Network Upgrading

Project Thesis

ESM 684

By

Kenneth L. Cypher

16 April 2001

NETWORK UPGRADING

In today's information age, one of the most important assets a company maintains is its information or information access. Many businesses either are faced or will be faced with the inevitable network replacement or upgrading to facilitate information storage, security, or access. This can be a costly and time consuming venture if not planned for in a deliberate manner such as a project. The current project of Windows 2000 deployment will be utilized as the basis for this management project thesis. The steps and the thought process we utilized will be explained in some detail. The published Microsoft deployment processes on Windows 2000 deployment or fielding were neither used nor reviewed prior to executing this project. A comparison of Microsoft's solution and our developed process will be made at the conclusion of this paper.

My current organization is a sub-division of a larger organization. The sub-division is organized into ten major elements geographically disbursed over more than 300 miles. Each element is sub-divided further into sections. I supervise and manage the information management and communications section of the sub-division's headquarters. I directly supervise a staff of five personnel and indirectly manage 20 additional personnel. The 20 additional personnel are one computer and one communication representative located in each major element. The sub-divisions' mission is to teach, mentor, and evaluate approximately 400 military reserve and National Guard units located throughout the United States east of the Mississippi river and US Caribbean territories. Throughout the rest of the paper, "we" will refer to the information management and communications section. Sub-division will refer to our 786 man organization.

Our sub-division was informed that we will be required to upgrade our current network operating system from a Windows NT4.0 to Windows 2000 Server(or NT5.0) during the fiscal

year 2001. A fiscal year for our organization spans from October to September. There was no defined funding limit. We could utilize our current budget, request additional funds from higher, and program for next year's funds. The only time constraint designated was completion by January 2002.

The initial notification to start planning was in September 2000. The initial notification gave only one restricting order. Active directory could not be activated until the parent organization developed the organizational wide structure of the Forests and Trees. A directory service is a network service that identifies all resources on a network and makes then accessible to users and applications. Active Directory is Microsoft's implementation of directory service. Within active directory, there is a hierarchal structure referred to as Forests and Trees. An estimated time of the active directory structure guidance and fielding was given as February 1, 2001. Once the structure was deployed, we could activate all the features inherent to Windows 2000 server products.

The decision to convert to Microsoft 2000 was dictated by our parent organization. We were not given the liberty to evaluate or compare the advantages and disadvantages of converting to a Unix, Linux, or Novell network. As a preliminary comparison without an actual evaluation, the lack of education within our sub-division of the Unix and Linux operating systems would make the initial learning curve extremely steep. Unix and Linux have very similar structure and organizational concepts but they are foreign to an individual with only a Microsoft background education. Novell on the other hand maintains a graphical interface that is significantly similar to Microsoft, which makes it a viable replacement. We have read several articles where other commercial businesses are using Novell Directory Services (NDS) with Windows 2000 networks instead of Microsoft's Active Directory. The decisions to implement their mixed products

appear to be mostly based on physical resource requirements and client licenses. Microsoft Active Directory requires an additional server and a client license per seat(user). NDS also operates across multiple platforms such as Intel or RISC (reduced instruction set computers) where Microsoft Active Directory does not. A platform is the hardware configuration. Microsoft 2000 products only support the Intel platform. In our situation, we are not multi-platformed. Our organization does not own any Unix boxes or maintain any RISC based machines. My belief is that the parent organization decided to maintain Microsoft products because their personnel do not have any addition knowledge on other operating systems. If given the opportunity, I would explore the Novell's products in much more detail before going with Microsoft.

The receipt of the directive to upgrade our current network to Windows 2000, which arrived on 11 September 2000, initiated the planning process. The first order of business was to set a time and date for the second meeting in order to facilitate the thought process for an intelligent decision-making and planning discussion. The second meeting was arranged for one week later. The only task directed from the first meeting was to arrive prepared to discuss plausible time lines and task assignments related to implementing a Windows 2000 network.

The second meeting, which was held on 20 September 2000, found everyone excited and prepared to participate. Having the opportunity to test and implement in a production environment is sometimes a once in a career opportunity. This is everyone's chance to implement his or her ideas for the baseline installation of the operating system. Several features and options can only be activated upon installation of the operating system. Table (1) reflects the initial assignments and goals for the next discussion meeting. There are three major areas with in our production environment that Windows 2000 products will greatly affect. The first is

the domain. A domain is a security boundary for a group of objects and users. Active Directory(AD) and the Domain Controller(DC) define the domain. The second area is the electronic mail server. Exchange 2000 is the electronic mail server for Microsoft 2000 products. The third is the Internet Information Server(IIS). Windows 2000 incorporates IIS 5.0 into the operating system. Under our current NT4.0 network, IIS 4.0 is a completely separate software package. A new feature provided by Windows 2000 that we are planning on utilizing is the remote installation server(RIS). This feature will enable an unattended remote installation of the operating system and software on to the user's workstation. The third meeting was scheduled for three months later. Current workload, leaves, and research time dictated the prolonged separation.

