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Contents

1 Executive Summary

The goal of this project was to make a Windows Server network for a small school system. This was achieved through three different phases. The first phase was completed as follows: three virtual machines were set up on vSphere to be prepared for the phases to follow. Once that was completed, Windows Server was installed, and VMware Workstation was installed to set up a nested virtual machine within one of the machines already created. However, this new VM ran on Windows 11 instead of 10 (like the first three virtual machines). In Phase 3, Active Directory Domain Services was used to set up the network's architecture (such as defining organizational units). Then, network file sharing was implemented and tested by sharing a folder and a Bullzip PDF printer. Inheritance was shown through the use of two different group policies, one at the domain level and the other was applied to an OU. This was done alongside the creation of GPO's and User Disk Quotas for the users within the network.

During this project, one major problem occurred. Appendix A Problem 1 pointed out that the domain controller could not connect to the DNS because of configuration issues. This prevented users from accessing network resources. After trying many solutions, the strategy that fixed this issue was setting up the DNS forward lookup zones on the domain controller. Problem 2 discussed the VM not being able to connect to the CNIT242G00 network. This was caused by selecting the wrong folder for the VM during its creation. Instead of the CNIT242G00 folder, CNIT242 was selected, which most likely did not have the network configuration files required to establish a connect. While the actual reason for the issue is unknown, all that was certain was that it could connect once the correct folder was corrected. The last issue was Problem 3, and it discussed the possibility of one of the VMs being deleted. This was because the cluster the VMs were a part of had a script that deleted virtual machines that were thick provisioned. Since one of the created VMs was thick provisioned, it needed to be altered or it would be deleted. Once this error was corrected, the threat of losing progress was eliminated. To hopefully avoid this issue (and any others that may arise) when recreating this project, testing the domain controller's connection, ensuring each VM that runs OS' like Windows 10 Pro Education (which work better when being installed via BIOS instead of EFI) has the firmware configured to BIOS, and installing Firefox to decrease lag are all recommended strategies to employ.

2 Business Scenario

Yorkshire County had a small school system trying to modernize its management system for their computers and other devices on their network. Since the county was home to one elementary school, one middle school, and one high school and many of the students attended only the schools within Yorkshire County, it is more logical to have a centralized management system for all the schools. The goal was to create a management system that provided the benefit of seamless file sharing between the schools for student records,

provided each of them with a consistent platform to complete their schoolwork throughout their academic careers, and allowed students and teachers to access their files remotely. Plus, it gave students the added benefit of being able to access their work from previous grades/schools. For this project, vSphere was utilized to create the following virtual machines: cnit242.winServerlab1, cnit242.juergens.win10, cnit242.gnegron.win10, and cnit242.elsner.win10 with Windows 10 and Server 2022 as operating systems. VMware Workstation was installed on cnit242.juergenswin10, used to create a VM running on Windows 11. Remote desktop was enabled on each machine so users could access them remotely. Next, Windows Server 2022 alongside Active Directories were used to create a network divided into three main organizational units (Elementary School, Middle School, and High School). This network was set up with a root domain and three domains branched from it (one for each of the schools). Then, within each domain there was an OU for groups (with one group for teachers and one group for students), and there was an OU for users. The users were then assigned to one of the groups. For ease of access, GPOs were configured so that certain applications open on login depending on what group and domain the user belongs to, and another GPO was made to redirect home folders to share on the domain controller, which allowed users to be able to access their files from any computer on the system. Roaming profiles were also set up to achieve a similar effect. Disk quotas were set to ensure each user only takes up a set amount of storage space on the network. Lastly, a Bullzip printer was added to the system so that users may access it through the network.

3 Procedures

This section contains the steps followed to achieve the desired network for this project. The procedures are divided into phases one through three.

3.1 Formatting Conventions

- **Bold:** Buttons and interactive elements.
- *Italicized:* Options, menu items, and text entered.
- Menu navigation is indicated by the pipe symbol: Start | Programs | MS Office | Word.

