

2023

CAPSTONE PROJECT



Jay Yoo

A00817434

3/20/2023

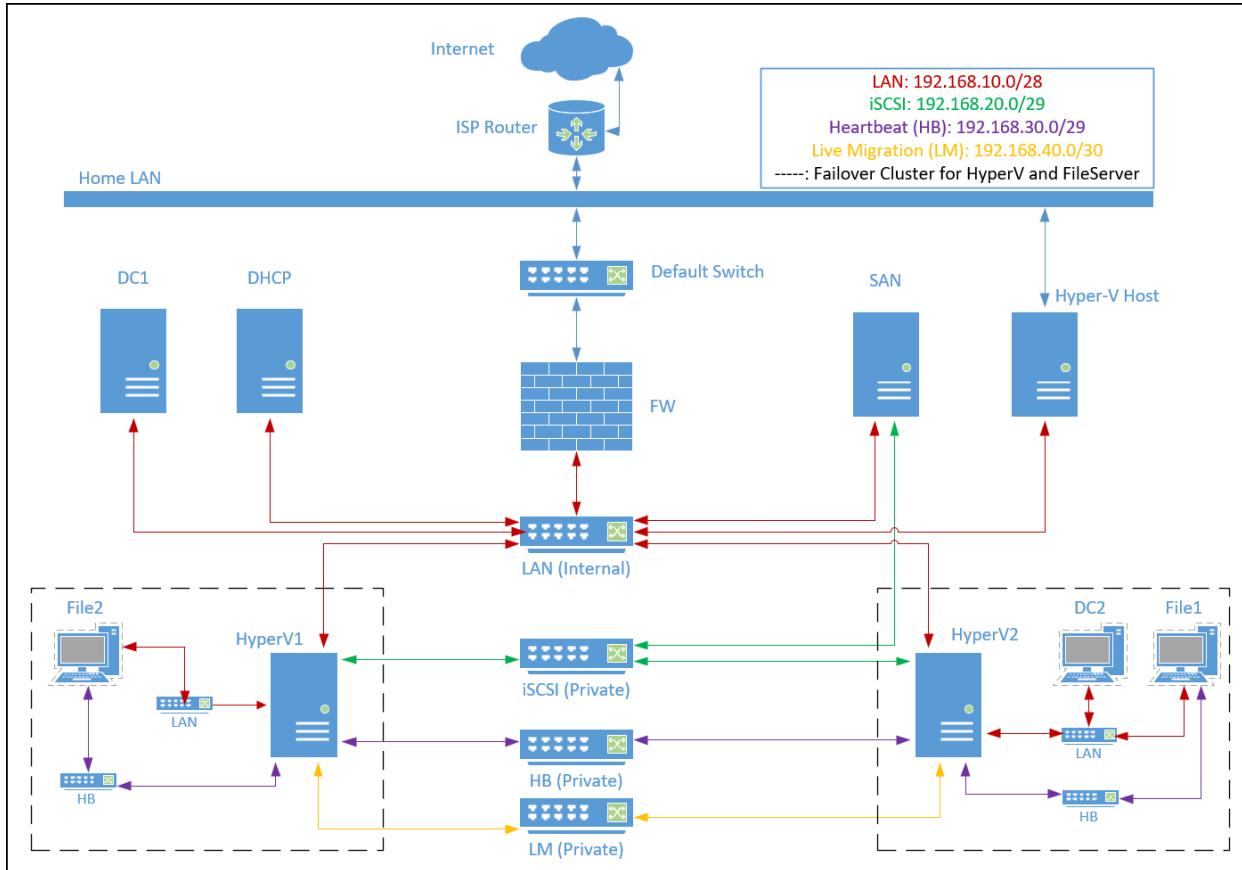
CAPSTONE PROJECT

Table of Contents

Network Diagram.....	2
IP Address Table.....	2
Configure the Physical Host	3
Create and configure pfSense Virtual Machine (VM)	7
SysPrep Windows Server Core Image	17
Create a Virtual Domain Controller	22
Join the Host PC to the Domain	31
Create Organizational Unit Structure	36
Configure DNS.....	37
Create and Configure a Linux DHCP Server	40
Create and Configure a Storage Area Network (SAN) with RAID 6 and an iSCSI Target.....	49
Create Server Core Nested Hyper-V Hosts	61
Create Two File Servers in a Failover Clustering using a VHD Set as Shared storage.....	91
Configure a Company Share with AGDLP File Permissions.....	100
Create and Apply a Folder Redirection GPO	112
Test Share and Folder NTFS Permission Through a Group Policy-Mapped Drive.....	116
Test File Server Failover.....	118
Create a Secondary Server Domain Controller	120
Reflective Writing	127
Links to Reference Websites.....	128

CAPSTONE PROJECT

Network Diagram



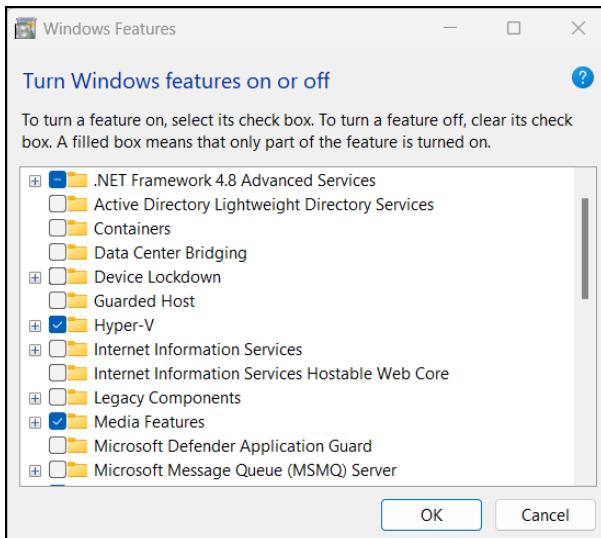
IP Address Table

	LAN 192.168.10.0/28 255.255.255.240	iSCSI 192.168.20.0/29 255.255.255.248	HB 192.168.30.0/29 255.255.255.248	LM 192.168.40.0/30 255.255.255.252
434-DC1	192.168.10.1			
434-DC2	192.168.10.2			
434-DHCP	192.168.10.3			
434-SAN	192.168.10.4	192.168.20.1		
434-HyperV1	192.168.10.5	192.168.20.2	192.168.30.1	192.168.40.1
434-HyperV2	192.168.10.6	192.168.20.3	192.168.30.2	192.168.40.2
HyperVCluster	192.168.10.7			
434-FileServer1	192.168.10.8		192.168.30.3	
434-FileServer2	192.168.10.9		192.168.30.4	
FileServerCluster	192.168.10.10			
434-FS	192.168.10.11			
Hyper-V Host (434-Jay)	192.168.10.13			
434-FW	192.168.10.14			

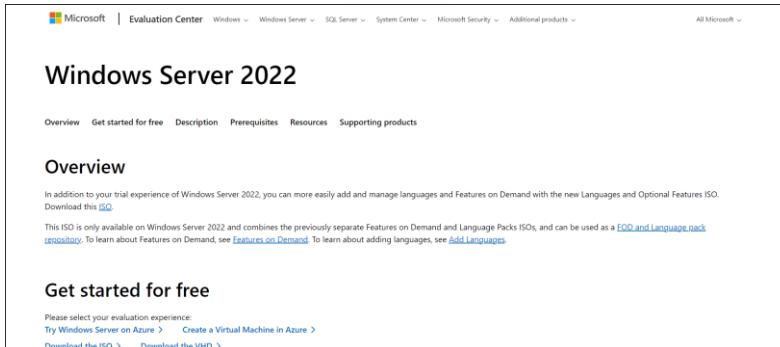
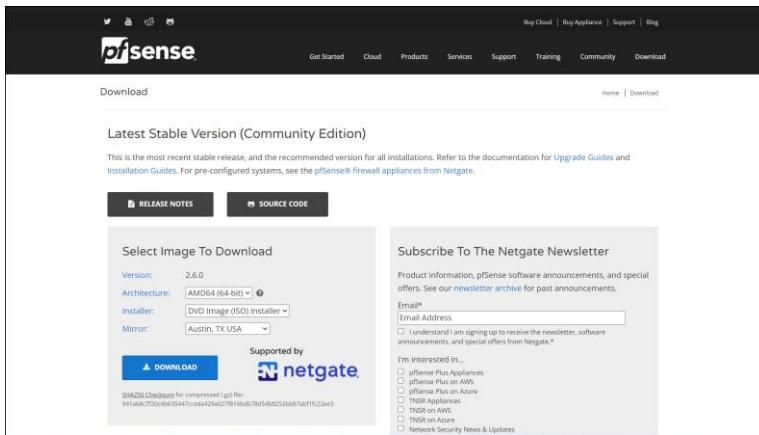
CAPSTONE PROJECT

Configure the Physical Host

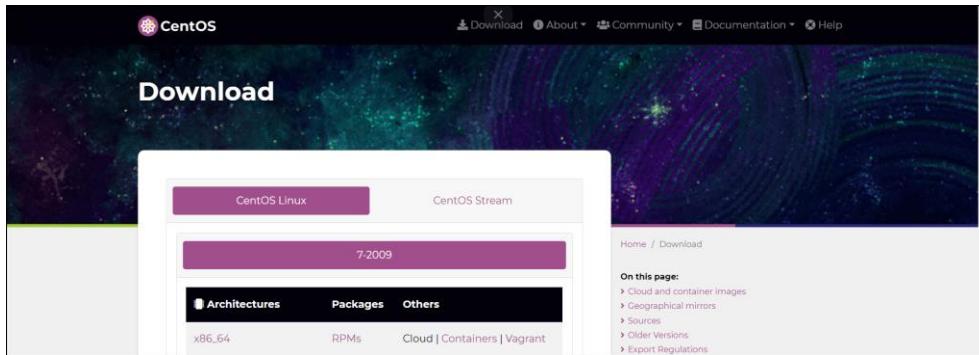
Search **Turn Windows features on or off** in the search box on the taskbar of your physical host machine and turn on the **Hyper-V** feature. Reboot your machine.



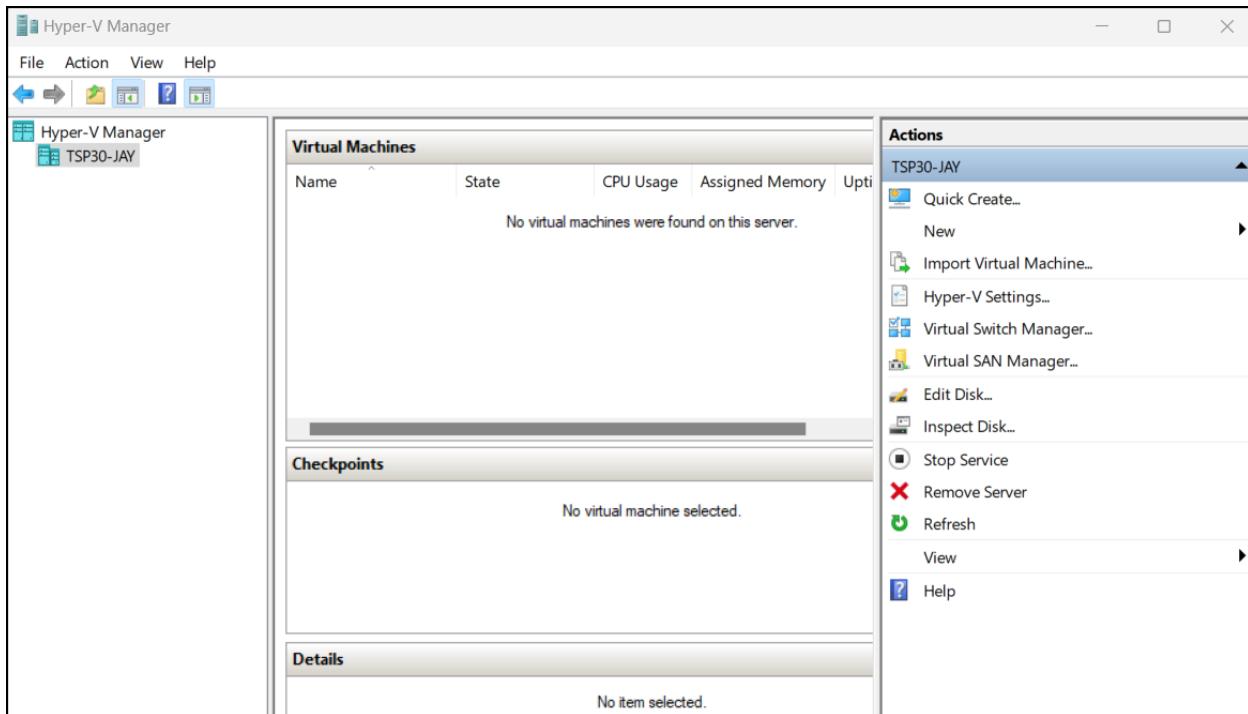
Download required iso files and save them in a same folder (pfSense, Windows Server 2022, CentOS 7). Check the reference section for links.



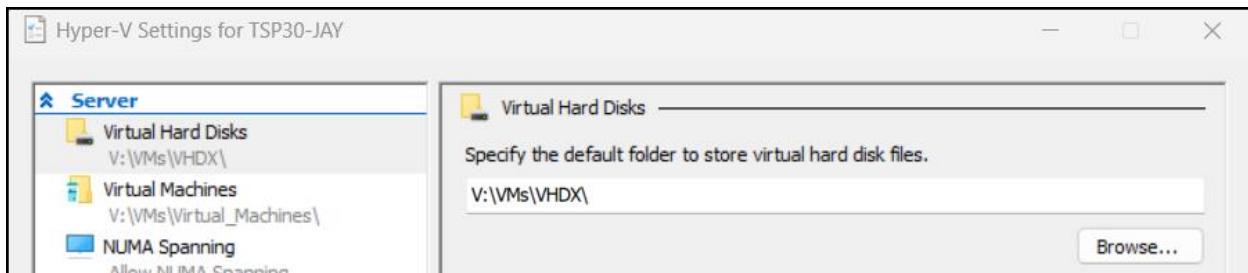
CAPSTONE PROJECT



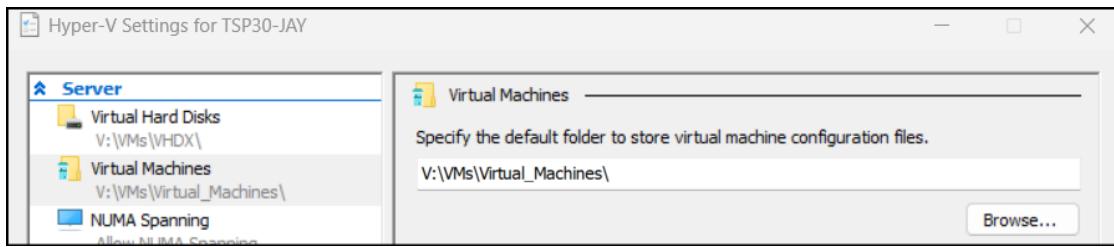
Open Hyper-V Manager.



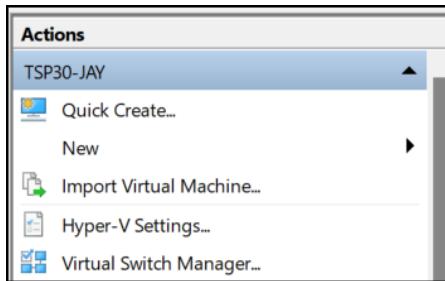
Click **Hyper-V Settings** in the right pane. Specify the directories for your virtual hard disk and virtual machine configuration files. Click **OK**.



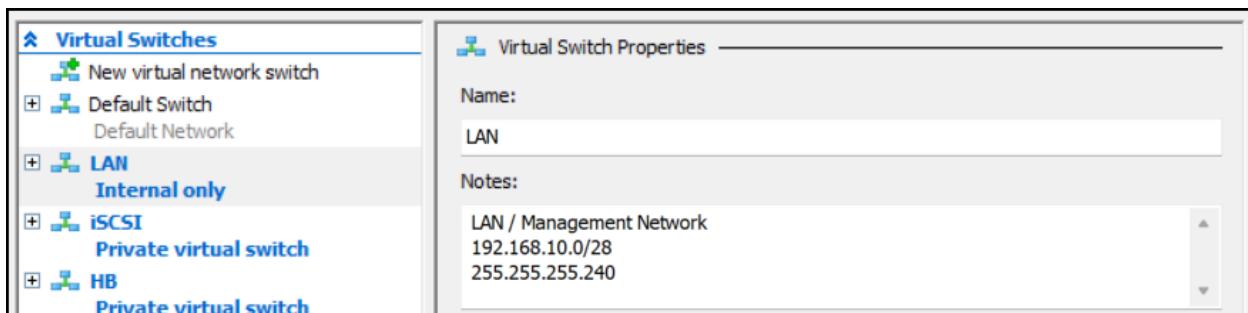
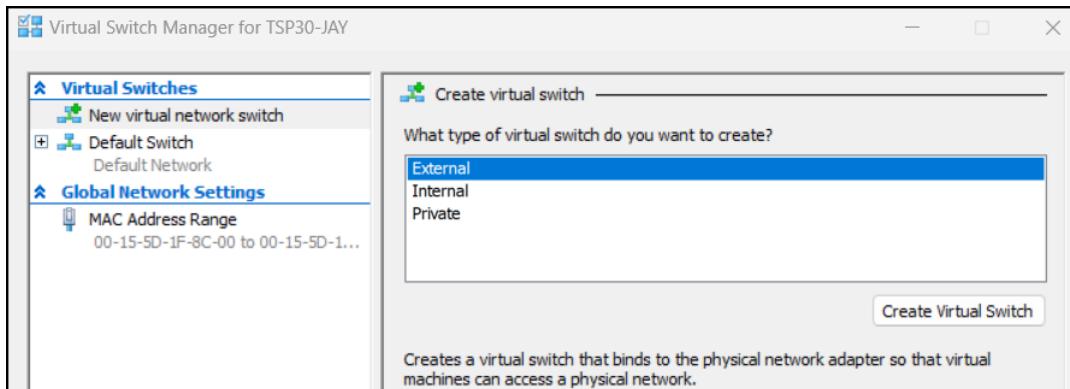
CAPSTONE PROJECT



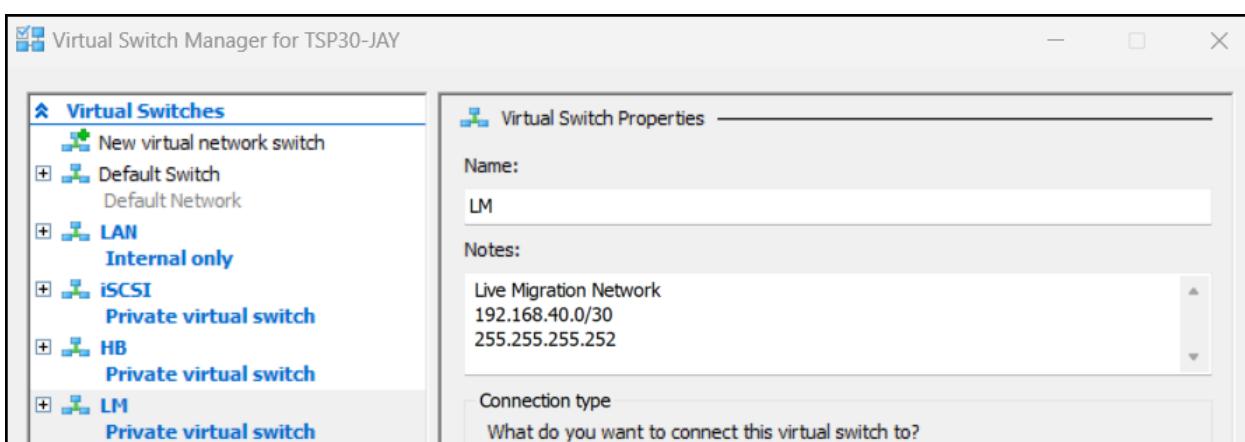
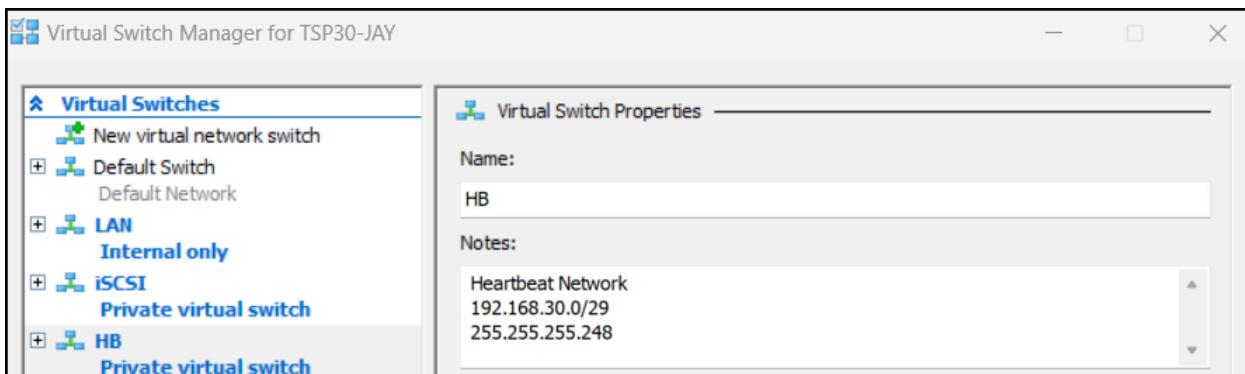
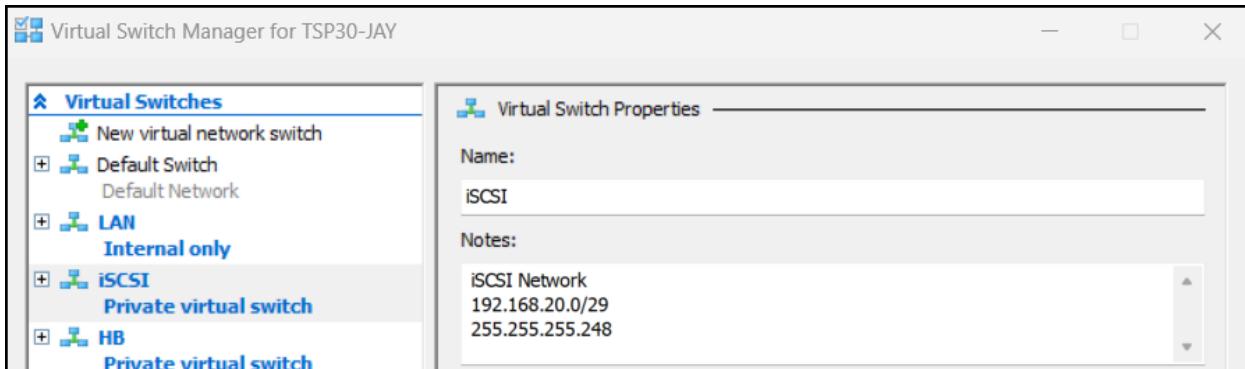
Click **Virtual Switch Manager** in the right pane.



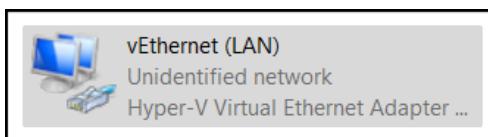
For our configuration, you need one **Internal** virtual switch and three **Private** virtual switches. Click **New virtual network switch** in the left pane and create four virtual switches using **Create Virtual Switch** button with the correct type selected. Name each switch and write the description in **Notes** section. Click **OK**.



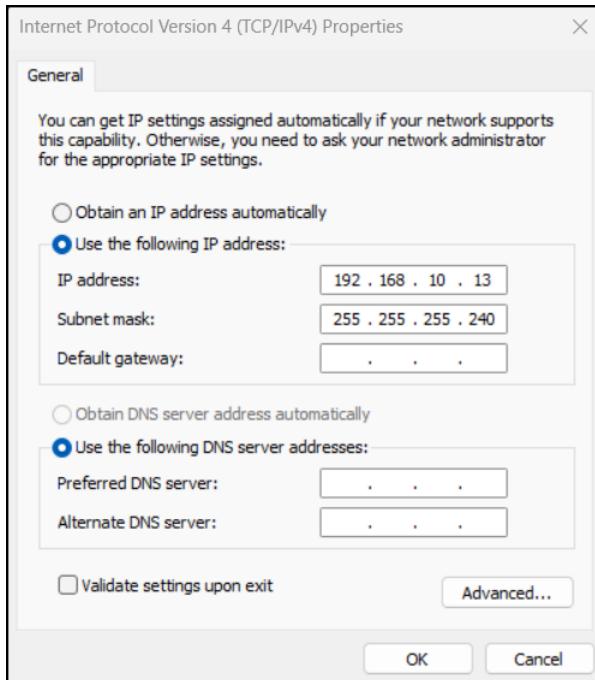
CAPSTONE PROJECT



Search **View network connections** in the search box on the taskbar and select it. You will see a newly created virtual adapter with a connection to your LAN network. Right-click the adapter, click **Properties**, and double-click **Internet Protocol Version 4 (TCP/IPv4)**. Assign a static **IP address** by clicking **Use the following IP address** and typing in the IP address manually. Type in **Subnet mask** manually as well. Do not put in Default gateway and DNS server information. Click **OK** and **OK**.

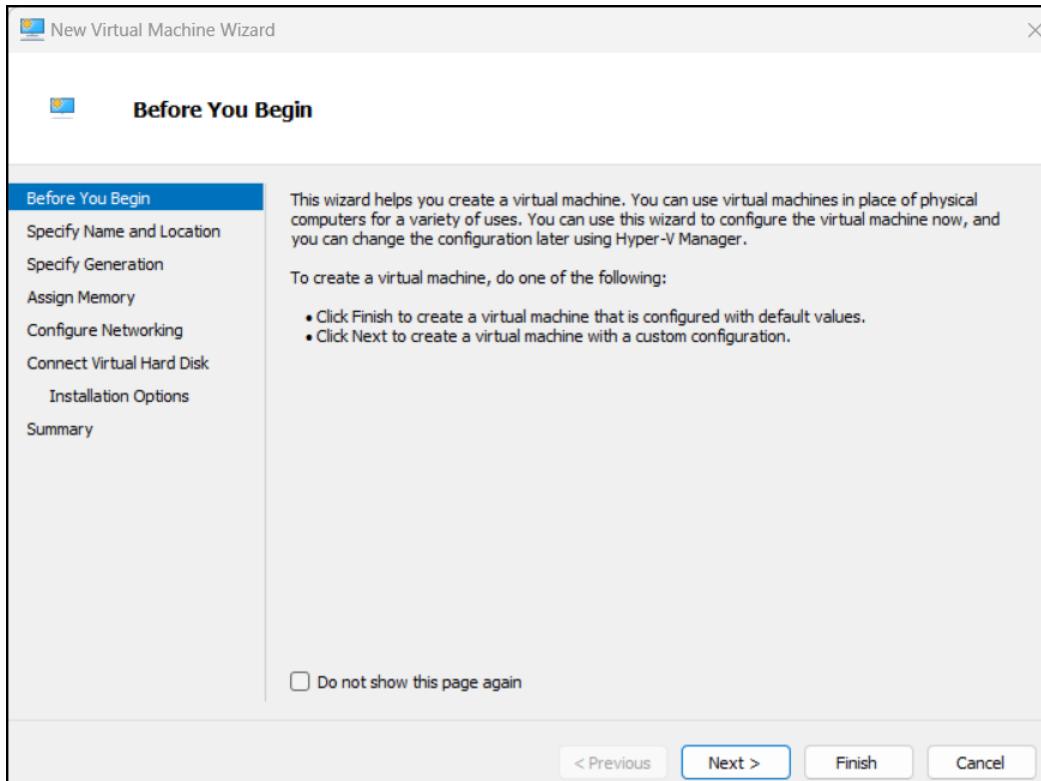


CAPSTONE PROJECT



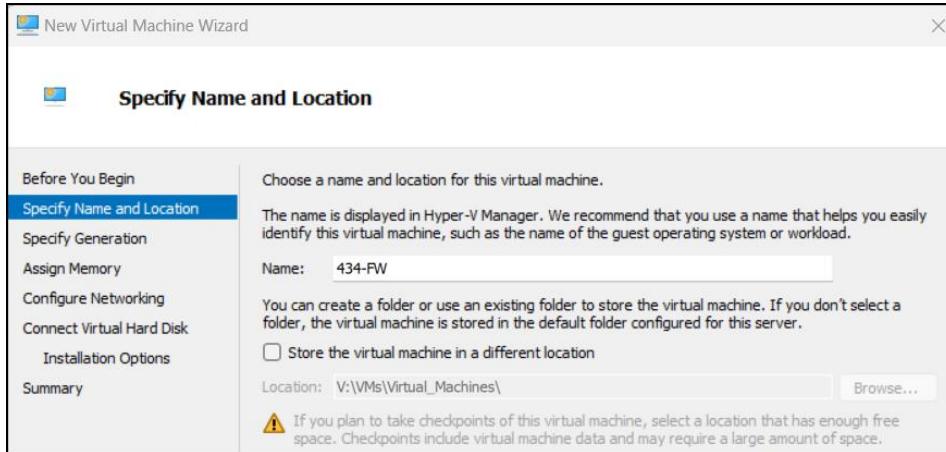
Create and configure pfSense Virtual Machine (VM)

In Hyper-V Manager, click **New -> Virtual Machine** in the right pane to open the Wizard. Click **Next**.

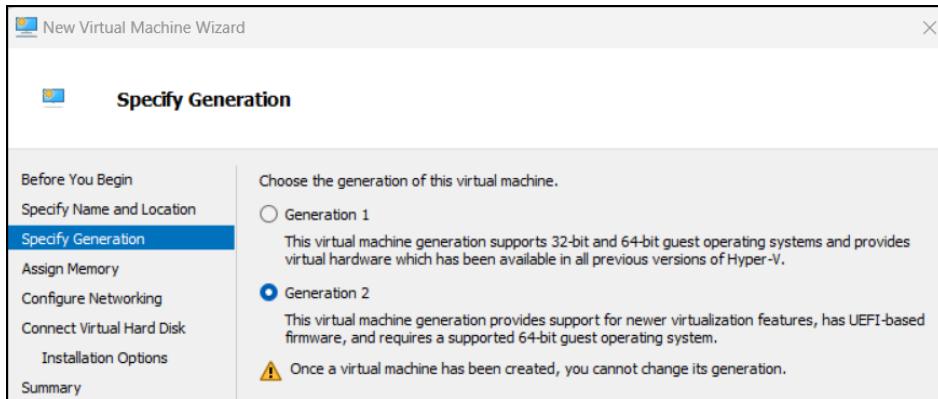


CAPSTONE PROJECT

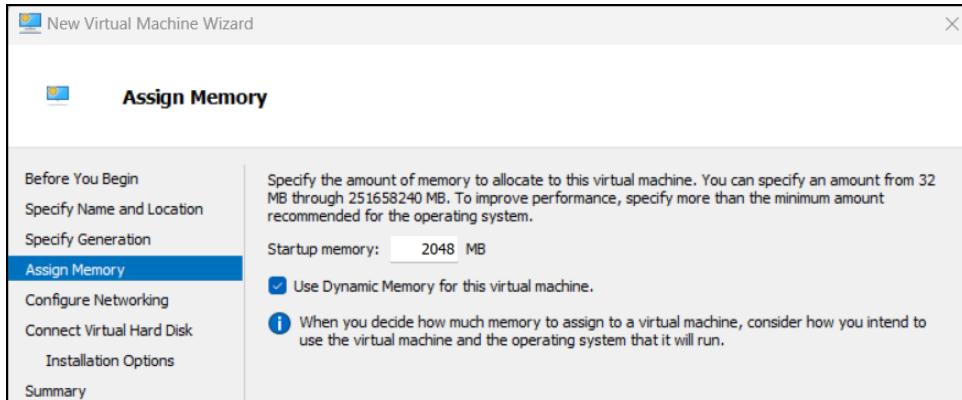
Name your pfSense VM accordingly. The default location is the folder that you specified in Hyper-V Settings. Click **Next**.



Choose **Generation 2**. Click **Next**.

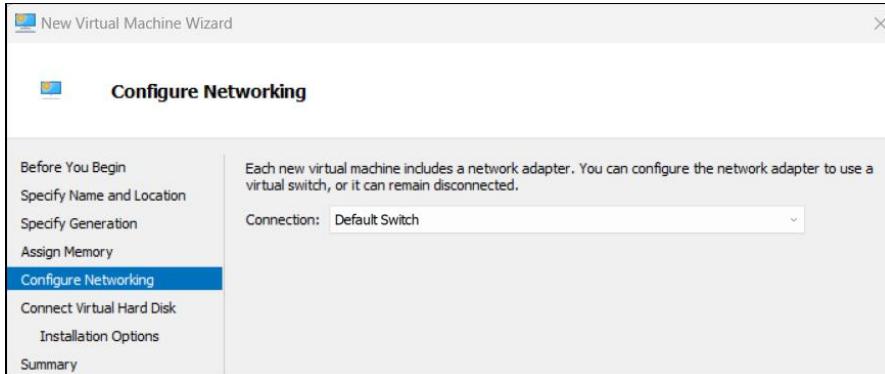


Assign enough **Startup Memory**. After initial configuration of pfSense, you will reduce the memory and use static memory instead of dynamic memory. Click **Next**.

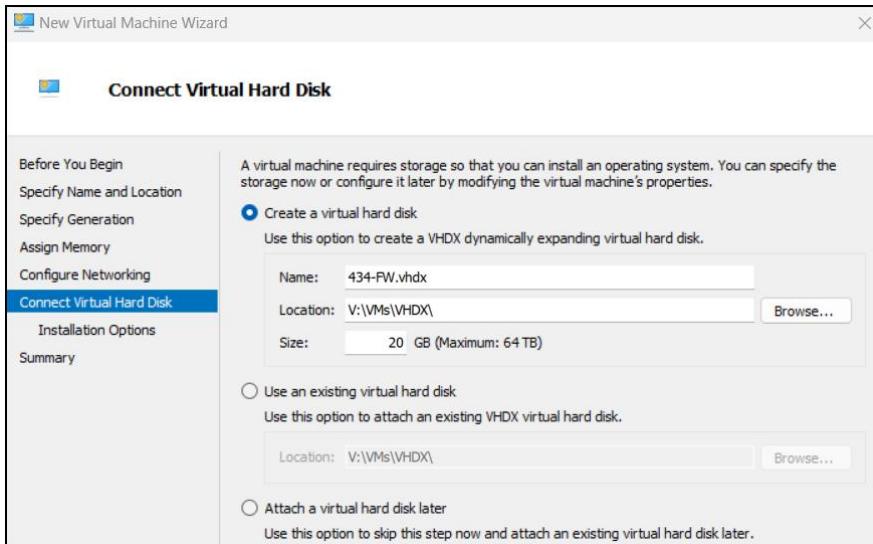


CAPSTONE PROJECT

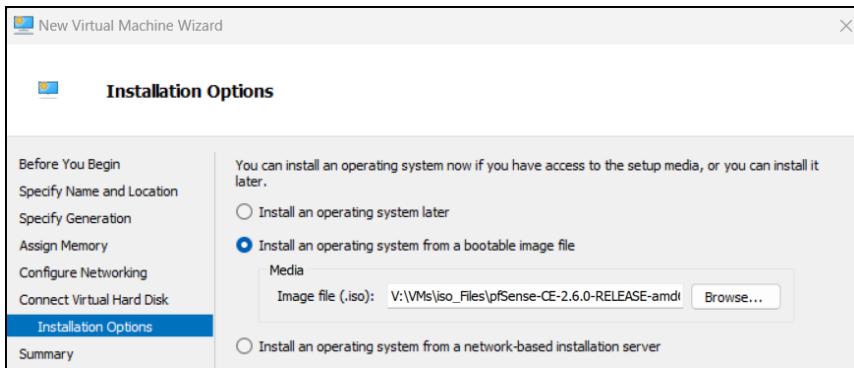
Connect the VM to **Default Switch**. This will be your **WAN** network connection. Click **Next**.



Choose **Create a virtual hard disk** and assign the size for the disk. Click **Next**.

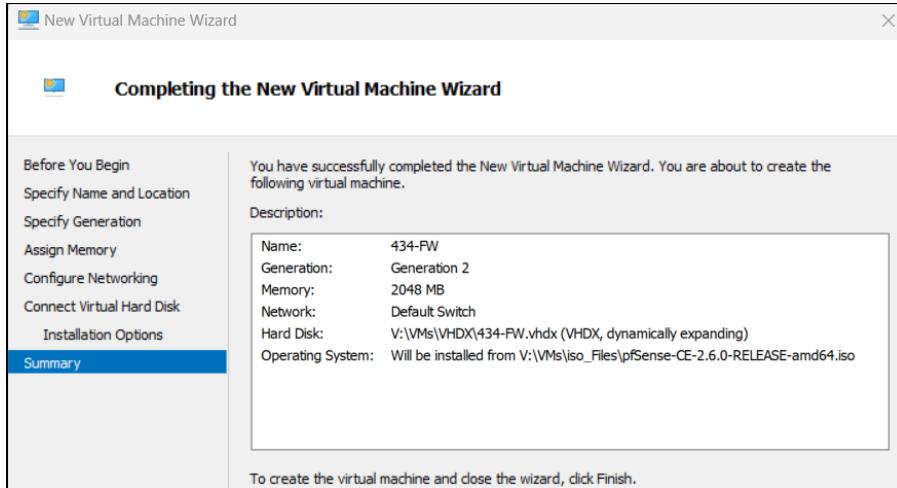


Choose **Install an operating system for a bootable image file** and select the iso image for pfSense. Click **Next**.

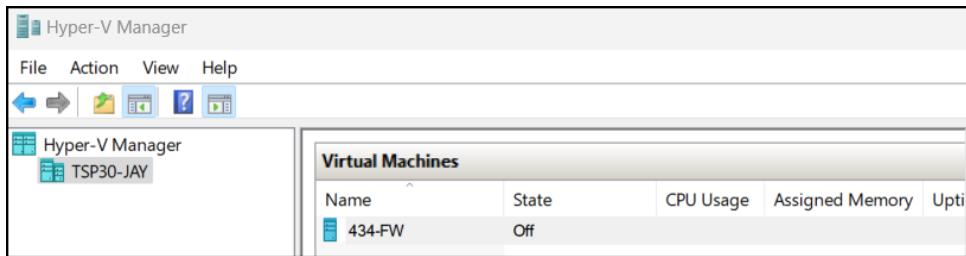


CAPSTONE PROJECT

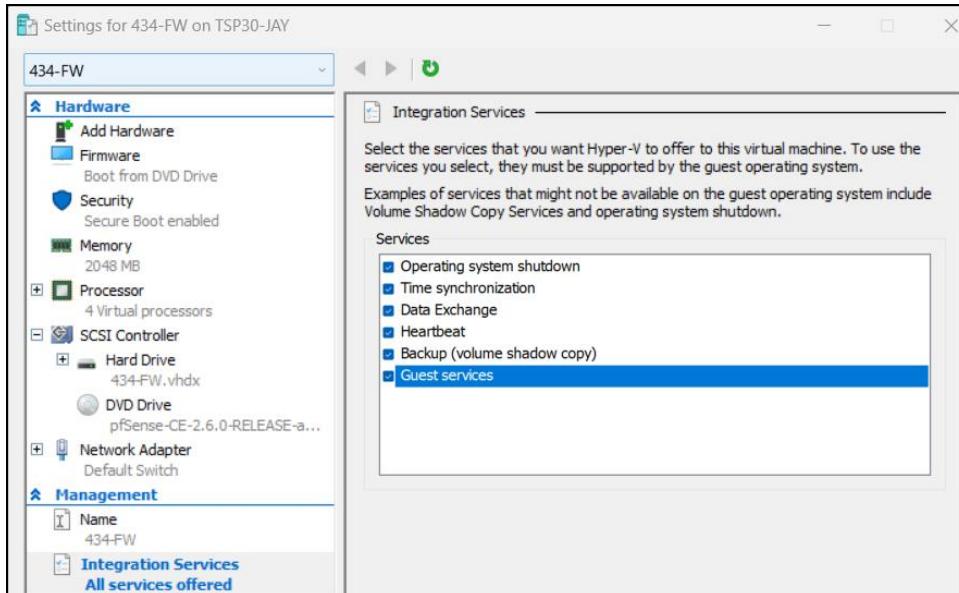
Check Summary and click **Finish**.