Task	Who	Goal
verify platform requirement for exchange 2000	exchange administrator	suggest training, hardware, and software requirements
verify platform requirements for IIS 5.0, back-ups, and UPS	IIS administrator	suggest training, hardware, and software requirements
review RIS and AD requirements	domain administrator	suggest training, hardware, and software requirements
bandwidth usage	all	approximate usage per area
class dates	supervisor	available classes and dates

Table (1)

There were two agreed upon execution events from this second discussion session. We had unprogrammed funds available from fiscal year 2000 that had to be spent before 31 September 2000. The execution events were the expenditure of available funds to provide prepaid training days from an outside agency(subject and dates to be determined) and to upgrade our current backbone infrastructure. The backbone infrastructure is the transmission media and devices used to carry the user's data from their workstation to the desired destination. This includes the fiber, cable, modems, bridges, routers, and switches. Figures one and two show all

the buildings and network connectivity for our organization. Appendix A will explain the infrastructure relationship between our local area network(LAN), the campus area network(CAN), and the wide area network(WAN). The infrastructure upgrades (figure 2) would provide for one gigabyte connection between switches and 100 megabyte(mb) switched connection between the switch and the workstation for all users on the LAN. Current infrastructure (figure 1) only supports a shared 10mb connection for all users on the LAN. Since we are moving towards a push verses pull software management technique under Windows 2000, the current available bandwidth was considered a project failure, reference appendix B. This upgrade increased the available bandwidth to the users workstation up to 100 fold depending on previous traffic load.

Figure 1.

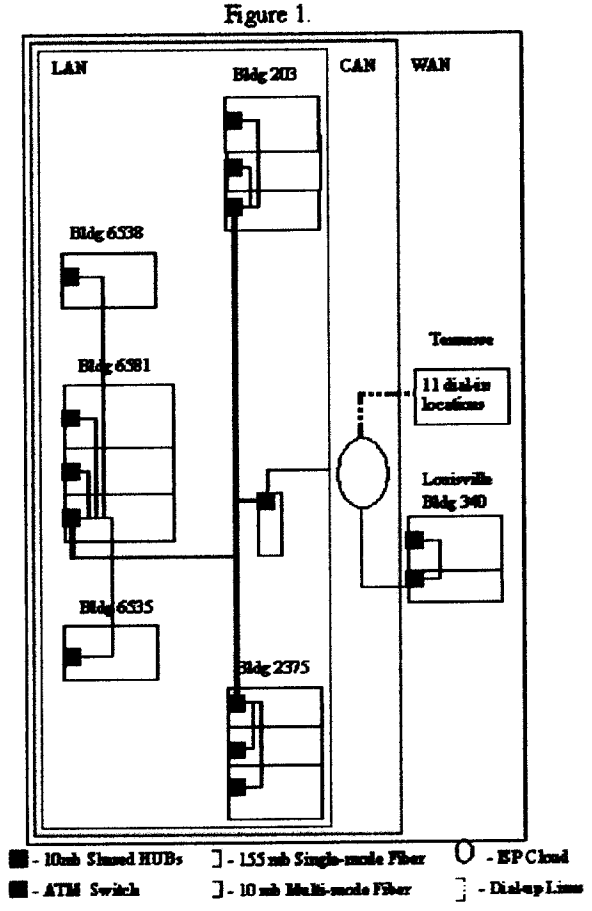
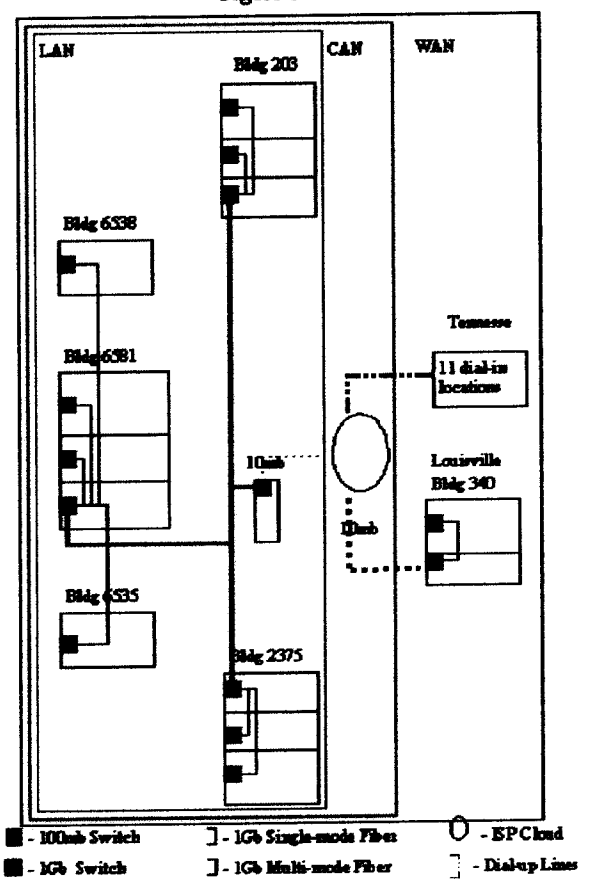


Figure 2.



The third meeting, held on 12 December 2000, proved to be very productive for the planning process. Each person preformed their respective research on their assigned task. Table (2) is a list of software and reference books we determined are required to be purchased. The reference books on the approved list are Microsoft press release publications. This was the most efficient way to provide official references and maintain a common knowledge base and terminology. If Microsoft technical support were required during the conversion, the common terminology and knowledge base would reduce confusion and time on the support line. Therefore, reducing the production down time for the conversion.