3.2 Phase 1: Working Individually

3.2.1 Access the Student Virtual Cluster

- Logged into the Cluster
- Opened a web browser
- Navigated to `https://studentvc.cit.lcl`
- Logged in with student credentials

3.2.2 Install a Windows 10 Client

- Created New VM
 - In the virtual cluster interface, clicked Create New VM
 - Selected Typical configuration and clicked Next
 - Selected Create a new virtual machine and clicked Next
 - Chose Windows 10 Education from the dropdown menu and clicked Next
- Named the VM
 - Entered cnit242.juergens.win10 in the Name field
 - Clicked Next
- Set CD/DVD to the Windows 10 ISO
 - Selected Use ISO image file
 - Browsed to the ISO datastore and selected the Windows 10 ISO file
 - Checked Connect at power on
 - Clicked Next
- Configured the NIC
 - Selected CNIT242G00 port group for the network adapter
 - Clicked Next
- Assigned IP Address
 - Opened the Edit virtual machine settings window
 - Selected Network Adapter and clicked Configure Adapter
 - Changed the ip address to *44.100.10.21*
 - Clicked OK
- Powered on the VM
 - Clicked Power on this virtual machine
 - Followed the Windows installation prompts to complete the setup
- Applied Windows Updates
 - Once logged into Windows, clicked Start | Settings | Update & Security | Windows Update
 - Clicked Check for updates and installed all available updates
- Installed VMware Tools
 - In the VM menu, clicked VM | Install VMware Tools
 - Accepted the default settings by clicking Next
 - Restarted the VM when prompted

3.3 Phase 2: Group Setup

3.3.1 Move and Reconfigure Windows 10 Instances

- Moved the VM to Group Space
 - In the virtual cluster interface, the VM was selected
 - Clicked Actions | Move to | Group Space
- Changed Networking Settings
 - Right-clicked on the VM and selected Edit Settings
 - Selected Network Adapter
 - Changed the Network label to the group VM port group
 - Clicked OK
- Reassigned the IP address according to the group IP address sheet
 - Primary Port Group: CNIT242G10A
 - Primary IP Address: 44.100.10.0/24
 - Secondary Port Group: CNIT242G10B
 - Secondary IP Address: 44.100.60.0/24
 - Domain: group10.c24200.cit.lcl

3.3.2 Install Windows Server 2022

- Created New VM
 - Followed the steps outlined in Phase 1 to create a new VM
 - Selected Windows Server 2022 as the operating system
- Configured Networking
 - Opened Edit Settings for the new VM
 - Selected Network Adapter and assigned the IP address 44.100.10.10
- Applied Service Packs and Updates
 - Logged into the server
 - Went to Start | Settings | Update & Security | Windows Update
 - Clicked Check for updates and installed all available updates
- Enabled Remote Desktop
 - Opened Start | Settings | System | Remote Desktop
 - Toggled Enable Remote Desktop to On
 - Clicked Confirm

3.3.3 Install VMware Workstation

- Downloaded VMware Workstation
 - On one of the Windows 10 VMs, opened File Explorer
 - Navigated to \.cit.lcl
 - Copied the VMware Workstation installer to the VM and ran it
- Ensured the VM had at least 16 GB of RAM
 - Right-clicked on the VM in the VMware interface
 - Selected Edit Settings
 - Adjusted the memory allocation to 16 GB
 - Clicked OK
- Created a Windows 11 VM in VMware Workstation
 - Opened VMware Workstation
 - Clicked File | New Virtual Machine
 - Selected Typical and clicked Next
 - Chose Windows 11 as the operating system
 - Set the hard drive size to 30 GB
 - Selected split virtual disk into multiple files

3.4 Phase 3: Network Services Configuration

3.4.1 Configure Directory Services

- Installed Active Directory Domain Services
 - Opened Server Manager
 - Clicked Add roles and features
 - Clicked Next through the wizard until reaching the Server Roles page
 - Checked Active Directory Domain Services
 - Clicked Next and installed
- Promoted Server to Domain Controller
 - After installation, clicked the flag icon in Server Manager
 - Clicked Promote this server to a domain controller
 - Selected Add a new forest
 - Entered group10.c242.cit.lcl as the root domain name

- Clicked Next through the wizard and completed the promotion
- Configured DNS Forwarding
 - Opened DNS Manager
 - Right-clicked on the server name and selected Properties
 - Went to the Forwarders tab
 - Clicked Edit and added cit.lcl DNS server IP address
 - Clicked OK
- Created Organizational Units (OUs)
 - Opened Active Directory Users and Computers
 - Right-clicked on the domain group10.c242.cit.lcl
 - Selected New | Organizational Unit
 - Created OUs for Elementary, Middle, and High School
 - Inside each school OU, created OUs for Users and Groups
 - Added Teacher and Student groups to the Groups OU
 - Added users to the respective school User OUs