Right-click the VM and select **Settings**.

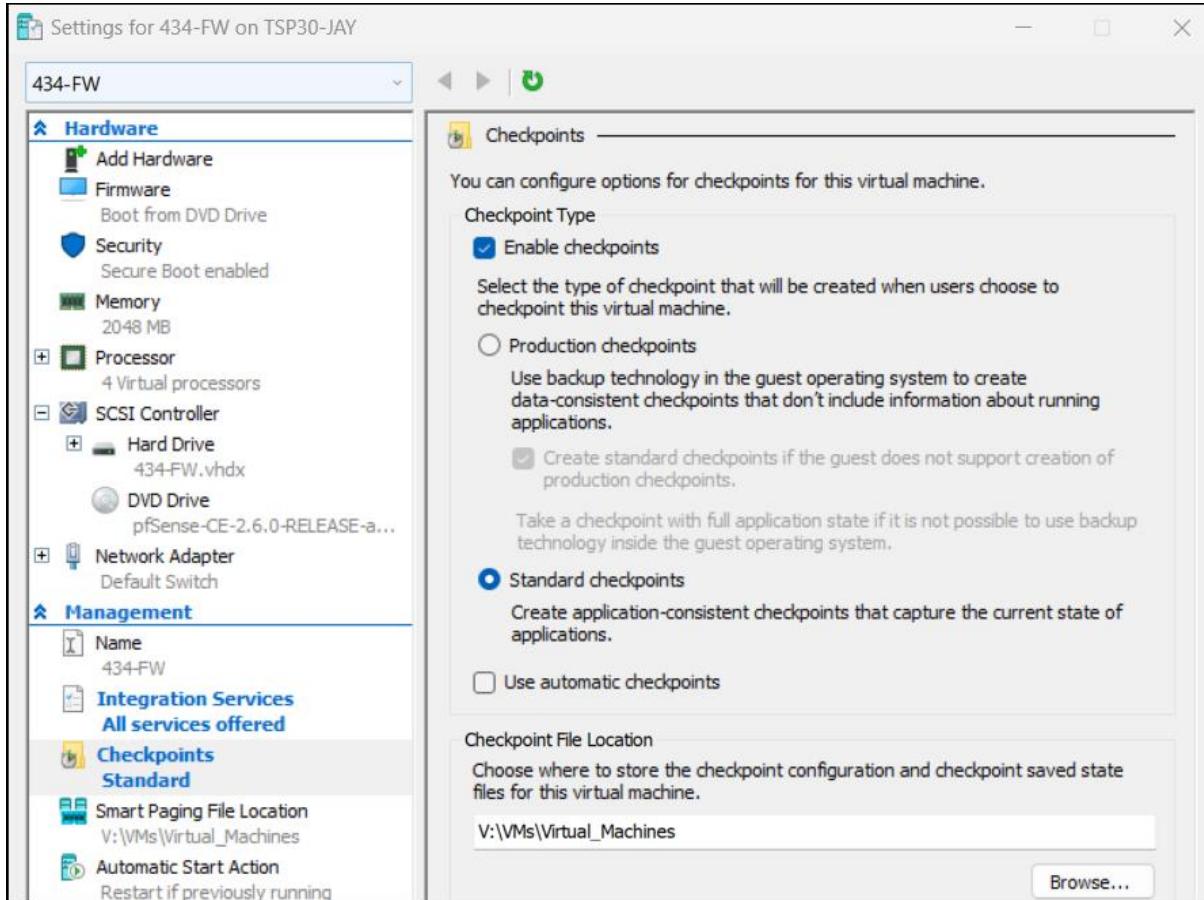


Click **Integration Services** tab and check **Guest services**.

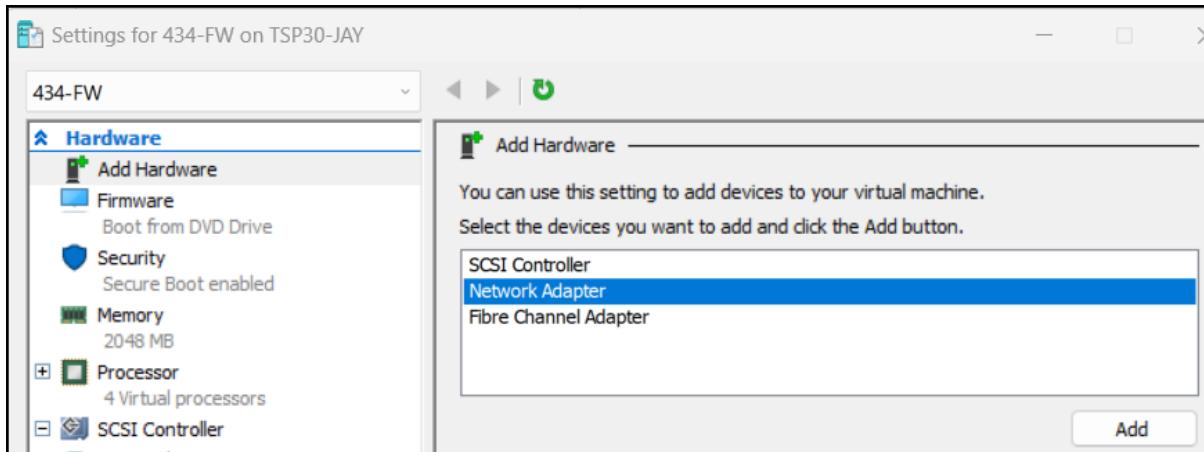


CAPSTONE PROJECT

Click **Checkpoints** tab and disable **Use automatic checkpoints**.

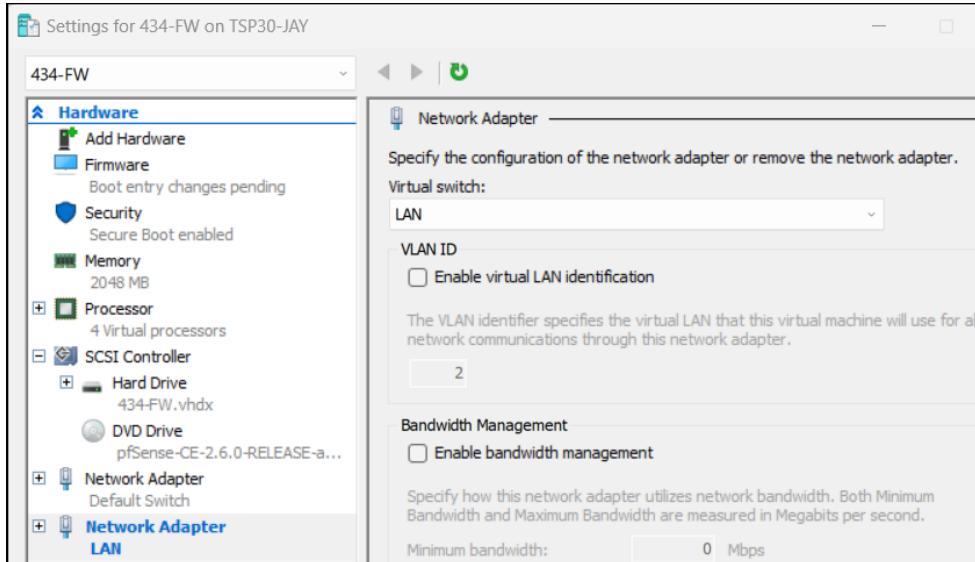


Click **Add Hardware** in the left pane, select **Network Adapter**, and click **Add**.

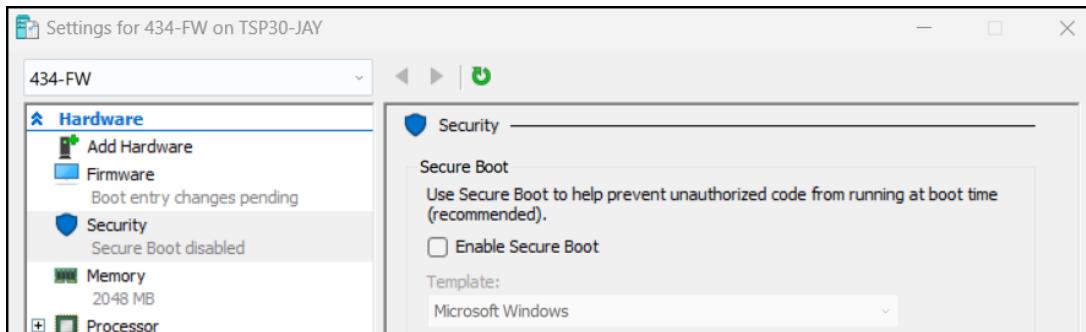


CAPSTONE PROJECT

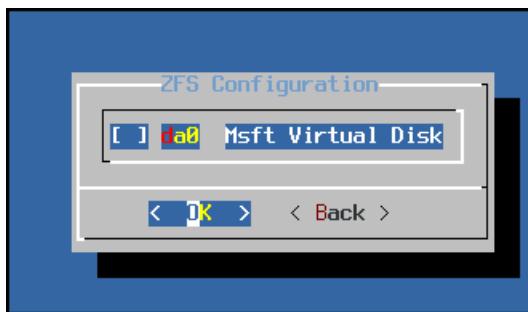
With the new network adapter selected, choose **LAN** for **Virtual switch** to connect to.



For the pfSense VM, the security boot feature needs to be disabled. Click **Security** in the left pane and uncheck **Enable Secure Boot**. Click **OK**.

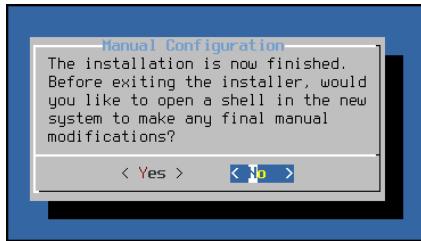


Double-click the VM and click **Start** in the new console. Installation will begin. Take default settings by pressing Enter without any change. When you need to choose the disk for OS installation, press Spacebar to choose the disk.

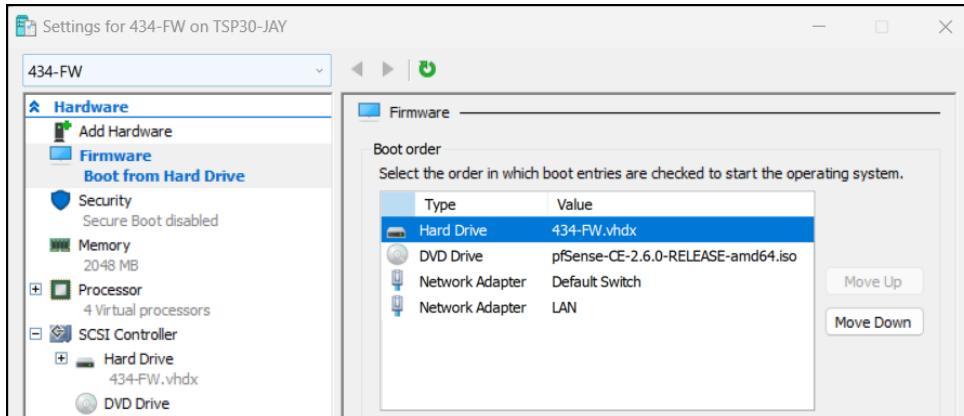


CAPSTONE PROJECT

After the installation is complete, it will ask for other modifications to make. Select **No**. Then you can either choose to reboot or enter the shell. Choose **Shell** and use the command **poweroff** to shut down the VM.



Enter the VM Settings again. Click **Firmware** tab and change the boot order so that **Hard Drive** is at the top of the entry. At this stage, you can also detach **DVD Drive** if you want. Click **OK** and start the VM.



Initial configuration begins. Type **n** for setting up VLANs. Type **hn0** for WAN interface. Type **hn1** for LAN interface. Type **y** to proceed.

```
Default interfaces not found -- Running interface assignment option.

Valid interfaces are:
hn0      00:15:5d:1f:8c:8d (down) Hyper-V Network Interface
hn1      00:15:5d:1f:8c:8e (down) Hyper-V Network Interface

Do VLANs need to be set up first?
If VLANs will not be used, or only for optional interfaces, it is typical to
say no here and use the webConfigurator to configure VLANs later, if required.

Should VLANs be set up now [y/n]? n

If the names of the interfaces are not known, auto-detection can
be used instead. To use auto-detection, please disconnect all
interfaces before pressing 'a' to begin the process.

Enter the WAN interface name or 'a' for auto-detection
(hn0 hn1 or a): hn0

Enter the LAN interface name or 'a' for auto-detection
NOTE: this enables full Firewalling/NAT mode.
(hn1 a or nothing if finished): hn1

The interfaces will be assigned as follows:
WAN -> hn0
LAN -> hn1

Do you want to proceed [y/n]? y
```

CAPSTONE PROJECT

Select option 2 to configure LAN interface. Choose the LAN interface with its assigned number. Type the static IP address and subnet bit count according to your network. Do not enable DHCP.

```
*** Welcome to pfSense 2.6.0-RELEASE (amd64) on pfSense ***

WAN (wan)      -> hn0      -> v4/DHCP4: 172.19.178.127/20
LAN (lan)      -> hn1      -> v4: 192.168.1.1/24

0) Logout (SSH only)          9) pfTop
1) Assign Interfaces          10) Filter Logs
2) Set interface(s) IP address 11) Restart webConfigurator
3) Reset webConfigurator password 12) PHP shell + pfSense tools
4) Reset to factory defaults   13) Update from console
5) Reboot system               14) Enable Secure Shell (sshd)
6) Halt system                 15) Restore recent configuration
7) Ping host                   16) Restart PHP-FPM
8) Shell

Enter an option: 2

Available interfaces:

1 - WAN (hn0 - dhcp, dhcp6)
2 - LAN (hn1 - static)

Enter the number of the interface you wish to configure: 2

Enter the new LAN IPv4 address. Press <ENTER> for none:
> 192.168.10.14

Subnet masks are entered as bit counts (as in CIDR notation) in pfSense.
e.g. 255.255.255.0 = 24
     255.255.0.0 = 16
     255.0.0.0 = 8

Enter the new LAN IPv4 subnet bit count (1 to 32):
> 28

For a WAN, enter the new LAN IPv4 upstream gateway address.
For a LAN, press <ENTER> for none:
>

Enter the new LAN IPv6 address. Press <ENTER> for none:
>

Do you want to enable the DHCP server on LAN? (y/n) n
Disabling IPv4 DHCPD...
Disabling IPv6 DHCPD...

Do you want to revert to HTTP as the webConfigurator protocol? (y/n) n
```

```
Hyper-V Virtual Machine - Netgate Device ID: 09cb08f5e229640fb2b4

*** Welcome to pfSense 2.6.0-RELEASE (amd64) on pfSense ***

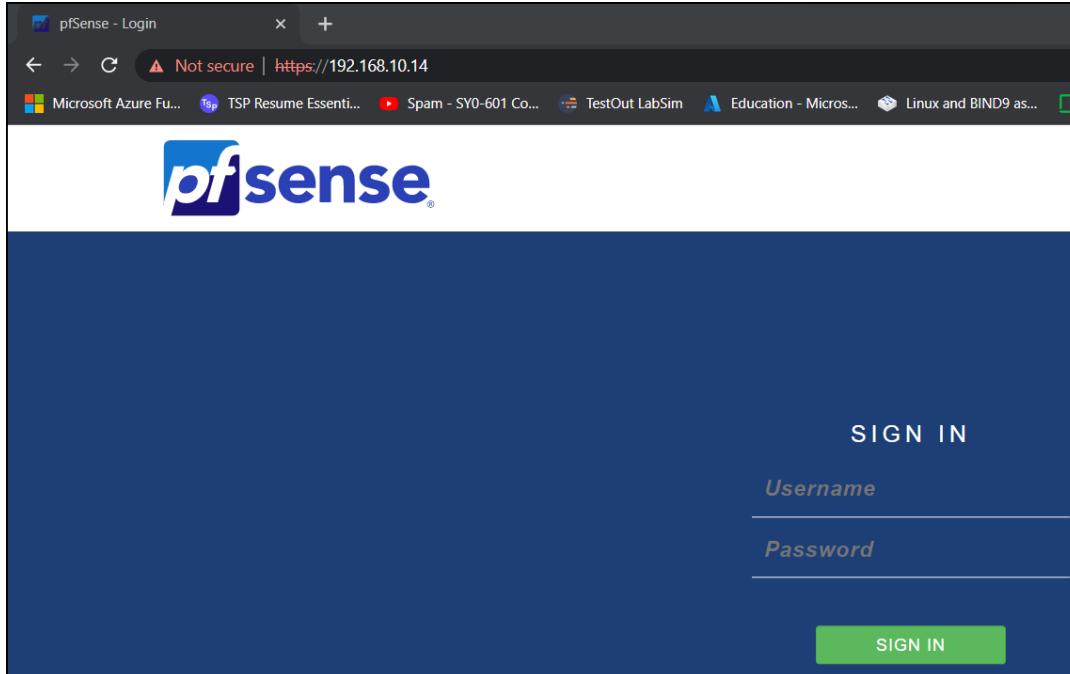
WAN (wan)      -> hn0      -> v4/DHCP4: 172.19.178.127/20
LAN (lan)      -> hn1      -> v4: 192.168.10.14/28

0) Logout (SSH only)          9) pfTop
1) Assign Interfaces          10) Filter Logs
2) Set interface(s) IP address 11) Restart webConfigurator
3) Reset webConfigurator password 12) PHP shell + pfSense tools
4) Reset to factory defaults   13) Update from console
5) Reboot system               14) Enable Secure Shell (sshd)
6) Halt system                 15) Restore recent configuration
7) Ping host                   16) Restart PHP-FPM
8) Shell

Enter an option:
```

CAPSTONE PROJECT

After the static IP settings are applied, you can access its webConfigurator from the web browser on your Hyper-V host machine by its LAN IP address. Type the IP address of pfSense in the address bar. The default username is **admin** and the password is **pfsense**.



Go through the initial configuration. Change the **Hostname** to match the VM name. Adjust **Timezone**. Change the password for default admin account. Take default settings for everything else.

General Information

On this screen the general pfSense parameters will be set.

Hostname	434-FW
EXAMPLE: myserver	
Domain	home.arpa
EXAMPLE: mydomain.com	

Time Server Information

Please enter the time, date and time zone.

Time server hostname	2.pfsense.pool.ntp.org
Enter the hostname (FQDN) of the time server.	
Timezone	America/Vancouver

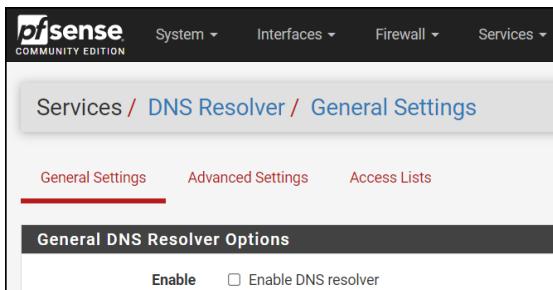
CAPSTONE PROJECT

Set Admin WebGUI Password

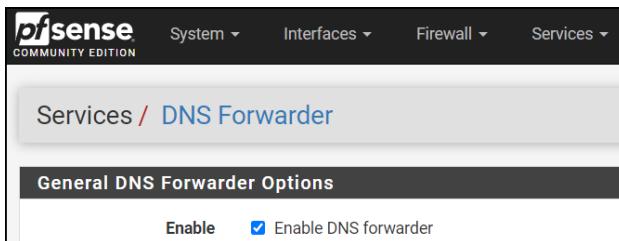
On this screen the admin password will be set, which is used to access the WebGUI and also SSH services if enabled.

Admin Password
Admin Password AGAIN

Click **Services -> DNS Forwarder** and uncheck **Enable DNS resolver**. Scroll down and click **Save -> Apply Changes**.



Click **Services -> DNS Forwarder** and check **Enable DNS forwarder**. Scroll down and click **Save -> Apply Changes**.



Later, you will come back to pfSense webConfigurator to create a rule which blocks certain servers from connecting to the Internet. They will still need Internet connection initially to activate Windows license.

Go back to Hyper-V Manager, right-click the VM, and click **Shutdown**.

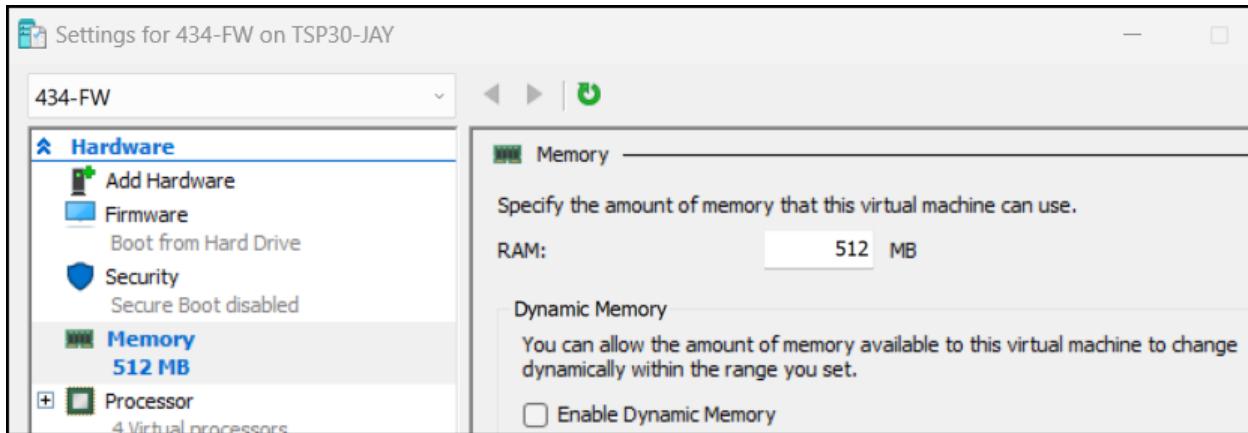
```
Enter an option:
Message from syslogd@pfSense at Mar 21 07:15:43 ...
php-fpm[366]: /index.php: Successful login for user 'admin' from: 192.168.10.13 (Local Database)
@hvhshutdown0: shutdown requested

pfSense is now shutting down ...

Waiting (max 60 seconds) for system process 'vnlnru' to stop... done
Waiting (max 60 seconds) for system process 'syncer' to stop...
Syncing disks, vnodes remaining... 0 0 0 0 done
Waiting (max 60 seconds) for system thread 'bufdaemon' to stop... done
Waiting (max 60 seconds) for system thread 'bufspacedaemon-0' to stop... done
All buffers synced.
Uptime: 59m27s
```

CAPSTONE PROJECT

Go to VM Settings, click **Memory** tab and reduce memory to 512MB. Disable **Dynamic Memory** as well. Click **OK**. Reboot the pfSense VM and let it run.



SysPrep Windows Server Core Image

Since you are going to spool up many Windows Server Core VMs, it will be beneficial for you to create a parent disk for Windows servers to use differencing disks to save storage and update time. First, you need to create a new VM with Windows Server 2022 iso file. Create a new VM in a same manner as you did for pfSense except a few differences: Give it a different name, assign a bigger storage, and use Windows Server 2022 iso image.

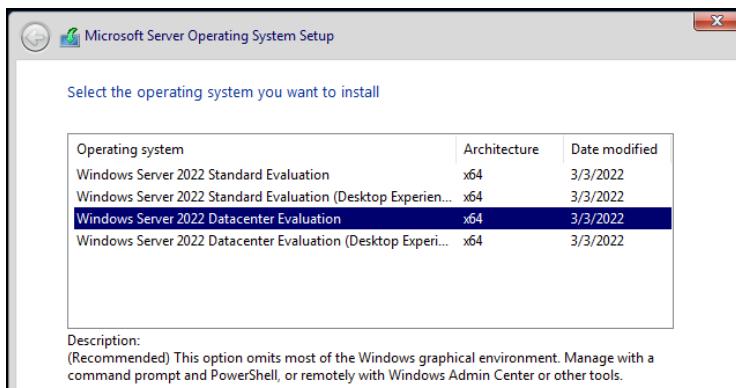
The screenshot shows the 'New Virtual Machine Wizard' with two steps visible: 'Connect Virtual Hard Disk' and 'Installation Options'.
Step 1: Connect Virtual Hard Disk
Left sidebar: Before You Begin, Specify Name and Location, Specify Generation, Assign Memory, Configure Networking, Connect Virtual Hard Disk (highlighted), Installation Options, Summary.
Main area: A virtual machine requires storage so that you can install an operating system. You can specify the storage now or configure it later by modifying the virtual machine's properties.
Options:
- Create a virtual hard disk (selected): Use this option to create a VHDX dynamically expanding virtual hard disk.
- Name: ParentDisk.vhdx
- Location: V:\VMs\vhdx\
- Size: 127 GB (Maximum: 64 TB)
Step 2: Installation Options
Left sidebar: Before You Begin, Specify Name and Location, Specify Generation, Assign Memory, Configure Networking, Connect Virtual Hard Disk, Installation Options (highlighted).
Main area: You can install an operating system now if you have access to the setup media, or you can install it later.
Options:
- Install an operating system later
- Install an operating system from a bootable image file (selected)
- Media: Image file (.iso): V:\VMs\iso_Files\windows_server_2022.iso
- Browse...

CAPSTONE PROJECT

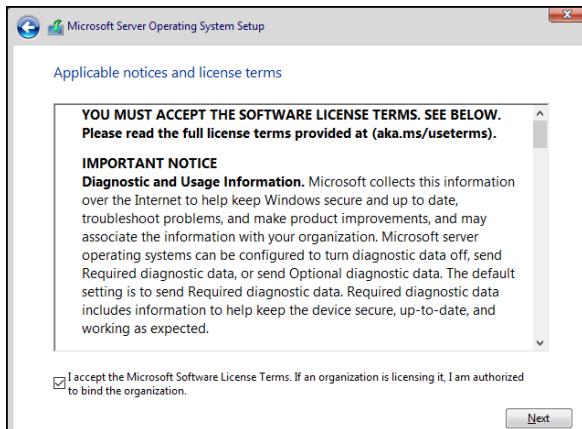
Go to VM Settings and enable Guest services and disable automatic checkpoints. Do not change any other settings. Click **OK**. Start the VM and press any key on keyboard right after it boots. Install the OS.



Choose **Windows Server 2022 Datacenter Evaluation**. Click **Next**.

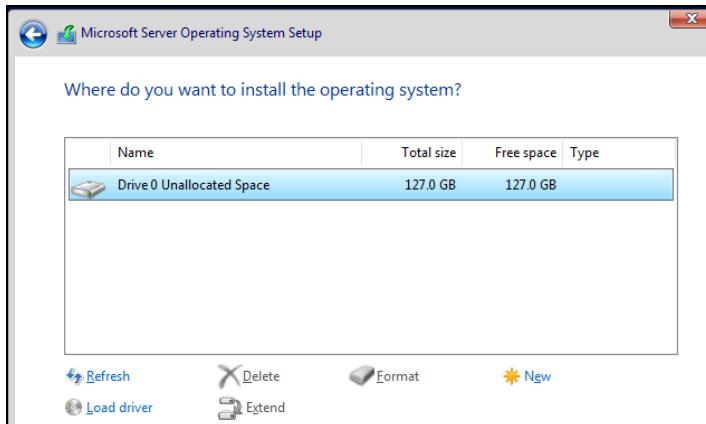


Accept the terms and click **Next**.

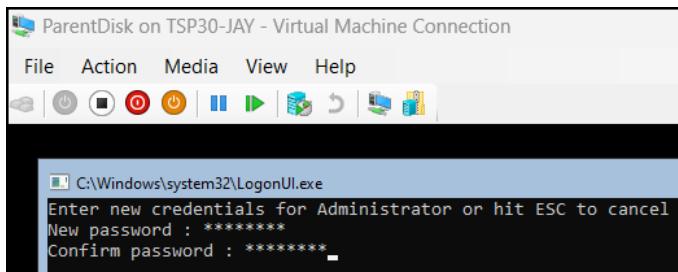


CAPSTONE PROJECT

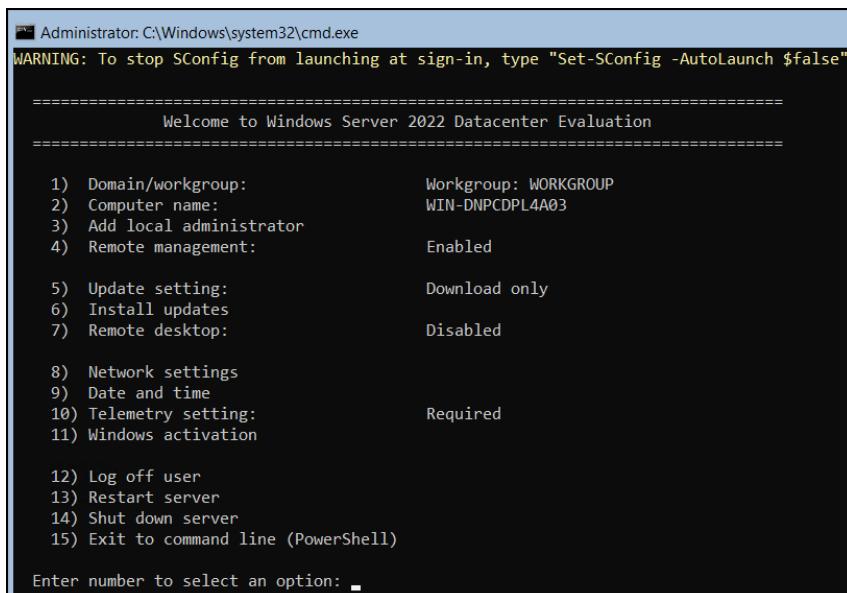
Choose **Custom** option, select the disk to install the operating system, and click **Next**. It will reboot after installation is finished.



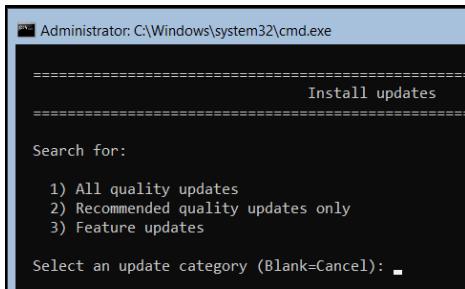
Enter a new password for **Administrator** account and press **Enter**.



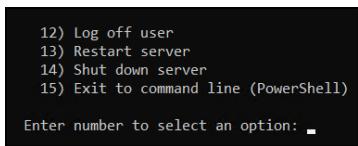
Choose Option **6)** to fully patch the OS. Several reboots are required.



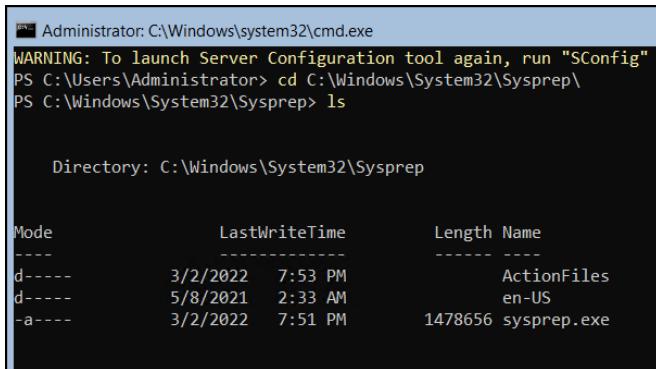
CAPSTONE PROJECT



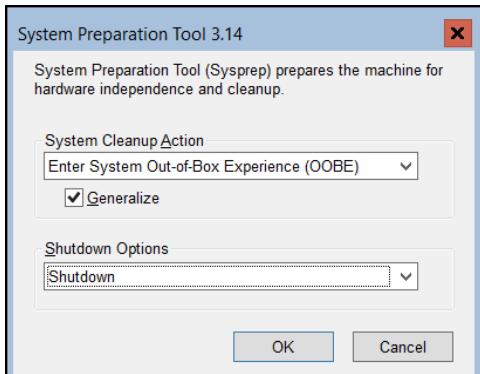
After a full patch, choose the option **15** at SConfig page to enter PowerShell.



Use the command **cd C:\Windows\System32\Sysprep** to change the directory. Type **ls** to confirm that you are in the correct directory with **sysprep.exe** tool.

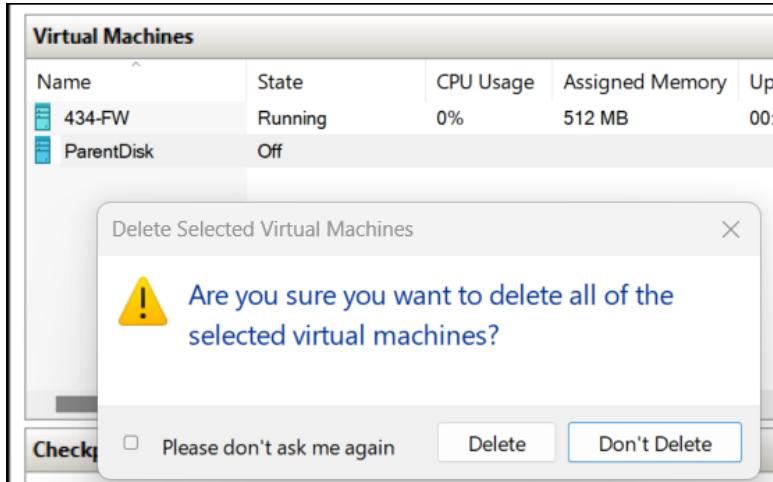


Run the command **.\\sysprep.exe** to start the tool. Select **OOBE**, check **Generalize**, and select **Shutdown**. Click **OK**. The VM will shut down. DO NOT START THE VM after it shuts down.

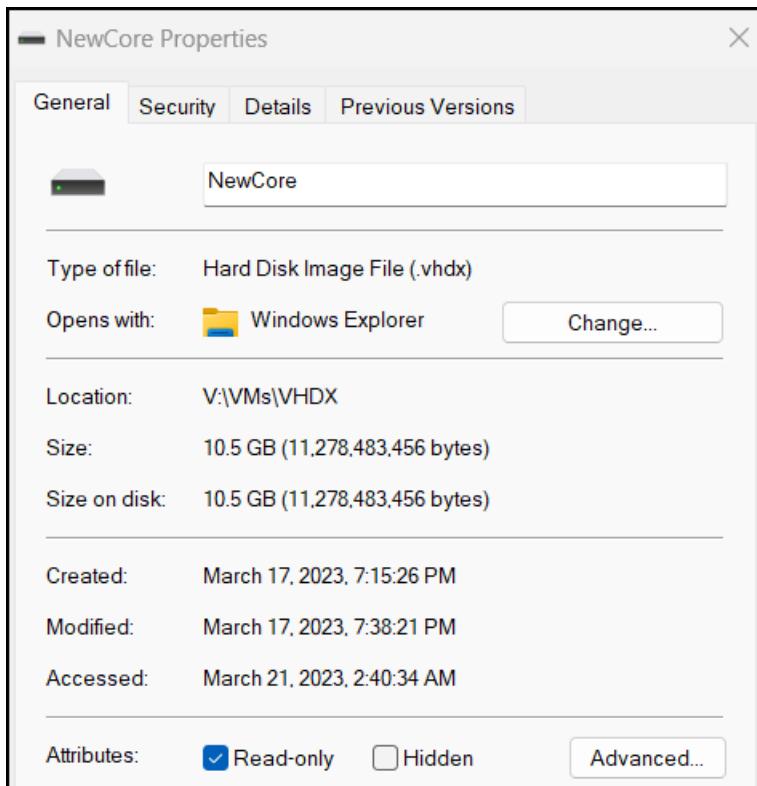


CAPSTONE PROJECT

Delete this VM from Hyper-V Manager.



Go to the directory where vhdx files are stored. The disk will still be there even if you delete the VM. Right-click the vhdx file for the SysPrepped disk and select **Properties**. Check **Read-only** and click **OK**. I changed the name to **NewCore**. Keep this disk as this will be your parent disk for all Windows Servers.



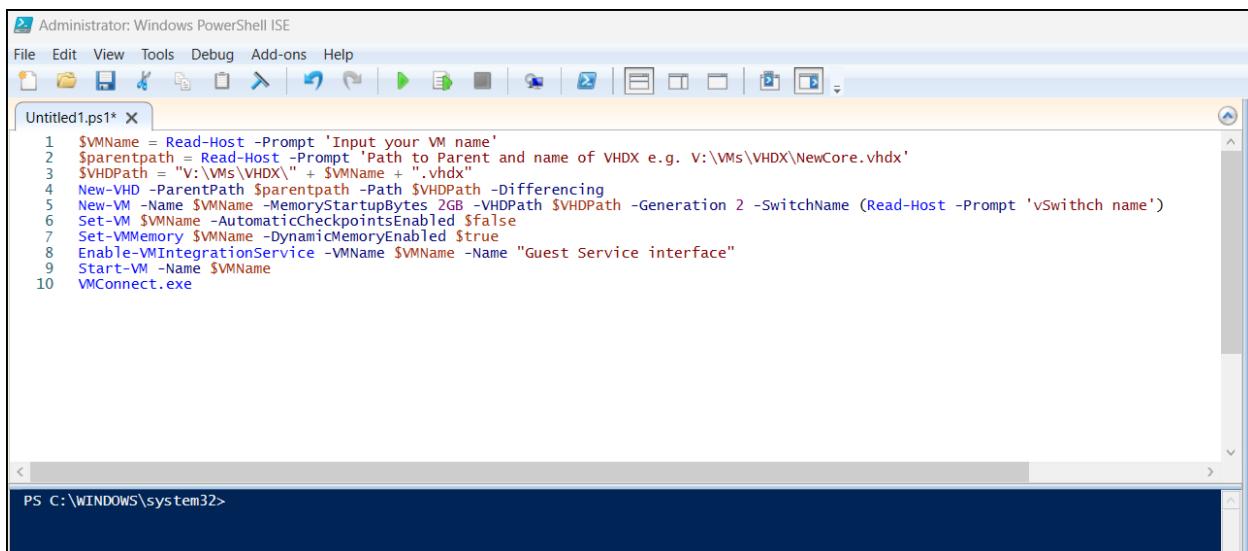
CAPSTONE PROJECT

Create a Virtual Domain Controller

You can create a VM with a differencing disk in both Hyper-V Manager and PowerShell. Here, PowerShell script will be used to create a new VM with a differencing disk. Search **Windows PowerShell ISE** in the search box on the taskbar, right-click it, and select **Run as Administrator**. Copy and paste the script below onto the script pane in PowerShell ISE:

```
$VMName = Read-Host -Prompt 'Input your VM name'  
  
$parentpath = Read-Host -Prompt 'Path to Parent and name of VHDX e.g.  
V:\VMs\VHDX\NewCore.vhdx'  
  
$VHDPath = "V:\VMs\VHDX\" + $VMName + ".vhdx"  
  
New-VHD -ParentPath $parentpath -Path $VHDPath -Differencing  
  
New-VM -Name $VMName -MemoryStartupBytes 2GB -VHDPath $VHDPath -Generation 2 -  
SwitchName (Read-Host -Prompt 'vSwithch name')  
  
Set-VM $VMName -AutomaticCheckpointsEnabled $false  
  
Set-VMMemory $VMName -DynamicMemoryEnabled $true  
  
Enable-VMIntegrationService -VMName $VMName -Name "Guest Service interface"  
  
Start-VM -Name $VMName
```

VMConnect.exe



The screenshot shows the Windows PowerShell ISE window. The title bar says "Administrator: Windows PowerShell ISE". The menu bar includes File, Edit, View, Tools, Debug, Add-ons, Help. The toolbar has various icons for file operations. The script pane contains the PowerShell script provided above, with line numbers 1 through 10. The output pane at the bottom shows the command PS C:\WINDOWS\system32>.