We planned to convert six NT4.0 severs and NT4.0 enterprise servers to Windows 2000. According to Microsoft's documentation, we only require Windows 2000 Server to meet our current requirements. We are working towards a larger application server implementation utilizing a web-based interface to provide better support for our dial-in users. Some of the advanced features are not available in Windows 2000 Server. One such feature is clustering of data servers. Therefore, we programmed for two packages of Windows 2000 Advanced Server to pre-stage for future implementations. Exchange 5.5, our current electronic mail software, will meet all current requirements of the sub-division. Exchange 2000 offers an interlink management with Active Directory. Exchange 5.5 does not. We decided the time saved in administrative work by removing duplicate work was worth the upgrade. Under our current exchange and office suite license, upgrading to 2000 software will only cost the price to print the media and ship it. The reason I approved upgrading the office suite is that Access2000 is not backwards compatible with Access97. Our current office suite software is Office97. Several of our client units have upgraded to the 2000 office suite. These units are forwarding information in Access2000 that our users cannot open or read. The back-up software, ARCServe, was not

compatible with the Windows 2000 environment according to the manufactures published reports. Therefore, the upgraded version with required options was programmed to be purchased.

Software	Reference Books
2000 Advanced Server x 2	Windows 2000 Resource Reference
2000 Server x 4	Active Directory Resource
Exchange 2000	Exchange 2000 Reference
Office 2000	IIS 5.0 Reference
ARCServe w/exch, open file, and disaster rec.	Windows 2000 Security Reference
Symantec Mobile Essentials	SQL 7.0 Reference

Table (2).

The preliminary research determined that our current NT4.0 Primary Domain Controller hardware platform would not handle Active Directory and the DC. A performance test of active directory on an identical platform proved a slow responsiveness. Therefore, a new sever platform was researched and ordered prior to 20 January 2001. The current Exchange, IIS, and data server hardware platform appeared to handle the Windows 2000 Server software with acceptable performance. The tape back-up device we utilize is an enterprise back-up device, an HP SureStore, which has a capacity to store 130 gigabytes of data. The back-up device maintained a large enough capacity to meet the projected requirements. Our current uninterrupted power supply(UPS) devices were compatible with Windows 2000 and the newly ordered server platform. Two more years remained on the projected life expectancy from date of purchase. Reference appendix C for further detail on platforms and testing.

The next topic of discussion was training classes for the information management section. No users will attend the network administration classes but they have basic windows, office, and computer skills classes available year round from a training center funded by the

headquarters. The information management section must budget and fund its personnel network administration classes. The prepaid training days funded from last fiscal year's funds were scheduled. I authorize who will attend these classes and when. Two windows 2000 server classes were scheduled in order to provide 100% information management section attendance on 15-19 January and 29 January - 2 February. One class for active directory on 5-9 February, exchange 2000 on 19-23 February, and security of windows 2000 on 12-16 March was scheduled to provide a current resident in-house trained "expert" before the planed conversion date. We determined that these classes were the essential ones required to update current knowledge and facilitate a smooth transition. Additional classes will be attended at later dates for specific needs not identified. The fourth meeting was scheduled for one month later. The intent set forth was a re-synchronization after the holidays and verification of attendees for the scheduled class dates.

A worksheet for the project was developed during the meeting, reference appendix D. Dissemination of the standard worksheet was the following business day. The tentative time line for activation of the Windows 2000 server network was developed. The target date was 8 April 2001. At that point in time, only one third of the user workstations will be windows 2000 Professional. This was considered acceptable by our organization. The initial cost to provide one time 100% conversion and implementation to a Windows 2000 pure or native environment was cost prohibitive for our organization, reference appendix E. Microsoft's term for 100% pure Windows 2000 network domain is native. The organization approved funding to convert all servers and one-third of the user workstations. The initial planning process calls for one of the current servers to be decommissioned. The decommissioned server, the new server, and three client systems will comprise the test bed for all planning configurations. The initial time line is

outlined in table (3).

Date	Event
17 January 2001	one current server off line/order complete
5 February 2001	test bed developed
21 February 2001	conversion plan review and begin verification
9 March 2001	conversion plan finalized
8-9 April 2001	implement conversion plan
8 May 2001	security verification finalized
15 May 2001	submit accreditation packet to headquarters
1 December 2001	activate native mode

Table (3).

One of the most fundamental outcomes from this meeting was the documenting of foreseen or known distracters within our area of responsibility. The major distractions that will impede the proposed time line were: the deployment of 40 new user workstations; implementation of the network upgrades purchased; a planned six day organizational exercise beginning on 22 February; and testing for a simultaneously planned project due on 15 June 2001. Each item listed as a distracter maintains unknown and unforeseen issues that require the same resource, time. The timeline outlined in table (3) is now the basis for scheduling the management meetings. The impact of each event on the organization will dictate if the management meeting is held before, during, or after the event.

The fourth meeting, held on 15 January 2001, brought everyone back to a common point after the holiday vacations. The scheduled classes and attendees were verified and the status on all products ordered was presented. Everything was on target with our previous schedule. The 40 workstations and network upgrade equipment had an expected deliver the first week of February. The plan for decommissioning a production server was reviewed and approved. The

plan for the implementation of the test bed was also presented and approved. Appendix F provides more details on the test bed development. The next meeting was scheduled for one month later. The stated goals were verification of the schedule and produce a per-server or workstation conversion outline based on new knowledge acquired from attended classes.

The fifth meeting was held on 12 February 2001. The test bed has been established as planned and everyone attended his or her respective Windows 2000 Server class. The approval to begin the experimentation and testing of different software configurations and implementations was giving for servers and workstations with in the test bed. The server and workstation conversion outlines will be tested. If time permits, experimentation of group and workstation policies will begin in order to determine the best remote installation configurations. The previously ordered 40 workstations arrived and were scheduled into the conversion plan for fielding with Windows 2000 Professional. The network backbone upgrade equipment also arrived on schedule. Coordination with the CAN administrators allowed the infrastructure upgrade to occur on 19 and 20 February. Reference appendix A for additional information on infrastructure relationships.