3.4.2 Implement Network File Sharing

- Configured Shared Resources
 - On the server, right-clicked the folder to share and selected Properties
 - Went to the Sharing tab and clicked Advanced Sharing
 - Checked Share this folder and clicked Permissions
 - Set appropriate permissions and clicked OK
- Mapped Network Drive on Clients
 - On each client machine, opened File Explorer
 - Clicked This PC
 - Clicked Map network drive
 - Entered the shared folder path `\01`
 - Clicked Finish

3.4.3 Install a PDF Printer

- Downloaded Bullzip PDF Printer
 - Opened File Explorer
 - Navigated to `\.cit.lcl`
 - Copied the Bullzip PDF Printer installer to the VM and ran it
- Shared the PDF Printer
 - Opened Devices and Printers
 - Right-clicked on Bullzip PDF Printer and selected Printer properties
 - Went to the Sharing tab
 - Checked Share this printer and gave it a share name
 - Clicked OK

3.4.4 Set Up Group Policy

- Opened Group Policy Management
 - Opened Server Manager
 - Clicked Tools | Group Policy Management
- Created a New GPO
 - Right-clicked on Group Policy Objects and selected New
 - Named the GPO (e.g., DisableRegedit)
 - Right-clicked the new GPO and selected Edit
 - Navigated to User Configuration | Policies | Administrative Templates | System
 - Double-clicked on Prevent access to registry editing tools
 - Set it to Enabled and clicked OK
- Implemented Seamless Profile and Document Access
 - Redirected Desktops and Home Directories
 - * Opened Group Policy Management
 - * Created a new GPO for folder redirection
 - * Navigated to User Configuration | Policies | Windows Settings | Folder Redirection
 - * Redirected Desktop and Documents to a network share
 - Enabled Roaming Profiles
 - * Right-clicked on the user account in Active Directory Users and Computers
 - * Selected Properties

- * Went to the Profile tab
 - * Entered the network path for the profile location
 - * Clicked OK
- Group Policy to Create a Login Script at the Root Domain Level
 - Opened Group Policy Management
 - * Opened Server Manager
 - * Clicked Tools | Group Policy Management
 - Created a New GPO at the Root Domain Level
 - * In the Group Policy Management Console, expanded the domain (group10.c242.cit.lcl)
 - * Right-clicked on the domain name and selected Create a GPO in this domain, and Link it here
 - * Named the GPO RootLoginScript and clicked OK
 - Edited the GPO
 - * Right-clicked on the RootLoginScript GPO and selected Edit
 - * In the Group Policy Management Editor, navigated to User Configuration | Policies | Windows Settings | Scripts (Logon/Logoff)
 - * Double-clicked on Logon
 - Added the Login Script
 - * In the Logon Properties window, clicked Add
 - * In the Add a Script window, clicked Browse
 - * In the Browse window, navigated to the Sysvol folder of the domain: \10.c242.cit.lcl\10.c242.cit.lcl\Sysvol
 - * Created a new batch file named RootLoginScript.bat with the following content: *start calc.exe*
 - * Saved the batch file and closed the editor
 - * In the Add a Script window, selected RootLoginScript.bat and clicked OK
 - Applied the GPO
 - * Closed the Logon Properties window
 - * The RootLoginScript GPO was linked to the root domain and applied to all users
- Group Policy to Create a Login Script for the Elementary School OU
 - Created a New GPO for the Elementary School OU
 - * In the Group Policy Management Console, expanded the domain (group10.c242.cit.lcl)
 - * Expanded the Organizational Units until finding the ElementarySchool OU
 - * Right-clicked on the ElementarySchool OU and selected Create a GPO in this domain, and Link it here
 - * Named the GPO ElementarySchoolLoginScript and clicked OK