CAPSTONE PROJECT

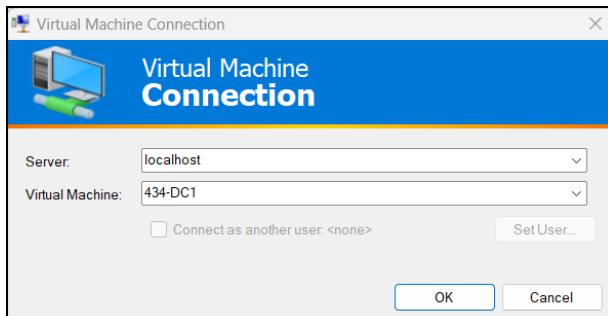
The script is equivalent of the process in GUI when you create a VM except using a differencing disk instead of creating a brand-new disk. The script also includes enabling Guest services and disabling automatic checkpoints. You can press **F5** or click the play button on the toolbar to run the script. Input your VM name. Specify the path to your parent vhdx file.

```
PS C:\WINDOWS\system32> $VMName = Read-Host -Prompt 'Input your VM name'  
$parentpath = Read-Host -Prompt 'Path to Parent and name of VHDX e.g. V:\VMs\VHDX\NewCore.vhdx'  
$VHDPath = "V:\VMs\VHDX\" + $VMName + ".vhdx"  
New-VHD -ParentPath $parentpath -Path $VHDPath -Differencing  
New-VM -Name $VMName -MemoryStartupBytes 2GB -VHDPath $VHDPath -Generation 2 -SwitchName (Read-Host -Prompt 'vSwitch name')  
Set-VM $VMName -AutomaticCheckpointsEnabled $false  
Set-VMMemory $VMName -DynamicMemoryEnabled $true  
Enable-VMIntegrationService -VMName $VMName -Name "Guest Service interface"  
Start-VM -Name $VMName  
VMConnect.exe  
Input your VM name: 434-DC1  
  
PS C:\WINDOWS\system32> $VMName = Read-Host -Prompt 'Input your VM name'  
$parentpath = Read-Host -Prompt 'Path to Parent and name of VHDX e.g. V:\VMs\VHDX\NewCore.vhdx'  
$VHDPath = "V:\VMs\VHDX\" + $VMName + ".vhdx"  
New-VHD -ParentPath $parentpath -Path $VHDPath -Differencing  
New-VM -Name $VMName -MemoryStartupBytes 2GB -VHDPath $VHDPath -Generation 2 -SwitchName (Read-Host -Prompt 'vSwitch name')  
Set-VM $VMName -AutomaticCheckpointsEnabled $false  
Set-VMMemory $VMName -DynamicMemoryEnabled $true  
Enable-VMIntegrationService -VMName $VMName -Name "Guest Service interface"  
Start-VM -Name $VMName  
VMConnect.exe  
Input your VM name: 434-DC1  
Path to Parent and name of VHDX e.g. V:\VMs\VHDX\NewCore.vhdx: V:\VMs\VHDX\NewCore.vhdx
```

Type the name of your LAN vSwitch to connect to.

```
ComputerName      : TSP30-JAY  
Path              : V:\VMs\VHDX\434-DC1.vhdx  
VhdFormat        : VHDX  
VhdType          : Differencing  
FileSize         : 4194304  
Size              : 136365211648  
MinimumSize       : 136363131392  
LogicalSectorSize : 512  
PhysicalSectorSize: 4096  
BlockSize         : 2097152  
ParentPath        : V:\VMs\VHDX\NewCore.vhdx  
DiskIdentifier    : 63818720-9F3B-4EF6-A6BF-8CE0F571F996  
FragmentationPercentage: 1  
Alignment         : False  
DiskNumber        :  
IsPmemCompatible  : False  
AddressAbstractionType: None  
Number            :  
  
vSwitch name: LAN
```

It will automatically open **Virtual Machine Connection** window. Select your **DC1** and click **OK**. You can close PowerShell ISE.



CAPSTONE PROJECT

Create a password for **administrator** account as you did before. At SConfig, select the option **8)** to configure IP settings. Select the network adapter index number.

```
Administrator: C:\Windows\system32\cmd.exe

=====
Network settings
=====

Available network adapters:

Index # | IP address      | Description
1       | 169.254.210.160  | Microsoft Hyper-V Network Adapter

Select network adapter index # (Blank=Cancel):
```

Select **1) Set network adapter address**.

```
=====
Network adapter settings
=====

NIC index: 1
Description: Microsoft Hyper-V Network Adapter
IP address: 169.254.210.160,
fe80::bbdd:d394:ea21:2bf1
Subnet mask: 255.255.0.0
DHCP enabled: True

Default gateway:
Preferred DNS server:
Alternate DNS server:

1) Set network adapter address
2) Set DNS servers
3) Clear DNS server settings

Enter selection (Blank=Cancel):
```

Assign static IP address, subnet mask, and default gateway according to your network.

```
Enter selection (Blank=Cancel): 1
Select (D)HCP or (S)tatic IP address (Blank=Cancel): s
Enter static IP address (Blank=Cancel): 192.168.10.1
Enter subnet mask (Blank=255.255.255.0): 255.255.255.240
Enter default gateway (Blank=Cancel): 192.168.10.14
Setting NIC to static IP...
Successfully released DHCP lease.
Successfully enabled static addressing. DHCP for this network adapter is disabled.
Successfully set gateway.
Successfully set network adapter address.
(Press ENTER to continue):
```

CAPSTONE PROJECT

Go back to **Network adapter settings** again and set DNS servers. For now, DNS server is your pfSense.

```
=====
          Network adapter settings
=====

NIC index:      1
Description:   Microsoft Hyper-V Network Adapter
IP address:    192.168.10.1,
               fe80:::bdd:394:ea21:2bf1
Subnet mask:   255.255.255.240
DHCP enabled: False

Default gateway:     192.168.10.14
Preferred DNS server:
Alternate DNS server:

  1) Set network adapter address
  2) Set DNS servers
  3) Clear DNS server settings

Enter selection (Blank=Cancel): 2
Enter new preferred DNS server (Blank=Cancel): 192.168.10.14
Enter alternate DNS server (Blank=None):
Successfully assigned DNS server(s).
(Press ENTER to continue): -
```

Enter PowerShell and ping Google to check the internet connectivity. You can type **SConfig** in command line to go back to SConfig page. Reboot to activate the Windows License. Check license information. (Option 11 in SConfig)

```
PS C:\Users\Administrator> ping google.ca

Pinging google.ca [142.251.33.99] with 32 bytes of data:
Reply from 142.251.33.99: bytes=32 time=21ms TTL=113
Reply from 142.251.33.99: bytes=32 time=16ms TTL=113
Reply from 142.251.33.99: bytes=32 time=19ms TTL=113
Reply from 142.251.33.99: bytes=32 time=15ms TTL=113

Ping statistics for 142.251.33.99:
  Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
  Minimum = 15ms, Maximum = 21ms, Average = 17ms
PS C:\Users\Administrator>
```

```
=====
          Windows activation
=====

  1) Display license information
  2) Activate Windows
  3) Install product key

Enter selection (Blank=Cancel): 1

Name: Windows(R), ServerDatacenterEval edition
Description: Windows(R) Operating System, TIMEBASED_EVAL channel
Partial Product Key: 37CYR
License Status: Licensed
Timebased activation expiration: 259196 minute(s) (180 day(s))

(Press ENTER to continue): -
```

CAPSTONE PROJECT

Check for any remaining Windows updates. (Option 6) in SConfig

```
=====
           Install updates
=====

Search for:

 1) All quality updates
 2) Recommended quality updates only
 3) Feature updates

Select an update category (Blank=Cancel): 1
Searching for all applicable updates...

Available update(s):
 1) Security Intelligence Update for Microsoft Defender Antivirus - KB2267602 (Version 1.385.649.0)

Install update? (Y)es or (N)o: -
```

Enter PowerShell and type **Get-NetAdapter** to check your network adapter information. The default name is **Ethernet**. Use the command **Rename-NetAdapter -Name "Ethernet" -NewName "LAN"** to change the name of the adapter.

```
Administrator: C:\Windows\system32\cmd.exe
WARNING: To launch Server Configuration tool again, run "SConfig"
PS C:\Users\Administrator> Get-NetAdapter

Name           InterfaceDescription          ifIndex Status      MacAddress      LinkSpeed
----           -----                         -----   -----      -----          -----
Ethernet       Microsoft Hyper-V Network Adapter    6 Up        00-15-5D-1F-8C-10  10 Gbps

PS C:\Users\Administrator> Rename-NetAdapter -Name "Ethernet" -NewName "LAN"
PS C:\Users\Administrator> Get-NetAdapter

Name           InterfaceDescription          ifIndex Status      MacAddress      LinkSpeed
----           -----                         -----   -----      -----          -----
LAN            Microsoft Hyper-V Network Adapter    6 Up        00-15-5D-1F-8C-10  10 Gbps

PS C:\Users\Administrator> -
```

Type **Rename-Computer -NewName [name-of-your-choice]** to change the computer name.

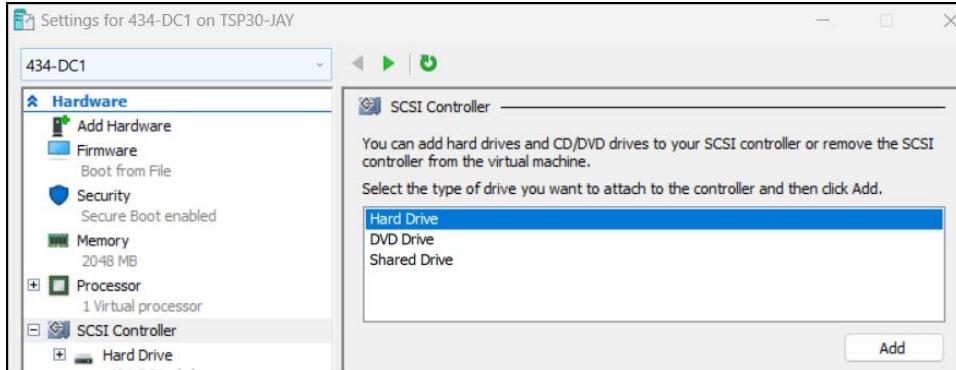
```
PS C:\Users\Administrator> Rename-Computer -NewName (Read-Host -Prompt 'Input the new PC name')
Input the new PC name: 434-DC1
WARNING: The changes will take effect after you restart the computer WIN-G1U5HMP7TF2.
PS C:\Users\Administrator> -
```

Type **Rename-LocalUser -Name "Administrator" -NewName "_Sysadmin"** to change the name of the default administrator account. Reboot your DC.

```
PS C:\Users\Administrator> Rename-LocalUser -Name "Administrator" -NewName "_Sysadmin"
PS C:\Users\Administrator> -
```

CAPSTONE PROJECT

One more thing you need to do before making your DC1 a domain controller is attaching a separate disk for configuration files of a domain controller. Open VM Settings for DC1, select **SCSI Controller** tab in the left pane, and add **Hard Drive**.

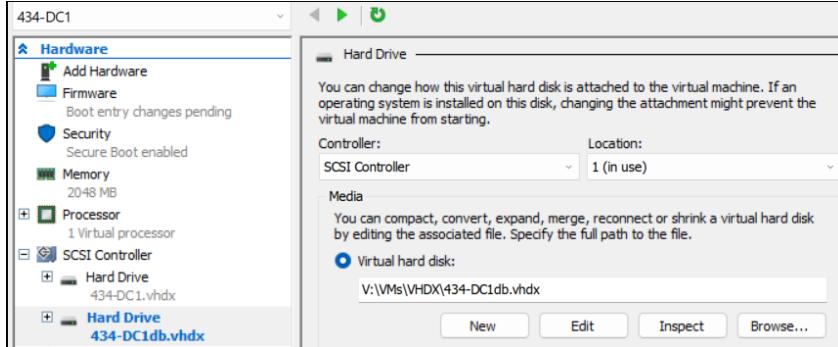


Click **New**. Create a new vhdx (**Dynamically expanding**), name it accordingly, and assign enough storage.

The screenshot shows the 'Hard Drive' creation dialog. It includes fields for 'Controller' (set to 'SCSI Controller') and 'Location' (set to '1 (in use)'). Under 'Media', the 'Virtual hard disk' option is selected. A note explains that 'Dynamically expanding' disks provide better use of physical storage space and are recommended for servers running applications that are not disk intensive. The virtual hard disk file is initially small and changes as data is added. Below this, a section specifies the name and location of the virtual hard disk file, with 'Name' set to '434-DC1db.vhdx' and 'Location' set to 'V:\VMs\vhdx'. At the bottom, a note states that you can create a blank virtual hard disk or copy the contents of an existing physical disk, with the 'Create a new blank virtual hard disk' option selected and a size of '20 GB (Maximum: 64 TB)' specified.

CAPSTONE PROJECT

Click **OK** to attach the new disk.



Enter PowerShell for DC1. You need to create a volume with the newly attached disk. Type **Get-Disk** to attain the disk number for the new disk. Initialize the disk by the command **Initialize-Disk [disk-number]** and set partition by typing **New-Partition -DiskNumber [disk-number] -UseMaximumSize -AssignDriveLetter**. Finally, format the drive into the volume with the command **Format-Volume -DriveLetter D**.

```
PS C:\Users\Administrator> get-disk
Number Friendly Name Serial Number          HealthStatus   OperationalStatus    Total Size Partition Style
-----  -----
0      Msft Virtu...                         Healthy       Online
1      Msft Virtu...                         Healthy       Offline           127 GB GPT
2

PS C:\Users\Administrator> Initialize-Disk 1
PS C:\Users\Administrator> New-Partition -DiskNumber 1 -UseMaximumSize -AssignDriveLetter

DiskPath: \\?\scsi#disk&ven_msft&prod_virtual_disk#5&39998357&0&000001#{53f56307-b6bf-11d0-94f2-00a0c91efb8b}
PartitionNumber  DriveLetter Offset          Size Type
-----  -----
2                  D          16777216        19.98 GB Basic

PS C:\Users\Administrator> Format-Volume -DriveLetter D
DriveLetter FriendlyName FileSystemType DriveType HealthStatus OperationalStatus SizeRemaining    Size
-----  -----
D          NTFS         Fixed     Healthy    OK            19.93 GB 19.98 GB

PS C:\Users\Administrator>
```

DC1 is ready to become a domain controller. Install **Active Directory Domain Services** role and required management tools with the command **Install-WindowsFeature -Name ad-domain-services -IncludeManagementTools**

```
Administrator: C:\Windows\system32\cmd.exe
WARNING: To launch Server Configuration tool again, run "SConfig"
PS C:\Users\Administrator> Install-WindowsFeature -Name ad-domain-services -IncludeManagementTools

Success Restart Needed Exit Code      Feature Result
-----  -----
True    No             Success      {Active Directory Domain Services, Group P...
```

CAPSTONE PROJECT

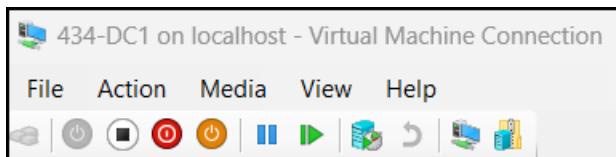
Type **Import-Module ADDSDeployment**. Then run these commands for configuration:

Install-ADDSForest `

```
-CreateDnsDelegation:$false `  
-DatabasePath "D:\NTDS" `  
-DomainMode "WinThreshold" `  
-DomainName "CAP.TSP" `  
-DomainNetbiosName "CAP" `  
-ForestMode "WinThreshold" `  
-InstallDns:$true `  
-LogPath "D:\NTDS" `  
-NoRebootOnCompletion:$false `  
-SysvolPath "D:\SYSVOL" `  
-Force:$true
```

```
PS C:\Users\Administrator> Import-Module ADDSDeployment  
PS C:\Users\Administrator> Install-ADDSForest `  
>> -CreateDnsDelegation:$false `  
>> -DatabasePath "D:\NTDS" `  
>> -DomainMode "WinThreshold" `  
>> -DomainName "CAP.TSP" `  
>> -DomainNetbiosName "CAP" `  
>> -ForestMode "WinThreshold" `  
>> -InstallDns:$true `  
>> -LogPath "D:\NTDS" `  
>> -NoRebootOnCompletion:$false `  
>> -SysvolPath "D:\SYSVOL" `  
>> -Force:$true  
SafeModeAdministratorPassword: *****  
Confirm SafeModeAdministratorPassword: *****
```

Set **Safe Mode Administrator Password** and the process starts. It takes some time so be patient. If you run into a problem with switching a user to log in, you can disable **Enhanced session** mode, log in with the account you want, then enable Enhanced session mode again to log in with the account of your choice. (Click a computer icon on the toolbar to switch between **Basic** and **Enhanced** session modes.)



CAPSTONE PROJECT

```
C:\Windows\system32\LogonUI.exe
Enter credentials for Other user or hit ESC to switch users/sign-in methods
User name : _Sysadmin
Password : *****
Sign in to: CAP
How do I sign in to another domain?
```

```
C:\Windows\system32\LogonUI.exe
Enter credentials for CAP\_Sysadmin or hit ESC to switch users/sign-in methods
Password : *****
```

Upon reboot, you must disable and enable **LAN** network adapter if your network profile is NOT set to domain network.

```
PS C:\Users\Administrator> Get-NetConnectionProfile

Name          : Network
InterfaceAlias : LAN
InterfaceIndex : 6
NetworkCategory : Public
IPv4Connectivity : Internet
IPv6Connectivity : NoTraffic
```

Commands are:

- **Disable-NetAdapter -Name “LAN”** to disable the adapter.
- **Enable-NetAdapter -Name “LAN”** to enable the adapter.
- **Get-NetConnectionProfile** to check the network connection status.

```
PS C:\Users\Administrator> Disable-NetAdapter -Name LAN

Confirm
Are you sure you want to perform this action?
Disable-NetAdapter 'LAN'
[Y] Yes [A] Yes to All [N] No [L] No to All [S] Suspend [?] Help (default is "Y"): a
PS C:\Users\Administrator> Enable-NetAdapter -Name LAN
PS C:\Users\Administrator> Get-NetConnectionProfile

Name          : CAP.TSP
InterfaceAlias : LAN
InterfaceIndex : 6
NetworkCategory : DomainAuthenticated
IPv4Connectivity : Internet
IPv6Connectivity : NoTraffic
```

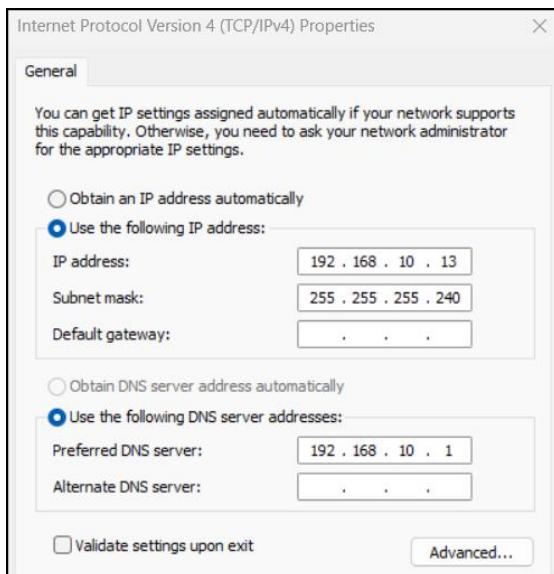
CAPSTONE PROJECT

Join the Host PC to the Domain

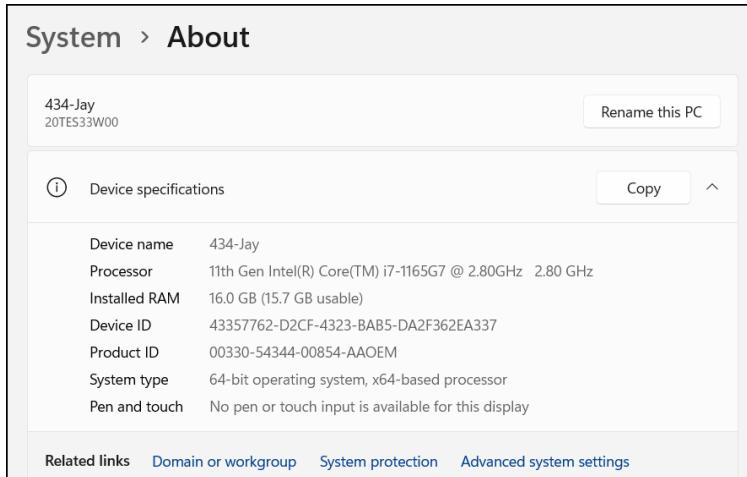
On your host machine, search **About your PC** in the search box and click it. You can rename your PC if you want to match the naming scheme of your domain computers by clicking **Rename this PC**. Reboot.



Edit IPv4 settings of vNIC of the host machine that is connected to your **LAN**. Add the IP address of **DC1** to **Preferred DNS server**.

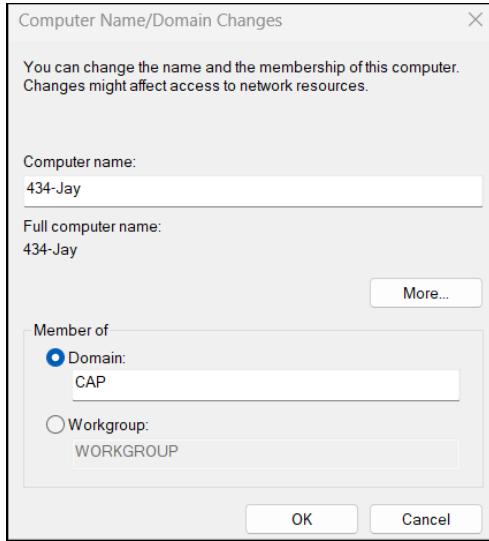


Go to **About your PC** again and click **Domain or workgroup -> Change**.

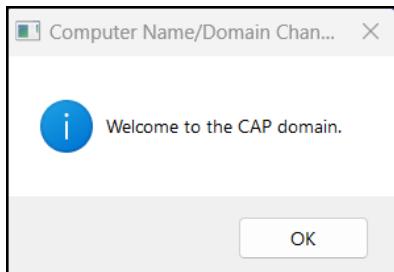
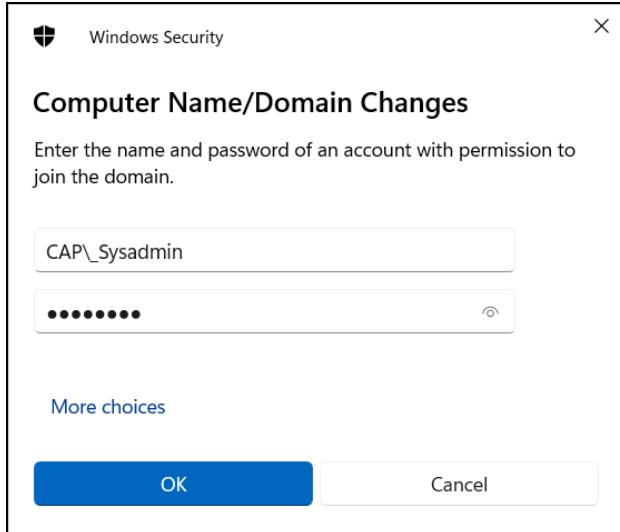


CAPSTONE PROJECT

Select **Domain** and type in **CAP**. Click **OK**.

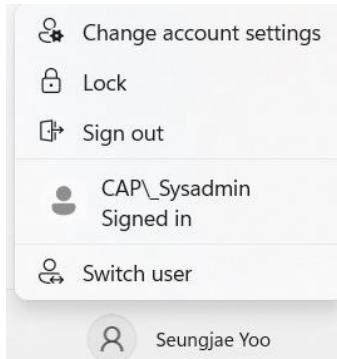


Provide domain administrator credentials. After joining the domain, reboot your computer.

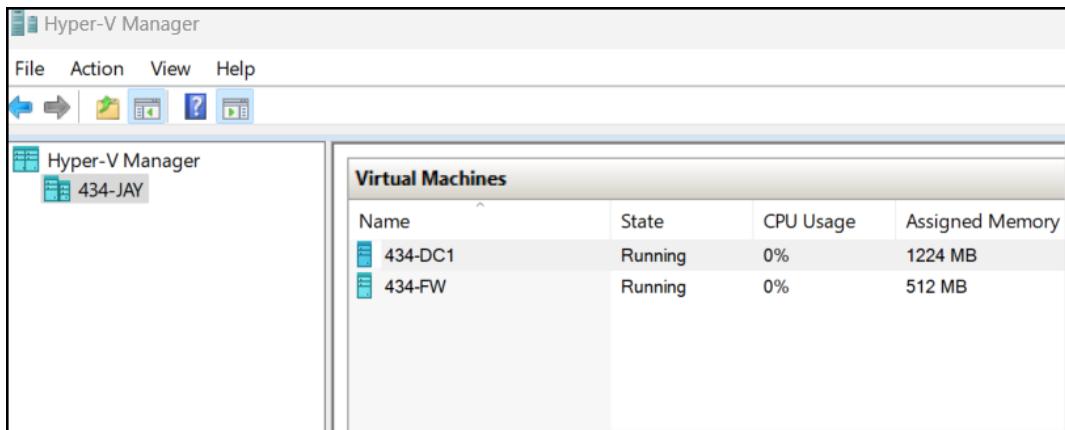


CAPSTONE PROJECT

After reboot, log in with the local account first. Copy and paste any files you need to access to **C:\Users\Public** which you will have access with the domain administrator account (**_Sysadmin** at this point) as well. Sign out and log in as **_Sysadmin** to the domain network.



Open Hyper-V Manager to confirm that VMs are still running.

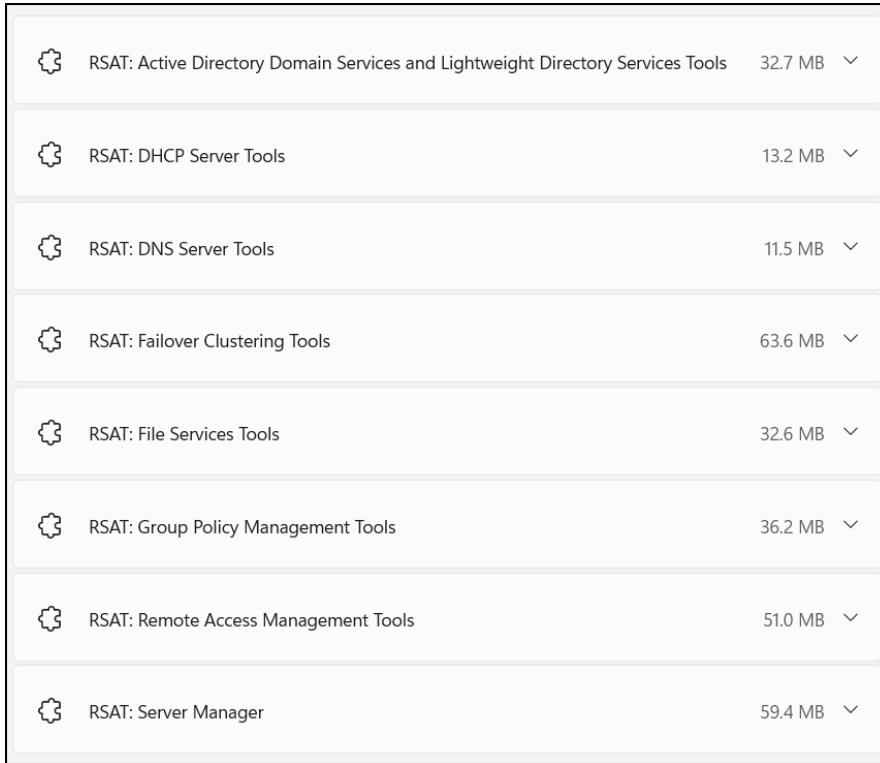


Copy and paste files you saved in **Public** directory to the desktop.

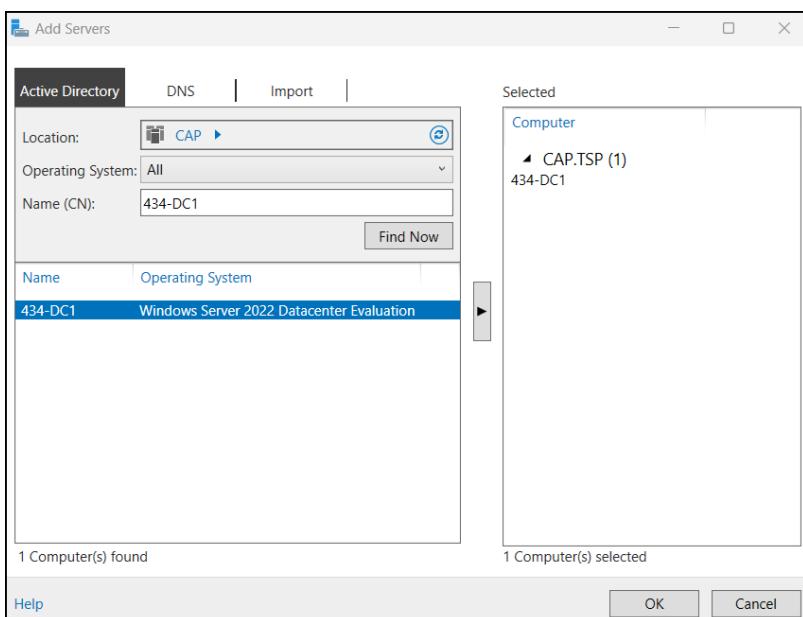


CAPSTONE PROJECT

Search **Optional features** in the search box and enter. Click **View features** and search **RSAT**. Download following RSAT tools:

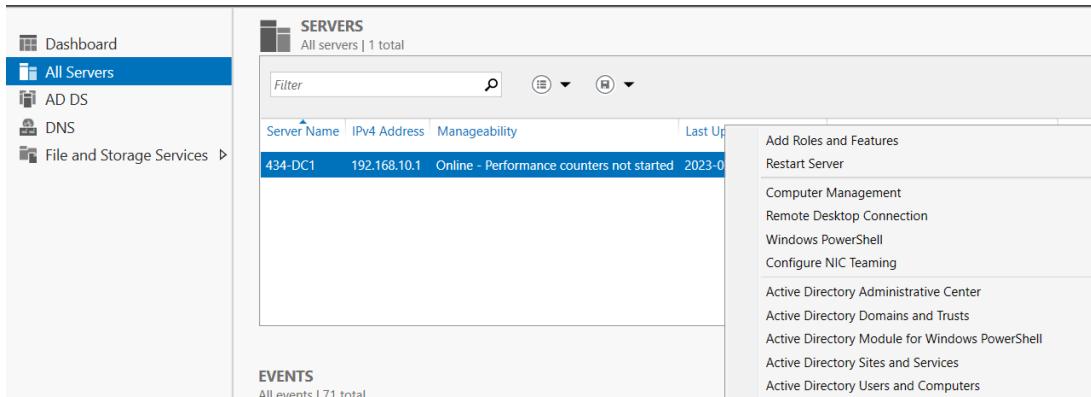


Open **Server Manger** and click **Add other servers to manage**. Search your DC1 and add it to the list.

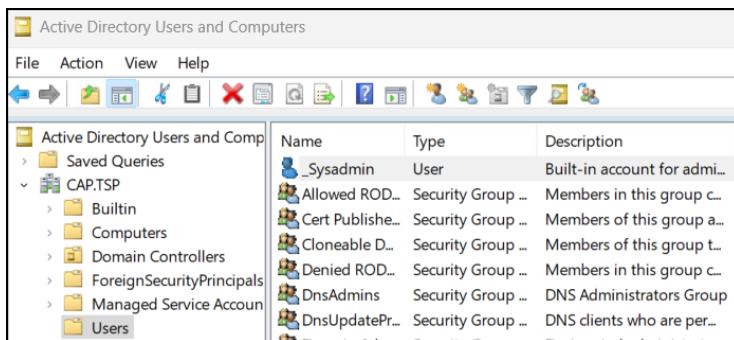


CAPSTONE PROJECT

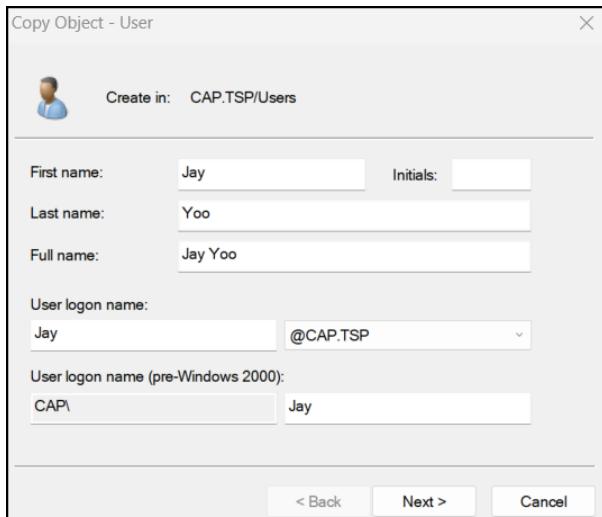
Click **All Servers** in the left pane of Server Manager and right-click DC1 to open **Active Directory Users and Computers (ADUC)**.



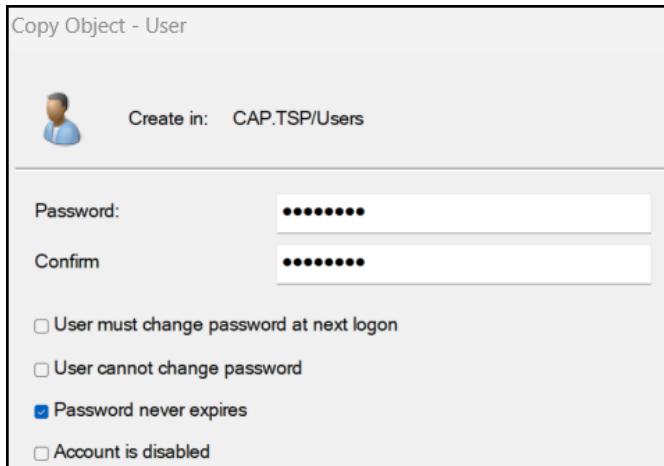
Select **Users**, right-click **_Sysadmin**, and click **Copy** to make it as a template for a new account you will create.



Create your own domain administrative account.



CAPSTONE PROJECT



From now on, you will ONLY use your own account to administer the domain. Log out as **_Sysadmin** and log in with your new account.

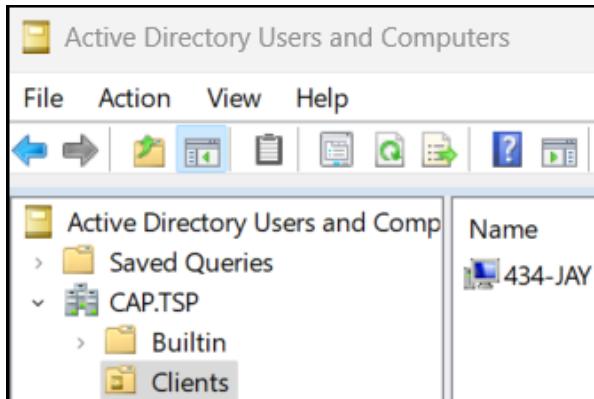
Create Organizational Unit Structure

Again, add DC1 to Server Manager and open ADUC. Click the domain in the left pane. Make four organizational units: **Clients, Domain_Users, Security_Groups, and Servers**.

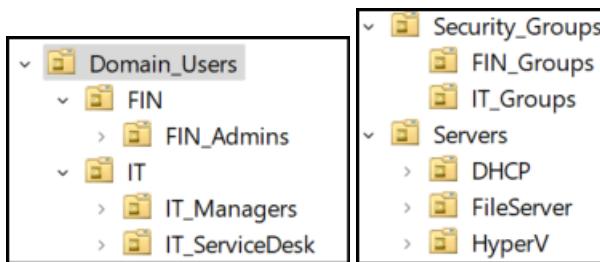
Name	Type	Description
Builtin	builtinDomain	
Clients	Organizational ...	
Computers	Container	Default container for up...
Domain Con...	Organizational ...	Default container for do...
Domain_Users	Organizational ...	
ForeignSecur...	Container	Default container for sec...
Managed Se...	Container	Default container for ma...
Security_Gro...	Organizational ...	
Servers	Organizational ...	
Users	Container	Default container for up...

CAPSTONE PROJECT

Click **Computers** in the left pane. Your host computer resides in this OU. Move it to **Clients** OU.

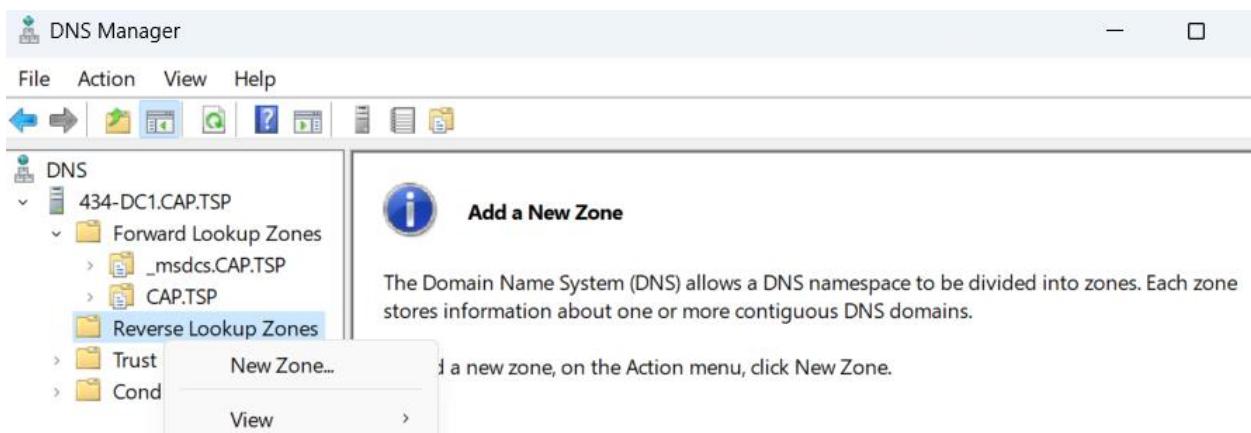


Build sub-OUs according to your network. You will create users and groups at later time.