The sixth meeting was held on 21 February 2001. The infrastructure upgrade was implemented with no major disruptions or issues. The users who maintain machines with 10/100mb auto sense network interface cards(NIC) noticed an immediate decrease in access time across the network. Auto sense will automatically switch back and forth between 10mb to 100mb based on what the NIC senses on the cable. All other users would not have noticed a decrease in access time until their individual workstation NICs have been upgraded. We physically checked all workstations to ensure connectivity was not lost due to a failed device, port, or incompatible NIC. The current status on test configurations was presented. The status

on class graduates and attendees was presented. Each section briefed their areas current objective status for completing the conversion plan.

The seventh meeting was held on 9 March 2001. It was decided to purchase new network interface cards that were pre-execution boot(PXE) complainant and additional memory for the legacy workstations that Windows 2000 professional supported. Our testing demonstrated that with these upgrades the workstation performance was acceptable and they were still maintained under warrantee. 22 March was set as the completion date for the installation of the upgrades. We received the guidance required to finish the conversion plan. The local installation CAN will operate as a separate site. The installation will operate the primary domain name service(DNS) for the installation CAN site. Our organization will be a subordinate domain of the parent organization. We will also operate a subordinate DNS domain from the installation CAN. The parent organization is not part of the installation CAN. Appendix G contains the conversion plan synopsis.

The eighth meeting was held on 23 March 2001. While we were coordinating with the CAN administrators, it was identified that the installation CAN's activation of the dynamic update DNS(domain name service) was postponed for 30 days. The installation CAN security personnel were not prepared for the activation. Our permission to activate our subordinate DNS server from the installation CAN was revoked. The earliest date allowable is now 3 May 2001. We informed our parent organization and adjusted our time line by 30 days. The new scheduled date for conversion is 5 May 2001. The workstation upgrades were completed on schedule. All workstations included in the conversion are now prepared. The organization had scheduled all events around our original conversion schedule for 8 April. We decided to take advantage of the time. The production servers received all the currently available flash upgrades. The flashing is

an independent function. The purpose for flashing is to install the latest basic instruction operation set on all hardware components. This is a recommended process by all hardware component manufactures to help eliminate compatibility issues.

As of the submission of this paper, the information management section believes we are prepared to perform the conversion. A sampling of each hardware platform has been converted and tested. Various policy configurations were implemented and evaluated for effects on daily work functions within the test bed. Now that the opportunity for a prolonged test period has presented itself, we are replicating each isolated or specialized process. An isolated or specialized process is a program only utilized by one person or a small section. An example would be a property accountability program, budget program, or personnel management program. The software manufacture claims compatibility with Windows 2000. We now have the luxury to verify.

For a comparison, we reviewed the "Windows 2000 Enterprise Planning Workbook" planning process and sequence of implementation against ours. They were very similar. Microsoft breaks their Windows 2000 deployment template into seven major categories spanning across 365 working days. Using Microsoft's categories and definitions, we used six identical categories over 172 working days. Our time line is condensed mainly because Microsoft based their schedule off of a 2500 person organization and ours is only 786. Appendix H shows Microsoft's deployment project category break down.

Several of the class theories learned from the Engineering Science Management program have been applied throughout the course of this project. Cost Estimating(ESM610) re-enforced writing out the details and recording of real man-hours. An example would be the cost of purchasing pre-made cables that have a warrantee or the cost of purchasing the tools, materials,

and man-hours to make the cables. Now estimate the value of the warrantee verses no warrantee. A good cost estimate is in the details. Once the projects cost estimate is calculated, the financial decisions begin. Financial Management(BA625) helped to prepare proposals on the best time to finance or pay cash based on funding release schedules. Computer Simulation(ESM619) and Operational Research(ESM621) theories enabled projections to be produced on expected high volume times and processing speed of data based on different densities of users. The same applied theories are used to calculate volume of personnel arriving at a bank teller line, fast food restaurants, and traffic intersections within a populated area. Project Management(ESM609) theories enabled the data to be organized and presented in an understandable manner. Realistic scheduling of personnel work days or weeks could not have been possible without the understandable organization. The theories helped to identify points to consider outsourcing to meet the time requirements.

The consideration of warrantees and fair labor contract requirements would have been seriously violated if not for the Business Law class. Understanding the basic rights is essential for a company to understand when it should consult legal advice. We would not have requested legal clarification on some important warrantee and sub-contract issues if not for the business law class. Previously attended courses from Boston University, Data communications and Database Management, helped specifically on this project development because of the technical nature. Details such as understanding the correct order to activate services or load programs originated from these technical courses. Performing functions out of order could adversely effect the communications between the programs or network services like security management.

Each class has passed along its own unique fundamental theory that when

combined have produced an invaluable technical management tool kit for each of us to apply and utilize as we gain experience. I believe this project has exercised each tool within the kit even if not expressly demonstrated.

