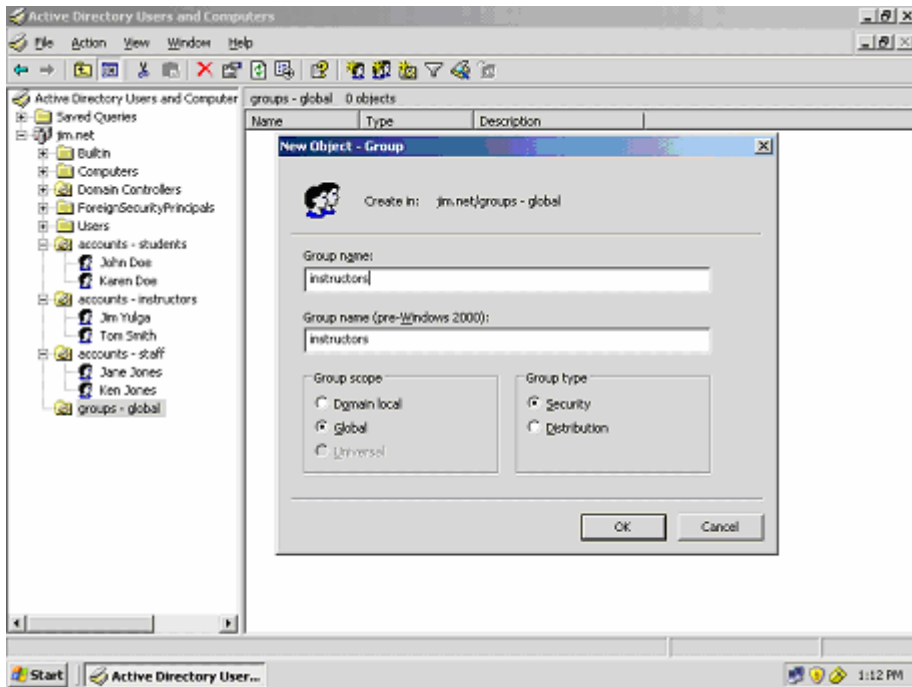


Figure 21 AGDLP, Global group creation

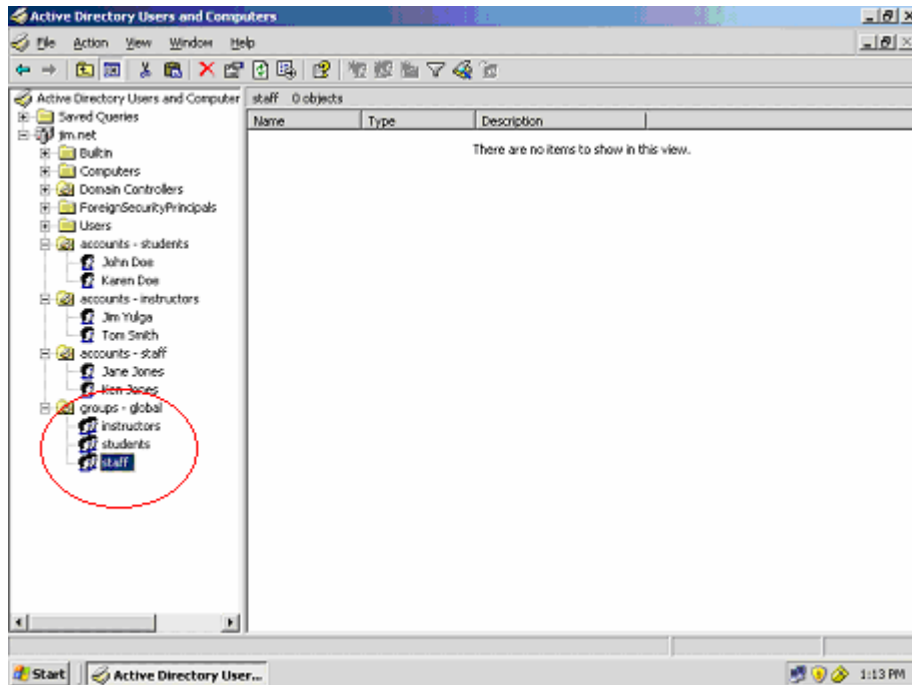


Figure 22 AGDLP, complete set of Global groups

Within each global group, add each user into their respective group, i.e. users *Jim Yulga* and *Tom Smith* should be a member of *instructors*. Unfortunately, ADUC does not display the contents of a group on the right pane. The properties of the group must be viewed.

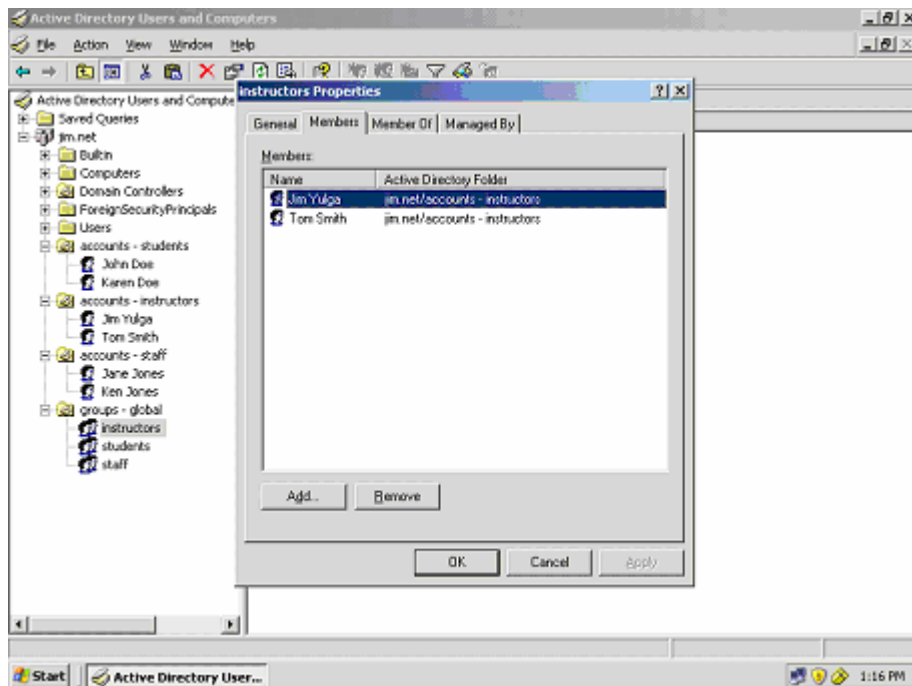


Figure 23 AGDLP, adding users to Global group

DL – Domain Local Groups

Next create Domain Local groups. DL groups are used to control resources on the server itself. The term “Domain Local” might seem to be a bit of an oxymoron. Domain implies global, while Local pertains to the local computer itself. Global groups will be members of DL groups, which are then applied to NTFS permissions.