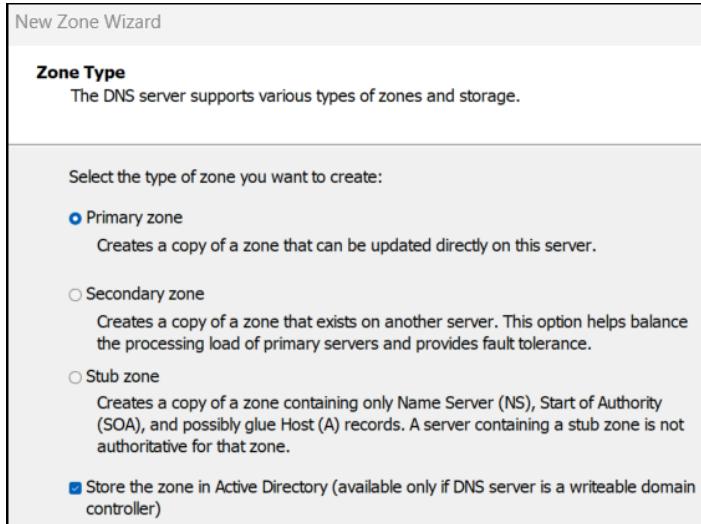
Configure DNS

When you installed ADDS role onto DC1, you chose AD-Integrated DNS zone as well, which automatically created the forward DNS lookup zone. You just need to create the reverse lookup zone. Open **DNS Manager**, right-click **Reverse Lookup Zones**, and select **New Zone**.

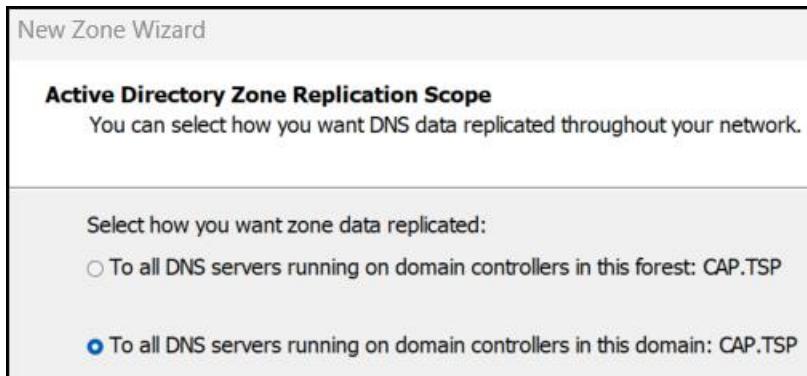


CAPSTONE PROJECT

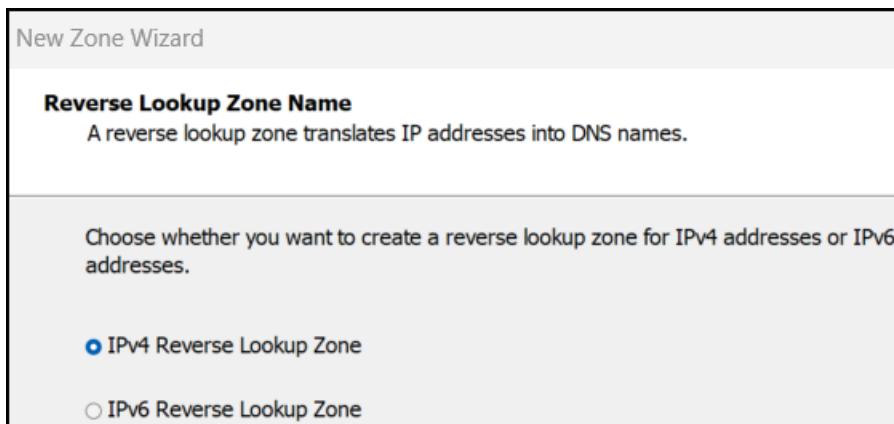
Choose **Primary zone**. Store the zone in Active Directory.



Choose **Replication Scope**. In our environment, first two choices are both valid.

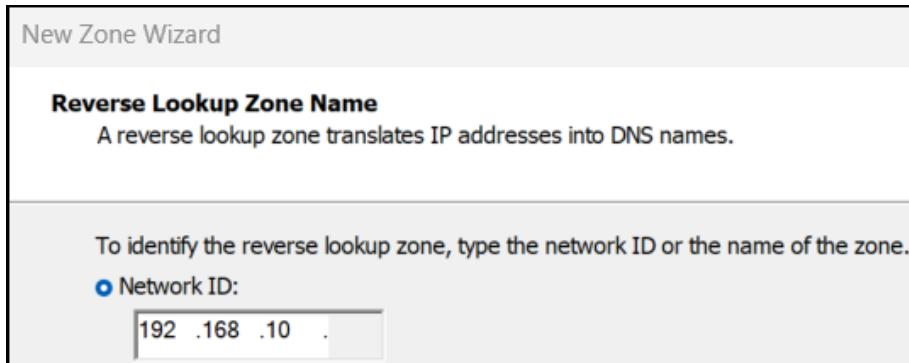


Create **IPv4 Reverse Lookup Zone**.

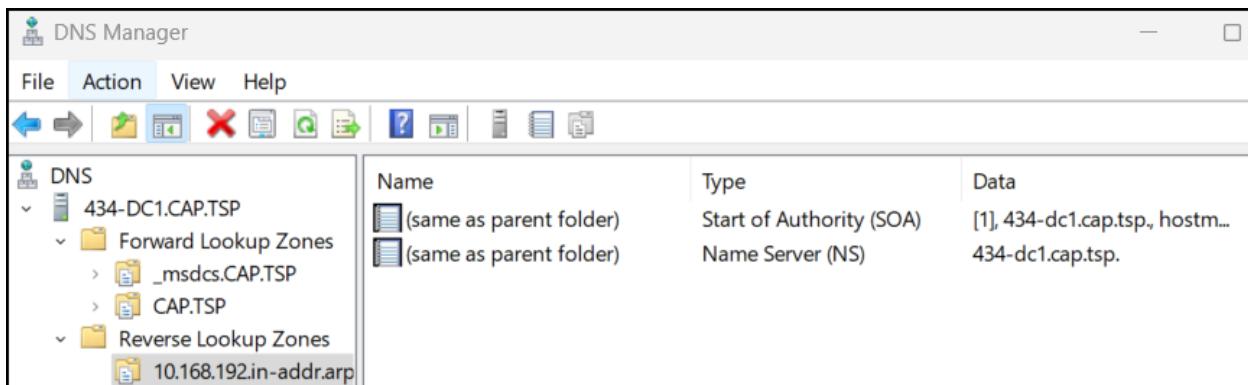
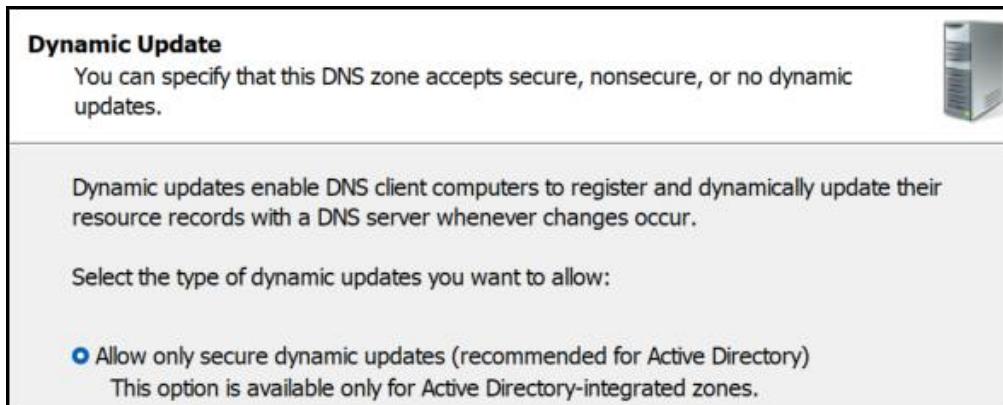


CAPSTONE PROJECT

Type first three numbers of your LAN network to create default reverse lookup zone name.



Pick the first choice for dynamic update type. Finish the Wizard. The reverse lookup zone is created.

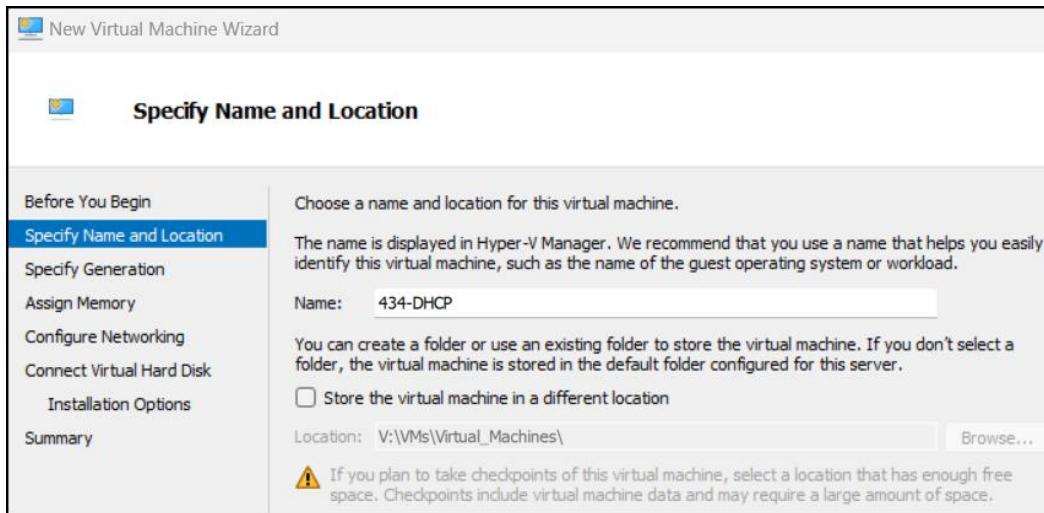


Sign out from the domain and log in with your local account. Shut down **DC1** and reduce the RAM to static 521MB.

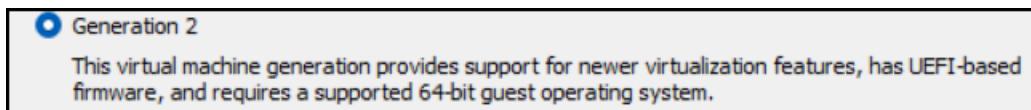
CAPSTONE PROJECT

Create and Configure a Linux DHCP Server

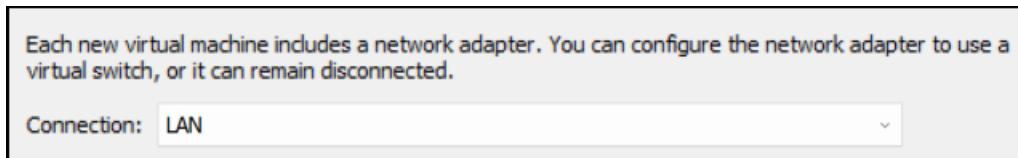
Create a new VM named **434-DHCP**.



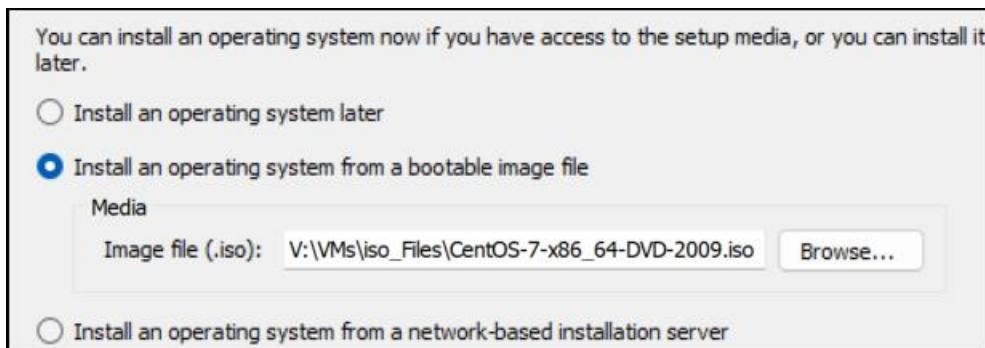
Choose **Gen 2**.



Connect to **LAN**.

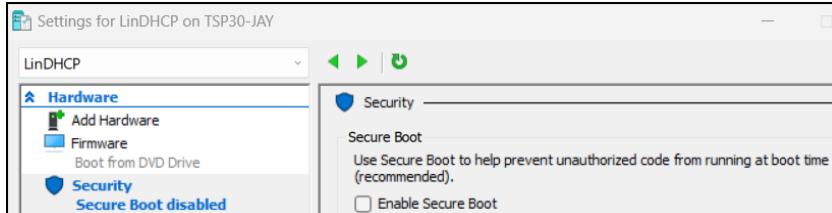


Choose **Install an operating system from a bootable image file** for CentOS 7.

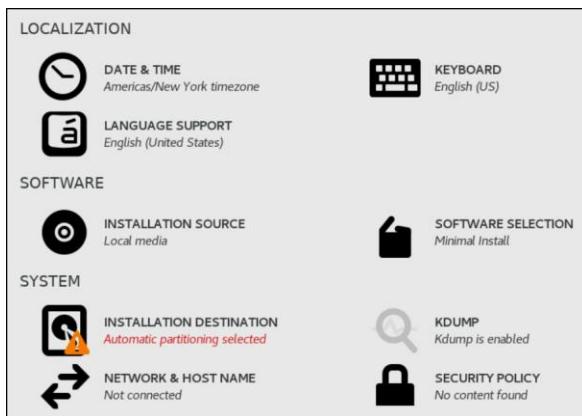


CAPSTONE PROJECT

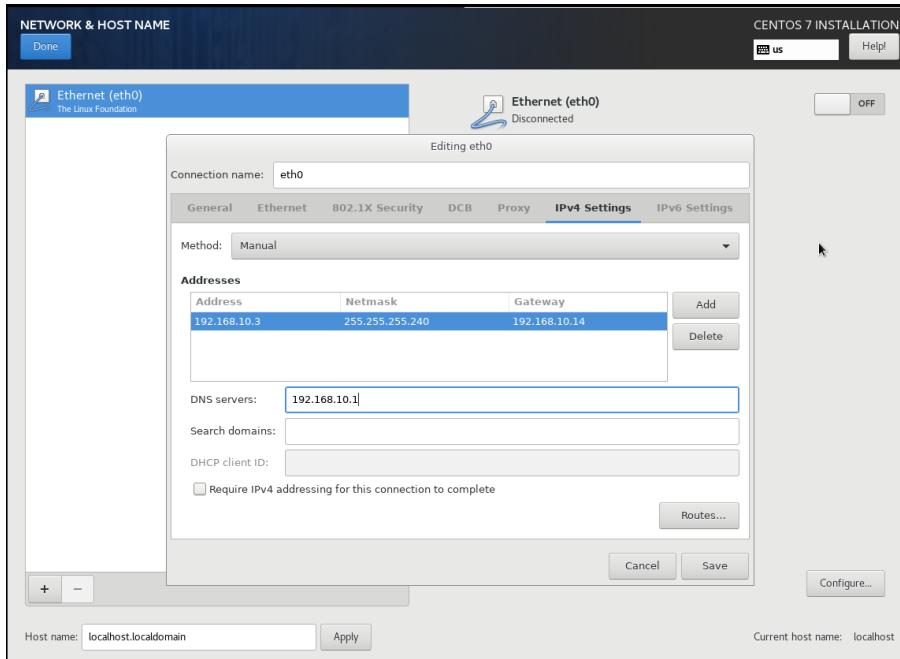
Disable Secure boot in **Settings for DHCP**. You can disable automatic checkpoint as well.



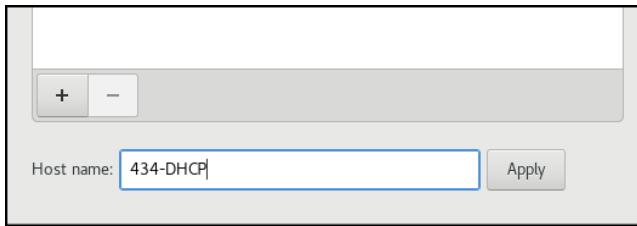
Start the VM and installation page shows up. Click **NETWORK & HOST NAME**. You can name your host name here.



Click **Configure** and assign static **IPv4 Settings**. Click **Save**. Change **Host name** and click **Apply -> Done**.

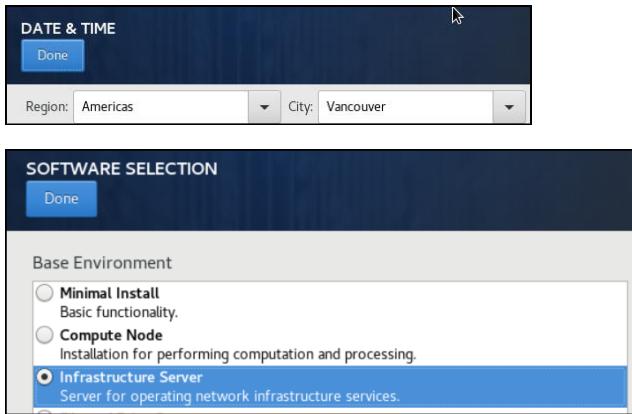


CAPSTONE PROJECT



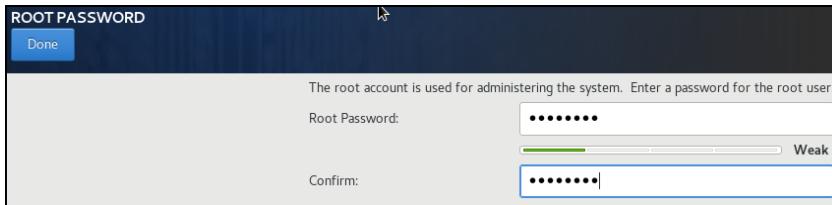
A screenshot of a host name configuration interface. It features a top bar with zoom controls (+, -). Below is a text input field containing "434-DHCP" with a blue border, followed by an "Apply" button.

Sync time. Enter **SOFTWARE SELECTION** and pick **Infrastructure Server**.



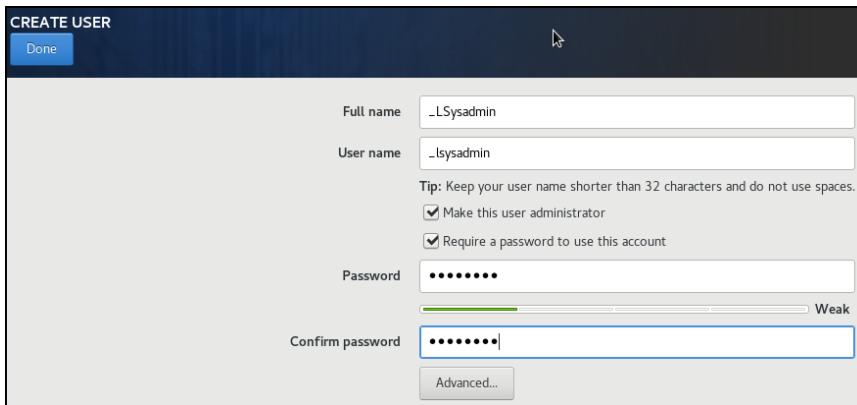
The image shows two stacked software selection interfaces. The top one is titled "DATE & TIME" with a "Done" button, showing "Region: Americas" and "City: Vancouver". The bottom one is titled "SOFTWARE SELECTION" with a "Done" button, showing three options under "Base Environment": "Minimal Install" (radio button), "Compute Node" (radio button), and "Infrastructure Server" (radio button, selected and highlighted in blue). A tooltip for "Compute Node" says "Installation for performing computation and processing." and for "Infrastructure Server" says "Server for operating network infrastructure services."

Set a root password.



A screenshot of a root password configuration screen. It has a "ROOT PASSWORD" title and a "Done" button. The instructions say "The root account is used for administering the system. Enter a password for the root user." Below are two password input fields: "Root Password" and "Confirm". The "Root Password" field contains "*****" and is labeled "Weak". The "Confirm" field also contains "*****".

Create a user. You can make administrative user account. Wait until the installation is complete. Reboot.



A screenshot of a user creation configuration screen. It has a "CREATE USER" title and a "Done" button. The user information is as follows:

Full name	_LSysadmin
User name	_lsysadmin
Tip: Keep your user name shorter than 32 characters and do not use spaces.	
<input checked="" type="checkbox"/> Make this user administrator	
<input checked="" type="checkbox"/> Require a password to use this account	
Password	*****
Confirm password	*****

A "Weak" password strength indicator is shown next to the password fields. An "Advanced..." button is at the bottom.

CAPSTONE PROJECT

Log in with your user account (No capital letters in username). Use **ip addr** command to check the IP settings. Type **hostname** to check the computer name.

```
[_lsysadmin@434-DHCP ~]$ ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
        inet 127.0.0.1/8 scope host lo
            valid_lft forever preferred_lft forever
            inet6 ::1/128 scope host
                valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP group default qlen 1000
    link/ether 00:15:5d:1f:8c:11 brd ff:ff:ff:ff:ff:ff
        inet 192.168.10.3/28 brd 192.168.10.15 scope global noprefixroute eth0
            valid_lft forever preferred_lft forever
            inet6 fe80::31be:3fc3:9e2d:b61e/64 scope link noprefixroute
                valid_lft forever preferred_lft forever
[_lsysadmin@434-DHCP ~]$ hostname
434-DHCP
[_lsysadmin@434-DHCP ~]$
```

Type **sudo yum -y install dhcp** to install DHCP server and client.

Type **sudo nano /etc/dhcp/dhcpd.conf** to configure DHCP server. Read through copied samples to understand the general syntax for configuration, then comment out or delete everything. This is my configuration:

```
default-lease-time 600;

max-lease-time 7200;

subnet 192.168.10.0 netmask 255.255.255.240 {
    range 192.168.10.12 192.168.10.12;
    option domain-name-servers 192.168.10.1, 192.168.10.2;
    option routers 192.168.10.14;
}

host 434-DC1 {
    hardware ethernet 00:15:5D:1F:8C:10;
    fixed-address 192.168.10.1;
}
```

CAPSTONE PROJECT

```
default-lease-time 600;
max-lease-time 7200;

subnet 192.168.10.0 netmask 255.255.255.240 {
    range 192.168.10.12 192.168.10.12;
    option domain-name-servers 192.168.10.1, 192.168.10.2;
    option routers 192.168.10.14;
}

host 434-DC1 {
    hardware ethernet 00:15:5D:1F:8C:10;
    fixed-address 192.168.10.1;
}
```

The reason that IP range is just one address is because it is the only available IP address in my LAN network (/28). All the other addresses will be statically assigned to other VMs. You have not created **DC2** yet, but you can add it to DHCP configuration in advance. The third section is a reservation for **434-DC1**. You will add more reservations as you create more VMs. Lease time values are in seconds. Save and exit.

Type **sudo systemctl restart dhcpcd** and **sudo systemctl enable dhcpcd** to initiate DHCP server.

To test DHCP, connect any VM (other than **DC1**) to **LAN** network. Newly created Windows VMs are always DHCP enabled initially.

```
=====
          Network adapter settings
=====

NIC index:      1
Description:   Microsoft Hyper-V Network Adapter
IP address:    192.168.10.12,
               fe80::6a97:302a:be2c:356d
Subnet mask:   255.255.255.240
DHCP enabled: True

Default gateway:     192.168.10.14
Preferred DNS server: 192.168.10.1
Alternate DNS server: 192.168.10.2

1) Set network adapter address
2) Set DNS servers
3) Clear DNS server settings

Enter selection (Blank=Cancel): -
```

CAPSTONE PROJECT

On your DHCP server, type **sudo cat /var/lib/dhcpd/dhcpd.leases** to check the DHCP leases.

```
lease 192.168.10.12 {
    starts 3 2023/03/22 02:09:23;
    ends 3 2023/03/22 02:19:23;
    cltt 3 2023/03/22 02:09:23;
    binding state active;
    next binding state free;
    rewind binding state free;
    hardware ethernet 00:15:5d:1f:8c:15;
    uid "\001\000\025|\037\214\025";
    client-hostname "WIN-07564JQQRC0";
}
192.168.10.12
```

To join Linux Server to Windows domain, you need to install required packages. Type **sudo yum -y install sssd realmd oddjob oddjob-mkhomedir adcli samba-common samba-common-tools krb5-workstation openldap-clients policycoreutils-python** to download and install these packages.

Installed:	adcli.x86_64 0:8.0.1-16.el7_9.1 odd.job-mkhomedir.x86_64 0:8.31.5-4.el7 realmd.x86_64 0:0.16.1-12.el7_9.1 sssd.x86_64 0:1.16.5-10.el7_9.15	krb5-workstation.x86_64 0:1.15.1-55.el7_9 openldap-clients.x86_64 0:2.4.44-25.el7_9 samba-common.noarch 0:4.10.16-24.el7_9	odd.job.x86_64 0:0.31.5-4.el7 policycoreutils-python.x86_64 0:2.5-34.el7 samba-common-tools.x86_64 0:4.10.16-24.el7_9
Dependency Installed:	audit-libs-python.x86_64 0:2.8.5-4.el7 checkpolicy.x86_64 0:2.5-8.el7 gnutls.x86_64 0:3.3.29-9.el7_6 libcgroup.x86_64 0:0.8.41-21.el7 libini_config.x86_64 0:1.3.1-32.el7 libltdb.x86_64 0:1.5.4-2.el7 libref_array.x86_64 0:0.1.5-32.el7 libsss_automount.x86_64 0:1.16.5-10.el7_9.15 libtalloc.x86_64 0:2.1.16-1.el7 libwbclient.x86_64 0:4.10.16-24.el7_9 pyldb.x86_64 0:1.5.4-2.el7 python-sssconfig.noarch 0:1.16.5-10.el7_9.15 samba-common-libs.x86_64 0:4.10.16-24.el7_9 sssd-ad.x86_64 0:1.16.5-10.el7_9.15 sssd-ipa.x86_64 0:1.16.5-10.el7_9.15 sssd-ldap.x86_64 0:1.16.5-10.el7_9.15	avahi-libs.x86_64 0:0.6.31-20.el7 cups-libs.x86_64 1:1.6.3-51.el7 http-parser.x86_64 0:2.7.1-9.el7 libcollection.x86_64 0:0.7.0-32.el7 libipa_hbac.x86_64 0:1.16.5-10.el7_9.15 libmsidmap.x86_64 0:0.25-19.el7 libsemanage-python.x86_64 0:2.5-14.el7 libsss_certmap.x86_64 0:1.16.5-10.el7_9.15 libtdb.x86_64 0:1.3.18-1.el7 nettle.x86_64 0:2.7.1-9.el7_9 pytalloc.x86_64 0:2.1.16-1.el7 python-tdb.x86_64 0:1.3.18-1.el7 samba-libs.x86_64 0:4.10.16-24.el7_9 sssd-common.x86_64 0:1.16.5-10.el7_9.15 sssd-krb5.x86_64 0:1.16.5-10.el7_9.15 sssd-proxy.x86_64 0:1.16.5-10.el7_9.15	c-ares.x86_64 0:1.10.0-3.el7 cyrus-sasl-gssapi.x86_64 0:2.1.26-24.el7_9 libbasicobjects.x86_64 0:0.1.1-32.el7 libdhash.x86_64 0:0.5.0-32.el7 libkadm5.x86_64 0:1.15.1-55.el7_9 libpath_utils.x86_64 0:0.2.1-32.el7 libsmbcclient.x86_64 0:4.10.16-24.el7_9 libsss_sudo.x86_64 0:1.16.5-10.el7_9.15 libtevent.x86_64 0:0.9.39-1.el7 psmisc.x86_64 0:22.28-17.el7 python-1Py.noarch 0:0.75-6.el7 samba-client-libs.x86_64 0:4.10.16-24.el7_9 setools-libs.x86_64 0:3.3.8-4.el7 sssd-common-pac.x86_64 0:1.16.5-10.el7_9.15 sssd-krb5-common.x86_64 0:1.16.5-10.el7_9.15 trousers.x86_64 0:0.3.14-2.el7
Dependency Updated:	curlsas1-lib.x86_64 0:2.1.26-24.el7_9 libsss_idmap.x86_64 0:1.16.5-10.el7_9.15 sssd-client.x86_64 0:1.16.5-10.el7_9.15	curlsas1-plain.x86_64 0:2.1.26-24.el7_9 libsss_nss_idmap.x86_64 0:1.16.5-10.el7_9.15	krb5-libs.x86_64 0:1.15.1-55.el7_9 openldap.x86_64 0:2.4.44-25.el7_9
Complete!			

The CentOS server will need to be able to resolve the Active Directory domain to successfully join it. In this instance my DNS server in **/etc/resolv.conf** is set to the Active Directory server hosting the **CAP.TSP** domain that I wish to join. Type **sudo nano /etc/resolv.conf** and edit according to your domain. (The picture below is outdated. Put CAP.TSP instead of TSP.int.)

GNU nano 2.3.1	File: /etc/resolv.conf
# Generated by NetworkManager	
search TSP.int	█
nameserver 192.168.10.1	

CAPSTONE PROJECT

Now you can join the domain with the '**realm join**' command. You will need to specify the username of an account in the domain that has privileges to join a computer to the domain. Type **sudo realm join --user=[username] [domain]** to join. Type **sudo realm list** to confirm that CentOS DHCP server is in the domain.

```
[l(sysadmin@434-DHCP ~]$ sudo realm join --user=Jay CAP.TSP
Password for Jay:
[l(sysadmin@434-DHCP ~]$ sudo realm list
CAP.TSP
  type: kerberos
  realm-name: CAP.TSP
  domain-name: cap.tsp
  configured: kerberos-member
  server-software: active-directory
  client-software: sssd
  required-package: oddjob
  required-package: oddjob-mkhomedir
  required-package: sssd
  required-package: adcli
  required-package: samba-common-tools
  login-formats: %U@cap.tsp
  login-policy: allow-realm-logins
```

Confirm the machine is in **Computers** OU in ADUC. Move the object to **DHCP** OU under **Servers**.

The screenshot shows the 'Active Directory Users and Computers' window. The left pane displays the navigation tree with 'Active Directory Users and Computers' selected. Underneath it, 'Saved Queries', 'CAP.TSP' (which is expanded to show 'Builtin', 'Clients', and 'Computers'), and other standard AD container icons like 'Domain Controllers' and 'Groups'. The right pane is a table view with columns 'Name', 'Type', and 'Description'. It lists one item: '434-DHCP' with 'Type' set to 'Computer'. The 'Name' column contains a small thumbnail icon of the computer.

This screenshot shows the same 'Active Directory Users and Computers' window after the move. The navigation tree now shows 'Active Directory Users and Computers' and 'CAP.TSP' expanded. Under 'CAP.TSP', the 'Computers' folder is listed, along with 'Builtin', 'Clients', 'Domain Controllers', 'Domain_Users', 'ForeignSecurityPrincipals', 'Managed Service Account', 'Security_Groups', and 'Servers'. The 'Servers' folder is expanded, and its child 'DHCP' folder is selected. The right pane table shows the same '434-DHCP' entry, but now it is listed under the 'DHCP' container, indicating it has been moved.

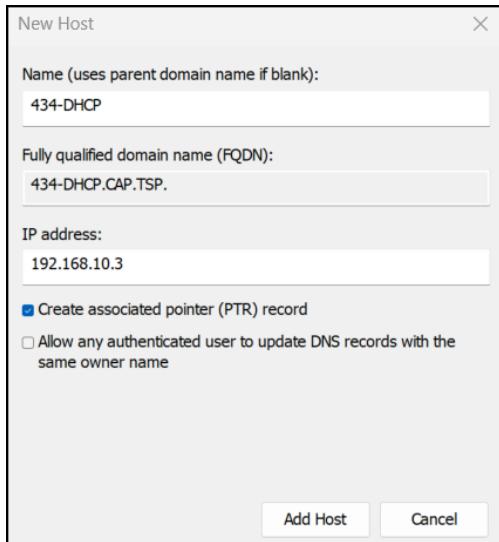
CAPSTONE PROJECT

Shut down **DHCP** and reduce RAM to 512MB. Upon reboot, you can log in with domain credentials.

```
CentOS Linux 7 (Core)
Kernel 3.10.0-1160.el7.x86_64 on an x86_64

434-DHCP login: Jay@CAP.TSP
Password:
Creating home directory for Jay@CAP.TSP.
[jay@CAP.TSP@434-DHCP ~]$ whoami
jay@CAP.TSP
[jay@CAP.TSP@434-DHCP ~]$
```

You need to manually create **Host (A) record** for the Linux DHCP server in DNS Manager.



For consistency, you need to rename NIC in DHCP to be **LAN**. Log in with local sudoer account (**_lsysadmin** in this case). Type **ip addr** again. You are using **eht0** interface for LAN connection.

```
[_lsysadmin@434-DHCP ~]$ ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
        inet 127.0.0.1/8 scope host lo
            valid_lft forever preferred_lft forever
        inet6 ::1/128 scope host
            valid_lft forever preferred_lft forever
2: eht0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP group default qlen 1000
    link/ether 00:15:5d:1f:8c:11 brd ff:ff:ff:ff:ff:ff
        inet 192.168.10.3/28 brd 192.168.10.15 scope global noprefixroute eht0
            valid_lft forever preferred_lft forever
        inet6 fe80::31be:3fc3:9e2d:b61e/64 scope link noprefixroute
            valid_lft forever preferred_lft forever
[_lsysadmin@434-DHCP ~]$ hostname
434-DHCP
[_lsysadmin@434-DHCP ~]$
```

CAPSTONE PROJECT

Bring down the NIC you want to rename and verify that “state UP” has turned to “state DOWN”.

sudo ifdown eth0

Rename the NIC to the desired name. In our case, the name is **LAN**.

sudo ip link set eth0 name LAN

Rename the NIC configuration file in network-scripts directory.

sudo mv /etc/sysconfig/network-scripts/ifcfg-eth0 /etc/sysconfig/network-scripts/ifcfg-LAN

Edit the NIC configuration file and replace the old device name with the new one. Also make sure the **HWADDR** field is included. The HWADDR parameter is the MAC address of the NIC which can be seen when you use the command, **ip addr** to verify the NICs on the system.

sudo nano /etc/sysconfig/network-scripts/ifcfg-LAN

```
TYPE="Ethernet"
PROXY_METHOD="none"
BROWSER_ONLY="no"
BOOTPROTO="none"
DEFROUTE="yes"
IPV4_FAILURE_FATAL="no"
IPV6INIT="yes"
IPV6_AUTOCONF="yes"
IPV6_DEFROUTE="yes"
IPV6_FAILURE_FATAL="no"
IPV6_ADDR_GEN_MODE="stable-privacy"
NAME="eth0"
UUID="52024154-8dc0-4916-9111-a865601a8f61"
DEVICE="LAN"
ONBOOT="yes"
IPADDR="192.168.10.3"
PREFIX="24"
GATEWAY="192.168.10.14"
DNS1="192.168.10.1"
IPV6_PRIVACY="no"
HWADDR=00:15:5d:1f:8c:14
```

Bring up the renamed NIC.

sudo ifup LAN

CAPSTONE PROJECT

Verify the NIC is up. Also reboot your system to confirm it is persistent across reboot.

```
[l(sysadmin@434-DHCP ~] $ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
        inet 127.0.0.1/8 scope host lo
            valid_lft forever preferred_lft forever
        inet6 ::1/128 scope host
            valid_lft forever preferred_lft forever
2: LAN: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP group default qlen 1000
    link/ether 00:15:5d:1f:8c:14 brd ff:ff:ff:ff:ff:ff
        inet 192.168.10.3/28 brd 192.168.10.15 scope global noprefixroute LAN
            valid_lft forever preferred_lft forever
        inet6 fe80::5bf7:b8be:e05c:f994/64 scope link noprefixroute
            valid_lft forever preferred_lft forever
```

Create and Configure a Storage Area Network (SAN) with RAID 6 and an iSCSI Target

Spool up a new Windows server VM named **434-SAN**. You can change network settings in SConfig or use the script below:

```
$IP = Read-Host -Prompt 'Input your IP Address'
$MaskBits = 28 # This means subnet mask = 255.255.255.240
$Gateway = "192.168.10.14"
$Dns = "192.168.10.1,192.168.10.2"
$IPType = "IPv4"

# Retrieve the network adapter that you want to configure
$adapter = Get-NetAdapter | ? {$_.Status -eq "up"}

# Remove any existing IP, gateway from our ipv4 adapter
If (($adapter | Get-NetIPConfiguration).IPv4Address.IPAddress) {
    $adapter | Remove-NetIPAddress -AddressFamily $IPType -Confirm:$false
}

If (($adapter | Get-NetIPConfiguration).Ipv4DefaultGateway) {
    $adapter | Remove-NetRoute -AddressFamily $IPType -Confirm:$false
}

# Configure the IP address and default gateway
$adapter | New-NetIPAddress `
```

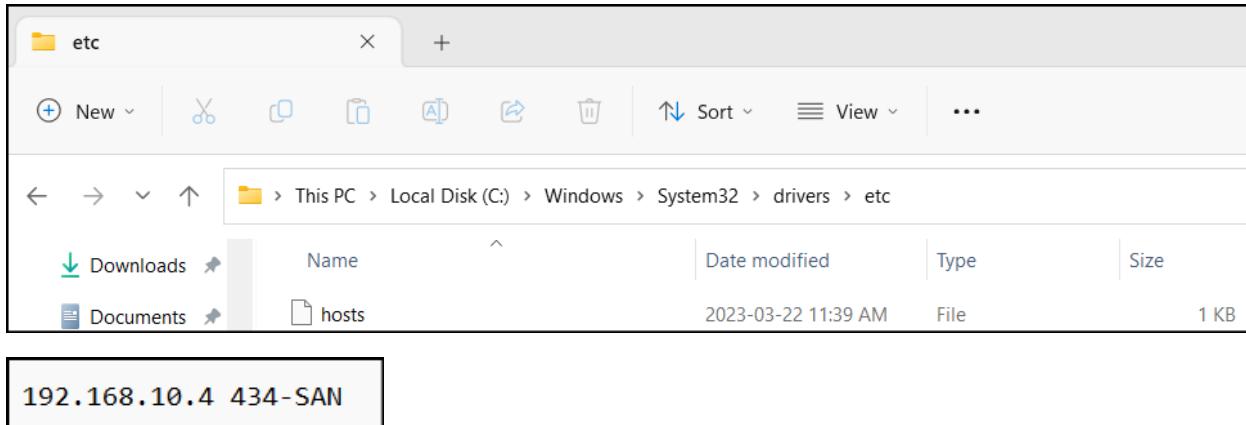
CAPSTONE PROJECT

```
-AddressFamily $IPType  
-IPAddress $IP  
-PrefixLength $MaskBits  
-DefaultGateway $Gateway  
# Configure the DNS client server IP addresses  
$adapter | Set-DnsClientServerAddress -ServerAddresses $DNS
```

Rename the NIC, computer, and local administrator username. Reboot.

```
Rename-NetAdapter -Name "Ethernet" -NewName "LAN"  
Rename-Computer -NewName "434-SAN"  
Rename-LocalUser -Name "Administrator" -NewName "_LSysadmin"  
Restart-Computer -Force
```

To manage **SAN** not joined to domain in Server Manager, there are several steps to follow. First, open notepad as administrator and open hosts file in **C:\Windows\System32\Drivers\etc\hosts**. Add DNS record and save the change.