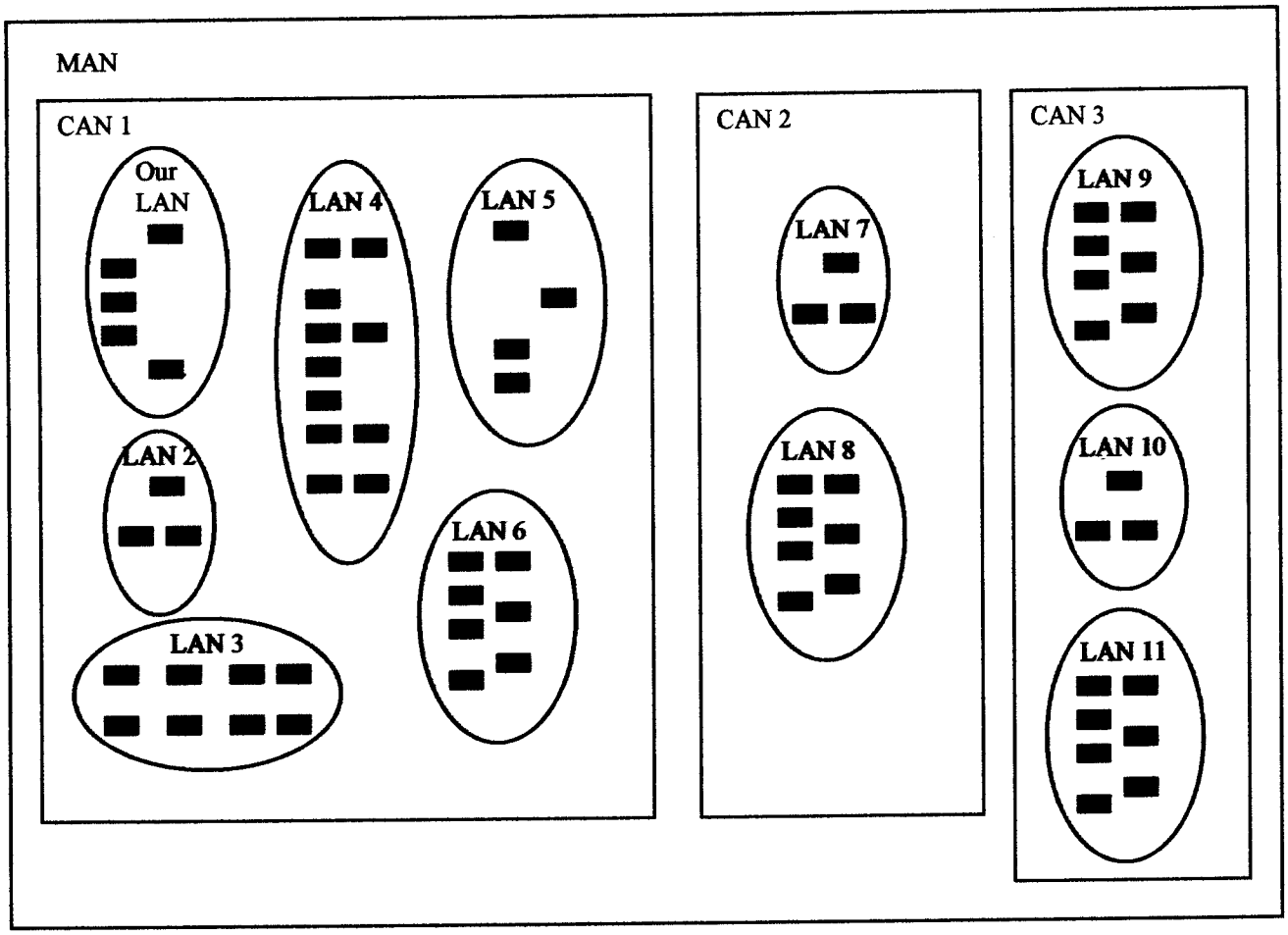
APPENDIX A (Infrastructure Relationships)

There are four common divisions of an area network. They are local, campus, metropolitan, and wide. The area networks are normally characterized by the amount of geographical area the network covers. A local area network(LAN) is normally contained within a building or structure. A campus area network(CAN) will contain more than one LAN or building. A good analogy would be a city block containing two or more buildings. A metropolitan area network(MAN) contains more than one CAN or equivalent to city containing more than one city block. A wide area network(WAN) contains more than one MAN or city.

In my sub-division's case, we are one LAN located within a MAN. The MAN contains three CANs and eleven LANs(figure 3). We do not have infrastructure network personnel on the pay roll. We contract for a flat annual fee for support from the CAN infrastructure network team. We provide current requirements and project out two-year requirements. The CAN support team provide an estimate for upgrade and new equipment to meet the requirements specified. New equipment is not covered under the annual support contract. The contract covers survey, installation, troubleshooting, maintenance, and security.

We are not a large enough organization to keep an infrastructure network person fully employed. Therefore, our outside access or network gateway funnels through the CAN network operations center(NOC). This enables the CAN NOC to provide all the network infrastructure security, monitoring, management, and limited maintenance from one location.

Figure 3. Logical Metropolitan Area Network Diagram



APPENDIX B (Net Available Bandwidth)

The net available bandwidth is the percentage of cable capacity actually available for user data transmission. Ethernet devices use carrier sense multiple access collision detection or CSMA/CD. The collision detection is done within the collision domain. A collision domain is a group of devices located within a logical boundary of the network. The network devices, such as a bridge, router, Hub, or switch, establish the collision domains. On a shared device, the collision domain contains all ports on the device. Therefore, every workstation off of the shared device must compete for available space. Collisions occur frequently. When a collision happens, all workstations are informed to stop sending information. Each workstation calculates a random wait time then begins sending information. If another collision occurs, the process starts over. A switched device enables each port to act, as it's own collision domain. Therefore, eliminating contention or collisions if only one workstation is attached. Our organizational standard, based on sniffer analysis over time, for available bandwidth for multiple devices within a collision domain is 31% of the total capacity. In real terms, a 10mbs shared collision domain provides only 3.1mbs of available bandwidth for user data transmission. Our current standard if one machine is attached to each port on a switched device is 93% for net available bandwidth. In real terms, a 10mbs switched device provides 9.3mbs of bandwidth for user data transmission.