- Edited the GPO
 - * Right-clicked on the ElementarySchoolLoginScript GPO and selected Edit
 - * In the Group Policy Management Editor, navigated to User Configuration | Policies | Windows Settings | Scripts (Logon/Logoff)
 - * Double-clicked on Logon
- Added the Login Script
 - * In the Logon Properties window, clicked Add
 - * In the Add a Script window, clicked Browse
 - * In the Browse window, navigated to the Sysvol folder of the domain: \10.c242.cit.lcl10.c242.c
 - * Created a new batch file named ElementarySchoolLoginScript.bat with the following content: *start mspaint.exe*
 - * Saved the batch file and closed the editor
 - * In the Add a Script window, selected ElementarySchoolLoginScript.bat and clicked OK
- Applied the GPO
 - * Closed the Logon Properties window
 - * The ElementarySchoolLoginScript GPO was linked to the ElementarySchool OU and applied only to users within this OU

3.4.5 Implement User Disk Quotas

- Configured Disk Quotas
 - On the server, right-clicked the volume and selected Properties
 - Went to the Quota tab
 - Clicked Show Quota Settings
 - Checked Enable quota management
 - Set appropriate quota limits and clicked OK

4 Results

The result was a network with one domain controller running windows server 2022, three workstations running windows 10 along with a shared printer. The network used Active Directory and Group Policy to manage profiles, provide system security, and a seamless user experience between desktops. Figures 1 and 2 demonstrate the topology of the network created during this project. This was achieved by giving each domain two OUs. One OU was for the groups and the other OU contained all the users. The two groups within the Groups OU were teachers and students, and users were then assigned to one of those groups. This way GPOs could be set at the group level, which is easier than setting them for each user. A remote desktop was also set up for each of the VMs on the system, which gave users the ability to access a machine on the network remotely. In addition, a Windows 11

workstation was created using VMworkstation, which gave users a consistent environment to work on regardless of what Windows machine they were doing work on. It was at this point in the project when Active Directory Domain Services was installed and one of the machines created on the network was promoted to be a domain controller. Then, the OUs were created. A printer was added by sharing it over the network from the domain controller, giving all users on the printer access to it. NTP was also incorporated, which synchronized the system clocks on all the machines on the network. Without doing this, certain applications would not work. Several GPOs were created in AD. The first GPO was used to disable Regedit, and this prevented users from manipulating their OS' registry. The next GPO was used for file redirection, which was achieved by redirecting users' home folders to the network. File redirection made it so that any a user saved to one file could be accessed and manipulated from another computer (only if that machine was signed in with the same user's credentials). While this was created separately, the users were set as roaming profiles, and this allowed for each user's desktop environment and settings to be saved on the centralized network. File redirection combined with roaming profiles allowed the seamless transfer of user information between machines, so users had a consistent user experience if their machine was connected to the network. This prevented users from using all the network's storage capacity. There was another GPO forced a password policy on the users. Doing so ensured users made strong passwords that decreased the likelihood of a breach. The next two GPOs that were created had certain applications open upon logon, depending on the user's group and domain. One GPO launched the calculator app for students belonging to the Middle School domain, and the other GPO launched MS Paint at logon for students belonging to the Elementary School domain. These features were more for ease of access for the users rather than improving the system, but they demonstrated inheritance working as intended within the network. Then, Disk quotas were set to 5 Gb, which prevented users from bloating the network's storage with their files.