Open PowerShell as administrator on the host and run the command **Enable-PSRemoting**. This enables required WinRM service. Very likely, it is already set up and enabled if you have been using Hyper-V.

```
PS C:\WINDOWS\system32> Enable-PSRemoting
WinRM is already set up to receive requests on this computer.
WinRM is already set up for remote management on this computer.
PS C:\WINDOWS\system32>
```

CAPSTONE PROJECT

Run the command **Get-Item WSMAN:\localhost\Client\TrustedHosts** to see the list of trusted hosts. If you have an old entry, clear it with the command **Clear-Item WSMAN:\localhost\Client\TrustedHosts -Force**.

```
PS C:\WINDOWS\system32> Get-Item WSMAN:\localhost\Client\TrustedHosts

WSManConfig: Microsoft.WSMAN.Management\WSMAN::localhost\Client

Type          Name          SourceOfValue  Value
----          --          -----        -----
System.String TrustedHosts           *.*.yoo.int
```

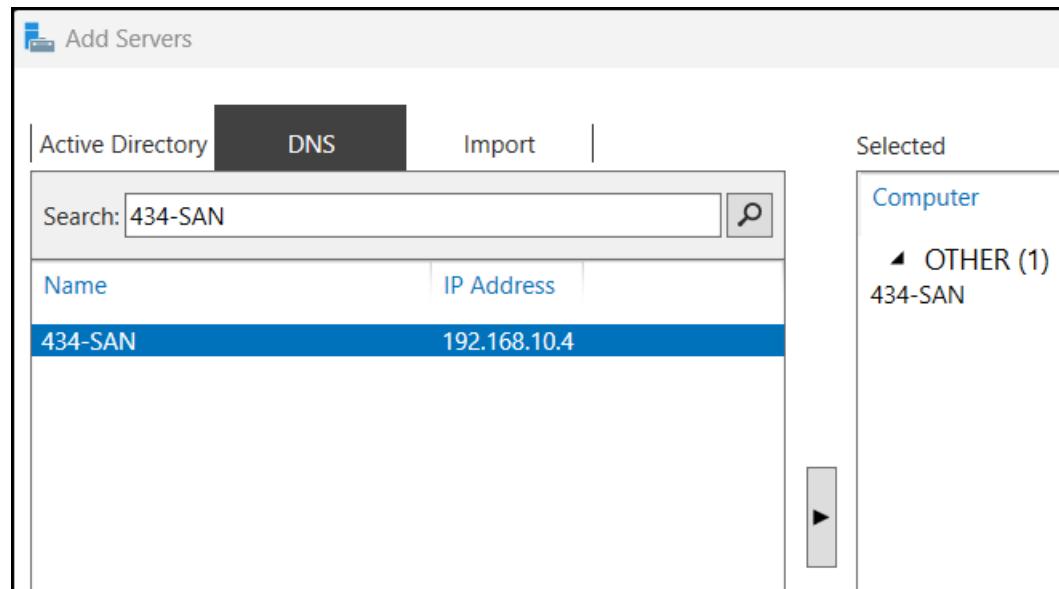
```
PS C:\WINDOWS\system32> Clear-Item WSMAN:\localhost\Client\TrustedHosts -Force
```

Type the command **Set-Item WSMAN:\localhost\Client\TrustedHosts -Value [name of your SAN]** to add your SAN to the trusted hosts list.

```
PS C:\WINDOWS\system32> Set-Item WSMAN:\localhost\Client\TrustedHosts -Value 434-SAN

WinRM Security Configuration.
This command modifies the TrustedHosts list for the WinRM client. The computers in the TrustedHosts list might not be authenticated. The client might send credential information to these computers. Are you sure that you want to modify this list?
[Y] Yes  [N] No  [S] Suspend  [?] Help (default is "Y"): y
PS C:\WINDOWS\system32>
```

In Server Manager, add a new server **SAN** via DNS search.



CAPSTONE PROJECT

Right-click **SAN** in the server list and click **Manage As** to provide credentials.

The screenshot shows the Windows Server Manager interface. On the left, the navigation pane includes links for Dashboard, All Servers (which is selected and highlighted in blue), AD DS, DNS, and File and Storage Services. The main area is titled 'SERVERS' and shows a list of 'All servers | 2 total'. The list contains two entries: '434-DC1' and '434-SAN'. The '434-SAN' entry is selected and highlighted in blue. A context menu is open over this entry, listing options: 'Add Roles and Features', 'Restart Server', 'Computer Management', 'Remote Desktop Connection', 'Windows PowerShell', 'Configure NIC Teaming', and 'Manage As ...'. The 'Manage As ...' option is currently highlighted with a blue border.

Enter administrative user account for your **SAN** VM, check **Remember me**, and click **OK**.



CAPSTONE PROJECT

You are authenticated.

434-DC1	192.168.10.1	Online - Performance counters not started
434-SAN	192.168.10.4	Online - Performance counters not started

Open Powershell as administrator on the **Host** (not on your **SAN**) and run the command **New-VHD -Path V:\VMs\VHDX\434-SAN_Storage1.vhdx -SizeBytes 30GB** to create a new dynamic 30GB virtual disk named **434-SAN_Storage1**. Make 7 disks with different names.

434-SAN_Storage1	2023-03-22 1:53 PM	Hard Disk Image F...	4,096 KB
434-SAN_Storage2	2023-03-22 1:54 PM	Hard Disk Image F...	4,096 KB
434-SAN_Storage3	2023-03-22 1:54 PM	Hard Disk Image F...	4,096 KB
434-SAN_Storage4	2023-03-22 1:54 PM	Hard Disk Image F...	4,096 KB
434-SAN_Storage5	2023-03-22 1:54 PM	Hard Disk Image F...	4,096 KB
434-SAN_Storage6	2023-03-22 1:54 PM	Hard Disk Image F...	4,096 KB
434-SAN_Storage7	2023-03-22 1:54 PM	Hard Disk Image F...	4,096 KB

Use this command to attach one newly created disk to your **SAN VM**:

Add-VMHardDiskDrive -VMName 434-SAN -Path V:\VMs\VHDX\434-SAN_Storage1.vhdx

Attah seven disks to **SAN VM**.

```
PS C:\WINDOWS\system32> Add-VMHardDiskDrive -VMName 434-SAN -Path V:\VMs\VHDX\434-SAN_Storage1.vhdx
PS C:\WINDOWS\system32> Add-VMHardDiskDrive -VMName 434-SAN -Path V:\VMs\VHDX\434-SAN_Storage2.vhdx
PS C:\WINDOWS\system32> Add-VMHardDiskDrive -VMName 434-SAN -Path V:\VMs\VHDX\434-SAN_Storage3.vhdx
PS C:\WINDOWS\system32> Add-VMHardDiskDrive -VMName 434-SAN -Path V:\VMs\VHDX\434-SAN_Storage4.vhdx
PS C:\WINDOWS\system32> Add-VMHardDiskDrive -VMName 434-SAN -Path V:\VMs\VHDX\434-SAN_Storage5.vhdx
PS C:\WINDOWS\system32> Add-VMHardDiskDrive -VMName 434-SAN -Path V:\VMs\VHDX\434-SAN_Storage6.vhdx
PS C:\WINDOWS\system32> Add-VMHardDiskDrive -VMName 434-SAN -Path V:\VMs\VHDX\434-SAN_Storage7.vhdx
```

To create a RAID vDisk that will survive 2-disks failure, first, open Server Manager and go to **File and Storage Services -> Volumes -> Disks**. Bring the disks **online**.

0	Online	127 GB	1.00 MB	GPT		SAS	Msft Virtual Disk
1	Offline	30.0 GB	30.0 GB	Unknown	✓	SAS	Msft Virtual Disk
2	Offline	30.0 GB	30.0 GB	Unknown	✓	SAS	Msft Virtual Disk
3	Offline	30.0 GB	30.0 GB	Unknown	✓	SAS	Msft Virtual Disk
4	Offline	30.0 GB	30.0 GB	Unknown	✓	SAS	Msft Virtual Disk
5	Offline	30.0 GB	30.0 GB	Unknown	✓	SAS	Msft Virtual Disk
6	Offline	30.0 GB	30.0 GB	Unknown	✓	SAS	Msft Virtual Disk
7	Offline	30.0 GB	30.0 GB	Unknown	✓	SAS	Msft Virtual Disk

CAPSTONE PROJECT

Now, go to **Storage Pools**, right-click the white space under **STORAGE POOLS** pane, and select **New Storage Pool**.

The screenshot shows the 'File and Storage Services' interface with 'Volumes' selected in the navigation bar. The left sidebar has 'Storage Pools' selected. The main pane displays a table titled 'STORAGE POOLS' with one item: 'Windows Storage (1)' which is 'Primordial' and managed by '434-SAN'.

Name the pool **Production**.

The screenshot shows the 'New Storage Pool Wizard' with 'Storage Pool Name' selected. The 'Name' field is set to 'Production'. The 'Description' field is empty. Below it, a table lists available disks: 'Managed by' '434-SAN', 'Available to' '434-SAN', 'Subsystem' 'Windows Storage', and 'Primordial Pool' 'Primordial'.

Select the disks.

The screenshot shows the 'Select physical disks for the storage pool' step. It lists several 'Msft Virtual Disk...' entries, all checked, with a total capacity of 210 GB selected. The 'Physical disks' table has columns: Slot, Name, Capacity, Bus, RPM, Model, Allocation, and Chassis.

CAPSTONE PROJECT

Create the pool.

View results

Before You Begin
Storage Pool Name
Physical Disks
Confirmation
Results

You have successfully completed the New Storage Pool Wizard.

Task	Progress	Status
Gather information	<div style="width: 100%;"></div>	Completed
Create storage pool	<div style="width: 100%;"></div>	Completed
Update cache	<div style="width: 100%;"></div>	Completed

Type **New-VirtualDisk -StoragePoolFriendlyName "Production" -FriendlyName "VMStorage" -Size 100GB -ProvisioningType Fixed -ResiliencySettingName "Parity" -PhysicalDiskRedundancy 2 -NumberOfColumns 7** to create vDisk from **PowerShell** (on SAN, not your host) instead of using GUI. (Windows Server 2022 seems to have a bug where creating vDisk in Server Manager fails always.)

```
WARNING: To launch Server Configuration tool again, run "SConfig"
PS C:\Users\Administrator> New-VirtualDisk -StoragePoolFriendlyName "Production" -FriendlyName "VMStorage" -Size 100GB -ProvisioningType Fixed -ResiliencySettingName "Parity" -PhysicalDiskRedundancy 2 -NumberOfColumns 7

FriendlyName ResiliencySettingName FaultDomainRedundancy OperationalStatus HealthStatus Size FootprintOnPool StorageEfficiency
----- -----
VMstorage Parity 2 OK Healthy 100 GB 145.25 GB 68.85%

```

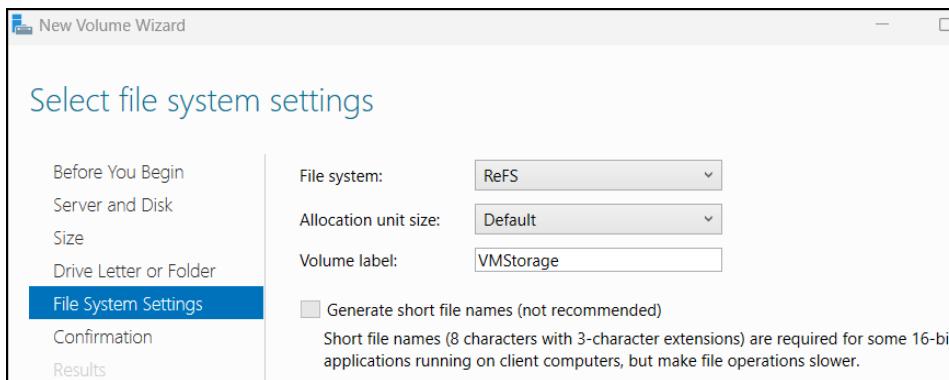
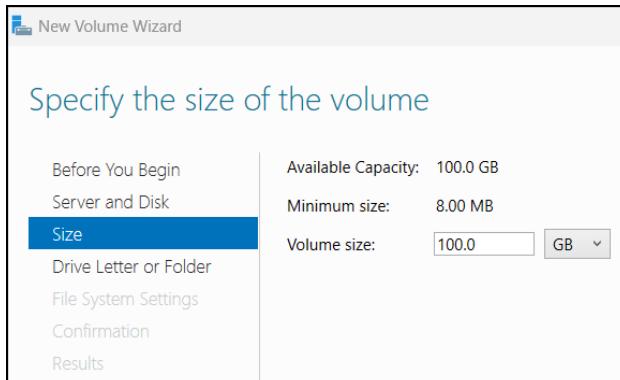
PS C:\Users\Administrator>

A new virtual disk is displayed after refresh. Make a new Volume on **VMStorage** vDisk. (Bring disk online -> Initialize -> Create a new volume; all can be done by right-clicking virtual drive in Server Manager.) Assign default drive letter, choose **ReFS** for file system, and name the Volume **VMStorage**.

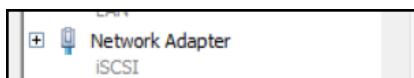
DISKS
All disks | 4 total

Number	Virtual Disk	Status	Capacity	Unallocated	Partition	Rea...	Cluste...	Subsystem	Bus Type	Name
0	434-DC1 (2)	Online	127 GB	1.00 MB	GPT			SAS		Msft Virtual Disk
1		Online	20.0 GB	0.00 B	GPT			SAS		Msft Virtual Disk
0	434-SAN (2)	Online	127 GB	1.00 MB	GPT			SAS		Msft Virtual Disk
8	VMStorage	Offline	100 GB	100 GB	Unknown ✓		Windows S...	Storage Spaces		VMStorage

CAPSTONE PROJECT



You will need to attach another network adapter to **SAN** for iSCSI communication. Connect this NIC to iSCSI virtual switch.



Rename the adapter to **iSCSI**.

```
PS C:\Users\Administrator> Get-NetConnectionProfile

Name          : Unidentified network
InterfaceAlias : Ethernet
InterfaceIndex : 10
NetworkCategory : Public
IPv4Connectivity : NoTraffic
IPv6Connectivity : NoTraffic

Name          : Network
InterfaceAlias : LAN
InterfaceIndex : 6
NetworkCategory : Public
IPv4Connectivity : Internet
IPv6Connectivity : NoTraffic

PS C:\Users\Administrator> Rename-NetAdapter -Name Ethernet -NewName iSCSI
```

CAPSTONE PROJECT

Assign static IP address and subnet mask according to your network with the command **New-NetIPAddress -InterfaceAlias iSCSI -IPAddress 192.168.20.1 -PrefixLength 29.**

```
PS C:\Users\Administrator> New-NetIPAddress -InterfaceAlias iSCSI -IPAddress 192.168.20.1 -PrefixLength 29

IPAddress      : 192.168.20.1
InterfaceIndex : 10
InterfaceAlias : iSCSI
AddressFamily   : IPv4
Type           : Unicast
PrefixLength    : 29
PrefixOrigin    : Manual
SuffixOrigin    : Manual
AddressState    : Tentative
ValidLifetime   : Infinite ([TimeSpan]::MaxValue)
PreferredLifetime : Infinite ([TimeSpan]::MaxValue)
SkipAsSource    : False
PolicyStore     : ActiveStore
```

We need to enable **Jumbo Packet** for iSCSI connection. Type **Get-NetAdapterAdvancedProperty -Name iSCSI** to check the current advanced settings for iSCSI NIC.

```
PS C:\Users\Administrator> Get-NetAdapterAdvancedProperty -Name iSCSI

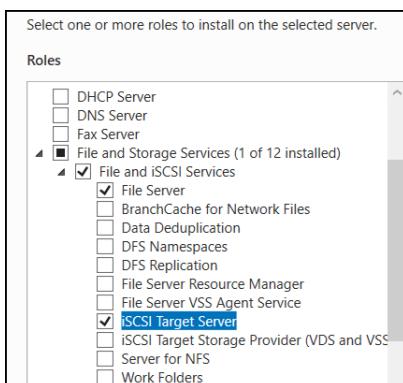
Name          DisplayName          RegistryKeyword RegistryValue
---          -----
iSCSI         IPv4 Checksum Offload *IPChecksum0... {3}
iSCSI         IPSec Offload       *IPsecOffloadV2 {3}
iSCSI         Jumbo Packet       *JumboPacket    {1514}
```

Use **Set-NetAdapterAdvancedProperty -Name iSCSI -RegistryKeyword *JumboPacket -Registryvalue 9014** to change Jumbo Packet settings.

```
PS C:\Users\Administrator> Set-NetAdapterAdvancedProperty -Name iSCSI -RegistryKeyword *JumboPacket -Registryvalue 9014
PS C:\Users\Administrator> Get-NetAdapterAdvancedProperty -Name iSCSI

Name          DisplayName          RegistryKeyword RegistryValue
---          -----
iSCSI         IPv4 Checksum Offload *IPChecksum0... {3}
iSCSI         IPSec Offload       *IPsecOffloadV2 {3}
iSCSI         Jumbo Packet       9014 Bytes        *JumboPacket    {9014}
```

Open Server Manager and install a new Role **iSCSI Target Server** and required features on SAN.



CAPSTONE PROJECT

Create a new iSCSI virtual disk in Server Manager.

The screenshot shows the 'Server Manager' interface with the navigation path: 'File and Storage Services > iSCSI'. On the left, a sidebar lists 'Servers', 'Volumes', 'Disks', 'Storage Pools', 'Shares', 'iSCSI' (which is selected and highlighted in blue), and 'Work Folders'. The main content area is titled 'iSCSI VIRTUAL DISKS' and displays the message 'All iSCSI virtual disks | 0 total'. It also includes the text 'There are no iSCSI virtual disks.' and 'To create an iSCSI virtual disk, start the New iSCSI Virtual Disk Wizard.'

The iSCSI Virtual Disk Wizard opens. Pick your vDrive.

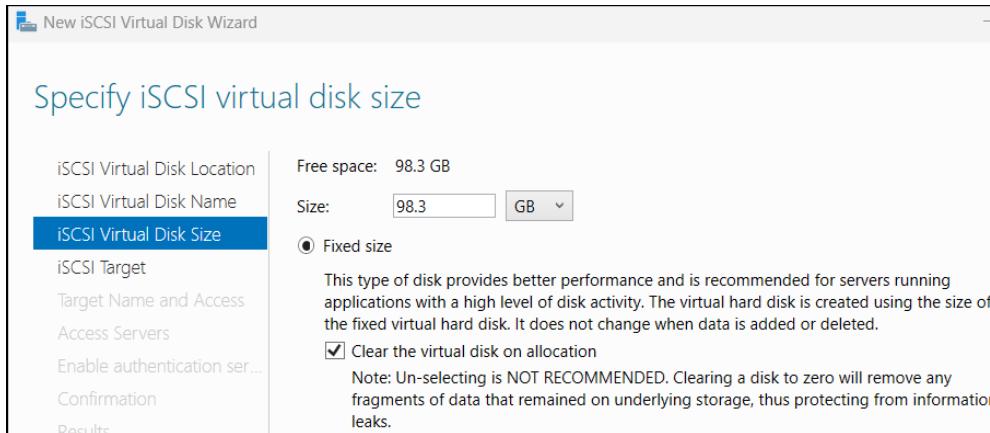
This screenshot shows the 'Select by volume' step of the iSCSI Virtual Disk Wizard. The heading is 'Storage location:' followed by a radio button labeled 'Select by volume:'. A table lists two volumes: 'C:' with 117 GB free space, 126 GB capacity, and NTFS file system, and 'D:' with 98.3 GB free space, 99.9 GB capacity, and ReFS file system. Below the table, a note states: 'The iSCSI virtual disk will be saved at \iSCSIVirtualDisk on the selected volume.'

Name the disk **VMStorage**.

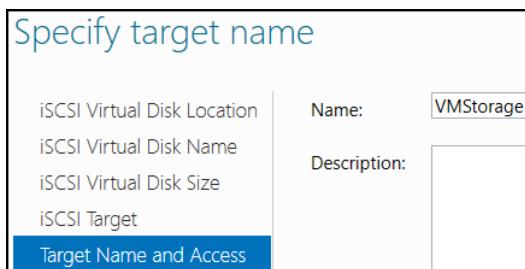
This screenshot shows the 'Specify iSCSI virtual disk name' step. On the left, a sidebar lists 'iSCSI Virtual Disk Location', 'iSCSI Virtual Disk Name' (which is selected and highlighted in blue), 'iSCSI Virtual Disk Size', 'iSCSI Target', 'Target Name and Access', 'Access Servers', 'Enable authentication ser...', 'Confirmation', and 'Results'. The main panel has fields for 'Name:' (containing 'VMStorage'), 'Description:' (empty), and 'Path:' (containing 'D:\iSCSIVirtualDisks\VMStorage.vhdx').

CAPSTONE PROJECT

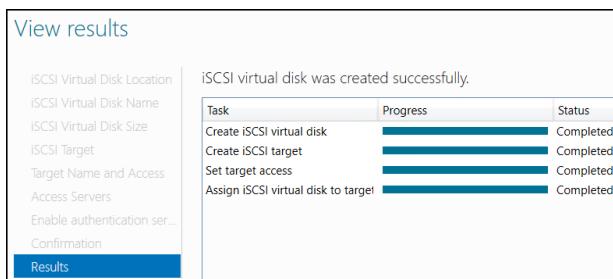
Choose **Fixed size**.



Create a new iSCSI target and name it **VMStorage**.



Add the IP addresses of upcoming **HyperV** Servers (Initiators).



CAPSTONE PROJECT

The screenshot shows a table of iSCSI virtual disks. The columns are Path, Status, Virtual Disk Status, Target Name, Target Status, Initiator ID, and Size. One entry is visible:

Path	Status	Virtual Disk Status	Target Name	Target Status	Initiator ID	Size
D:\iSCSVirtualDisks\VMStorage.vhdx	Clearing (85%)	Unknown	vmstorage	Not Connected	IPAddress:192.168.20.2, IPAddress:192.168.20.3	98.3 GB

You need to create another iSCSI disk as a quorum witness for a failover cluster. You are going to make another iSCSI disk in **SAN** and It does not need to be big (I assign 5GB generously). General process is identical to making **VMStorage**.

```
Administrator: C:\Windows\system32\cmd.exe
WARNING: To launch Server Configuration tool again, run "SConfig"
PS C:\Users\Administrator> New-VirtualDisk -StoragePoolFriendlyName "Production" -FriendlyName "HyperWitness" -Size 5GB
-ProvisioningType Fixed -ResiliencySettingName "Parity" -PhysicalDiskRedundancy 2 -NumberOfColumns 7

FriendlyName ResiliencySettingName FaultDomainRedundancy OperationalStatus HealthStatus Size FootprintOnPool StorageEfficiency
----- -----
HyperWitness Parity 2 OK Healthy 5 GB 12.25 GB 40.82%
PS C:\Users\Administrator>
```

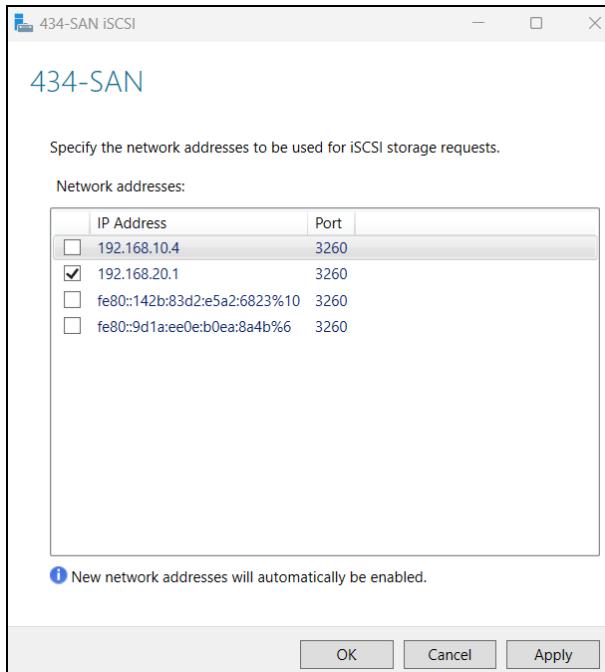
The screenshot shows the 'File System Settings' step of the New Volume Wizard. The left pane lists steps: Before You Begin, Server and Disk, Size, Drive Letter or Folder, File System Settings (selected), Confirmation, and Results. The right pane shows settings for a ReFS file system, allocation unit size (Default), volume label (Witness), and a note about generating short file names.

Choose Existing iSCSI target **VMStorage**.

The screenshot shows the 'Assign iSCSI target' step of the New iSCSI Virtual Disk Wizard. The left pane lists steps: iSCSI Virtual Disk Location, iSCSI Virtual Disk Name, iSCSI Virtual Disk Size, iSCSI Target (selected), Confirmation, and Results. The right pane shows the 'Existing iSCSI target' option selected, listing a target named 'vmstorage' with the description 'IPAddress:192.168.20.2, IPAddress:19...'. There is also a note about assigning the disk to an existing target.

CAPSTONE PROJECT

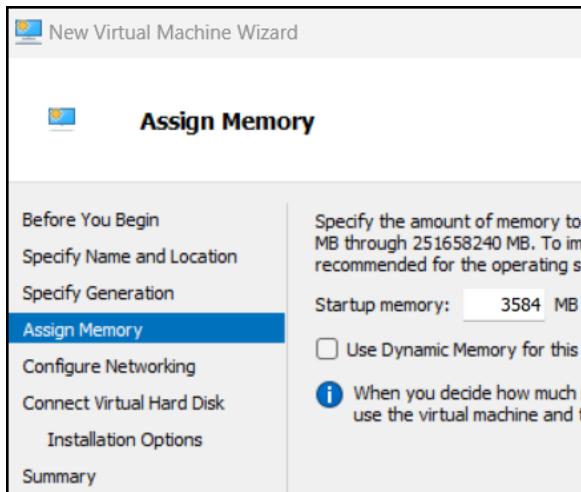
In Server Manager, go to **File and Storage Services -> Servers** and right-click **SAN**. Select **iSCSI Target Settings** and check only IPv4 address in the iSCSI network.



All the settings in **SAN** are finished. Shutdown the VM, reduce RAM, and reboot.

Create Server Core Nested Hyper-V Hosts

Create a new Server Core VM which will be your first of two nested Hyper-V Servers (**HyperV1**). This VM must handle three Server Core VMs and Live Migration along with its own OS. Assign as much RAM as you can without causing bottleneck on your host machine. I personally gave 3.5 GB (**3584 MB**).



CAPSTONE PROJECT

Initial configuration is identical to other Core VMs. **DO NOT** start the VM yet. Since this will be **nested** hypervisor, you need to extend virtualization capabilities of your top-level hypervisor (Hyper-V on the host machine). Open PowerShell as administrator on the **HOST** and run this command:

```
Set-VMProcessor -VMName 434-HyperV1 -ExposeVirtualizationExtensions $true
```

```
| PS C:\WINDOWS\system32> Set-VMProcessor -VMName 434-HyperV1 -ExposeVirtualizationExtensions $true
| PS C:\WINDOWS\system32>
```

Start the VM and do post installation tasks.

Assign static IP address for **LAN** connection.

```
NIC index:      1
Description:    Microsoft Hyper-V Network Adapter
IP address:    192.168.10.5,
                fe80::85d7:1c48:d611:b6c1
Subnet mask:   255.255.255.240
DHCP enabled:  False

Default gateway:    192.168.10.14
Preferred DNS server: 192.168.10.1
Alternate DNS server: 192.168.10.2

1) Set network adapter address
2) Set DNS servers
3) Clear DNS server settings

Enter selection (Blank=Cancel): ■
```

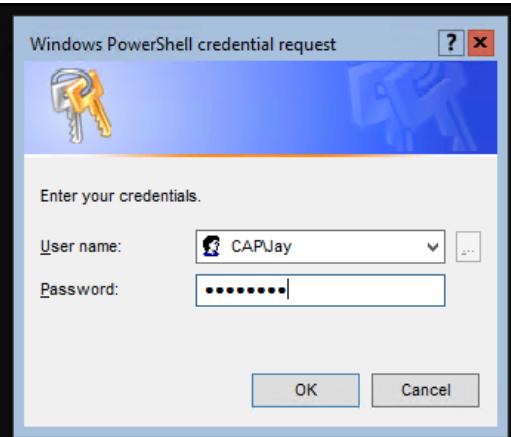
Rename NIC, local administrator, and computer. Restart the VM.

```
WARNING: To launch Server Configuration tool again, run "SConfig"
PS C:\Users\Administrator> Rename-NetAdapter -Name Ethernet -NewName LAN
PS C:\Users\Administrator> Rename-Computer -NewName "434-HyperV1"
WARNING: The changes will take effect after you restart the computer WIN-P93VCT3H02V.
PS C:\Users\Administrator> Rename-LocalUser -Name "Administrator" -NewName "_LSysadmin"
PS C:\Users\Administrator> Restart-Computer -Force■
```

CAPSTONE PROJECT

Join it to domain. Type \$cred = Get-Credential Jay to save credential to a variable. Provide a domain administrator username and password.

```
PS C:\Users\Administrator> $cred = Get-Credential Jay
```



Use the command **Add-Computer -DomainName CAP.TSP -Credential \$cred -OUPath (Read-Host -Prompt 'What OU e.g OU=Servers,DC=TSP,DC=INT')** to join the VM to the domain. Provide OU path information. (Under my OU structure, it is **OU=HyperV,OU=Servers,DC=CAP,DC=TSP**). Restart the VM to finish joining to the domain.

```
PS C:\Users\Administrator> Add-Computer -DomainName CAP.TSP -Credential $cred -OUPath (Read-Host -Prompt 'What OU e.g OU=Servers,DC=TSP,DC=INT')  
What OU e.g OU=Servers,DC=TSP,DC=INT: OU=HyperV,OU=Servers,DC=CAP,DC=TSP
```

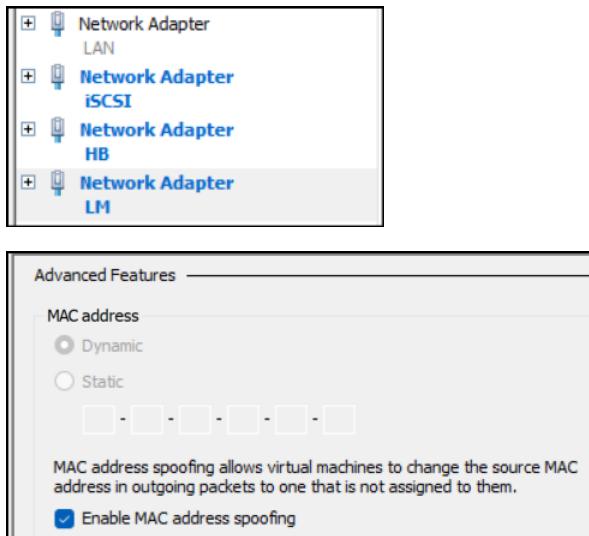
Check ADUC. Follow same procedures for the second HyperV Server.

A screenshot of the Active Directory Users and Computers (ADUC) management console. The left pane shows a tree view of the directory structure under "Active Directory Users and Computers". The "Servers" node is expanded, showing "DHCP", "FileServer", and "HyperV" sub-nodes. The right pane displays a table with two computer objects:

Name	Type
434-HYPERV1	Computer
434-HYPERV2	Computer

CAPSTONE PROJECT

Before making them Hyper-V Servers, attach 3 more NICs to each VM from Hyper-V VM settings. Attach each adapter to different switches. Expand Network Adapter sections connected to **LAN** and **HB**, click **Advanced Features**, and enable **Mac address spoofing**. These two adapters will have to be used by nested VMs as well, therefore, this is mandatory.



From **HyperV1**, use the command **Get-NetConnectionProfile** to collect **InterfaceAlias** parameter information.

```
PS C:\Users\Jay> Get-NetConnectionProfile

Name          : CAP.TSP
InterfaceAlias : LAN
InterfaceIndex : 3
NetworkCategory : DomainAuthenticated
IPv4Connectivity : Internet
IPv6Connectivity : NoTraffic

Name          : Unidentified network
InterfaceAlias : Ethernet
InterfaceIndex : 10
NetworkCategory : Public
IPv4Connectivity : NoTraffic
IPv6Connectivity : NoTraffic

Name          : Unidentified network
InterfaceAlias : Ethernet 2
InterfaceIndex : 14
NetworkCategory : Public
IPv4Connectivity : NoTraffic
IPv6Connectivity : NoTraffic

Name          : Unidentified network
InterfaceAlias : Ethernet 3
InterfaceIndex : 18
NetworkCategory : Public
IPv4Connectivity : NoTraffic
```

CAPSTONE PROJECT

Use the command **Rename-NetAdapter -Name "[current_InterfaceAlias]" -NewName [name_matching_connected_switch]** to rename NICs.

```
Name          : CAP.TSP
InterfaceAlias : LAN
InterfaceIndex : 3
NetworkCategory : DomainAuthenticated
IPv4Connectivity : Internet
IPv6Connectivity : NoTraffic

Name          : Unidentified network
InterfaceAlias : iSCSI
InterfaceIndex : 10
NetworkCategory : Public
IPv4Connectivity : NoTraffic
IPv6Connectivity : NoTraffic

Name          : Unidentified network
InterfaceAlias : HB
InterfaceIndex : 14
NetworkCategory : Public
IPv4Connectivity : NoTraffic
IPv6Connectivity : NoTraffic

Name          : Unidentified network
InterfaceAlias : LM
InterfaceIndex : 18
NetworkCategory : Public
IPv4Connectivity : NoTraffic
IPv6Connectivity : NoTraffic
```

For **iSCSI** NIC, enable jumbo packets.

```
Set-NetAdapterAdvancedProperty -Name iSCSI -RegistryKeyword *JumboPacket -Registryvalue 9014
```

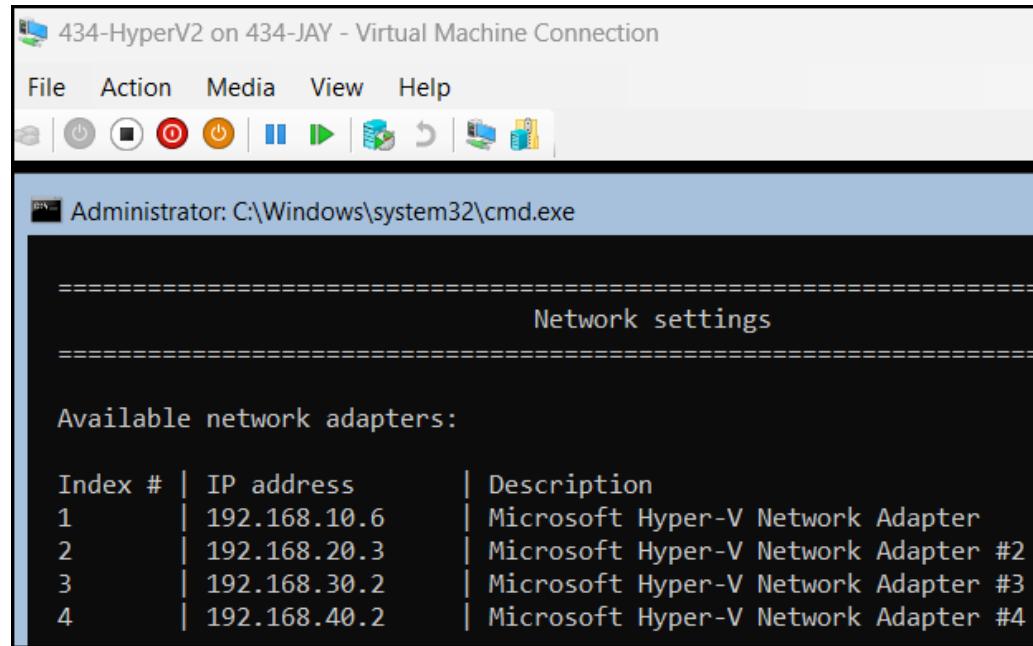
Use the command **New-NetIPAddress -InterfaceAlias iSCSI -IPAddress 192.168.20.2 -PrefixLength 29** to assign static IP.

CAPSTONE PROJECT

Do the same for NICs connected to **HB** and **LM** by changing parameters in the command above. Type **ipconfig** to check IP settings.

```
Ethernet adapter iSCSI:  
  
Connection-specific DNS Suffix . :  
Link-local IPv6 Address . . . . . : fe80::daf:f058:c8c2:6884%10  
IPv4 Address. . . . . : 192.168.20.2  
Subnet Mask . . . . . : 255.255.255.248  
Default Gateway . . . . . :  
  
Ethernet adapter HB:  
  
Connection-specific DNS Suffix . :  
Link-local IPv6 Address . . . . . : fe80::a199:7d98:ef3:cd6f%14  
IPv4 Address. . . . . : 192.168.30.1  
Subnet Mask . . . . . : 255.255.255.248  
Default Gateway . . . . . :  
  
Ethernet adapter LM:  
  
Connection-specific DNS Suffix . :  
Link-local IPv6 Address . . . . . : fe80::d19b:744b:cc84:c603%18  
IPv4 Address. . . . . : 192.168.40.1  
Subnet Mask . . . . . : 255.255.255.252  
Default Gateway . . . . . :
```

Follow these steps of attaching and configuring NICs for your second Hyper-V Server.



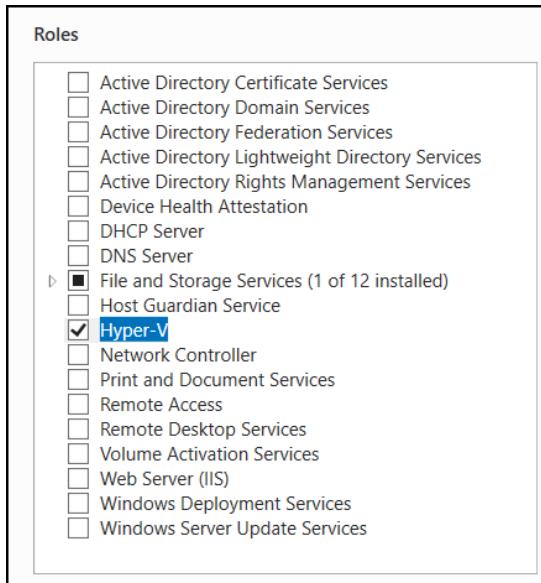
CAPSTONE PROJECT

Open each console for **SAN**, **HyperV1**, and **HyperV2** and enable inbound ping requests for connectivity testing, with the command:

```
Netsh advfirewall firewall add rule name="ICMP Allow incoming V4 echo request"  
protocol=icmpv4:8,any dir=in action=allow
```

(This command will fail if you try from the host machine through SSH.)

Add Hyper-V servers in Server Manager on the host machine and install **Hyper-V** role.

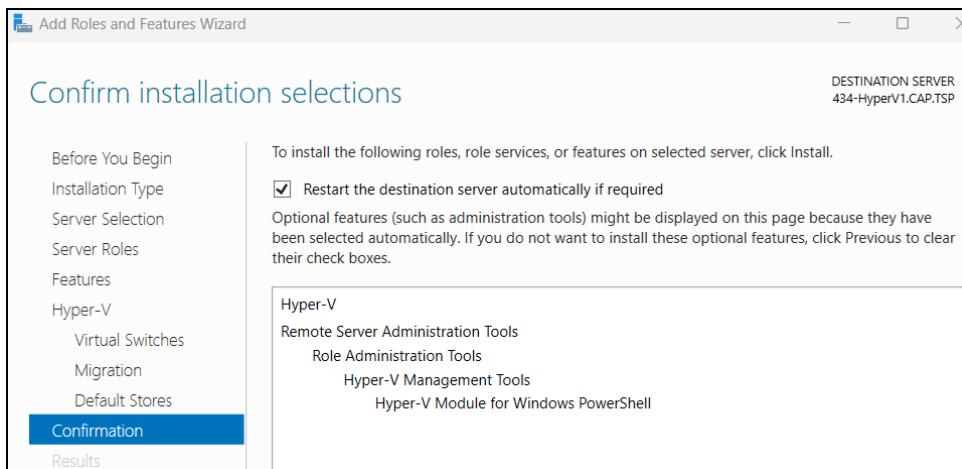
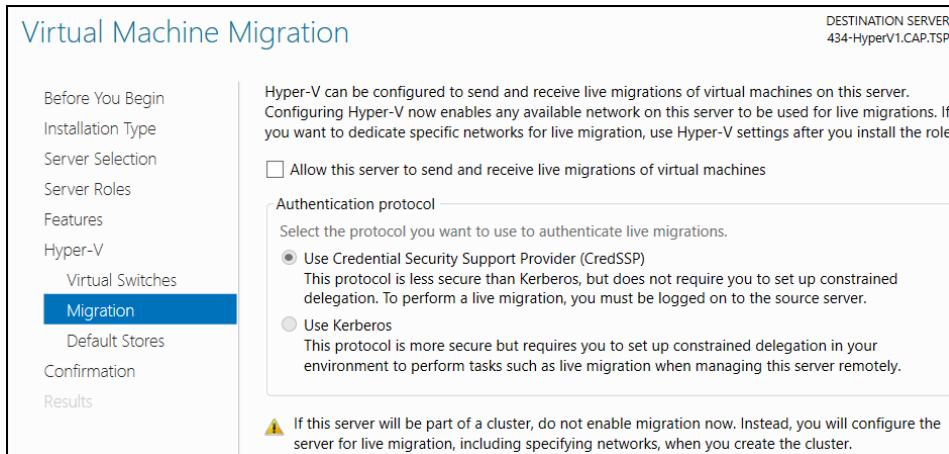


You can check LAN and HB now to automatically create an external virtual switch for each NICs, you can also do it using the **Virtual Switch Manager**. I chose to do it later manually.