Proper engineering of the infrastructure can dramatically improve the over all network performance. The segregation of collision domains is referred to as layer 2 switching. Layer 2 is referring to the second or datalink layer of the open systems interconnect(OSI) model. Layer 3 switching refers to the segregation of broadcast domains and utilizes the third or transport layer of the OSI model. Layer 3 switching will further increase the performance of the infrastructure.

Our organizations current infrastructure, as shown in figure 1, was 10mb shared. The

current performance met our organizational needs. Windows 2000 Server networks provided several more inherent security and management features not currently being utilized within our organization. Each of the features requires network infrastructure overhead or bandwidth. Some of the inherent functions would be the automatic active directory to global catalog updates and the domain controller to domain controller updates. These functions are similar to the two way implicit trust of an NT4.0 network. In other words, the servers trust each other and transfer all their security information for each user back and forth. The difference in Windows 2000 is this information is transferred and verified for each and every file or object accessed. NT4.0 only checks to the folder level not file level. This is a considerable bandwidth overhead increase for Windows 2000. An example of a feature would be the intele-mirror features, RIS and software installation. These are similar features to systems management server(SMS) under a NT4.0 network. Our organization does not own SMS. Systems were manually loaded with CDs not over the network. The projected bandwidth requirements for remotely installing software and with the added overhead of the security on our current 500 user network would have degraded the current performance. Our organization chief considers a degrading of current service unacceptable. Therefore, an infrastructure upgrade would be required to maintain or improve current performance.

The next projected infrastructure requirements, we could foresee, were the future support for desktop video and voice over IP. With that in mind, we chose to upgrade as shown in figure 2. The 100mb layer 3 switched to the users workstation with gigabyte connections between switches enabled the largest cost effective net available bandwidth from the servers to the users workstation. This plan provided the sufficient bandwidth to support current, planed, and future functions with an increased performance. The gigabyte infrastructure was chosen over

asynchronous transfer mode solely on cost.

APPENDIX C (Computer Platforms & Testing)

There are basically two categories for computer hardware platforms, legacy and current. The technology has been advancing at such a rate that any computer whether it is a user machine or server once placed in the production environment is no longer "state of the art". Our organization has 30% current machines and 70% legacy.

Our organizational requirements to classify a server as current must meet these basic minimum requirements. The server must have dual processors, capable of handling two gigabytes of random access memory, hardware RAID 5, 100Mhz motherboard, SCSI ultra 3, and maintain a built in redundant power supply. The organizational classification for a current user machine is a 133Mhz motherboard, ATA 100 hard drive format, and a 10/100 pre-execution boot(PXE) compliant network interface card. Processor speed is not addressed because processors are tied to the motherboards megahertz capability. All other machines will be classified as legacy. At the time of the evaluation for upgrading to Windows 2000, we maintained two current server platforms, four legacy server platforms, 133 current user workstations, and 350 legacy user workstations.

The test bed proved very successful. We verified our earlier assumption that our legacy server platform hosting the Primary Domain Controller would not perform satisfactory with Windows 2000 Active Directory and Domain Controller running on it. Our tests under a normal network loads demonstrated a 30% increase in the average users login time. The data access time from this server increased 15% due to the addition security information maintained and transferred. These percentages were calculated of a series of 200 accesses. The increase was deemed unacceptable by the whole information management staff. We did not test if the login time increased for a dial-in user. We did not have the equipment to actually replicate the current

process of a dial-in user. We accepted the assumption that if time increased for a directly connected user the time increased for a dial-in user. The legacy platforms used as a data warehouses preformed adequately with Windows 2000 server. The 5-8% time increase for data access was we deemed acceptable. These legacy platforms will be scheduled next year for replacement due to life-cycle expectancy. The manufacture published failure rate for age and usage will reach an unacceptable risk level next fiscal year.

According to Microsoft's published standard requirements for Windows 2000 Professional, 135 of our current user machines failed. These machines are programmed for replacement next fiscal year. That leaves 215 machines consisting of only three unique hardware platforms. We reviewed the vendors published documentation on Windows 2000 compatibility and checked the compatibility lists published by Microsoft. Once the notes were compiled on required upgrades, including firmware and BOIS flashing, we upgraded one of each platform for testing in the test bed. We verified each of the configurations and added addition upgrade requirements to meet or exceed current access rates. Most upgrades added by our organization consisted of memory (64mb to 128mb) and network interface cards (from 10mb to 100mb PXE compliant) on the legacy user workstations. The organizational break down on users workstations turned out to be 30% current, 40% legacy could be upgraded, and 30% needed replaced.

We have users that need to occasionally participate in multiple non-trusted domains. As described earlier, a domain is a security boundary containing groups of users and objects. Non-trusted means the user is required different logins one for each domain name. If the domains are trusted, this is not an issue. The multiple domains will appear on a drop down domain tab on the login screen. Our organization currently provides two workstations or multiple operating

systems loaded on a workstation for non-trusted domains, one for each domain. It is not very cost effective to maintain two sets of licensed software and possibly two workstations depending on the users knowledge or capabilities. Windows 2000 does not provide any inherent support to participate in multiple non-trusted domains. There is third party software available to meet this requirement. We used Norton Mobile Essentials to accomplish this task with in the test bed. The software enabled the user to choose which domain to authenticate on the user login screen, there-by eliminating the possibility of simultaneous non-trusted logons. This enabled a standard implementation for a required user in contrast to personally configuring each required user. One license for software, client access, and machine is now required for each user regardless of domain requirements.