4.1 Logical Topology

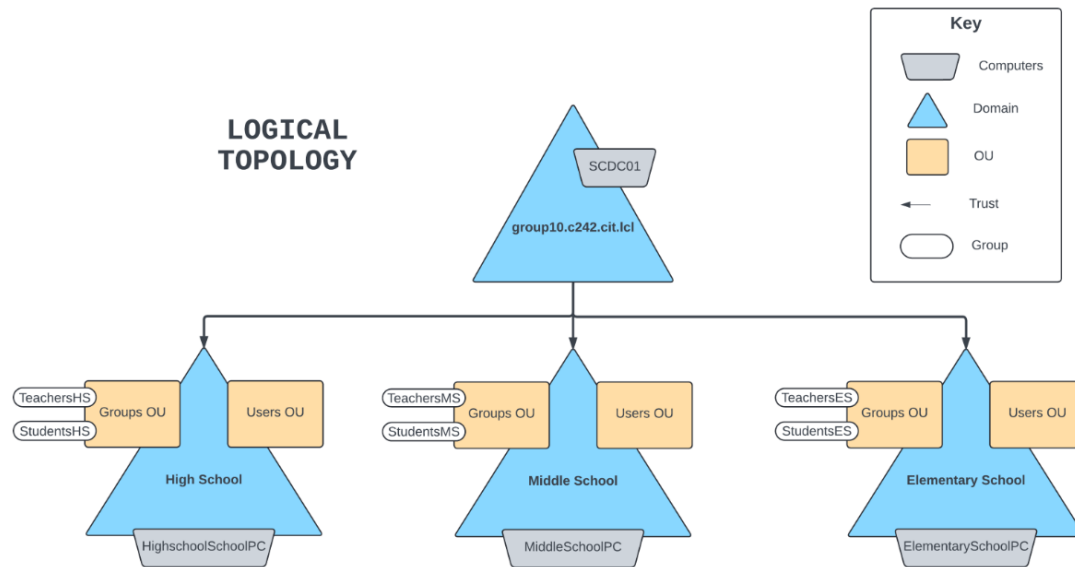


Figure 1: Diagram of logical topology

4.2 Physical Topology

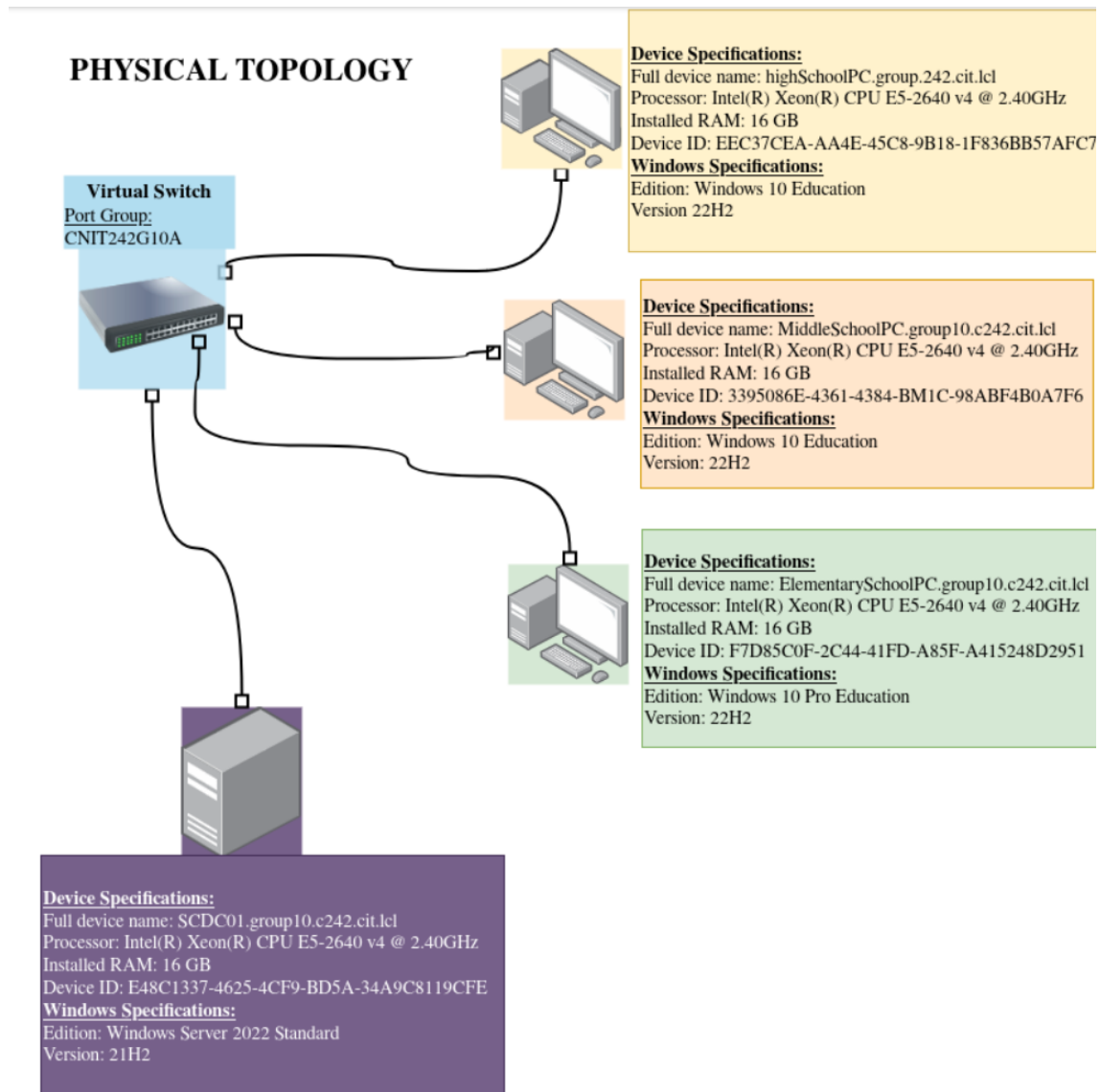


Figure 2: Diagram of physical topology

4.3 Machine Networking/Login Information Table

table	ElementarySchoolPC	HighSchoolPC	MiddleSchoolPC
Pnic1 (CNIT242G10A)	44.100.10.36	44.100.10.21	44.100.10.14
Subnet Mask	255.255.255.0	255.255.255.0	255.255.255.0
Default Gateway	44.100.10.1	44.100.10.1	44.100.10.1
DNS	44.100.10.10	44.100.10.10	44.100.10.10

table cont.	Windows 2022 Srv.(SCDC01)	Windows 11 VM
Pnic1 (CNIT242G10A)	44.100.10.10	44.100.10.111
Subnet Mask	255.255.255.0	255.255.255.0
Default Gateway	44.100.10.1	44.100.10.1
DNS	44.100.10.10	44.100.10.10

5 Conclusions

In the final analysis, the desired network that was specified in the business scenario was successfully created. Yorkshire County wanted a network divided by school, and each school had a group for students and teachers. This was achieved by making a root domain with the branching domains three domains and creating the groups and users OUs. The OUs were used to satisfy YC's requirement of having users being separated by teachers or students. Other steps were taken to ensure that this network worked efficiently and as intended. This included creating a few GPOs on AD. The first was used for folder redirection. In addition, the users were set as roaming profiles, and these fulfilled YC's requirement of having a centralized system. Disk quotas were also set to ensure this system worked without the potential of one user bloating the network's storage capacity. The next two GPOs were created to add a "quality of life feature" that improved the user experience and overall satisfaction with the network. A remote desktop was also set up for each of the VMs on the system, which satisfied Yorkshire County's requirement of being able to access the machines remotely. Another step that was taken was adding a printer to the network.