Create an OU to contain the Domain Local groups (this is merely good housekeeping practice):

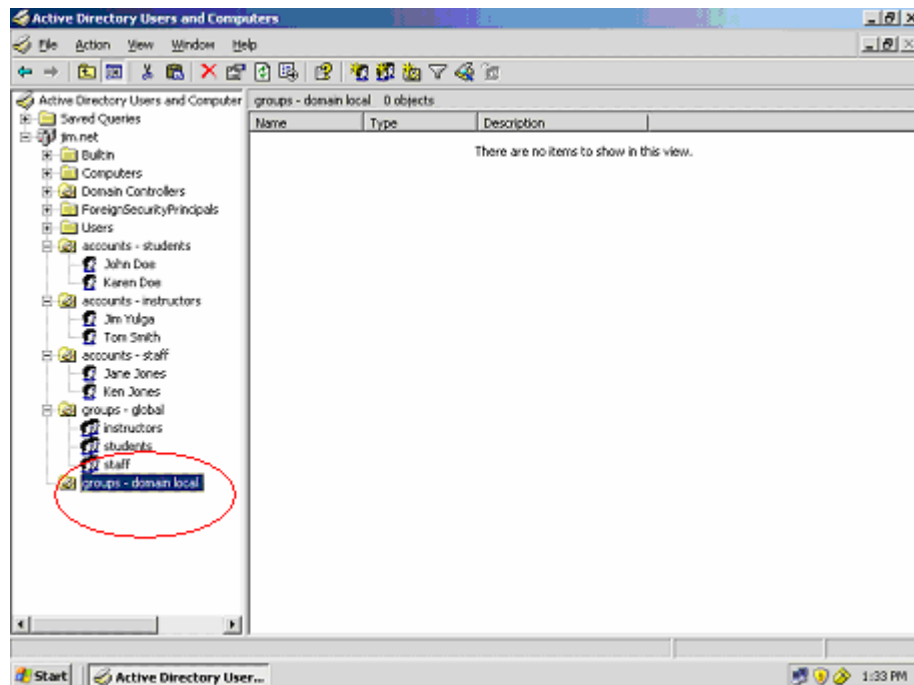


Figure 24 AGDLP, OU for Domain Local groups

The DL groups will relate to the restrictions on a folder. In this exercise, instructors will have the NTFS permission “modify” and students will only have “list” and “write” permissions to a folder. Create a new Domain Local security group using the format “folder – permissions”, i.e., *submissions – m* and *submissions – w*. When creating a DL group, make sure to select “Domain Local” as the Group scope, otherwise the subsequent steps cannot be followed (W2K3 will not allow a Global group to be added to another Global group).

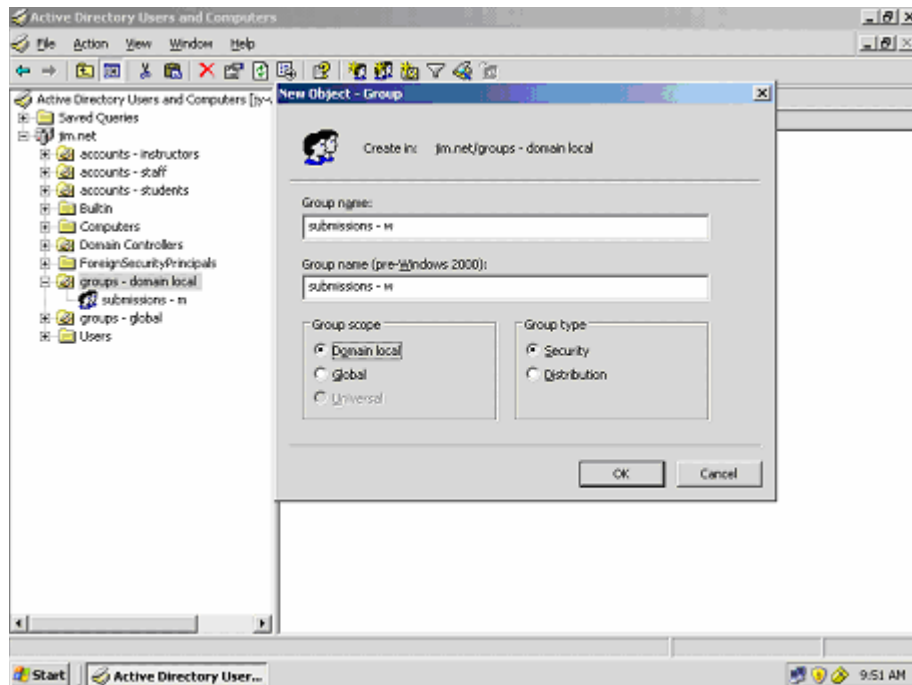


Figure 25 AGDLP, Domain Local group creation

Add the Global group *students* to the Domain Local group *submissions -w*. Repeat for the instructor's Global and Domain Local group.

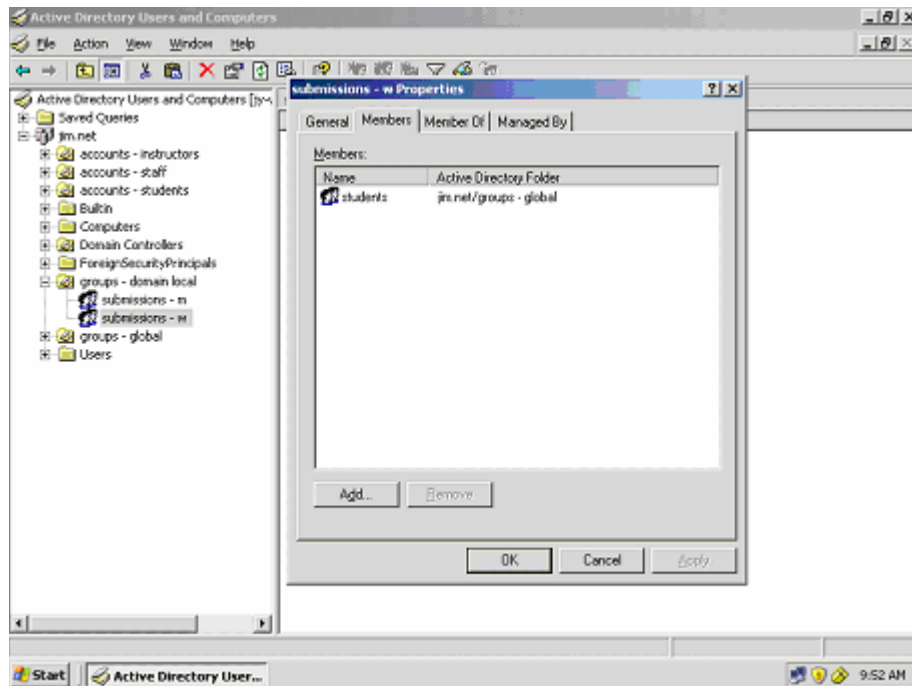


Figure 26 AGDLP, adding Global group to Domain Local group

P - Permissions

The final step is to assign the DL groups to a folder named *submissions*. The following displays the ACLs. Instructors will have “modify” permission, whereas students will have “list” and “write” permissions.