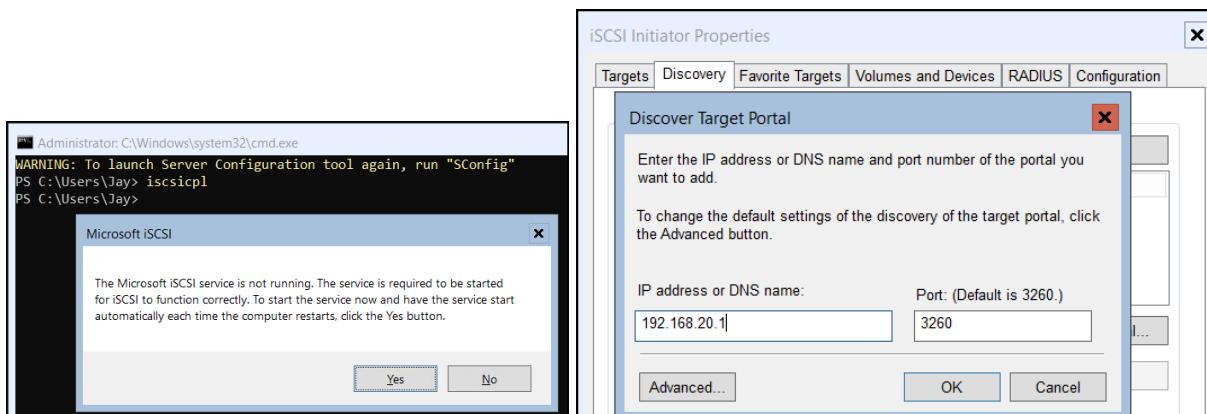
The screenshot shows the 'Create Virtual Switches' wizard. The left sidebar lists steps: Before You Begin, Installation Type, Server Selection, Server Roles, Features, Hyper-V, **Virtual Switches** (selected), Migration, Default Stores, Confirmation, and Results. The right pane displays information about virtual switches and a list of network adapters. It states that virtual machines require virtual switches to communicate with other computers. One virtual switch will be created for each network adapter selected. It also recommends creating at least one virtual switch now to provide virtual machines with connectivity to a physical network. Below this, a table shows network adapters: LAN (Microsoft Hyper-V Network Adapter) and iSCSI (Microsoft Hyper-V Network Adapter). A note at the bottom says: 'We recommend that you reserve one network adapter for remote access to this server. To reserve a network adapter, do not select it for use with a virtual switch.'

CAPSTONE PROJECT

Make sure allowing live migration option is **UNCHECKED**. The reason is shown at the bottom of the Wizard. Finish installing the role and do the same for **HyperV2**.

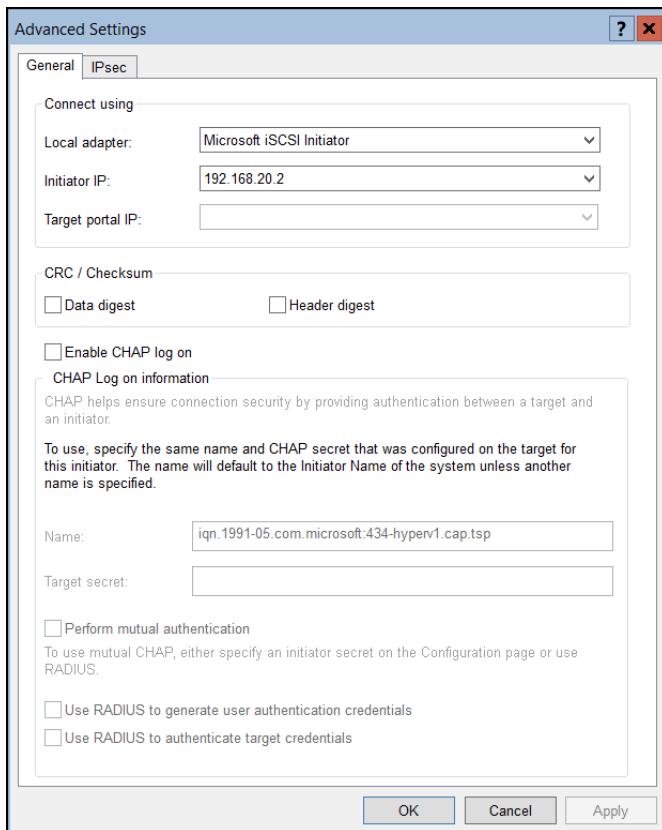


iSCSI Initiator role is pre-installed by default for all Windows servers. Open the console for **HyperV1** and use the command **iscsicpl** to start iSCSI Initiator setup. Select the **Discovery** tab and click **Discover Portal**. Put in the IP address of the **SAN** and click **Advanced**.

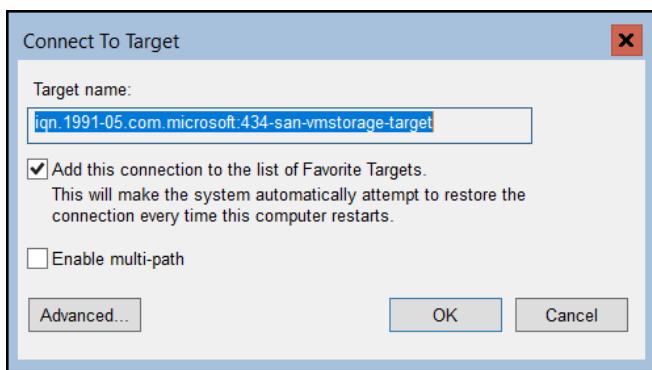


CAPSTONE PROJECT

In the **Advanced Settings**, select **Microsoft iSCSI Initiator** and type in the **Initiator IP**, which is 192.168.20.2 in this case. Click **OK** twice.



Select **Targets** tab and click **Connect -> OK**. If the connection fails, restart the Storage Server (SAN) or restart the iSCSI Target Service. Make sure that the target is connected before you move on. Close **iSCSI Initiator Properties** window.



Name	Status
iqn.1991-05.com.microsoft:434-san-vmstorage-target	Connected

CAPSTONE PROJECT

Go to **File and Storage Services -> Disks** tab in Server Manager. You will see two iSCSI disks. Bring them online, initialize, and create each of them into a new volume. Choose **NTFS** file system.

DISKS								
All disks 9 total								
Number	Virtual Disk	Status	Capacity	Unallocated	Partition	Rea...	Cluste...	Subsystem
▲ 434-HyperV1 (3)								
0	Online	127 GB	1.00 MB	GPT			SAS	Msft Virtual Disk
1	Offline	98.3 GB	98.3 GB	Unknown	✓		iSCSI	MSFT Virtual HD
2	Offline	3.90 GB	3.90 GB	Unknown	✓		iSCSI	MSFT Virtual HD

File system: **NTFS**

Allocation unit size: **Default**

Volume label: **VMStorage**

Generate short file names (not recommended)
Short file names (8 characters with 3-character extensions) are required for some 16-bit applications running on client computers, but make file operations slower.

Click **Volumes** in the left pane of Server Manager to check that new volumes are created.

VOLUMES								
All volumes 17 total								
▲	Volume	Status	File System	Label	Provisioning	Capacity	Free Space	Deduplication Rate
▲ 434-HyperV1 (5)								
\?\Volume{60...	Fixed	96.0 MB	68.2 MB					
\?\Volume{80...	Fixed	524 MB	83.0 MB					
C:	Fixed	126 GB	117 GB					
D:	VMStorage	Fixed	98.3 GB	98.2 GB				
E:	HyperVWitness	Fixed	3.88 GB	3.86 GB				

CAPSTONE PROJECT

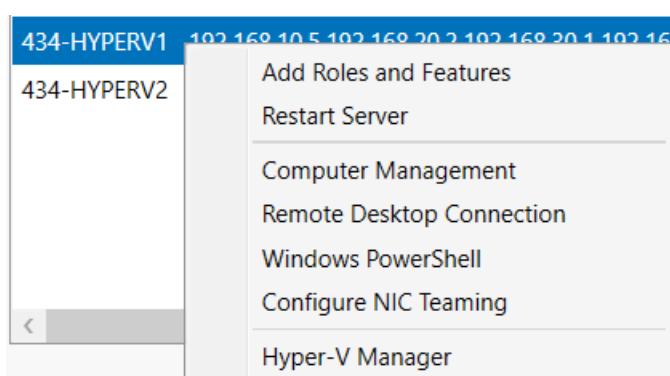
Follow the same process of setting up iSCSI initiator for **HyperV2**. You **DO NOT** initialize and format the disk from **HyperV2**. By design only one server can write to a volume at a time. The disk only needs to be attached.

434-HyperV1 (3)						
0	Online	127 GB	1.00 MB	GPT	SAS	Msft Virtual Disk
1	Online	98.3 GB	0.00 B	GPT	iSCSI	MSFT Virtual HD
2	Online	3.90 GB	0.00 B	GPT	iSCSI	MSFT Virtual HD
434-HyperV2 (3)						
0	Online	127 GB	1.00 MB	GPT	SAS	Msft Virtual Disk
1	Offline	98.3 GB	0.00 B	GPT	✓	iSCSI
2	Offline	3.90 GB	0.00 B	GPT	✓	iSCSI

At this point, **Hyper-V** tab should be present in left pane of Server Manager. You can access Hyper-V Manager of your **HyperV1** and **HyperV2** here or you can access them from Hyper-V Manager on the host machine.

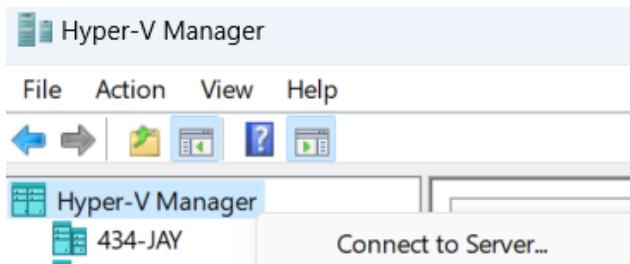
The screenshot shows the Windows Server Manager interface. The left navigation pane has several tabs: Dashboard, All Servers, AD DS, DNS, File and Storage Services, and Hyper-V. The Hyper-V tab is currently selected and highlighted in blue. The main content area is titled "Hyper-V" and displays a list of servers: "434-HYPERV1" and "434-HYPERV2". Each server entry shows its name and its IPv4 address. The "434-HYPERV1" entry is highlighted with a blue background.

Server Name	IPv4 Address
434-HYPERV1	192.168.10.5, 192.168.20.2, 192.168.30.1, 192.168.40.1
434-HYPERV2	192.168.10.6, 192.168.20.3, 192.168.30.2, 192.168.40.2

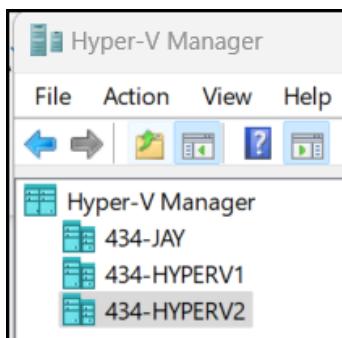
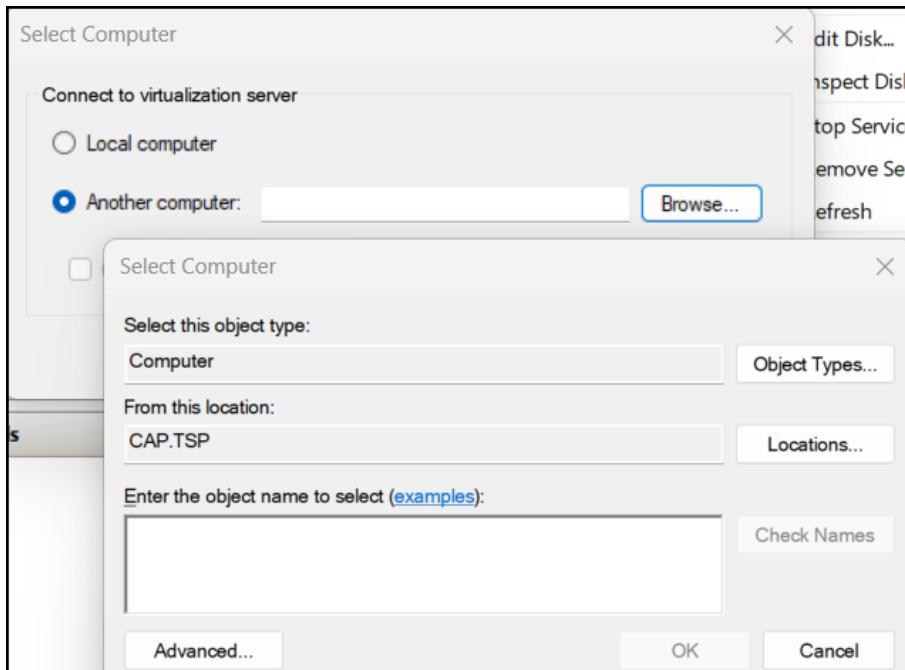


CAPSTONE PROJECT

Right-click **Hyper-V Manager** in the left pane of Hyper-V Manager on the host, and select **Connect to Server**.



Search the name of your Hyper-V servers and add them.



CAPSTONE PROJECT

Open **Virtual Switch Manager** and make an external switch for NICs connected to **LAN** or **HB**. Pick the correct network adapter.

The image contains two side-by-side screenshots of the Microsoft Virtual Switch Manager interface.

Screenshot 1: LANBridge Configuration

- Left Panel:** Shows the "Virtual Switches" section with a new entry for "LANBridge". It also lists "Global Network Settings" and a MAC Address Range (00-15-5D-0A-05-00 to 00-15-5D-0B-05-00).
- Right Panel:** Shows the "Virtual Switch Properties" for "LANBridge".
 - Name:** LANBridge
 - Notes:** Bridge to upper LAN switch
 - Connection type:** External network (radio button selected). Sub-options include "Microsoft Hyper-V Network Adapter" (selected), "Allow management operating system to share this network adapter" (checked), and "Enable single-root I/O virtualization (SR-IOV)" (unchecked).

Screenshot 2: HBBridge Configuration

- Left Panel:** Shows the "Virtual Switch Properties" for "HBBridge".
 - Name:** HBBridge
 - Notes:** Bridge to upper HB switch
 - Connection type:** External network (radio button selected). Sub-options include "Microsoft Hyper-V Network Adapter #3" (selected), "Allow management operating system to share this network adapter" (checked), and "Enable single-root I/O virtualization (SR-IOV)" (unchecked).

Make external switches for **HyperV2** as well.

Now back to Server Manager, install **Failover Clustering** feature (**NOT ROLE**) on both Hyper-V servers.

The image shows the "Add Roles and Features Wizard" window under the "Select features" step.

Left Panel (Before You Begin): Includes tabs for "Features" (which is selected), "Confirmation", and "Results".

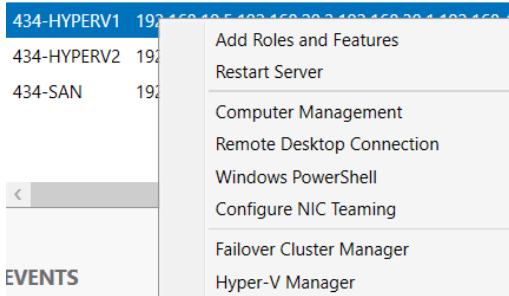
Right Panel (Select features): Shows the "Features" list and their descriptions.

- Features:** .NET Framework 3.5 Features, .NET Framework 4.8 Features (2 of 7 installed), Background Intelligent Transfer Service (BITS), BitLocker Drive Encryption, BitLocker Network Unlock, BranchCache, Client for NFS, Containers, Data Center Bridging, Direct Play, Enhanced Storage, **Failover Clustering** (selected), Group Policy Management.
- Description:** Failover Clustering allows multiple servers to work together to provide high availability of server roles. Failover Clustering is often used for File Services, virtual machines, database applications, and mail applications.

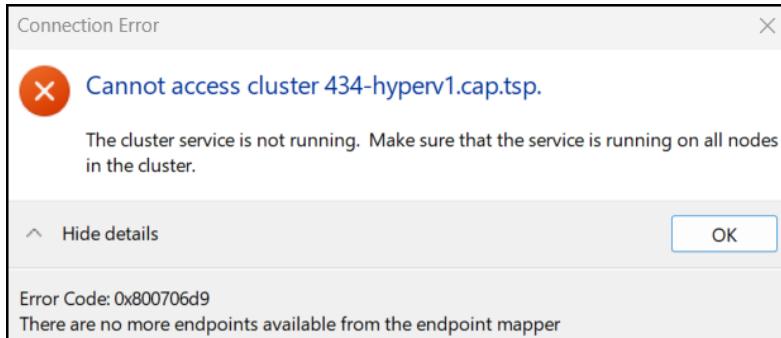
Top Right: DESTINATION SERVER: FileServer1.yoo.int

CAPSTONE PROJECT

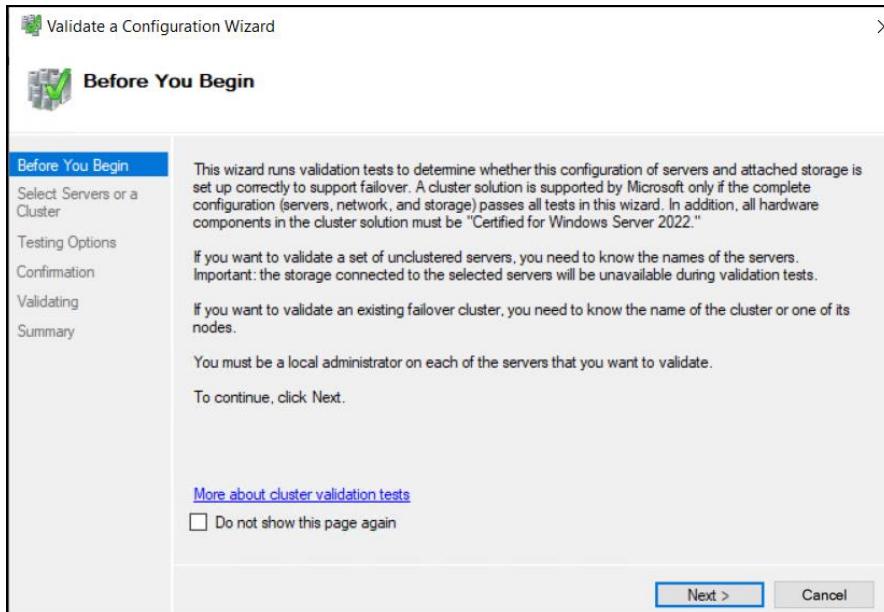
Right-click **HyperV1** in Server Manager and click **Failover Cluster Manager**.



The error message pops up. This is because **HyperV1** is not in a cluster yet. Click **OK**.

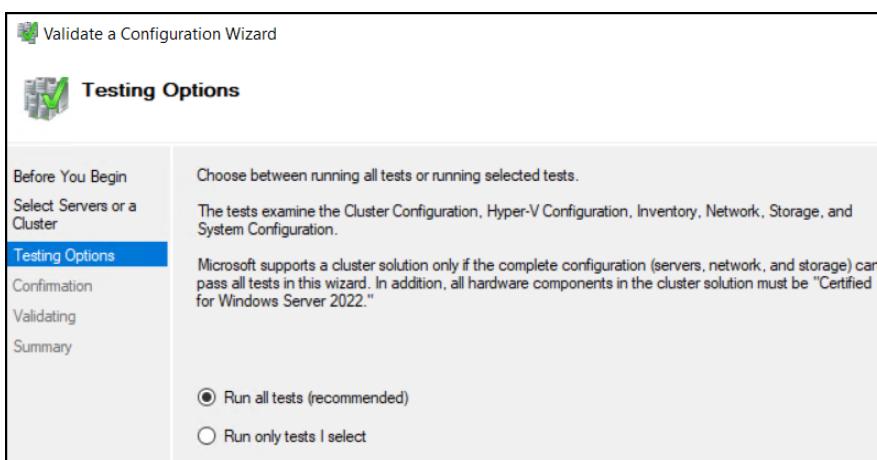
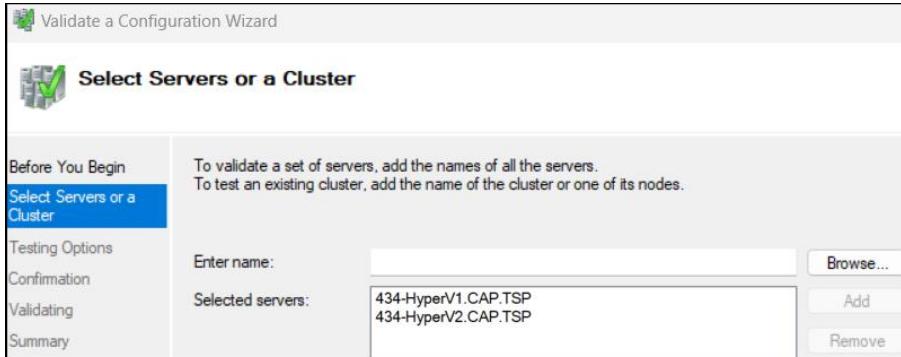


In Failover Cluster Manager, click **Validate Configuration**. Validate a Configuration Wizard opens.

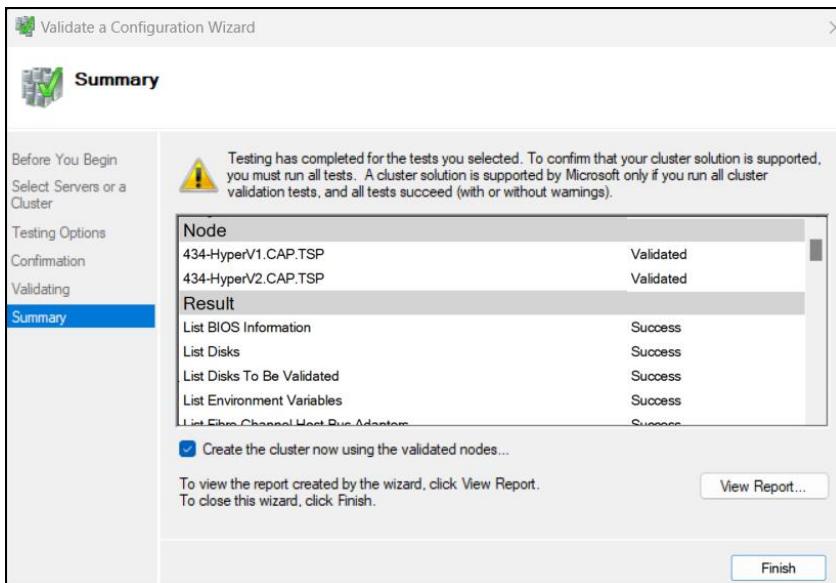


CAPSTONE PROJECT

Add your two Hyper-V Servers. Run all validation tests.



Review any warnings or errors. In my case, I passed all tests. Check **Create the cluster now using the validated nodes** and click **Finish** to create the cluster.



CAPSTONE PROJECT

Name the cluster **HyperVCluster** and give the cluster an IP address in the **LAN** network.

 Create Cluster Wizard

 **Access Point for Administering the Cluster**

Before You Begin	Type the name you want to use when administering the cluster.						
Access Point for Administering the Cluster	Cluster Name: <input type="text" value="HyperVCluster"/>						
Confirmation	The NetBIOS name is limited to 15 characters. One or more IPv4 addresses could not be configured automatically. For each network to be used, make sure the network is selected, and then type an address.						
Creating New Cluster	<table border="1"><thead><tr><th></th><th>Networks</th><th>Address</th></tr></thead><tbody><tr><td><input checked="" type="checkbox"/></td><td>192.168.10.0/28</td><td>192 . 168 . 10 . 7</td></tr></tbody></table>		Networks	Address	<input checked="" type="checkbox"/>	192.168.10.0/28	192 . 168 . 10 . 7
	Networks	Address					
<input checked="" type="checkbox"/>	192.168.10.0/28	192 . 168 . 10 . 7					
Summary							

Confirm and create a new cluster.

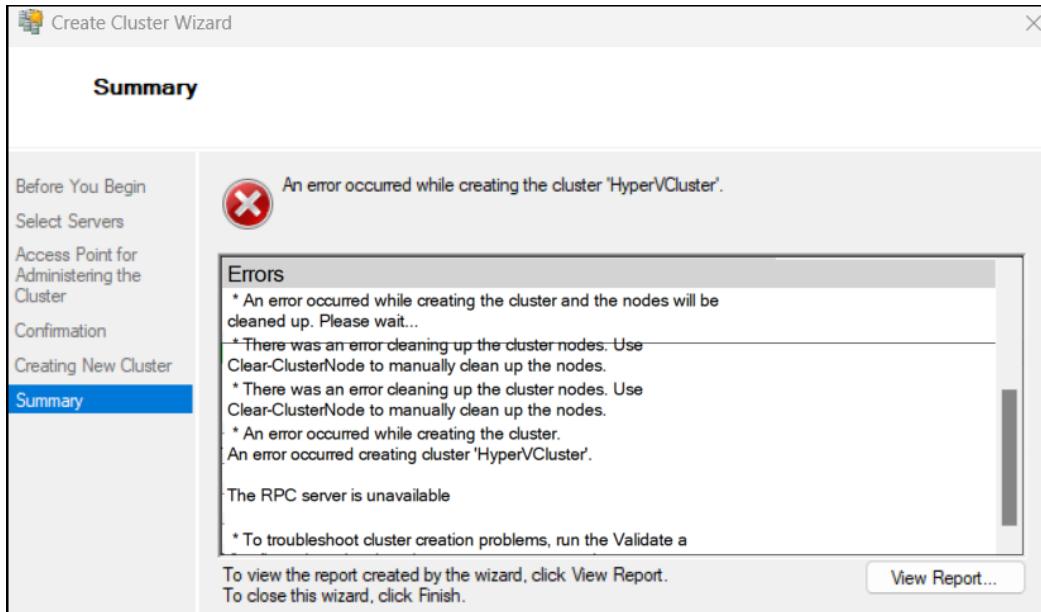
 Create Cluster Wizard

 **Confirmation**

Before You Begin	You are ready to create a cluster. The wizard will create your cluster with the following settings:							
Access Point for Administering the Cluster								
Confirmation	<table border="1"><tr><td>Node</td></tr><tr><td>434-HyperV1.CAP.TSP</td></tr><tr><td>434-HyperV2.CAP.TSP</td></tr><tr><td>Cluster registration</td></tr><tr><td>DNS and Active Directory Domain Services</td></tr><tr><td>IP Address</td></tr><tr><td>192.168.10.7</td></tr></table>	Node	434-HyperV1.CAP.TSP	434-HyperV2.CAP.TSP	Cluster registration	DNS and Active Directory Domain Services	IP Address	192.168.10.7
Node								
434-HyperV1.CAP.TSP								
434-HyperV2.CAP.TSP								
Cluster registration								
DNS and Active Directory Domain Services								
IP Address								
192.168.10.7								
Creating New Cluster								
Summary	<p><input checked="" type="checkbox"/> Add all eligible storage to the cluster.</p> <p>To continue, click Next.</p>							

CAPSTONE PROJECT

I kept running into the error.



Clicked **View Report** to detailed information.



CAPSTONE PROJECT

One of the troubleshooting methods I found was to prestage a cluster name object (CNO) in **ADDS**. First, in ADUC, click View and check **Advanced Features** in the console tree, right-click the OU where you want to create the CNO (**HyperV** OU in my case), point to **New**, and then select **Computer**. In the Computer name box, enter the name that will be used for the failover cluster, and then select **OK**.

The image consists of three screenshots illustrating the creation of a Cluster Name Object (CNO) in Active Directory:

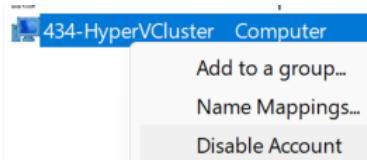
- Screenshot 1: ADUC View Menu**
Shows the "View" menu open in the Active Directory Users and Computers (ADUC) interface. The "Advanced Features" option is highlighted with a blue selection bar.
- Screenshot 2: New Object - Computer Dialog**
Shows the "New Object - Computer" dialog box. The "Create in:" dropdown is set to "CAP.TSP/Servers/HyperV". The "Computer name:" field contains "434-HyperVCluster". The "User or group:" field shows "Default: Domain Admins" with a "Change..." button. A checkbox for "Assign this computer account as a pre-Windows 2000 computer" is unchecked. Buttons at the bottom include "OK", "Cancel", and "Help".
- Screenshot 3: Computer List Table**
Shows a table of computer accounts:

Name	Type
434-HYPERV1	Computer
434-HYPERV2	Computer
434-HyperVCluster	Computer

As a best practice, right-click the computer account that you just created, select **Properties**, and then select the **Object** tab. On the Object tab, select the **Protect object from accidental deletion** check box, and then select **OK**.

CAPSTONE PROJECT

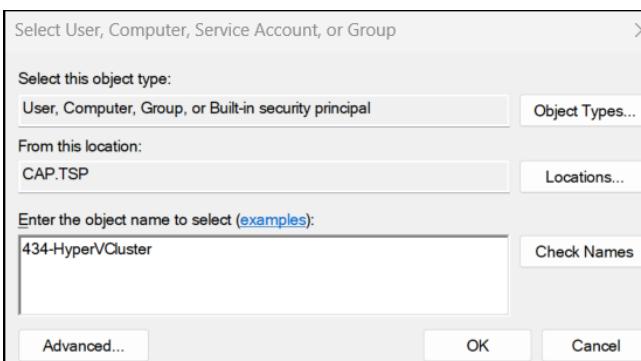
Right-click the computer account that you just created, and then select **Disable Account**. Select **Yes** to confirm, and then select **OK**.



Right-click the **OU** where you created the **CNO** (Cluster Name Object) and then select **Properties -> Security -> Advanced -> Add -> Select a principal**.

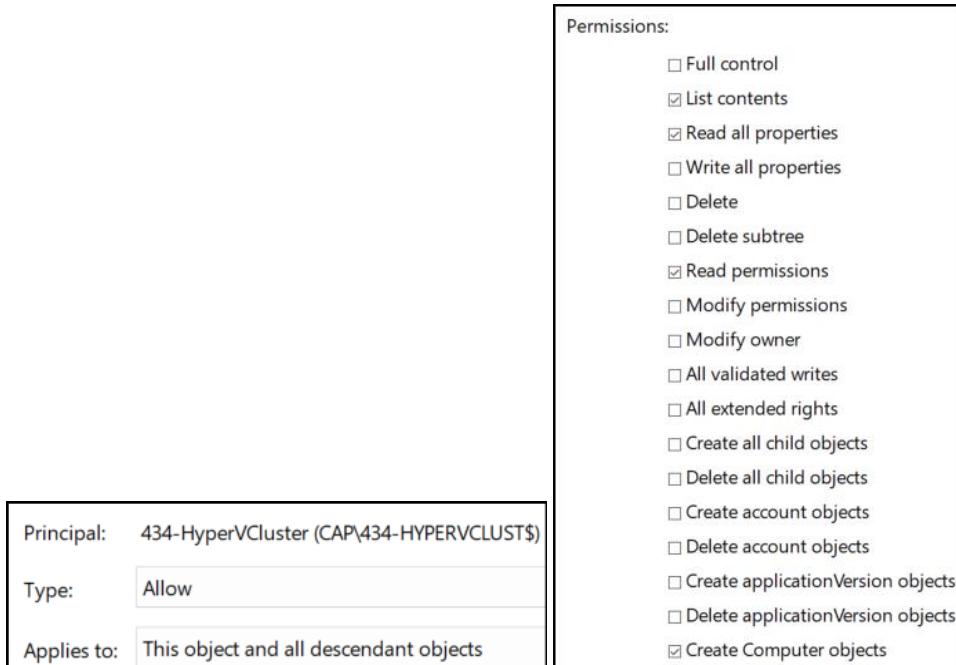
The top screenshot shows the Active Directory Users and Computers console. It displays a tree view of 'Security_Groups', 'Servers' (which contains 'DHCP', 'FileServer', and 'HyperV'), and three computer objects: '434-HYPERV1', '434-HYPERV2', and '434-HyperVCluster'. The bottom screenshot shows the 'Permission Entry for FILESERVER' dialog box. Under 'Principal:', 'Select a principal' is selected. Under 'Type:', 'Allow' is chosen. Under 'Applies to:', 'This object and all descendant objects' is selected. In the 'Permissions:' section, 'List contents' is checked.

In the **Select User, Computer, Service Account, or Group** dialog box, select **Object Types**, select the **Computers** check box, and then select **OK**. Under **Enter the object names to select**, enter the name of the CNO then select **OK**.

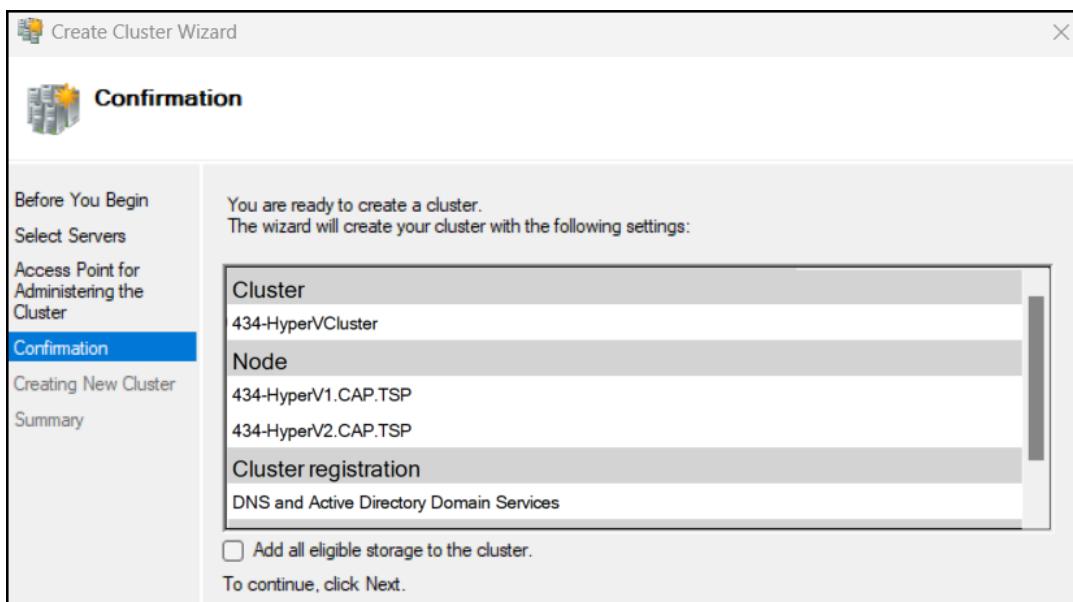


CAPSTONE PROJECT

In the Permission Entry dialog box, make sure that the Type list is set to Allow, and the Applies to list is set to This object and all descendant objects. Under Permissions, select the Create Computer objects check box.

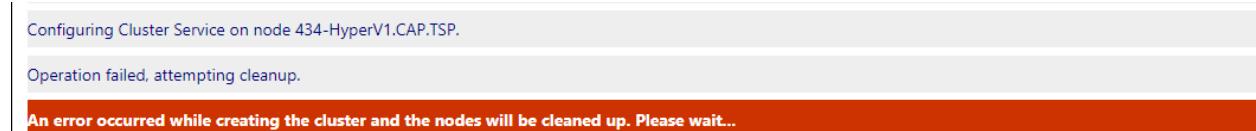


Select **OK** until you return to the Active Directory Users and Computers snap-in. I tried creating a cluster again but faced same error.



CAPSTONE PROJECT

I checked the error report again to address the starting point of the error. My intuition was that I could not configure Cluster Service on remote node (Configuring Hyper-V Server from the host machine's Server Manager). I deleted the CNO in ADUC and created a new one named **HyperVCluster**.



Then, I opened a console to **434-HyperV1** server and created a cluster using PowerShell command.

- **Test-Cluster -Node "434-HyperV1", "434-HyperV2"** to run the validation test.
- **New-Cluster -Name HyperVCluster -Node "434-HyperV1", "434-HyperV2" -NoStorage -StaticAddress 192.168.10.7** to create a cluster with the static IP address and without adding storage automatically.

```
WARNING: To launch Server Configuration tool again, run "SConfig"  
PS C:\Users\Jay> Test-Cluster -Node "434-HyperV1", "434-HyperV2"  
  
Mode LastWriteTime Length Name  
---- ----- ---- --  
-a--- 3/23/2023 11:44 AM 582202 Validation Report 2023.03.23 At 11.41.19.htm  
  
PS C:\Users\Jay> New-Cluster -Name HyperVCluster -Node "434-HyperV1", "434-HyperV2" -NoStorage -StaticAddress 192.168.10.7  
  
Name  
----  
HyperVCluster  
  
PS C:\Users\Jay>
```

It successfully created a cluster for Hyper-V servers.

The screenshot shows the Active Directory Users and Computers (ADUC) interface. On the left, the navigation pane shows the following structure:

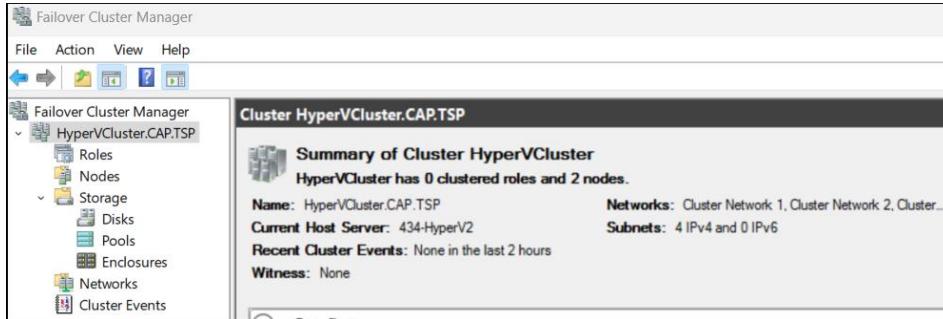
- > Security_Groups
- ✓ Servers
 - > DHCP
 - > FileServer
 - HyperV

The main pane displays a table of objects:

Name	Type	Description
434-HYPERV1	Computer	
434-HYPERV2	Computer	
HyperVCluster	Computer	Failover cluster virtual network name account

CAPSTONE PROJECT

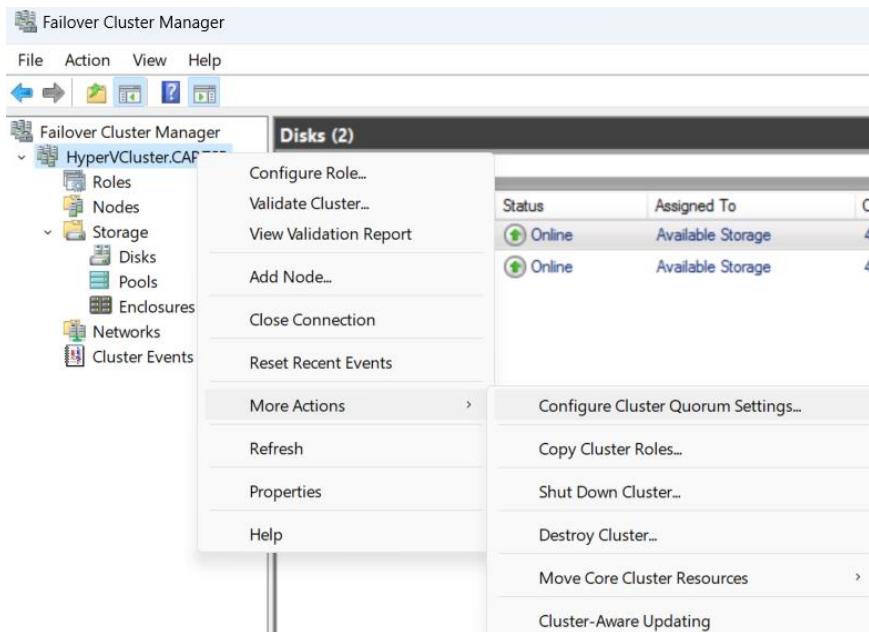
In Server Manager, right-click one of Hyper-V servers and open **Failover Cluster Manager**.