By sharing the printer over the network from the domain controller, everyone on the network was able to access the printer, which satisfied another requirement. All-in-all, this project can be deemed a success because of the following: the desired network topology was achieved through the proper use of domains and OUs, seamless file sharing was created using GPOs and roaming profiles, "quality of life features" were added to improve efficiency and user experience, and users were able to access their machines remotely thanks to remote desktop.

6 Recommendations

- **Recommendation 1:** After creating the domain controller, test to see if it can connect properly. This is because the DNS configuration settings are very specific. If any of those are wrong, then the domain controller cannot connect. The DC not connecting would be a larger issue moving on because it is required for user authentication, centralized management, active directory servers, replication, and group policy implementation.
- **Recommendation 2:** Double-check VM firmware is set to BIOS before trying to launch it for the first time. BIOS is the simplest way to set up a Windows machine that is running Windows 10 Education, so it is recommended to do that instead of EFI. If EFI is the firmware when the VM is booted up for the first time, then it cannot be changed to BIOS.
- **Recommendation 3:** Install Firefox on each workstation before beginning. Edge generates a lot of pop-ups when joining in as a new user, and the homepage ads might be annoying.

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8 APPENDIX A: Problem Solving

8.1 Problem 1 - Inability to Connect to Domain Controller due to DNS Configuration Issues

8.1.1 Problem Description:

The issue arose when users and systems were unable to connect to the domain controller.

This connectivity problem prevented users from authenticating and accessing network resources. Initially, the problem appeared as if the domain controller itself was unresponsive. However, further investigation revealed that the core issue was related to DNS configuration, specifically the lack of properly set up DNS forward lookup zones.

Active directory requires DNS to function properly, which explained why there were connection issues. This problem could be reproduced by deleting the zones that were created. Also, one would likely need to flush the DNS using the command line.