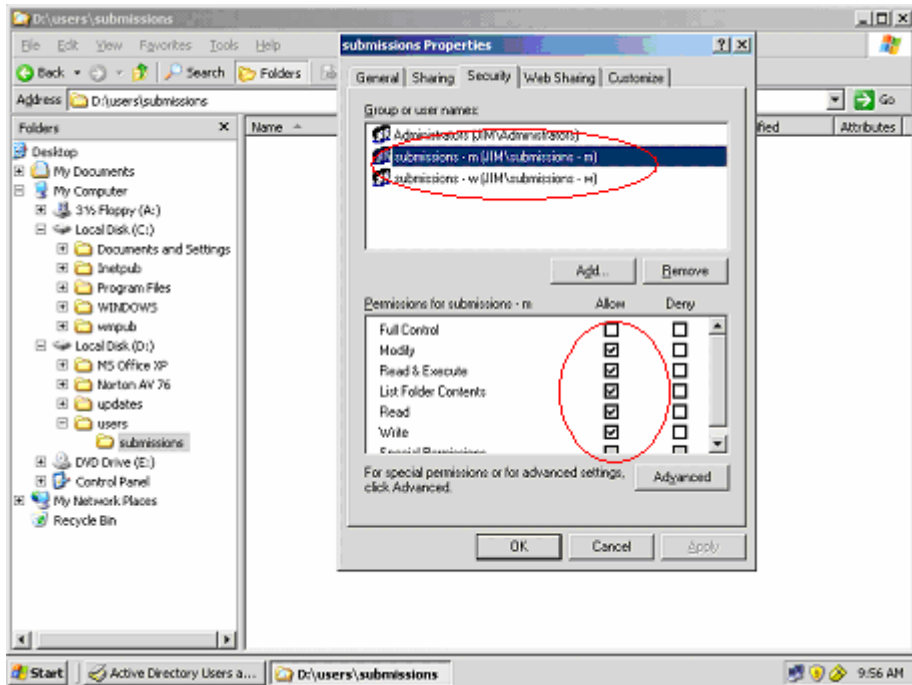


Figure 27 AGDLP, Access Control List

And:

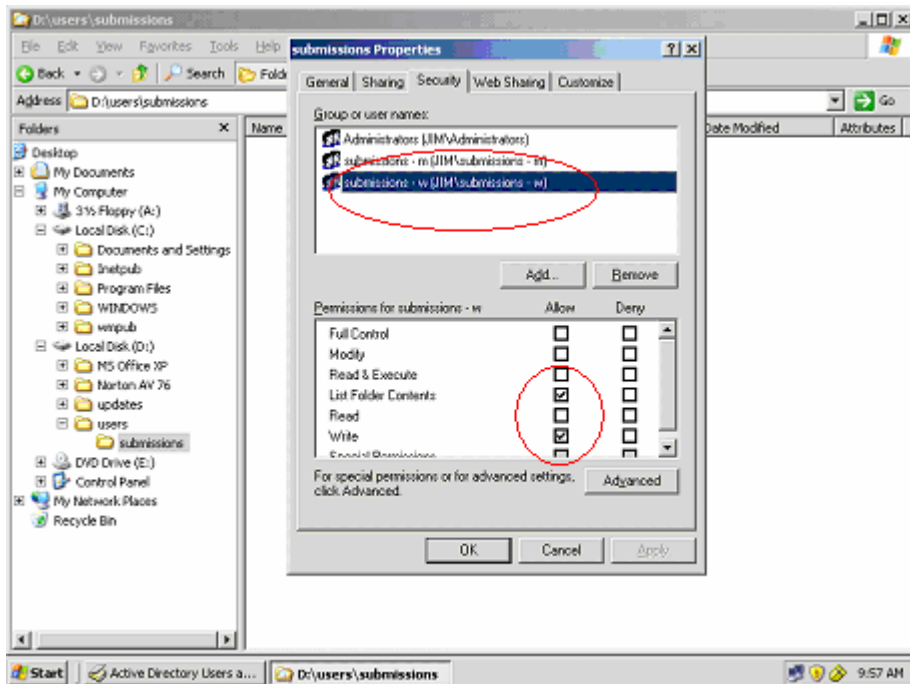


Figure 28 AGDLP, Access Control List, part 2

Finally, share the *submissions* folder with full permission for the group *Everyone* (this setting will allow access to the share over the network; NTFS permissions will override from there on).

AGDLP Proof

From the XP client, log onto the domain using an instructor account and a student account, and test the permissions on the *submissions* folder. Map a drive to this share. Instructors will be able to modify, and students will be able to list the contents and write to the *submissions* folder.

Here, *jyulga*, an instructor, is logged on:

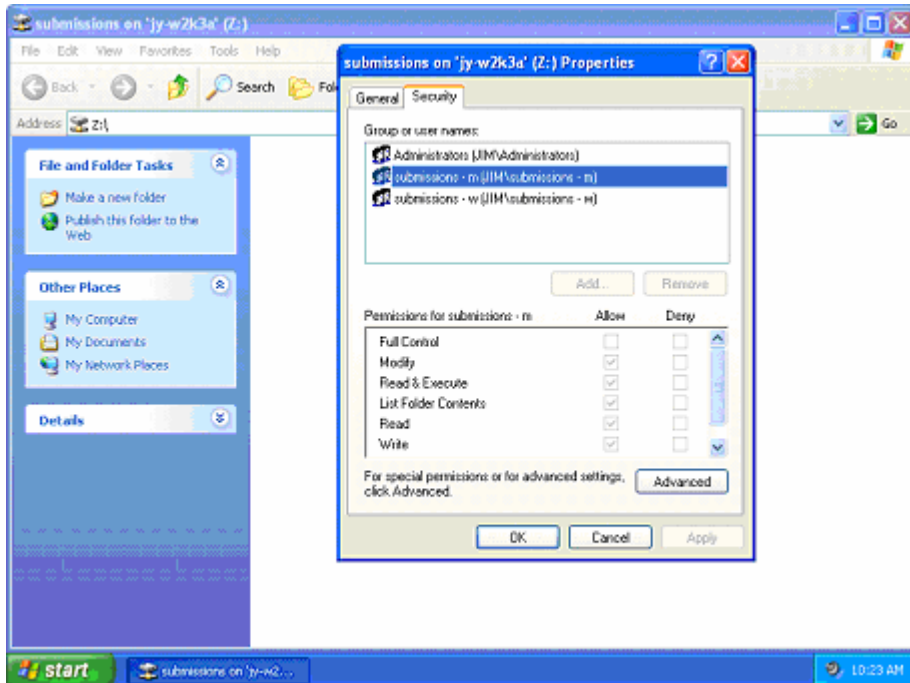


Figure 29 AGDLP, instructor test of ACL from client

Create a folder for a course:

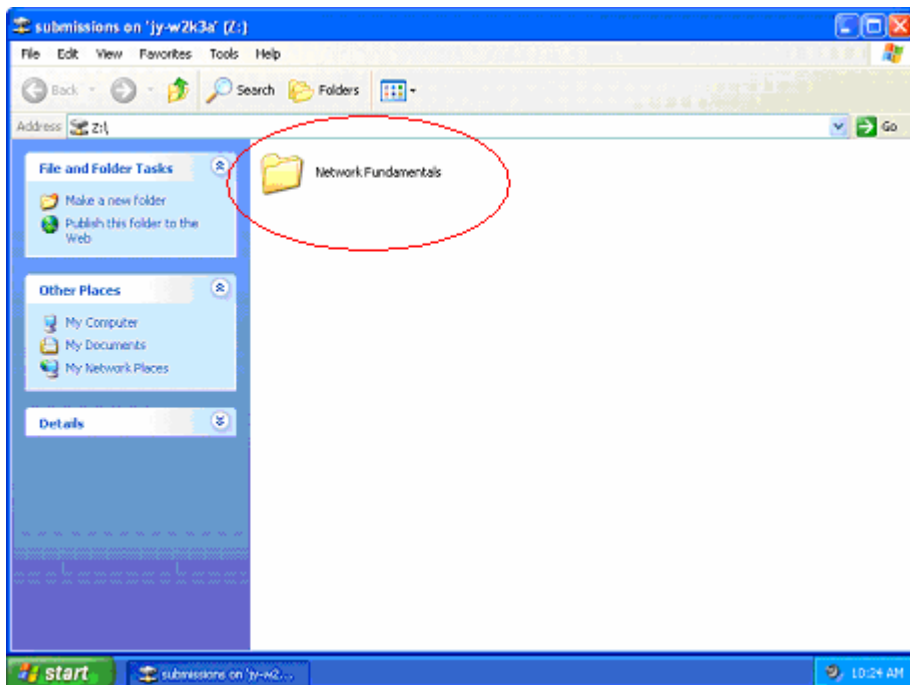


Figure 30 AGDLP, instructor test of ACL, from client, continued

Next, log on using a student account (*kdoe*), and map a drive to the *submissions* share, and display the NTFS permissions.

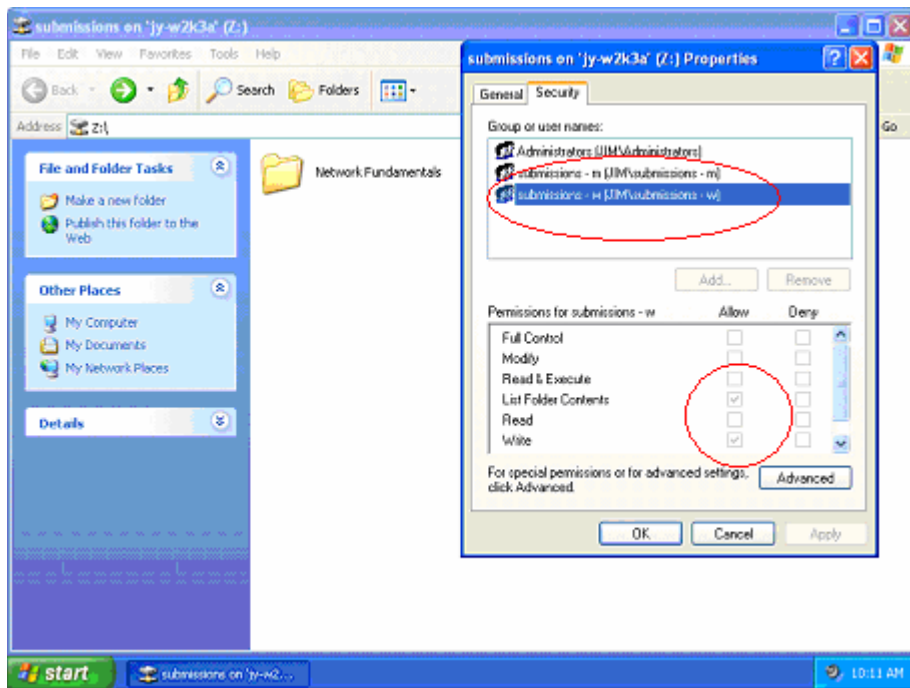


Figure 31 AGDLP, student test of ACL from client

Copy and paste a document into the Network Fundamentals course folder:

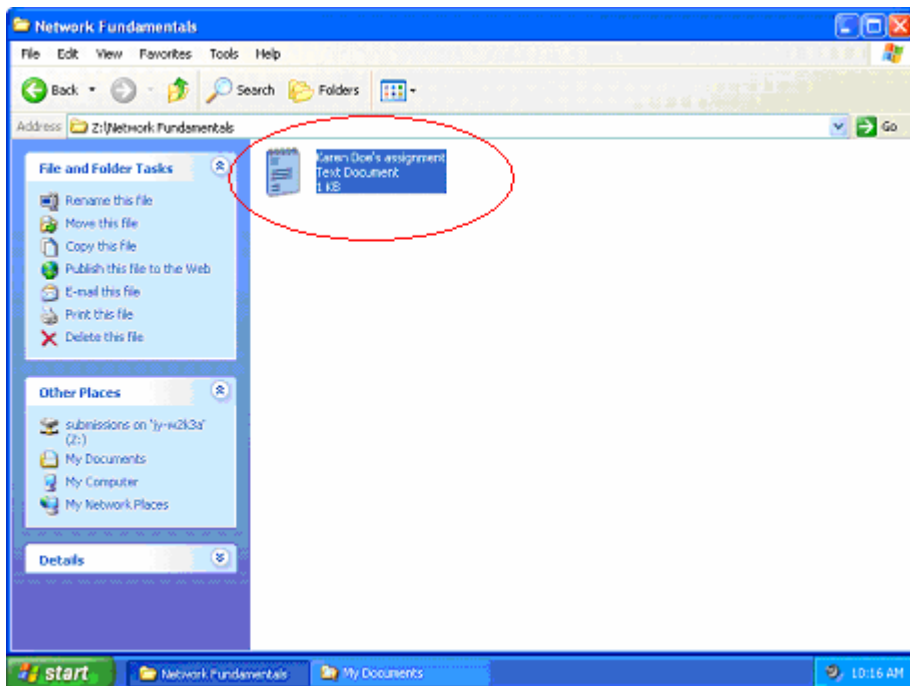


Figure 32 AGDLP, student ACL test from client, continued

Next, open the document just copied. XP will report:

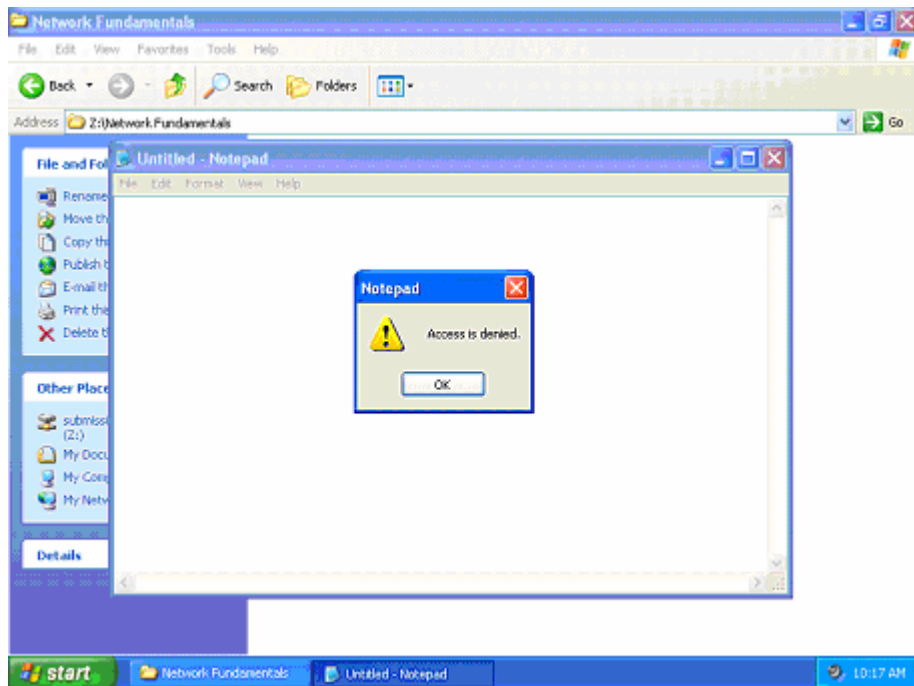


Figure 33 AGDLP, student proof of ACL from client

Students can see the folder contents and write a file to the folder, but cannot change the file contents once a file has been written. This will prevent students from modifying their assignment, and from seeing the contents of other student's assignments.

To complete the task, log back on as the instructor *jjulga*, and view the file just submitted by the student *kdoe*.

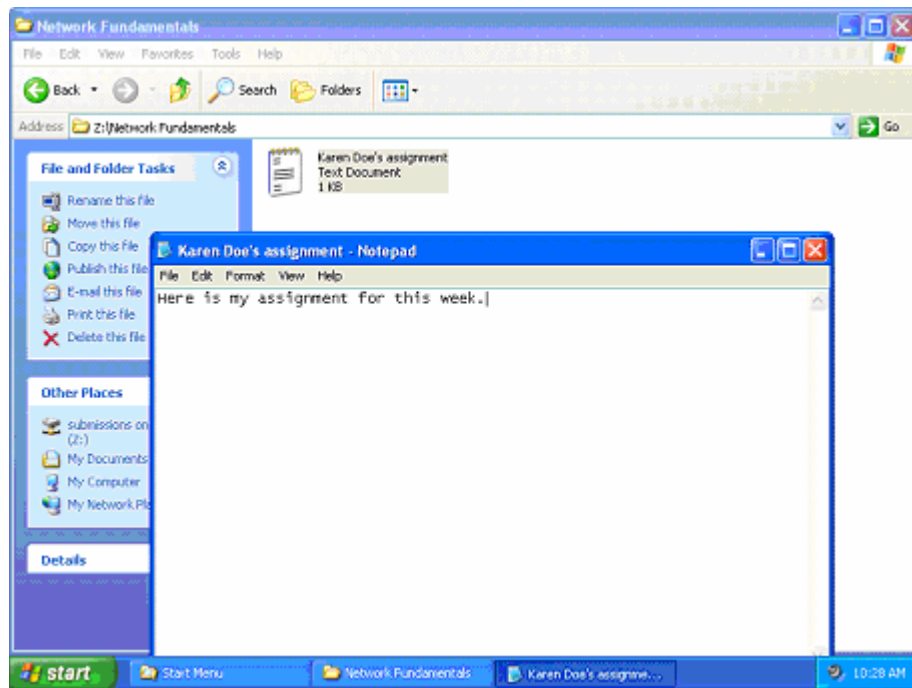


Figure 34 AGDLP, instructor proof from client

Group Policy Objects

The next component of this exercise is the implementation of a Group Policy Object. GPOs are a method to control a user's environment, typically the desktop. When a user logs onto a domain, the GPO restrictions are pushed from the domain controller to the user's workstation and override any local settings. Most GPO settings are actually Windows's registry settings. As a result, through AD, a domain can modify a local computer's registry.

GPOs are attached to the "accounts – functional group name" OU. While "GPO" stands for "Group Policy Object", they cannot be attached to a group. Following the AGDLP best practice implementation, allows the structure to be used for both resource ACLs and GPOs.

The premise behind this implementation of AGDLP is that the users that have restricted resources access, will also have restrictive policies. By attaching a restrictive GPO to an account OU, the restrictive policies can be implemented.

The implementation of GPOs can be complex, as there is a process of inheritance from GPOs from the domain (i.e., *jim.net*), to the account OUs, to computer OUs. This inheritance is beyond the scope of this exercise.

First, determine that certain policy settings are not configured for the student accounts, i.e., the settings are in their default configuration. On the XP client, *kdoe* is logged on as shown below.

The policies that will be enforced are:

- 1) Remove the “run” command from the Start menu
- 2) Prevent changing of the desktop background.
- 3) Prevent changing of the screen saver.

“Run” command is present on the Start menu:

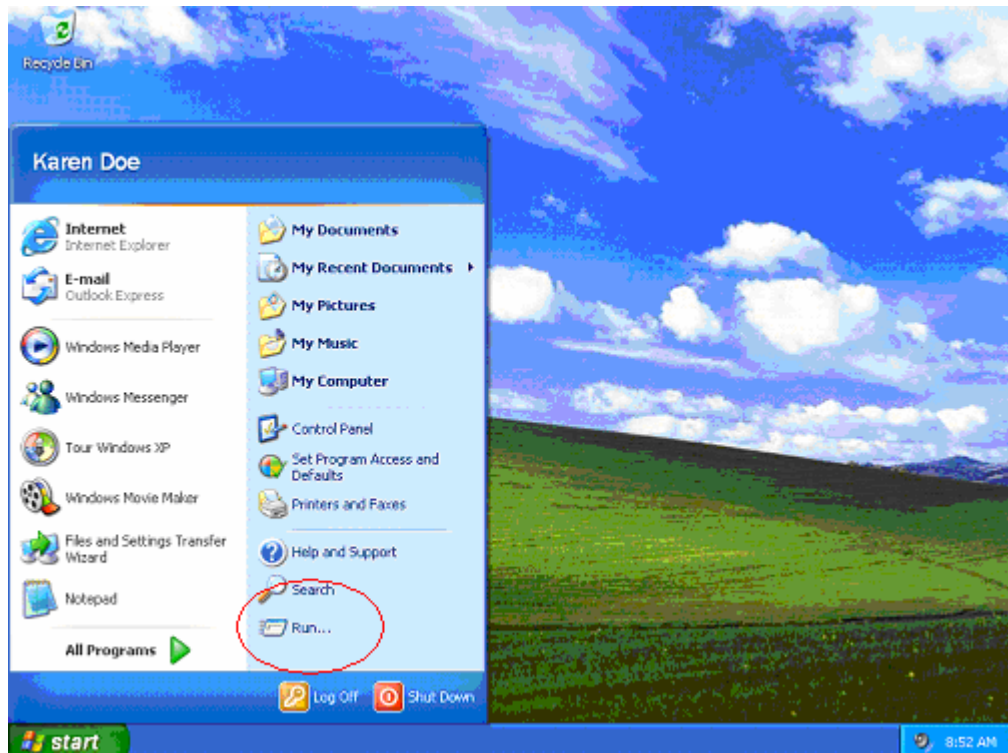


Figure 35 GPO, student proof from client without GPO implemented

The desktop (background) and screen saver options are available.