APPENDIX D (Worksheet 5 Person Information Management Section)

	Sept	Oct	Nov	Dec	Jan(1-15)	(16-31)	Feb(1-14)	(15-28)	Mar(1-15)	(16-31)	Apr(1-15)	(16-30)	May
Education	101	67	194	144	64	126	79	147	57	93	24		
Class			40			80		80		40			
Internet-R	30	14	52	32	20	8	32	16	24	10	12		
Book-R	35	27	72	80	28	24	26	28	10	23	3		
Colleague	36	26	30	32	16	14	21	23	23	20	9		
Test/Upgrade	14	9	4	24	34	23	65	87	61	56	13		
Hardware													
Firmware				5	6		2	2	6				
Bios				4	6		2	2	6				
Backplane	5	5		3	2		8	7	2				
Memory				2			9	4		6	6		
Adapters				2		6	4	5					
Software													
Compatibility	9	4		3	11	13	22	31	6	12	2		
Load/Config			4	5	9	4	18	36	41	38	5		
Admin	32	24	28	60	38	32	17	25	17	26	10		
Plan	28	22	20	26	14	16	11	17	11	18	6		
Teaching			4	30	22	12	6	2	2	4	2		
Instructions/list	4	2	4	4	2	4		6	4	4	2		
Breaks													
Implementation	7	14	14	36	25	38	51	40	39	16	47		
Hardware	3	7	3	6	9	4	17	11	8	3	12		
Software	2	2	2	19	5	16	24	13	4	5	16		
Peripherals		3	4	5	4	13	7	9	2	3	8		
Client	2	2	5	6	7	5	3	7	25	5	11		
Security	6	8	4	12	45	50	28	21	9	10	19		
Client	2	2		2	8	21	11	6			2		
Server	2	4		2	18	20	11	4	4	4	7		
Domain	2	2		4	13	5	2	11	4	4	6		
Physical			4	2	4	2	2		1	2	2		
Disaster				2	2	2	2				2		
Accreditation	6	8	2	18	6			4	26	60	25		
Physical	4	4			2				6	16	4		
Domain	2	2	2	2	2			4	10	14	4		
Disaster		2			2				2	12	6		
Client				16					8	18	11		

APPENDIX E (Cost Analysis Information)

The funding for the conversion was able to be split over three fiscal years and still meet the January 2002 implementation dead line. A fiscal year starts on October 1st and ends on September 31st. Therefore, we had year-end funds available in fiscal year 2000, fiscal year 2001 operating funds, and the ability to forecast funds for first quarter fiscal year 2002 to complete the conversion project.

We utilized the organizations unspent funds for fiscal year 2000 to purchase the infrastructure upgrades and pre-purchase training days. The infrastructure upgrades cost $53,000.00. The remaining $9625.00 purchased 35 training days from an outside corporate training company.

The cost of converting 100% of the user workstations and servers to Windows 2000 in one phase proved cost prohibitive for the fiscal year 2001 budget. The cost to move Windows 2000 organizational wide was $389,420.00. The information management budget for fiscal year 2001 was $295,628.00. When the budget for 2001 was forecasted, no one projected for a complete conversion of the network operating system. We were able to move money around and fund $87,472.00 for a server, some software, and workstation upgrades.

One server was required to be purchased. The cost for the server without software was $7797.00. All six servers required the Windows 2000 Server software. The following is the approved software purchase totaling $57,530.00: Windows 2000 Advanced Server X2 = $2690.00; Windows 2000 Server X4 = $3072.00; Exchange 2000 media only $27.00; ARCServe $3400.00; Windows 2000 Professional with Office 2000 X248 = $47,616.00; Symantec Mobile Essentials X25 = $725.00. The software license purchased with the original Exchange 5.5 allowed for free two-year upgrade advantage. We only had to pay for shipping and printing of

the compact disk. 215 workstations were approved for upgrades. The upgrades included 64mb of memory and a PXE compliant NIC card per workstation with a combined cost of $103.00 per workstation or a total of $22,145.00.

In order to complete the Windows 2000 conversion, 135 workstations were programmed for fiscal year 2002's budget. The projected cost was $2100.00 per workstation and $192.00 for the software license. The total budgeted was $309,420.00 for 135 workstations with software.

APPENDIX F (Test Bed Development and Implementation)

The test bed needed to be in an off location area physically connected to the network but the broadcast traffic needed to be isolated. The broadcast traffic would have interfered with the daily production operation. We were going to develop, test, and implement specific configurations for each server and user workstation platform, deployment strategies of software, operating systems, group polices, and security policies. Therefore, we coordinated with the CAN operations center to place all the access ports in a designated room under a temporary virtual private network (VPN) for testing purposes. The CAN administrators established the VPN on 1 February 2001. We scheduled the deactivation of the VPN on 8 May 2001. The VPN was established through the layer 3 switching configuration. Groups of network devices and/or ports are programmed into a virtual container that acts like a separate physical network and broadcast domain. We did not have the software capability to perform this function. The CAN administrator had this capability.

One of the critical processes we were going to execute was a live test of the disaster recovery and redundant features of each platform. A disaster in this case means a hardware or software failure of some kind. We documented procedures based on vendor provided documentation but this opportunity enabled us to evaluate the vender's disaster recovery options and the redundant features capabilities. If we were not satisfied, we would test our own ideas to facilitate the quickest and most complete recover under any circumstance short of a disaster caused by Mother Nature. The equipment designated for the test bed is a new server, current server, simulated network traffic machine, and three different platforms of user machines.