8.1.2 Possible Solutions:

1. Verify Network Connectivity:

- Ensure that all physical connections were intact and that network devices were operational.
 - Used tools like ping to verify that the domain controller was reachable.
2. Check DNS Configuration:
 - Verified that DNS services were running on the domain controller.
 - Checked the DNS server settings on client machines to ensure they were pointing to the correct DNS server.
 3. Set Up Forward Lookup Zones:
 - Created and configured forward lookup zones in the DNS management console on the domain controller.
 - Ensured that the forward lookup zone for the domain was correctly set up and populated with the necessary records.
 4. Restart DNS and Domain Services:
 - Restarted the DNS server service to ensure that any configuration changes took effect.
 - Restarted the Netlogon service on the domain controller to refresh its connectivity to the network.
 5. Clear DNS Cache:
 - Cleared the DNS cache on both the client machines and the DNS server using commands like `ipconfig /flushdns`.
 6. Check Firewall Settings:
 - Ensured that the firewall settings were not blocking DNS or domain controller traffic.
 - Configured necessary rules to allow DNS traffic.

8.1.3 Solutions Attempted:

1. Verified Network Connectivity:
 - Confirmed that the network infrastructure was functioning correctly and that the domain controller was reachable via its IP address.
2. Checked DNS Configuration:
 - Ensured that the DNS service was running on the domain controller.
 - Verified that client machines were using the correct DNS server.
3. Set Up Forward Lookup Zones:

- Initially overlooked the setup of forward lookup zones. Once identified as a potential issue, I configured the forward lookup zone for the domain, ensuring it included all necessary records.

4. Restarted DNS and Domain Services:

- Restarted the DNS server and Netlogon services to apply changes and refresh connections.

8.1.4 Final Solution:

The final solution involved flushing the DNS cache by running the command `ipconfig /flushdns` and verifying the resolution by running `ipconfig /displaydns`. This worked because the DNS resolver cache had stored the old IP addresses of DNS names that were previously queried, and after the addresses were switched, the DNS server tried to resolve domain names with the outdated IP's. Once the cache was cleared, the DNS server would only resolve domain names to the current IP addresses.

8.2 Problem 2 – The CNIT242G00 Network Would not Connect to a VM on Startup

8.2.1 Problem Description:

When creating a VM, there was an issue with the Customize hardware section. Under the New Network section, the Connect at Startup box would not be checked. In other words, the Virtual Machine could not connect to the CNIT242G00 network when it started up. Without the network, the virtual machine would not have access to network resources such as the internet and file shares. Furthermore, the VM could not connect to update servers and programs such as Remote Desktop Protocol, which depended on a connection to the server, would not work.

8.2.2 Possible Solutions:

- Backtracked to verify all the VM configurations such as the folder location were correct.
- Restarted the VM creation process to ensure all the configurations were properly set.

8.2.3 Solutions Attempted:

- Backtracked and changed the folder to CNIT242G00.

8.2.4 Final Solution:

Backtracking was a viable solution because the VM creation was not finalized yet. Therefore, it was simpler to backtrack to verify all the configurations preceding the Customize hardware page were correct. Upon searching for errors, it was discovered that the folder location assigned to the VM was CNIT242 instead of CNIT242G00. After the fix

was made and the CNIT242G00 folder was selected, the Connect at Startup box was able to be checked; therefore, it ensured that the VM would connect to the CNIT242G00 network when it started up. At the time, the reason why this solution worked was unknown. After some research, the most probable reason was that the important network configuration files that the VM used to connect to the network were in the CNIT242G00 folder, but because the CNIT242 folder was selected, the VMware could not find the files containing this information. However, this could not be confirmed because the contents of CNIT242G00 were unknown.

8.3 Problem 3 – VM was at Risk of Being Deleted from the Network

8.3.1 Problem Description:

The network created for CNIT242 hosted many virtual machines. To prevent the server from bloating, there was a script that deletes any VM that used thick provisioning. This was because thick provision would reserve 40+ GB of the network's storage capacity for the individual VM, so if every VM did this, then there would not be enough space on the network for each VM. Since one of the VMs was accidentally created as thick provisioned, it was at risk of being deleted.

8.3.2 Possible Solutions:

- Changed the VM from thick to thin provisioning.
- Deleted the VM and created a new one that used thin provisioning.

8.3.3 Solutions Attempted:

- Deleted the VM and created a new one that used thin provisioning.

8.3.4 Final Solution:

The solution that ended up working was deleting the thick-provisioned VM and recreating it to be thin-provisioned. This solution worked because the error that was made initially could be avoided during the second attempt. Once the VM was recreated, there was no longer the threat of it being deleted by the script on the network.