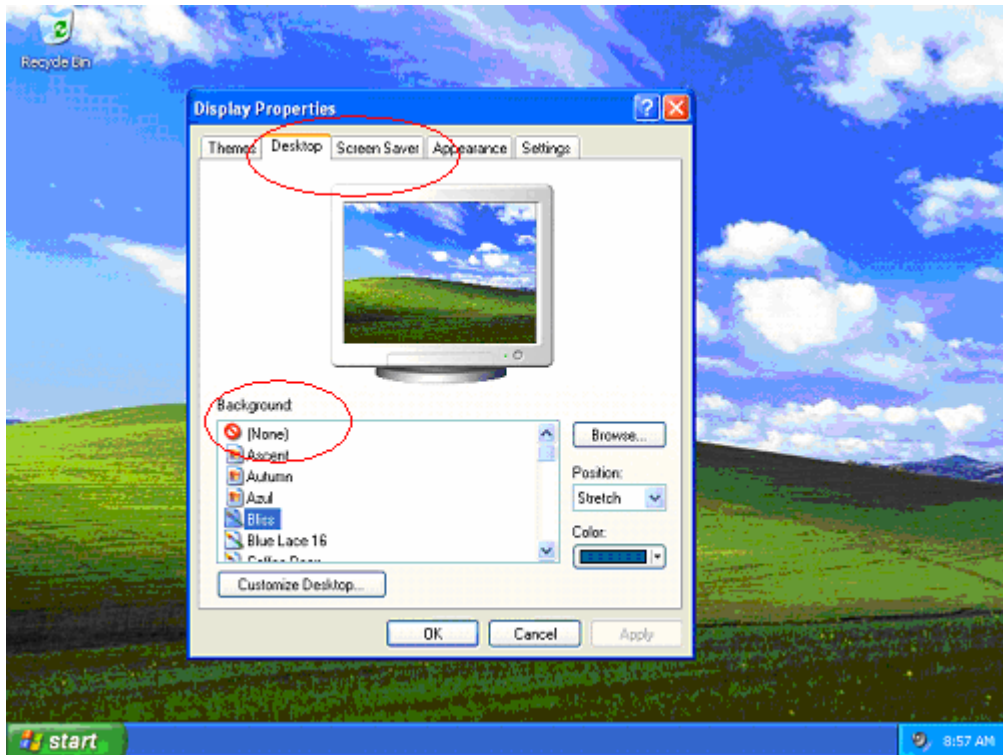


Figure 36 GPO, student proof from client without GPO implemented, continued

On the DC, create a GPO for the *accounts – students OU*.

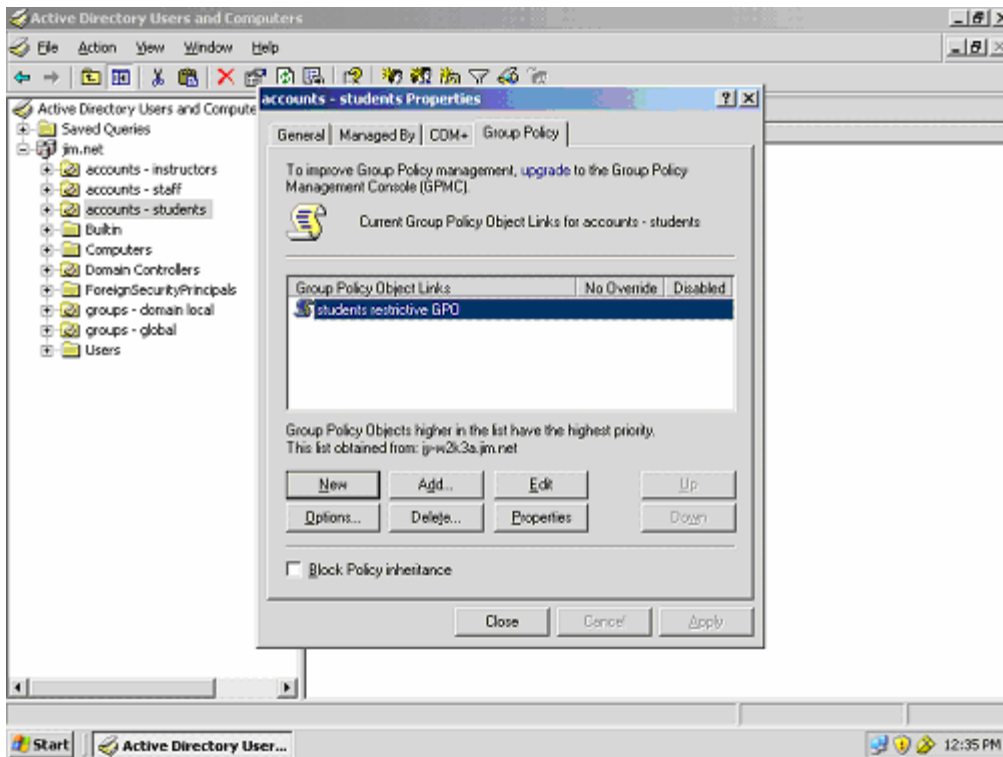


Figure 37 GPO creation

Edit the GPO, and enable “Remove Run Menu from Start Menu”:

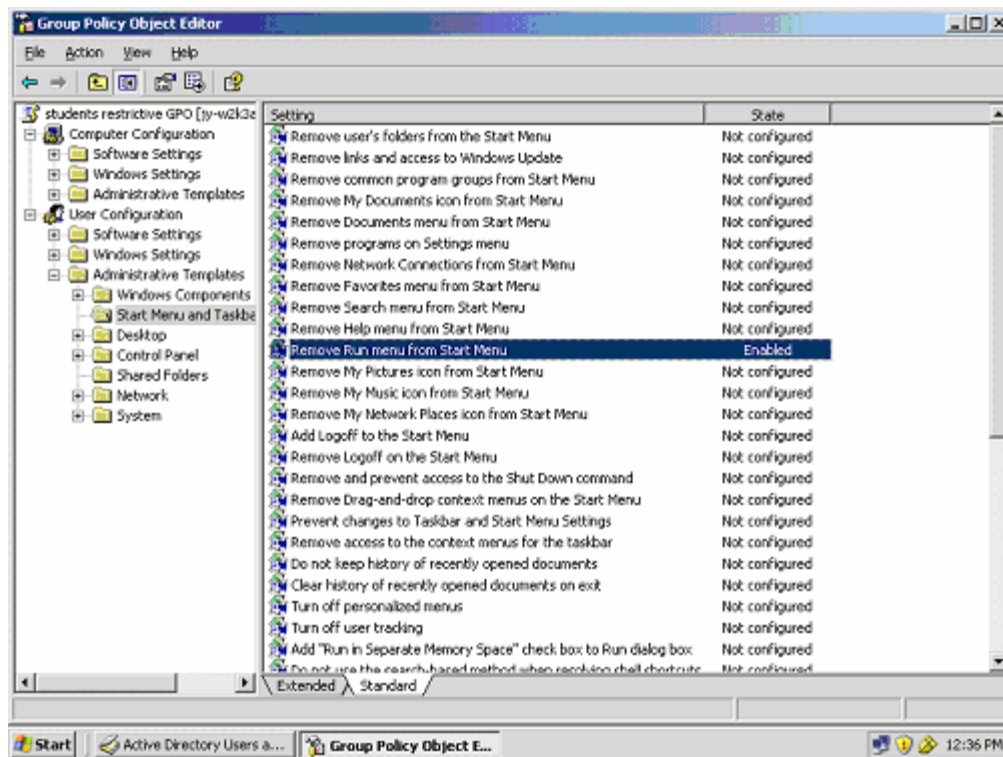


Figure 38 GPO, policy enabling

Enable “Prevent changing the wallpaper” and “Hide Screen Saver tab” policies. Close the GPO screen, and close the *accounts – students OU* properties dialog box. From the command line, run `gpupdate /force` to force a refresh of the GPOs into AD.

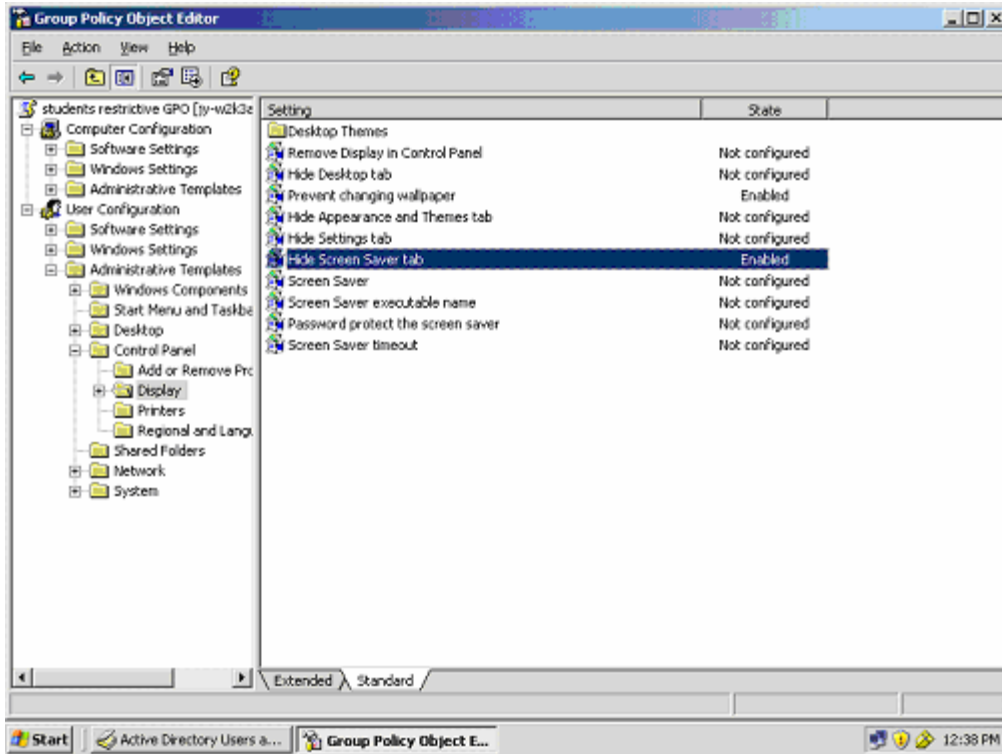


Figure 39 GPO, policy enabling, continued

On the XP client, logon as the student *kdoe*, and notice the run command is absent from the Start Menu:

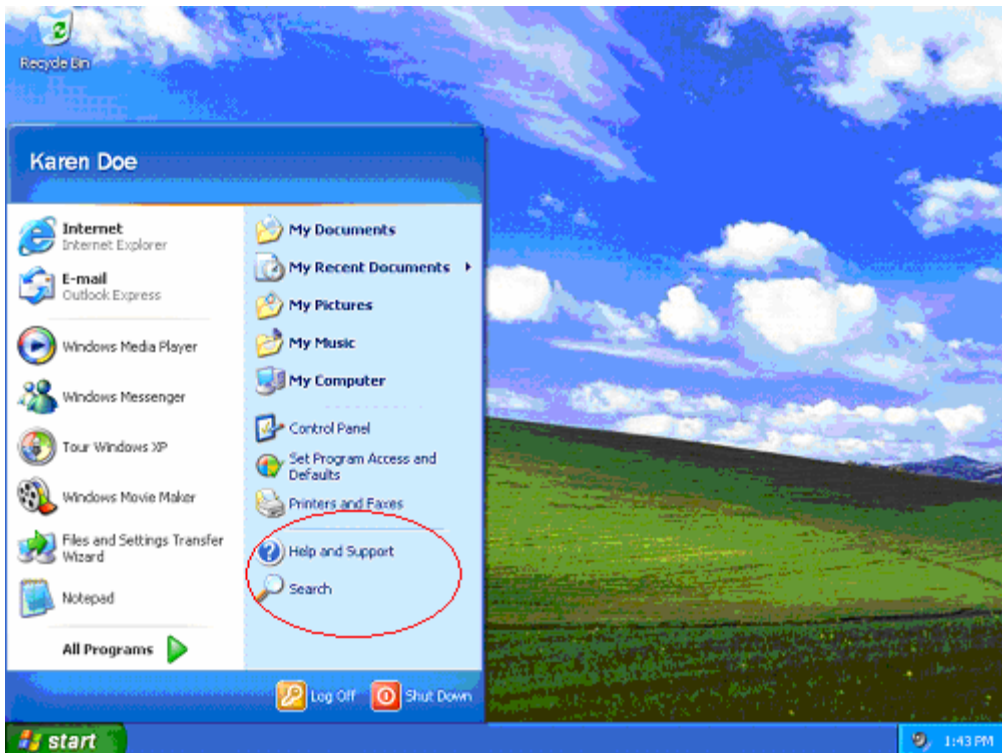


Figure 40 GPO, student proof from client

And the ability to change the background and screen saver are not available:

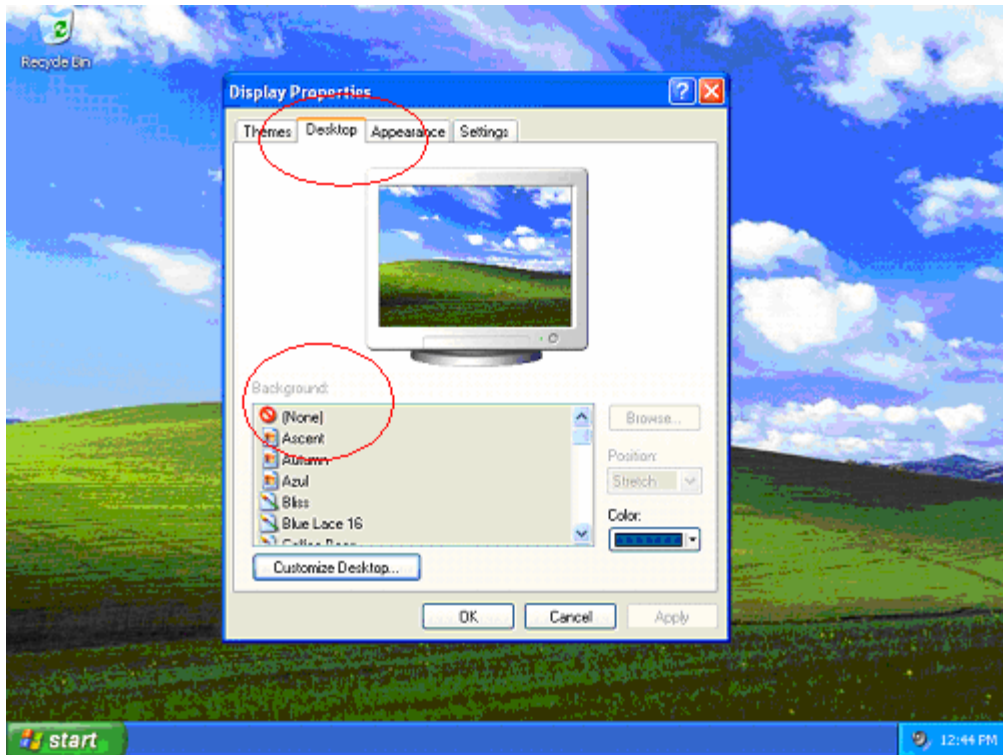


Figure 41 GPO, student proof from client, continued

Logging on as an instructor (*jyulga*) indicates the run command still available:

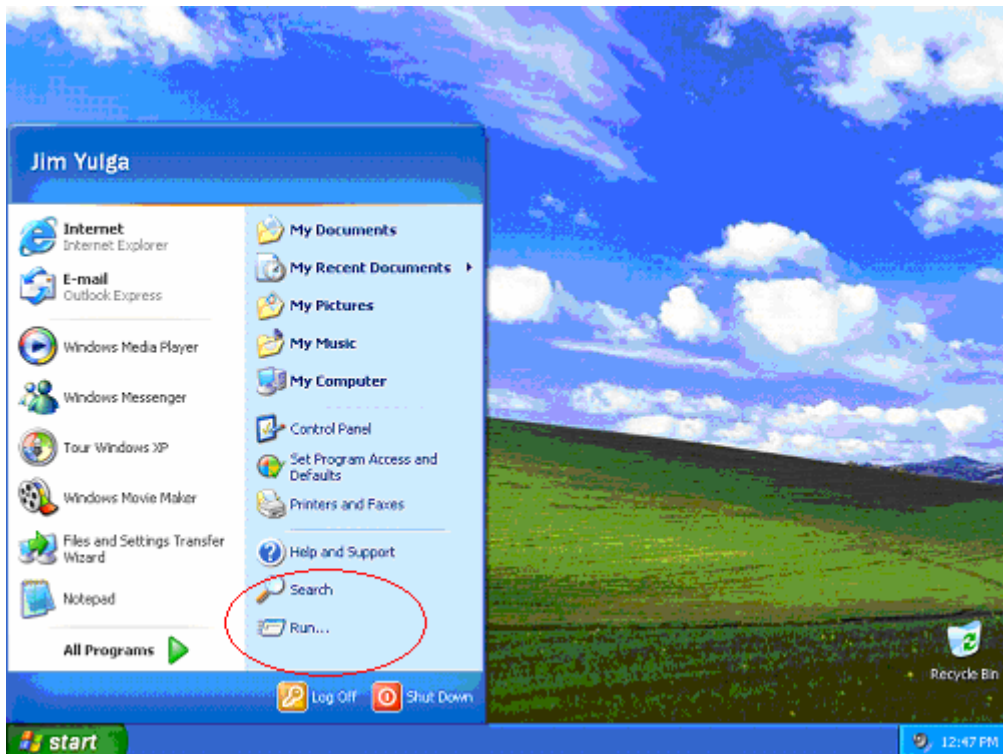


Figure 42 GPO, instructor proof from client

As are the options to change the background and screen saver.

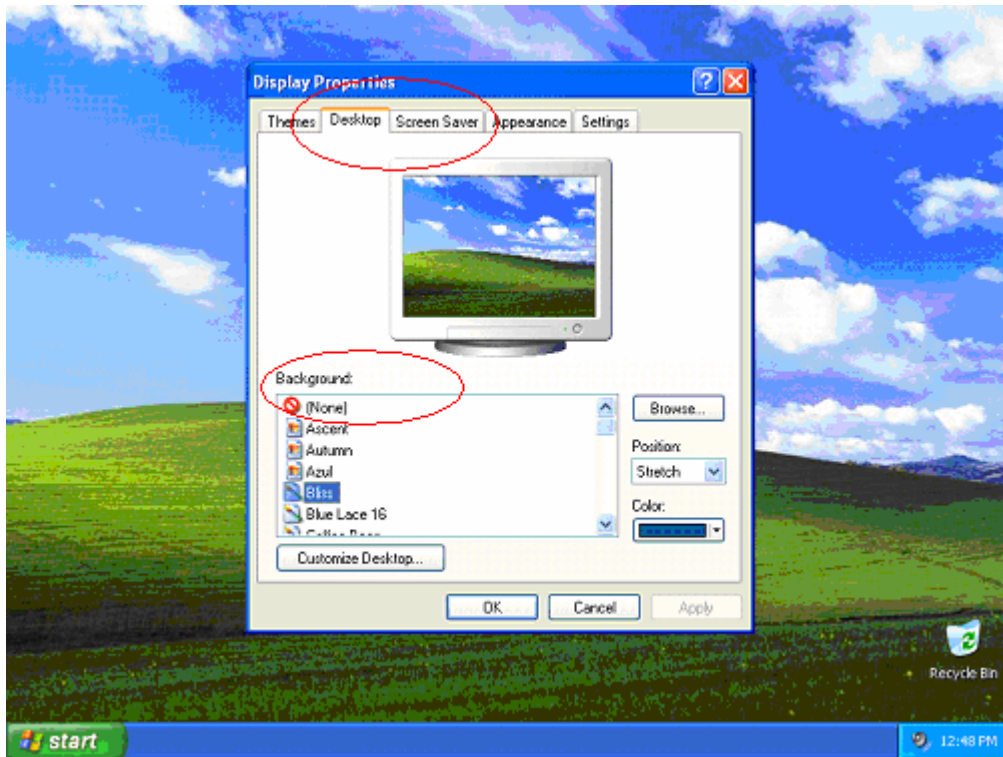


Figure 43 GPO, instructor proof from client, continued

This is because the instructors are in a separate OU (*accounts – instructors*) for which a GPO is not configured, and therefore, the default (domain) settings are used. For each “*accounts – functional group name*” OU, a separate GPO can be created that will enable/disable policies.