Add eligible storage to the cluster. Click **Disk**s in the left pane, click **Add Disk** in the right pane, then add both **VMStorage** and **HyperVWitness** iSCSI disks.

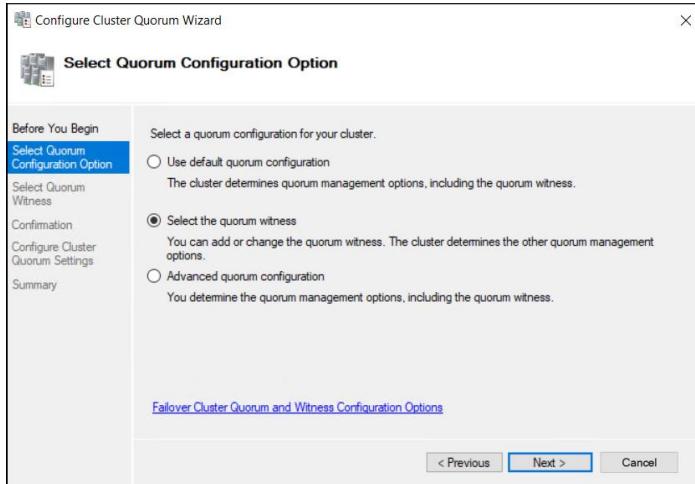


Right-click the **HyperVCluster** on Failover Cluster Manager and choose **More Actions -> Configure Cluster Quorum Settings**.

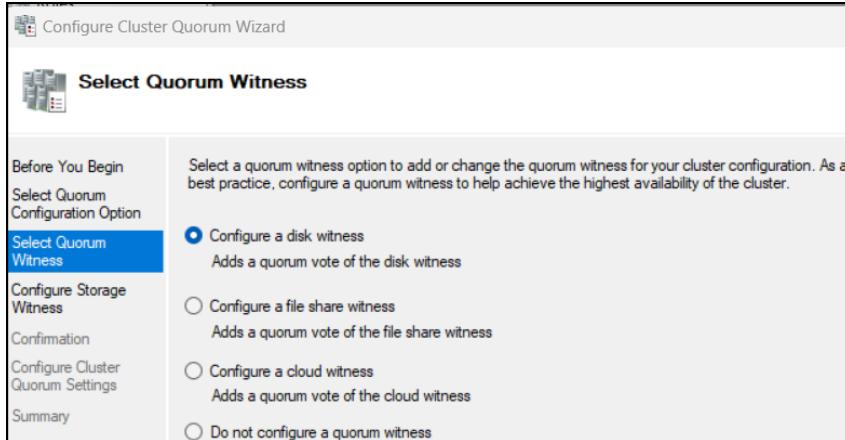


CAPSTONE PROJECT

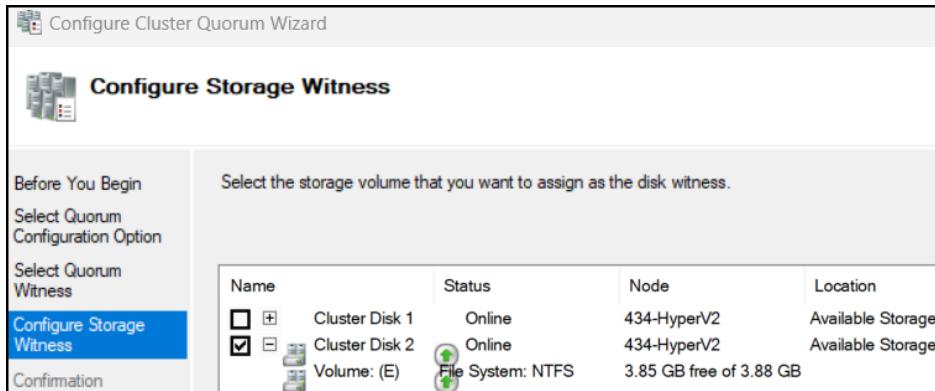
Choose **Select the quorum witness** option.



Choose **Configure a disk witness**.



Choose the iSCSI disk you created for quorum witness purpose. Finish the wizard.



CAPSTONE PROJECT

Confirm nodes. Notice vote change.

Name	Status	Assigned Vote	Current Vote
434-HyperV1	Up	1	1
434-HyperV2	Up	1	1

Confirm storage availability. You can rename cluster disks.

Name	Status	Assigned To	Owner Node
Cluster Disk 1	Online	Available Storage	434-HyperV2
Cluster Disk 2	Online	Disk Witness in Quorum	434-HyperV2

Confirm **networks**. You can rename the cluster networks by opening **Properties** of the networks. No communication on the **iSCSI** network. Cluster and client for **LAN**. Cluster only for **HB** and **LM**.

Name	Status	Cluster Use
iSCSI	Up	None
LM	Up	Cluster Only
LAN	Up	Cluster and Client
HB	Up	Cluster Only

Select **Disks** tab, click iSCSI disk for **VMStorage**, and click **Add Cluster Shared Volume** in the right pane.

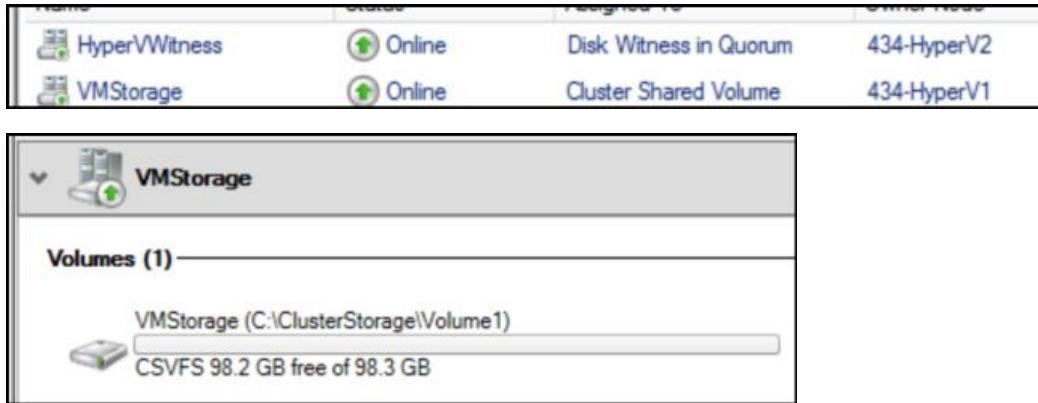
Name	Status	Assigned To	Owner Node	Disk Number
HyperWitness	Online	Disk Witness in Quorum	434-HyperV2	2
VMStorage	Online	Available Storage	434-HyperV2	1

Actions

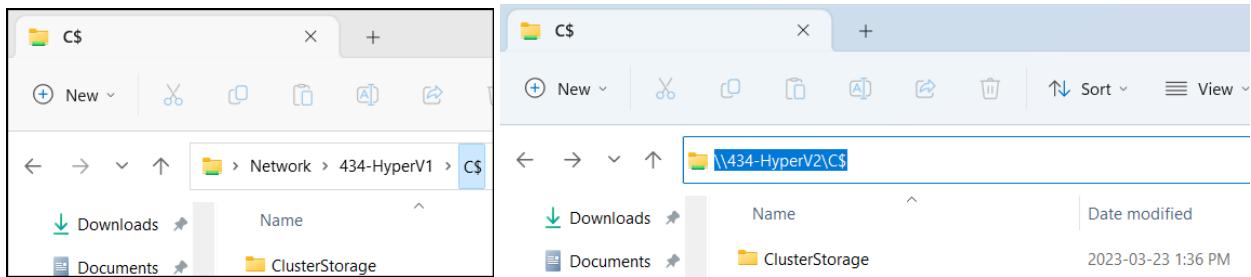
- Disks
 - Add Disk
 - Move Available Storage
 - View
 - Refresh
 - Help
- VMStorage
 - Bring Online
 - Take Offline
 - Add to Cluster Shared Vol...

CAPSTONE PROJECT

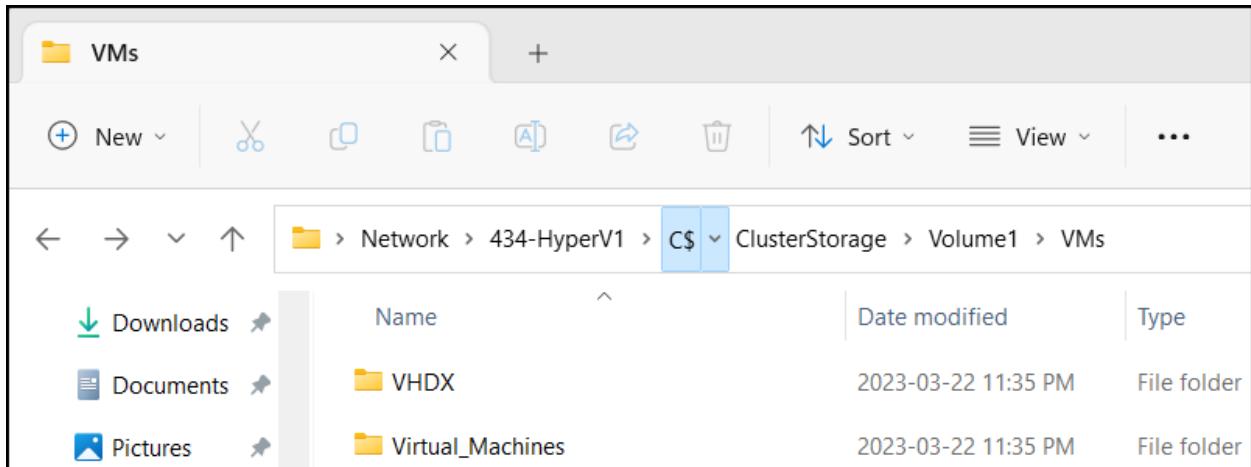
Now the storage is assigned as cluster shared volume (CSV).



This volume is accessible from both Hyper-V servers.

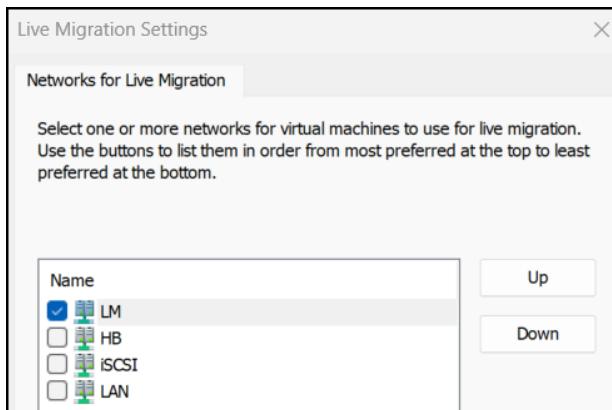


Create directories for your VM storage.

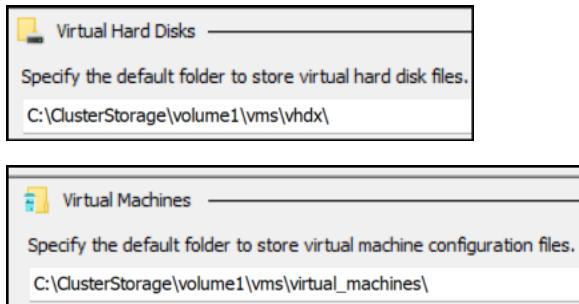


CAPSTONE PROJECT

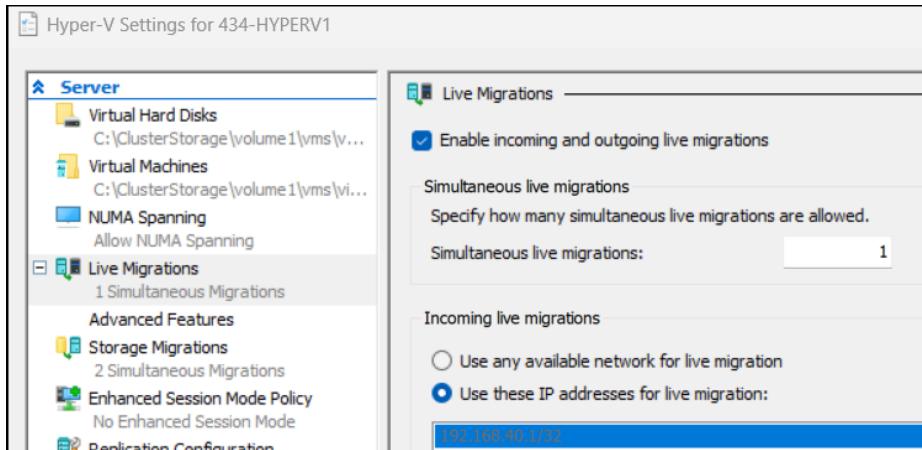
In Failover Cluster Manager, right-click **Networks** and select **Live Migration Settings**. Check only **LM** and click **OK**.



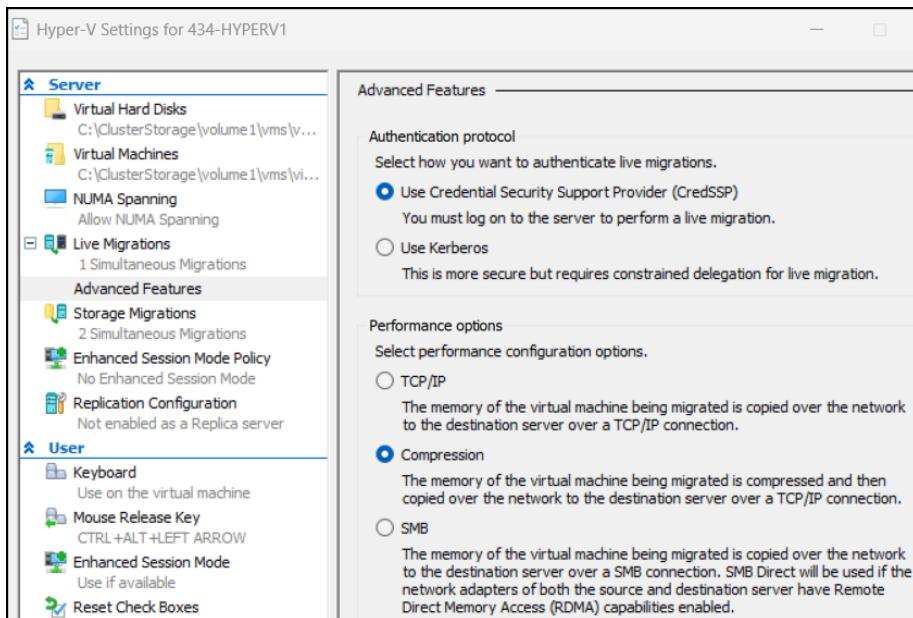
Change default locations of VM configuration and vhdx files for both Hyper-V servers in Hyper-V Manager.



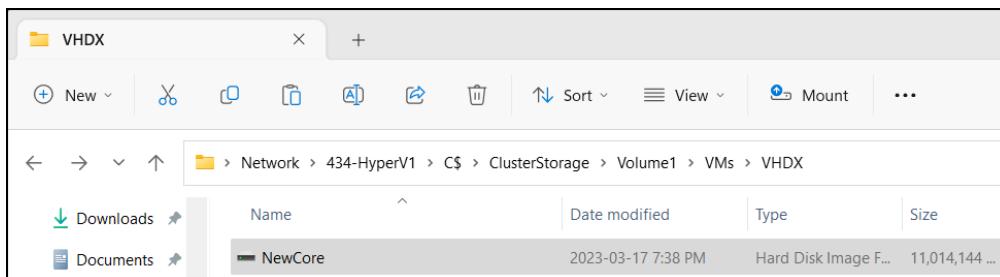
Check **Live Migrations** settings. Confirm that live migration is enabled. In our case, 1 simultaneous live migration is fine. Check **Advanced Features** too. If you decide to use **Kerberos** for authentication, there are extra steps to take. This document will not use Kerberos.



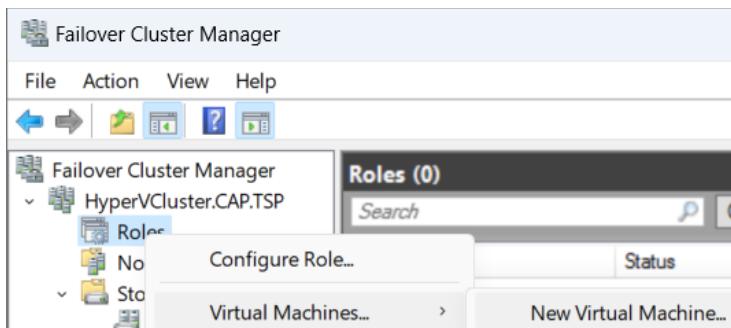
CAPSTONE PROJECT



To create a nested VMs, you will use Failover Cluster Manager from now on. Before creating a nested VM, copy your parent disk for Server Core VMs on the host machine and paste it to CSV. You can access the CSV from the host machine with `\434-HyperV1\C$` in File Explorer. (**I recommend closing unnecessary programs running since moving this file takes some resources. Your computer might slow down.**)

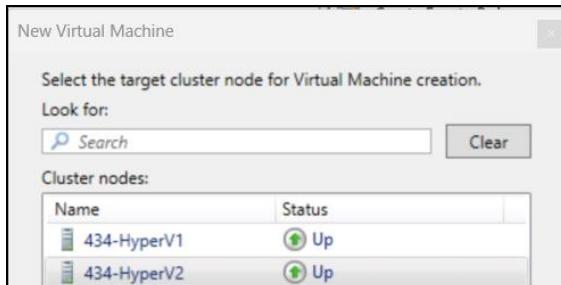


In Failover Cluster Manager, right-click **Roles** and click **Virtual Machines -> New Virtual Machine**.

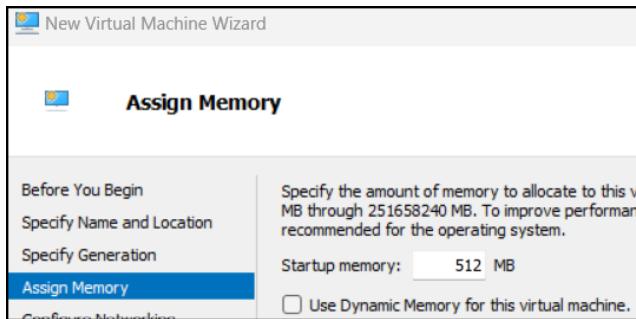


CAPSTONE PROJECT

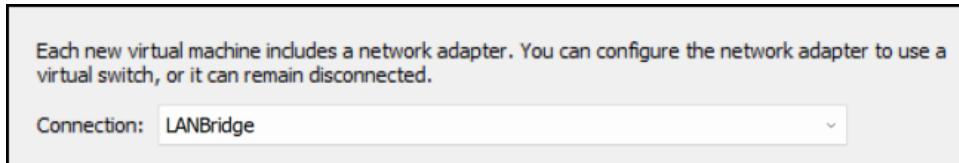
Choose any Hyper-V server. I will follow my network diagram and choose **434-HyperV2** to create the first file server named **434-FileServer1**.



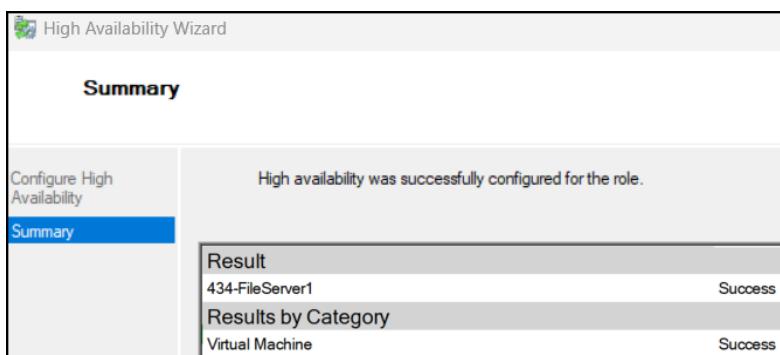
Create a VM. Be mindful of the memory you will assign.



Connect to **LANBridge**.

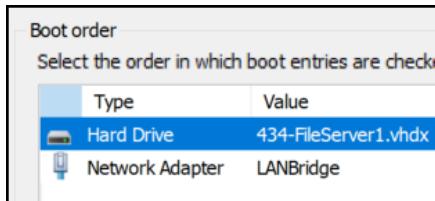


I will use attach a virtual hard disk later since I am using differencing disk. Unlike Hyper-V Manager, after creating a VM, **High Availability Wizard** opens automatically.



CAPSTONE PROJECT

Open VM settings (also in Failover Cluster Manager), attach a differencing disk, enable Guest services, assign 1 CPU, click Apply, and change the boot order. Click **OK**.



Start the VM. With low RAM and 1 CPU, it might take some time to finish initial configuration. Do not close the console. Leave at the distinguishable stage to test live migration.

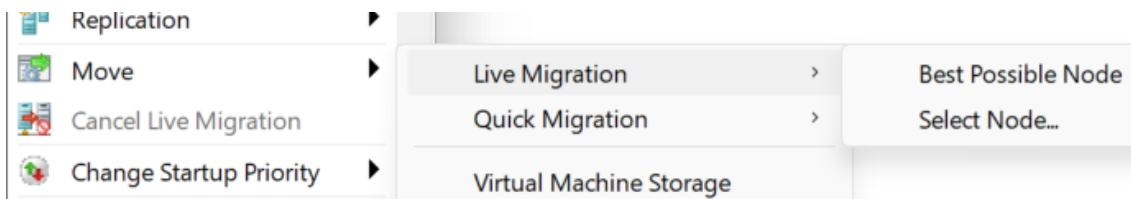
The image shows two windows side-by-side. On the left is the Failover Cluster Manager interface, specifically the 'Roles' section, which lists a single role named '434-FileServer1'. On the right is a PowerShell window running as Administrator. The command 'Get-NetConnectionProfile' is run, and the output shows details about the network connection:

```
Administrator: C:\Windows\system32\cmd.exe
WARNING: To launch Server Configuration tool again, run "SConfig"
PS C:\Users\Administrator> Get-NetConnectionProfile

Name          : Network
InterfaceAlias : Ethernet
InterfaceIndex : 6
NetworkCategory : Public
IPv4Connectivity : Internet
IPv6Connectivity : NoTraffic

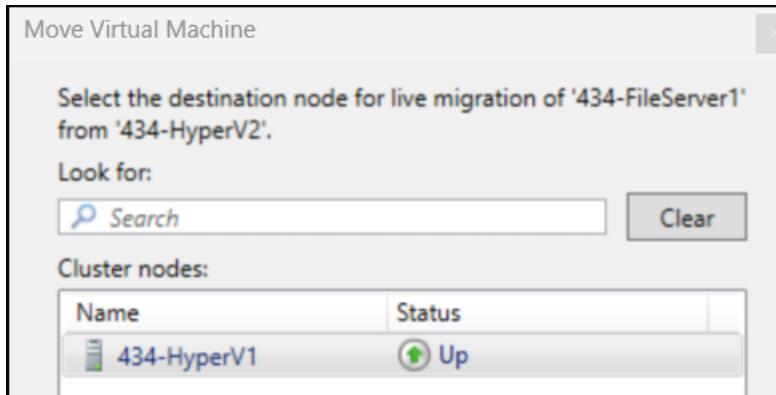
PS C:\Users\Administrator> @.
```

To test that live migration is working, go to Failover Cluster Manager, select your file server, and click **Move -> Live Migration -> Select Node** in the right pane.



CAPSTONE PROJECT

Choose other available Hyper-V server and click **OK**.



This will not take a long time. Notice that owner node has been changed to the server you specified. The console did not close and FileServer1 did not stop.

Roles (1)			
Search			
Name	Status	Type	Owner Node
434-FileServer1	Running	Virtual Machine	434-HyperV1

434-FileServer1 on 434-HyperV1 - Virtual Machine Connection

File Action Media Clipboard View Help

Administrator: C:\Windows\system32\cmd.exe

WARNING: To launch Server Configuration tool again, run "SConfig"
PS C:\Users\Administrator> Get-NetConnectionProfile

```
Name      : Network
InterfaceAlias  : Ethernet
InterfaceIndex   : 6
NetworkCategory  : Public
IPv4Connectivity : Internet
IPv6Connectivity : NoTraffic
```

PS C:\Users\Administrator> @

After testing live migration with the nested file server VM, I closed the file server and assigned 1 GB of RAM due to slowness.

CAPSTONE PROJECT

Create Two File Servers in a Failover Clustering using a VHD Set as Shared storage

Do post installation tasks on **FileServer1** including assigning static IP address.

```
NIC index: 1
Description: Microsoft Hyper-V Network Adapter
IP address: 192.168.10.8,
fe80::21b2:bc26:2a74:42e8
Subnet mask: 255.255.255.240
DHCP enabled: False

Default gateway: 192.168.10.14
Preferred DNS server: 192.168.10.1
Alternate DNS server: 192.168.10.2

1) Set network adapter address
2) Set DNS servers
3) Clear DNS server settings

Enter selection (Blank=Cancel): -
```

Rename the Network Adapter

Rename-NetAdapter -Name "Ethernet" -NewName "LAN"

Name Computer, add to Domain and OU placement

\$cred = Get-Credential Jay

Add-Computer -DomainName CAP.TSP -Credential \$cred -NewName (Read-Host -Prompt 'Input the new PC name') -OUPath (Read-Host -Prompt 'What OU e.g OU=Servers,DC=TSP,DC=INT')

Rename-LocalUser -Name "Administrator" -NewName "_LSysadmin"

Restart-Computer -Force

With the above command, the VM will be joined to the domain as well. Unfortunately, if you name your server using the above command, all letters in the name are capitalized.

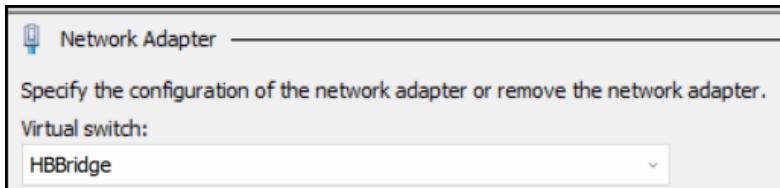
```
Administrator: C:\Windows\system32\cmd.exe
=====
Welcome to Windows Server 2022 Datacenter Evaluation
=====

1) Domain/workgroup: Domain: CAP.TSP
2) Computer name: 434-FILESERVER1
3) Add local administrator
4) Remote management: Enabled
5) Update setting: Download only
6) Install updates
7) Remote desktop: Disabled
8) Network settings
9) Date and time
10) Telemetry setting: Required
11) Windows activation
12) Log off user
13) Restart server
14) Shut down server
15) Exit to command line (PowerShell)

Enter number to select an option: -
```

CAPSTONE PROJECT

Connect the new NIC to **434-FILESERVER1** and attach it to **HBBridge** vSwitch (in Failover Cluster Manager).

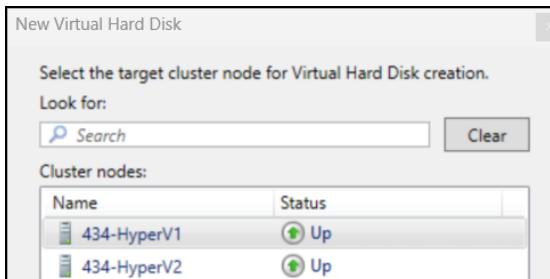


Configure new NIC for the **HB** network.

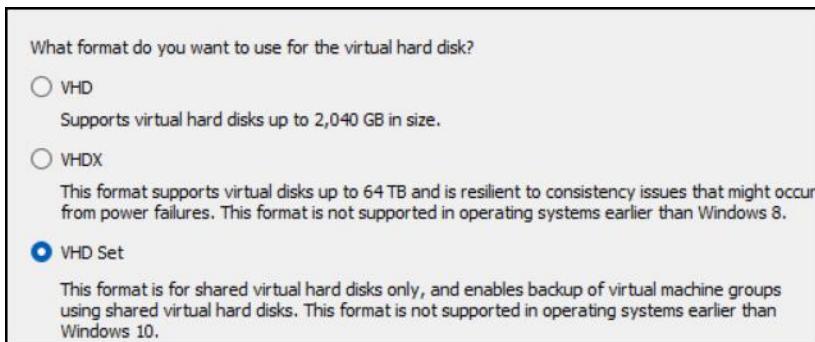
```
PS C:\Users\jay> Rename-NetAdapter -Name Ethernet -NewName HB
PS C:\Users\jay> New-NetIPAddress -InterfaceAlias HB -IPAddress 192.168.30.3 -PrefixLength 29
```

Shutdown **434-FILESERVER1** and create second file server in a same manner. Create **434-FILESERVER2** on the different Hyper-V cluster node to avoid RAM shortage. Shutdown this VM as well after post-installation tasks.

In Failover Cluster Manager, click **Roles** in the left pane, **Virtual Machines** in the right pane, and **New Hard Disk**. It does not matter which Hyper-V node you choose since disks are saved in CSV.



In **New Virtual Hard Disk Wizard**, choose **VHD Set**.



CAPSTONE PROJECT

Choose **Dynamically expanding**.

What type of virtual hard disk do you want to create?

Fixed size
This type of disk provides better performance and is recommended for servers running applications with high levels of disk activity. The virtual hard disk file that is created initially uses the size of the virtual hard disk and does not change when data is deleted or added.

Dynamically expanding
This type of disk provides better use of physical storage space and is recommended for servers running applications that are not disk intensive. The virtual hard disk file that is created is small initially and changes as data is added.

This will be a shared disk for a file share. Name it accordingly.

Specify the name and location of the virtual hard disk file.

Name: FileServer_Data.vhds

Location: C:\ClusterStorage\volume1\vms\vhdx\

We are not going to have many files. Assign storage accordingly. Finish the Wizard.

You can create a blank virtual hard disk or copy the contents of an existing physical disk.

Create a new blank virtual hard disk
Size: 15 GB (Maximum: 64 TB)

Create another VHD Set disk for the witness disk. You can assign small fixed size storage.

What type of virtual hard disk do you want to create?

Fixed size
This type of disk provides better performance and is recommended for servers running applications with high levels of disk activity. The virtual hard disk file that is created initially uses the size of the virtual hard disk and does not change when data is deleted or added.

Specify the name and location of the virtual hard disk file.

Name: FileServer_Witness.vhds

Location: C:\ClusterStorage\volume1\vms\vhdx\

You can create a blank virtual hard disk or copy the contents of an existing physical disk.

Create a new blank virtual hard disk
Size: 3 GB (Maximum: 64 TB)

CAPSTONE PROJECT

Attach both disks to both file servers. In VM settings, click **SCSI Controller** and add two shared drives.
Attach **vhds** files.



Start two file servers. You can manage them from Server Manager. Check the **Disks** tab.

434-FileServer1 (3)							
0	Online	127 GB	1.00 MB	GPT		SAS	Msft Virtual Disk
1	Offline	15.0 GB	15.0 GB	Unknown	✓	SAS	Msft Virtual Disk
2	Offline	3.00 GB	3.00 GB	Unknown	✓	SAS	Msft Virtual Disk
434-FileServer2 (3)							
0	Online	127 GB	1.00 MB	GPT		SAS	Msft Virtual Disk
1	Offline	15.0 GB	15.0 GB	Unknown	✓	SAS	Msft Virtual Disk
2	Offline	3.00 GB	3.00 GB	Unknown	✓	SAS	Msft Virtual Disk

Install File Server role and Failover Clustering feature on both file servers.



Create a new volume off each VHD Set disk.

File system:	NTFS
Allocation unit size:	Default
Volume label:	FileServerData

File system:	NTFS
Allocation unit size:	Default
Volume label:	FileServerWitness

CAPSTONE PROJECT

Open the console for **434-FileServer1** and create a cluster for file servers in PowerShell.

```
PS C:\Users\jay> Test-Cluster -Node "434-FileServer1", "434-FileServer2"
WARNING: System Configuration - Validate Software Update Levels: The test reported some warnings..
WARNING:
Test Result:
HadUnselectedTests, ClusterConditionallyApproved
Testing has completed for the tests you selected. You should review the warnings in the Report. A cluster solution is
supported by Microsoft only if you run all cluster validation tests, and all tests succeed (with or without warnings).
Test report file path: C:\Users\jay\AppData\Local\Temp\1\Validation Report 2023.03.23 At 18.46.29.htm

Mode           LastWriteTime      Length Name
----           -----          ----- 
-a---  3/23/2023 6:49 PM      510074 Validation Report 2023.03.23 At 18.46.29.htm

PS C:\Users\jay> New-Cluster -Name FileServerCluster -Node "434-FileServer1", "434-FileServer2" -NoStorage -StaticAddress 192.168.10.10

Name
----
FileServerCluster

PS C:\Users\jay>
```

Check ADUC.

The screenshot shows the Active Directory Users and Computers (ADUC) interface. In the left navigation pane, under the 'Servers' section, there is a node named 'FileServerCluster'. The right pane displays a table with columns: Name, Type, and Description. It lists three objects: '434-FILESERVER1' (Computer type), '434-FILESERVER2' (Computer type), and 'FileServerCluster' (Computer type, with a note in the Description column: 'Failover cluster virtual network name account').

Name	Type	Description
434-FILESERVER1	Computer	
434-FILESERVER2	Computer	
FileServerCluster	Computer	Failover cluster virtual network name account

Open Failover Cluster Manager from any file server. Add two VHD Set disks. Configure cluster quorum witness and rename disks accordingly. Name networks accordingly.

The screenshot shows the Failover Cluster Manager interface. It consists of two main sections: 'Disks (2)' and 'Networks (2)'.

Disks (2)

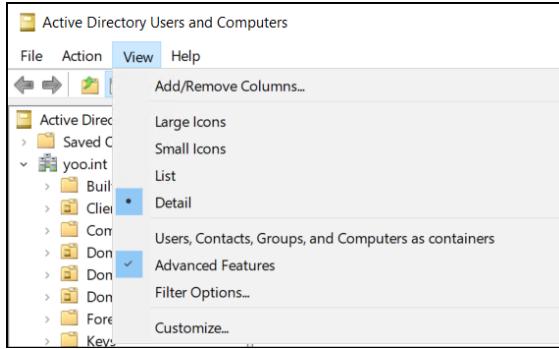
Name	Status	Assigned To	Owner Node
FileServerData	Online	Available Storage	434-FileServer2
FileServerWitness	Online	Disk Witness in Quorum	434-FileServer2

Networks (2)

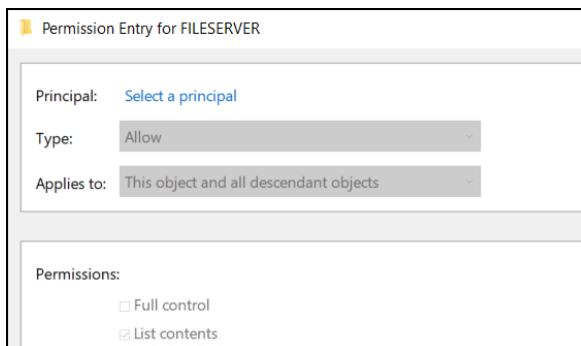
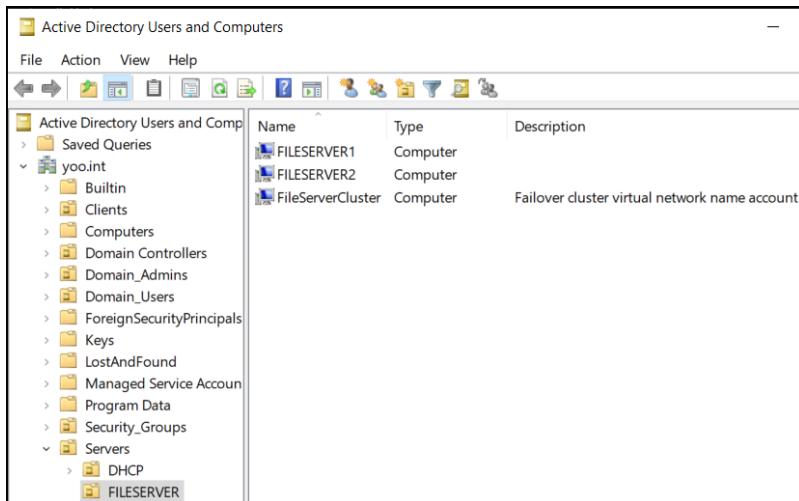
Name	Status	Cluster Use
LAN	Up	Cluster and Client
HB	Up	Cluster Only

CAPSTONE PROJECT

Before installing file server ROLE to **FileServerCluster**, similar with the case of setting up **HyperVCluster**, you need to assign adequate permission to FileServer CNO. In **Active Directory Users and Computers**, on the **View** menu, make sure that **Advanced Features** is selected.

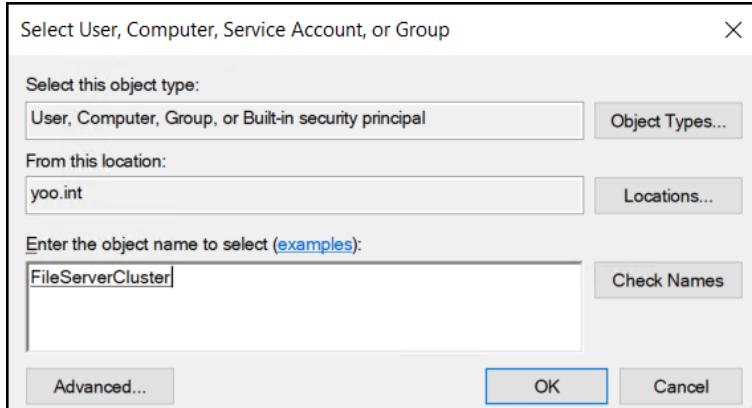


Right-click the **OU** where you created the CNO and then select **Properties -> Security -> Advanced -> Add -> Select a principal**.



CAPSTONE PROJECT

In the **Select User, Computer, Service Account, or Group** dialog box, select **Object Types**, select the **Computers** check box, and then select **OK**. Under **Enter the object names to select**, enter the name of the CNO then select **OK**.