The new server was ordered in time to take delivery before 5 February 2001 to facilitate maximum testing. The current server needed to be decommissioned from the production

environment. The network traffic machine and three user machines would be removed from user circulation when new machines were fielded and when machines returned from maintenance. This would provide the least disruption of service for the users.

The decommissioned server was a sub-project by itself. All network shares located on the decommissioning server were relocated to other production servers. The server selected was of current technology and was being utilized as a back-up domain controller, print share device, and a data repository. No mission critical programs or processes were being maintained on this server.

APPENDIX G (Conversion Plan)

One of the first decisions is to convert the user workstations first or the servers. We tested converting the workstations first by configuring one machine with all the approved machine policies and software configurations. Once it was complete, we ghosted the machine and placed the ghosted image on the server. We created a boot disk with scripts to automatically initialize the machine and install the image with scripted answer files. This worked fine but required more than basic operator knowledge of the machine. The second method is to ensure the workstations are pre-boot execution environment(PXE) compliant and configure a domain remote installation server(RIS). A configured RIS means an image of all platforms is installed, the user's account is established and placed in the appropriate organizational unit(OU), and all software group and security policy objects are configured. Once the user's data is backed-up, you erase the hard disk and turn the workstation off. When you turn the workstation on, you will be asked a question about either remote installation or enter PXE. The question varies from one vender's machine to the next. You have 3-5 seconds to answer "yes". You will be prompted to enter the users identification, password, and domain. Once entered, the workstation will automatically search for the RIS and load the operating system and all domain policies. When it reboots and the user re-enters their user identification and password, all other polices will be applied. This means all software authorized from the user's software group policy will automatically load.

We chose to convert the servers first to take advantage of the RIS capabilities. The first step is to back-up all the servers. Just incase something catastrophic happens and the server has to be reverted back during the conversion. Once the back-up had been verified, the conversion begins. The first server to be upgraded was the Primary Domain Controller(PDC). The PDC

will maintain its master roles along with the account and security setting information once the operating system is upgraded. Next, install the new Windows 2000 Domain Controller(DC). Once the DC is installed, move the master roles from the PDC to the DC. These roles include the infrastructure, PDC emulation, and relative identification (RID). This process will automatically transfer all accounts and associated security information from the PDC to the new DC with PDC emulation. The old PDC can be removed. Once the old PDC is removed, configure the DNS, WINS, and DHCP services. Now the organizational units(OUs) structure will be configured. Configure all default domain security policies, domain software group policy objects, and OU group policy objects.

The next server to be installed and configured is our Internet Information Server(IIS) because it is also the second DC, back-up WINS, and back-up DNS. For our organization, no additional information needs to be restored to the IIS. The third server to be installed and configured is the file server. Once configured, the print services will be setup and the data files restored. The file server is also the print server for the organization. The fourth server to be installed and configured is the network anti-virus and remote installation server. The fifth and last server to be installed and configured is the exchange 2000 server. Once the exchange is configured the old private and public information stores will be imported.

The SureStore tape storage device and the uninterrupted power supply management device will be installed on the network now that all the servers have been activated with in the production environment. Once all the servers, tape, and UPS devices have been tested, the user workstations will begin the conversion process. A representative from each section with in our organization will assist in the user workstation conversion process. This will help insure there is a personal interest for completing each section and to assist in restoring the user's workstation

data files. The 40 new workstations will be deployed during this phase of the conversion.

APPENDIX H (Windows 2000 Enterprise Planning Workbook)

An "X" marked in the project paper column denoting used in consideration for the organizations fielding, a "N/A" was used if not applicable, and blank if not considered.

Microsoft Windows 2000 Planning Workbook	Days	Project Paper	Days
Vision/Scope	22	X	5
Evaluate Windows 2000 Features		X	
Evaluate Corporate Business Objectives		X	
Determine Technology Goals and Objectives		X	
Formulate Preliminary Cost/Benefit Analysis			
Determine Project Scope		X	
Determine Major Milestones		X	
Secure Executive Sponsorship/Funding		X	
Planning	72	X	100
Assemble Project Teams/Define Roles		X	
Detail Current Computing Environment		X	
Preliminary Design Objectives		X	
Identify Coexistence Strategies		X	
Establish Test Lab Environment		X	
Perform Risk Assessment		X	
Define Communications Strategy		X	
Define Education/ Training Strategy		X	
Development	148	X	30
Evaluate Migration Strategies		X	
Active Directory		X	
Client Strategy, Standards, and Management		X	
Application Compatibility		X	
Security Considerations		X	
Public Key Infrastructure		N/A	
Member Server Migration		X	
Terminal Services		N/A	
Clustering		N/A	
Storage Management		X	
Remediate Risk Assessment		X	
Develop Communications		X	
Develop Education/Training		X	
Proof of Concept	30	X	15
Proof of Concept Preparation		X	
Deploy Development Solution to Lab Machines		X	
Perform Full Cycle Risk Assessment		X	
Pilot	55	N/A	
Planning			
Deployment			
Evaluate Pilot			

Post Pilot			
Deployment	26	X	2
Communications		X	
Education/Training		X	
Domain Migration		X	
Active Directory		X	
Security Infrastructure		X	
Public Key Infrastructure		N/A	
Clustering		N/A	
Storage Management Strategies		X	
Post Implementation Review	12		5