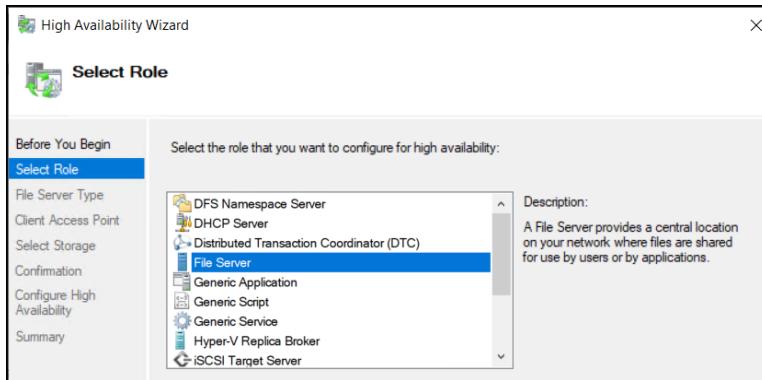


In the Permission Entry dialog box, make sure that the Type list is set to Allow, and the Applies to list is set to This object and all descendant objects. Under Permissions, select the **Create Computer objects** check box.

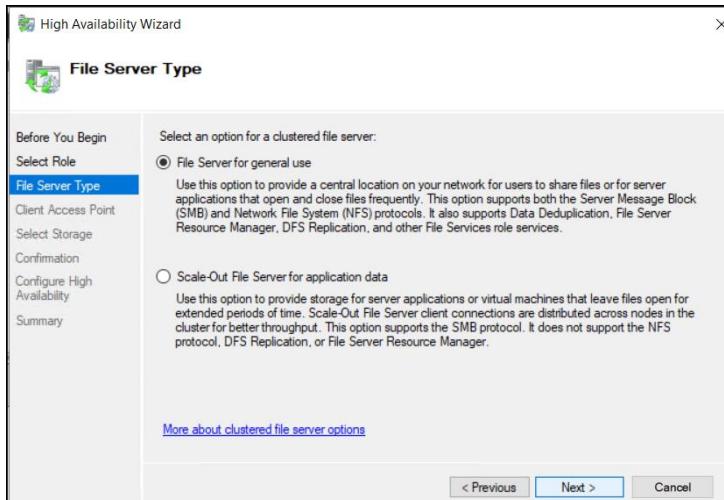
The dialog box has a title bar 'Permission Entry for FILESERVER'. It shows a summary table with fields: Principal: 'FileServerCluster (yoo\FileServerClust\$)' with a 'Select a principal' link; Type: 'Allow'; and Applies to: 'This object and all descendant objects'. To the right is a sidebar titled 'Permissions:' containing a list of checkboxes. The checked boxes are: 'List contents', 'Read all properties', 'Read permissions', 'Modify permissions', 'Modify owner', 'All extended rights', and 'Create Computer objects'.

CAPSTONE PROJECT

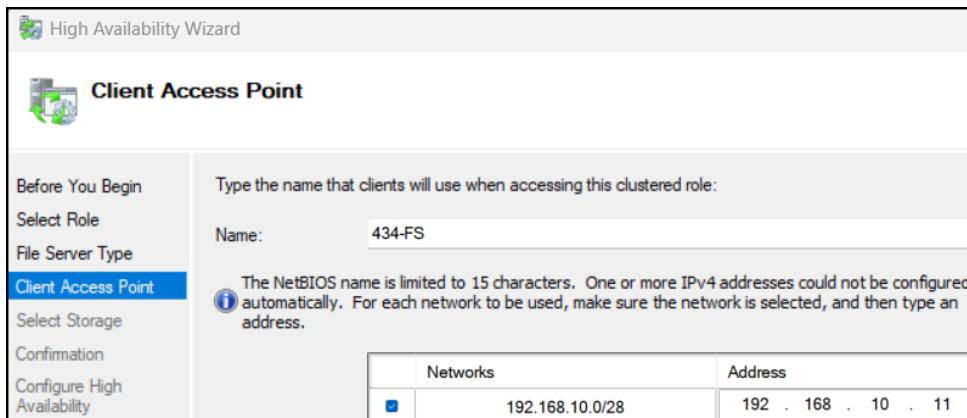
Select **OK** until you return to the ADUC. Go back to Failover Cluster Manager. Right-click **Roles** and select **Configure Role**. High Availability Wizard opens. Select **File Server** role.



Select **File Server** for general use.



Name the Client Access Point **434-FS** and assign an IP according to your network structure.



CAPSTONE PROJECT

Select the available storage for the cluster.

High Availability Wizard

Select Storage

Before You Begin
Select Role
File Server Type
Client Access Point
Select Storage
Confirmation
Configure High

Select only the storage volumes that you want to assign to this clustered role. You can assign additional storage to this clustered role after you complete this wizard.

Name	Status
<input checked="" type="checkbox"/> FileServerData	Online
Volume: (D)	File System: NTFS 14.9 GB free of 15.0 GB

Click **Finish**.

High Availability Wizard

Summary

Before You Begin
Select Role
File Server Type
Client Access Point
Select Storage
Confirmation
Configure High Availability
Summary

High availability was successfully configured for the role.

Network Name
434-FS
OU
OU=FileServer,OU=Servers,DC=CAP,DC=TSP
IP Address
192.168.10.11

To view the report created by the wizard, click View Report.
To close this wizard, click Finish.

Check **Volumes** tab in Server Manager.

▲ 434-FS (1)				
D:	FileServerData	Fixed	15.0 GB	14.9 GB

CAPSTONE PROJECT

Configure a Company Share with AGDLP File Permissions

Important: you must create the share on the file server that has the disk online. In my case, it was **434-FileServer2**.

Roles (1)			
Name	Status	Type	Owner Node
434-FS	Running	File Server	434-FileServer2

Open Failover Cluster Manager from the file server that has the disk online, Click **Roles**, select **FS** and **Add File Share** from the right pane. Create the share and directories below the share.

The screenshot shows the Failover Cluster Manager interface. On the left, there's a tree view with 'FileServerCluster.CAP.TSP' expanded, showing 'Nodes', 'Storage', 'Networks', 'Cluster Events', and 'HyperVCluster.CAP.TSP'. The main area is titled 'Roles (1)' and lists a single role: '434-FS' (Status: Running, Type: File Server, Owner Node: 434-FileServer2). On the right, a context menu is open for the '434-FS' role, with 'Actions' selected. The menu includes options like 'Configure Role...', 'Virtual Machines...', 'Create Empty Role', 'View', 'Refresh', 'Help', 'Start Role', 'Stop Role', and 'Add File Share'. The 'Add File Share' option is highlighted.

Select **SMB Share – Quick** for the profile.

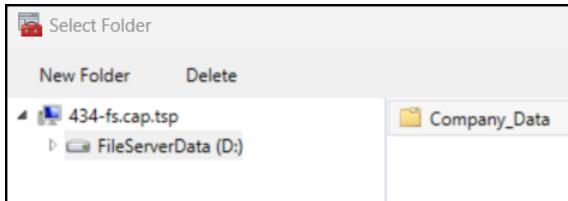
This screenshot shows a dialog box for selecting a file share profile. On the left, a list of profiles is shown: 'SMB Share - Quick' (selected), 'SMB Share - Advanced', 'SMB Share - Applications', 'NFS Share - Quick', and 'NFS Share - Advanced'. On the right, a detailed description of the selected profile is provided: 'This basic profile represents the fastest way to create an SMB file share, typically used to share files with Windows-based computers.' Below the description is a bulleted list: '• Suitable for general file sharing' and '• Advanced options can be configured later by using the Properties dialog'.

Select **434-FS** Server and **Type a custom Path:**. Click **Browse...**

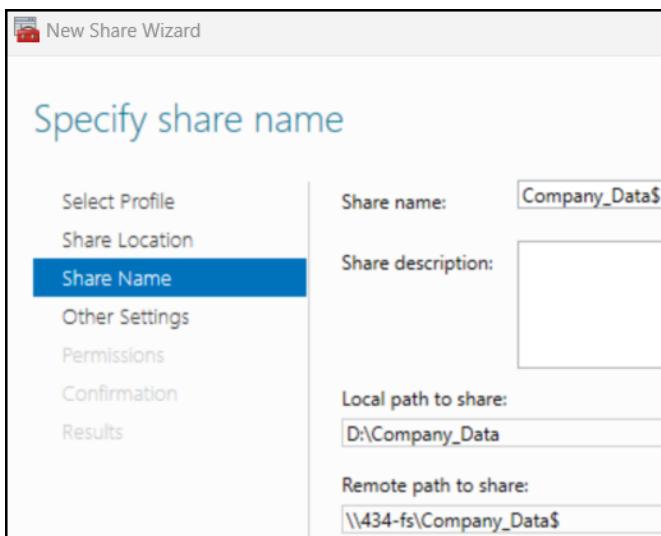
This screenshot shows a configuration dialog with a radio button labeled '(?) Type a custom path:' followed by an empty text input field and a 'Browse...' button.

CAPSTONE PROJECT

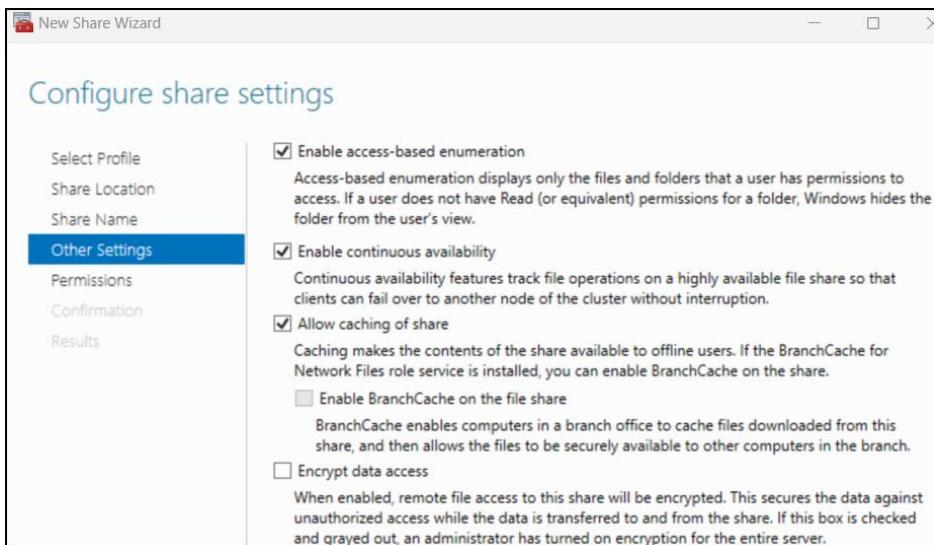
Create **Company_Data** folder under your **FileServerData** Drive and select it.



To create a hidden share, add “\$” at the end of Share name in **Share Name** page. Be aware of remote path to share.



Enable access-based enumeration.



CAPSTONE PROJECT

Click **Customize permissions**.

The screenshot shows a dialog box with a sidebar on the left containing links: Select Profile, Share Location, Share Name, Other Settings, **Permissions**, Confirmation, and Results. The main area displays share permissions and folder permissions. Share permissions are set to Everyone Full Control. Folder permissions show six entries for BUILTIN\Users, CREATOR OWNER, NT AUTHORITY\SYSTEM, and BUILTIN\Administrators, all with Full Control or higher access levels. A 'Customize permissions...' button is at the bottom.

Type	Principal	Access	Applies To
Allow	BUILTIN\Users	Special	This folder and subfolders
Allow	BUILTIN\Users	Read & execute	This folder, subfolders, and fil...
Allow	CREATOR OWNER	Full Control	Subfolders and files only
Allow	NT AUTHORITY\SYSTEM	Full Control	This folder, subfolders, and files
Allow	BUILTIN\Administrators	Full Control	This folder, subfolders, and files
Allow	BUILTIN\Administrators	Full Control	This folder only

Click **Share tab**, **Everyone**, and **Edit**. Currently everyone is given a full control to this share. Exit.

The screenshot shows a 'Permission Entry for Company_Data\$' dialog box. It has fields for Principal (Everyone), Type (Allow), and Permissions. The permissions listed are Full Control, Change, Read, and Special permissions (unchecked). The 'Select a principal' link is blue, indicating it's clickable.

Go to **Permission** tab and double-click permission entries for users. The first entry is for **Read & execute** permissions. Click **Show advanced permissions** to see details.

Show advanced permissions

CAPSTONE PROJECT

Currently, users can browse through the **Company_Data** share and all of its subfolders and read files. These are sufficient for users at this point to access the network resources.

Permission Entry for Company_Data

Principal: Users (FS1\Users) Select a principal

Type: Allow

Applies to: This folder, subfolders and files

Advanced permissions:

<input type="checkbox"/> Full control	<input type="checkbox"/> Write attributes
<input checked="" type="checkbox"/> Traverse folder / execute file	<input type="checkbox"/> Write extended attributes
<input type="checkbox"/> List folder / read data	<input type="checkbox"/> Delete subfolders and files
<input checked="" type="checkbox"/> Read attributes	<input type="checkbox"/> Delete
<input checked="" type="checkbox"/> Read extended attributes	<input checked="" type="checkbox"/> Read permissions
<input type="checkbox"/> Create files / write data	<input type="checkbox"/> Change permissions
<input type="checkbox"/> Create folders / append data	<input type="checkbox"/> Take ownership

Only apply these permissions to objects and/or containers within this container

The second entry is for **Special** permissions. Again, view the advanced permissions. This entry lets all users to create files, to write and append data, and to create folders. Since users should not be able to create directories directly below the **Company_Data** share, this entry should be removed.

Permission Entry for Company_Data

Principal: Users (FS1\Users) Select a principal

Type: Allow

Applies to: This folder and subfolders

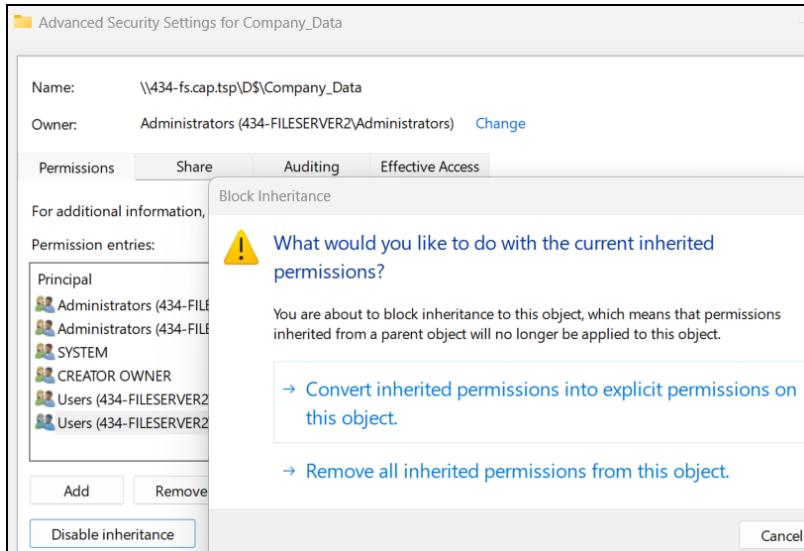
Advanced permissions:

<input type="checkbox"/> Full control	<input type="checkbox"/> Write attributes
<input type="checkbox"/> Traverse folder / execute file	<input type="checkbox"/> Write extended attributes
<input type="checkbox"/> List folder / read data	<input type="checkbox"/> Delete subfolders and files
<input type="checkbox"/> Read attributes	<input type="checkbox"/> Delete
<input type="checkbox"/> Read extended attributes	<input type="checkbox"/> Read permissions
<input checked="" type="checkbox"/> Create files / write data	<input type="checkbox"/> Change permissions
<input checked="" type="checkbox"/> Create folders / append data	<input type="checkbox"/> Take ownership

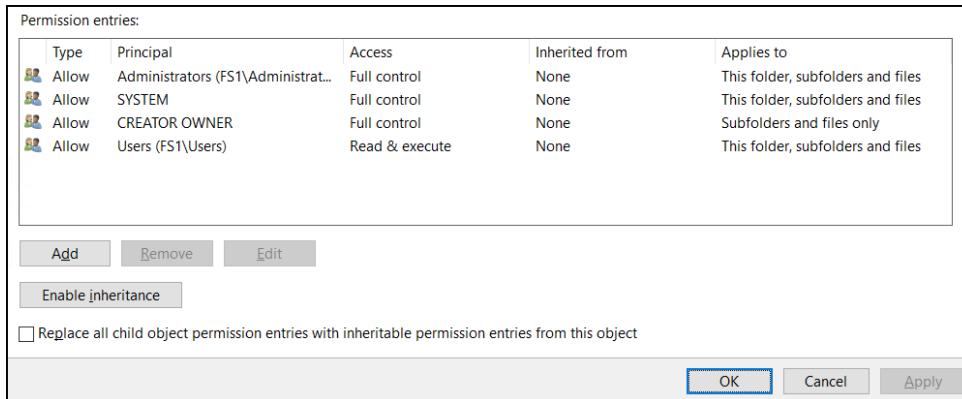
Only apply these permissions to objects and/or containers within this container

CAPSTONE PROJECT

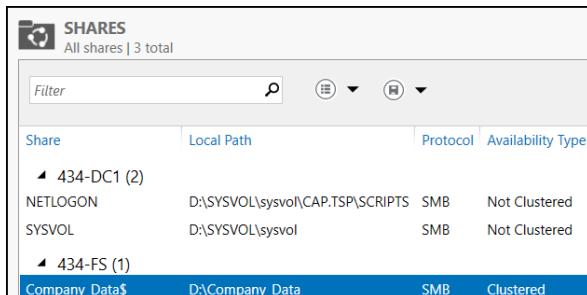
Back to **Advanced Security Settings for Company_Data** window, click **Disable inheritance -> Convert inherited permissions into explicit permission on this object**. This will keep current default permission configurations and let you edit permissions.



Select **Special** permission entry and click **Remove** and **OK**. Create a share.

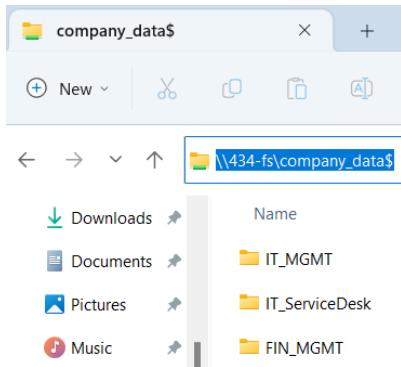


Check **Shares** tab in Server Manager.



CAPSTONE PROJECT

Open the share and create department directories in it called: **IT_MGMT**, **IT_ServiceDesk**, and **FIN_MGMT**.



Create 3 new users in ADUC. Each user will have different roles within the organization. Two Users will be **IT** employees (IT Manager and IT Service Desk) and one will be in **Finance** (Finance Administrator). The Users should be in appropriate Organizational Units.

New Object - User

Create in: CAP.TSP/Domain_Users/FIN/FIN_Admins

First name: Aaron Initials:
Last name: Johnson
Full name: Aaron Johnson
User logon name: Aaron @CAP.TSP
User logon name (pre-Windows 2000): CAP\Aaron

Object Classes: CAP.TSP, Builtin, Clients, Computers, Domain Controllers, Domain_Users, FIN, FIN_Admins, IT, IT_Managers, IT_ServiceDesk, ForeignSecurityPrincipals, Keys, LostAndFound, Managed Service Accounts, Program Data

New Object - User

Create in: CAP.TSP/Domain_Users/IT/IT_Managers

First name: Bob Initials:
Last name: Bill
Full name: Bob Bill
User logon name: Bob @CAP.TSP
User logon name (pre-Windows 2000): CAP\Bob

Object Classes: CAP.TSP, Clients, Computers, Domain Controllers, Domain_Users, FIN, FIN_Admins, IT, IT_Managers, IT_ServiceDesk, ForeignSecurityPrincipals, Keys, LostAndFound, Managed Service Accounts, Program Data, Security_Groups, Servers

CAPSTONE PROJECT

Saved Queries	New Object - User
CAP.TSP	
Builtin	
Clients	
Computers	
Domain Controllers	
Domain_Users	
FIN	
FIN_Admins	
IT	
IT_Managers	
IT_ServiceDesk	
ForeignSecurityPrincipals	
Keys	
LostAndFound	
Managed Service Accounts	
Printers	

Inside the IT_Groups OU, create a **Global Group** called **IT_Managers_G** and another called **IT_ServiceDesk_G**.

Active Directory Users and Computers		
File Action View Help		
Security_Groups	Name	Type
FIN_Groups	IT_Managers_G	Security Group - Global
IT_Groups	IT_ServiceDesk_G	Security Group - Global
Servers		

Inside the FIN_Groups OU, create a Global Group called **FIN_Admins_G**.

Active Directory Users and Computers		
File Action View Help		
Program Data	Name	Type
Security_Groups	FIN_Admins_G	Security Group - Global
FIN_Groups		

Add the users to their corresponding Global Group.

FIN_Admins_G	Aaron Johnson	CAP.TSP/Domain_Users/FIN/FIN_Admins
IT_Managers_G	Bob Bill	CAP.TSP/Domain_Users/IT/IT_Managers
IT_ServiceDesk_G	Cat Jung	CAP.TSP/Domain_Users/IT/IT_ServiceDesk

CAPSTONE PROJECT

Inside the IT_Groups OU, create Domain Local Security Groups called **IT_MGMT_RW_DL**, **IT_ServiceDesk_RW_DL**, **IT_MGMT_RE_DL**, and **IT_ServiceDesk_RE_DL**.

The screenshot shows the Active Directory Users and Computers interface. The left pane displays a tree view of objects under the 'Security_Groups' container, which includes 'FIN_Groups' and 'IT_Groups'. The right pane lists security groups with their names and types:

Name	Type
IT_Managers_G	Security Group - Global
IT_MGMT_RE_DL	Security Group - Domain Local
IT_MGMT_RW_DL	Security Group - Domain Local
IT_ServiceDesk_G	Security Group - Global
IT_ServiceDesk_RE_DL	Security Group - Domain Local
IT_ServiceDesk_RW_DL	Security Group - Domain Local

Inside the FIN_Groups OU, create a Domain Local Security Group called **FIN_MGMT_RW_DL**.

The screenshot shows the Active Directory Users and Computers interface. The left pane displays a tree view of objects under the 'Security_Groups' container, which includes 'FIN_Groups' and 'IT_Groups'. The right pane lists security groups with their names and types:

Name	Type
FIN_Admins_G	Security Group - Global
FIN_MGMT_RW_DL	Security Group - Domain Local

Nest the Global Groups into their appropriate Domain Local Groups.

The image contains four side-by-side screenshots of security group properties:

- FIN_MGMT_RW_DL Properties**: Shows the 'Members' tab with 'FIN_Admins_G' listed as a member of 'Active Directory Domain Services Folder' under 'CAP.TSP/Security_Groups/FIN_Groups'.
- IT_MGMT_RE_DL Properties**: Shows the 'Members' tab with 'FIN_Admins_G' listed as a member of 'Active Directory Domain Services Folder' under 'CAP.TSP/Security_Groups/FIN_Groups'.
- IT_MGMT_RW_DL Properties**: Shows the 'Members' tab with 'IT_Managers_G' listed as a member of 'Active Directory Domain Services Folder' under 'CAP.TSP/Security_Groups/IT_Groups'.
- IT_ServiceDesk_RE_DL Properties**: Shows the 'Members' tab with 'IT_Managers_G' listed as a member of 'Active Directory Domain Services Folder' under 'CAP.TSP/Security_Groups/IT_Groups'.

CAPSTONE PROJECT

IT_ServiceDesk_RW_DL Properties

Object	Security	Attribu
General	Members	Member Of
Members:		
Name	Active Directory Domain Services Folder	
IT_ServiceDe...	CAP.TSP/Security_Groups/IT_Groups	

Before proceeding, edit **Permissions** for the **Company_Data** share. Edit permissions for **Users** so that the current user permissions only apply to **This folder only**.

Permission Entry for company_data\$ (\\"434-fs)

Principal: Users (434-FILESERVER2\Users) Select a principal

Type: Allow

Applies to: This folder only

Basic permissions:

- Full control
- Modify
- Read & execute
- List folder contents
- Read
- Write
- Special permissions

Add groups with adequate permissions to each directory.

Permissions for FIN_MGMT

Object name: \\434-fs\company_data\$\FIN_MGMT

Group or user names:

- CREATOR OWNER
- FIN_MGMT_RW_DL (CAP\FIN_MGMT_RW_DL)
- SYSTEM
- Administrators (434-FILESERVER2\Administrators)

Permissions for FIN_MGMT_RW_DL

	Allow	Deny
Full control	<input type="checkbox"/>	<input type="checkbox"/>
Modify	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Read & execute	<input checked="" type="checkbox"/>	<input type="checkbox"/>
List folder contents	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Read	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Write	<input checked="" type="checkbox"/>	<input type="checkbox"/>

OK Cancel Apply

Permissions for IT_MGMT

Object name: \\434-fs\company_data\$\IT_MGMT

Group or user names:

- CREATOR OWNER
- IT_MGMT_RE_DL (CAP\IT_MGMT_RE_DL)
- IT_MGMT_RW_DL (CAP\IT_MGMT_RW_DL)
- SYSTEM
- Administrators (434-FILESERVER2\Administrators)

Permissions for IT_MGMT_RE_DL

	Allow	Deny
Full control	<input type="checkbox"/>	<input type="checkbox"/>
Modify	<input type="checkbox"/>	<input type="checkbox"/>
Read & execute	<input checked="" type="checkbox"/>	<input type="checkbox"/>
List folder contents	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Read	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Write	<input type="checkbox"/>	<input type="checkbox"/>

CAPSTONE PROJECT

The image displays three separate windows showing file security settings:

- Permissions for IT_MGMT:** Shows permissions for the folder \\434-fs\company_data\$\IT_MGMT. It lists users and groups under "Group or user names" and provides a table of permissions for "IT_MGMT_RW_DL".
- Permissions for IT_ServiceDesk:** Shows permissions for the folder \\434-fs\company_data\$\IT_ServiceDesk. It lists users and groups under "Group or user names" and provides a table of permissions for "IT_ServiceDesk_RE_DL".
- Permissions for IT_ServiceDesk:** This window appears to be a duplicate of the second one, showing the same folder path and permission table for "IT_ServiceDesk_RE_DL".

Permissions for IT_MGMT (Table):

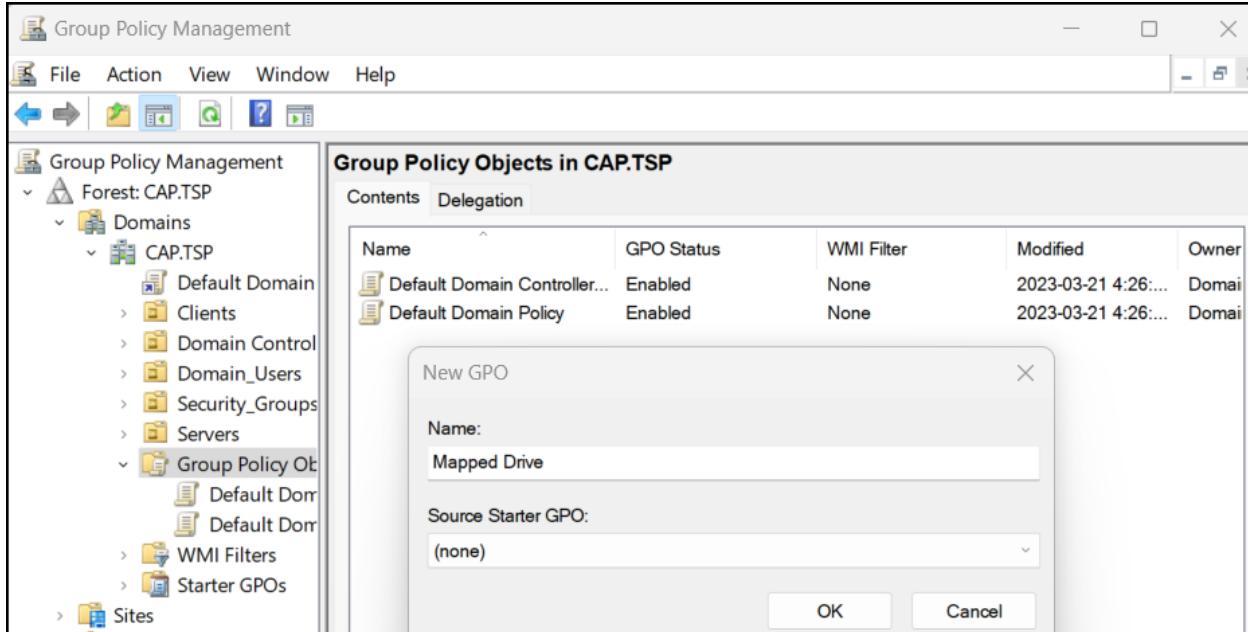
Permissions for IT_MGMT_RW_DL	Allow	Deny
Full control	<input type="checkbox"/>	<input type="checkbox"/>
Modify	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Read & execute	<input checked="" type="checkbox"/>	<input type="checkbox"/>
List folder contents	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Read	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Write	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Permissions for IT_ServiceDesk (Table):

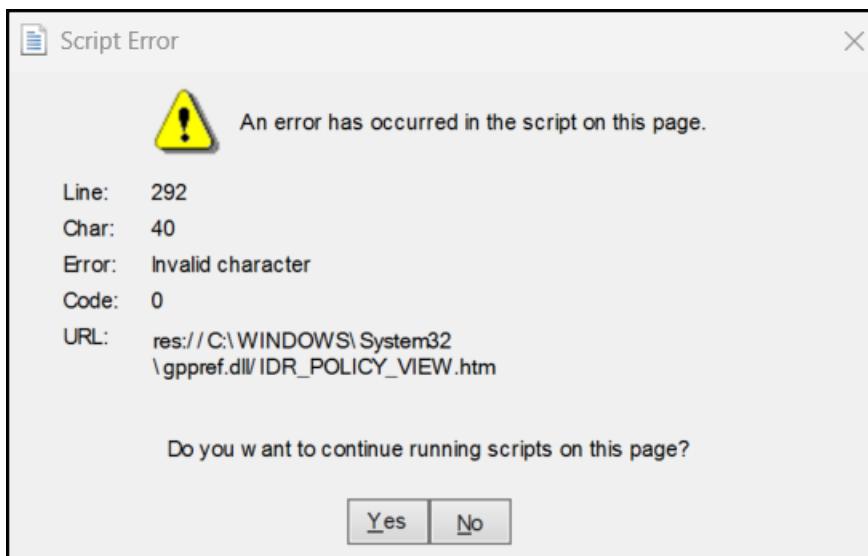
Permissions for IT_ServiceDesk_RE_DL	Allow	Deny
Full control	<input type="checkbox"/>	<input type="checkbox"/>
Modify	<input type="checkbox"/>	<input type="checkbox"/>
Read & execute	<input checked="" type="checkbox"/>	<input type="checkbox"/>
List folder contents	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Read	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Write	<input type="checkbox"/>	<input type="checkbox"/>

CAPSTONE PROJECT

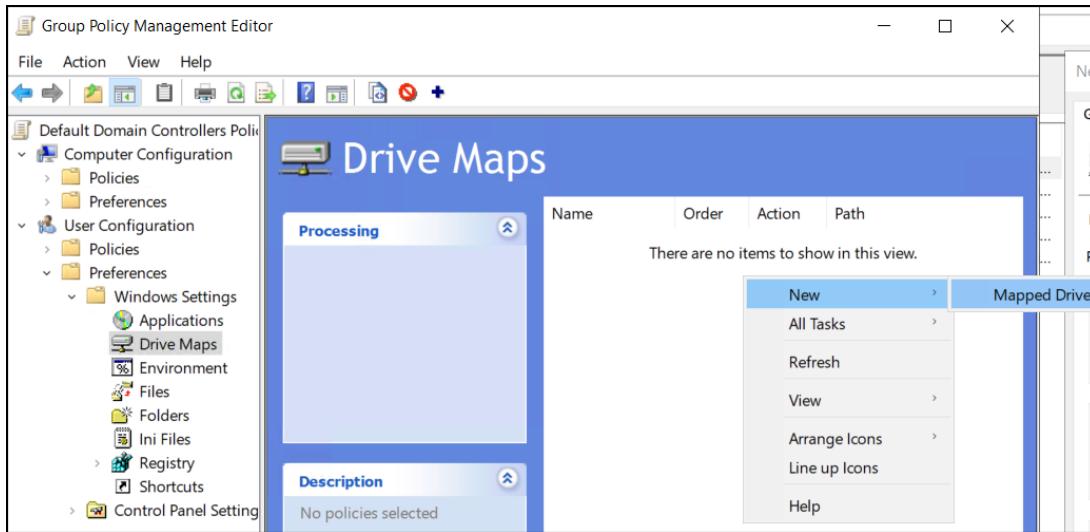
Now you need to create a mapped drive for the share through Group Policies, called **Mapped Drives**, so that users can access share without ever knowing remote path to the share. Open **Group Policy Management** (**Server Manager -> Tools**) and add new GPO to the domain. Name it accordingly.



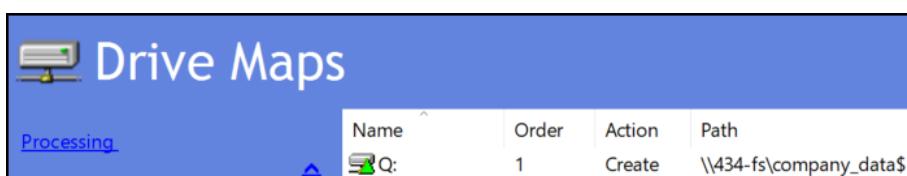
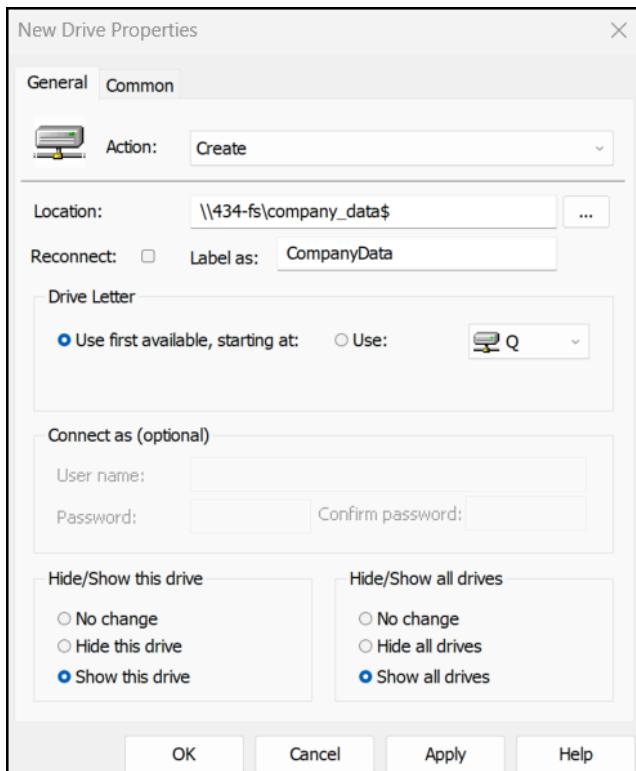
Right-click the GPO you created and go to **Edit -> User Configuration -> Preferences -> Windows Settings -> Drive Maps**. The error occurred. Through research, I found that this is a known issue with Windows 11 and Group Policy Preferences (GPP), with no official fix by Microsoft yet. Ignore and click **Yes** to continue. (Check the References section for related articles.)



CAPSTONE PROJECT

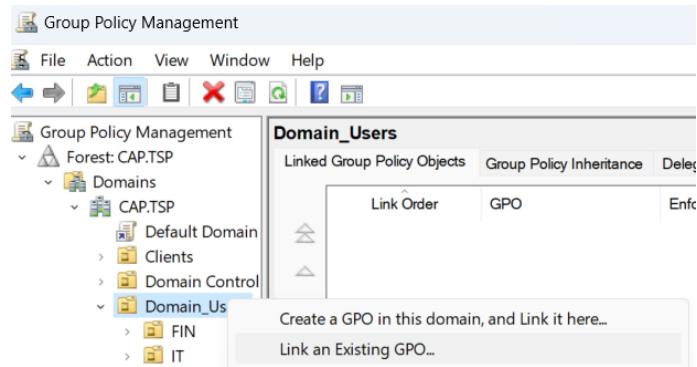


Change **Action** to **Create**, copy and paste the file share remote path to **Location**, give it a label and a drive letter, and select **Show** for this and other drives.

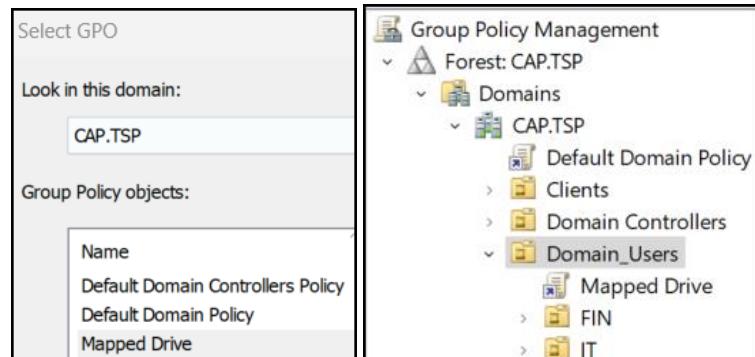


CAPSTONE PROJECT

In Group Policy Management, link this GPO to the OUs containing relevant users, which are **Domain_Users** in our case. Right-click Domain_Users OU and select **Link an Existing GPO**.

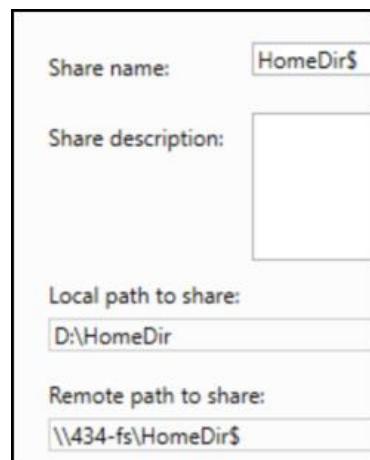


Select your mapped drive GPO and click **OK**.



Create and Apply a Folder Redirection GPO

You need to create another share from Failover Cluster Manager for a folder redirection. Name it **HomeDir**.



CAPSTONE PROJECT

As you did with the **Company_Data** share you need to **Customize permissions. Disable inheritance** and remove **Special** permission entry for users. Click **Edit** for Read/Execute access for users.

Permissions to access the files on a share are set using a combination of folder permissions, share permissions, and, optionally, a central access policy.

Share permissions: Everyone Full Control

Folder permissions:

Type	Principal	Access	Applies To
Allow	BUILTIN\Users	Special	This folder and subfolders
Allow	BUILTIN\Users	Read & execut...	This folder, subfolders, and files
Allow	CREATOR OWNER	Full Control	Subfolders and files only
Allow	NT AUTHORITY\SYSTEM	Full Control	This folder, subfolders, and files
Allow	BUILTIN\Administrators	Full Control	This folder, subfolders, and files
Allow	BUILTIN\Administrators	Full Control	This folder only

Customize permissions...

Advanced Security Settings for HomeDir

Name: \\434-fs.CAP.TSP\D\$\HomeDir

Owner: Administrators (434-FILESERVER2\Administrators) C

Permissions Share Auditing Effective Access

For additional information, double-click a permission entry. To modify

Permission entries:

Principal	Type	Access
Administrators (434-FILESERVER...)	Allow	Full control
Administrators (434-FILESERVER...)	Allow	Full control
SYSTEM	Allow	Full control
CREATOR OWNER	Allow	Full control
Users (434-FILESERVER2\Users)	Allow	Read & execute
Users (434-FILESERVER2\Users)	Allow	Special

Add Remove View

Disable inheritance

Change the **Applies to** parameter to **This folder only**, click **Show advanced permissions**, and check **Create folders / append data**. This is different from what you did with **Company_Data** share. Apply the change and create the share.

SHARES

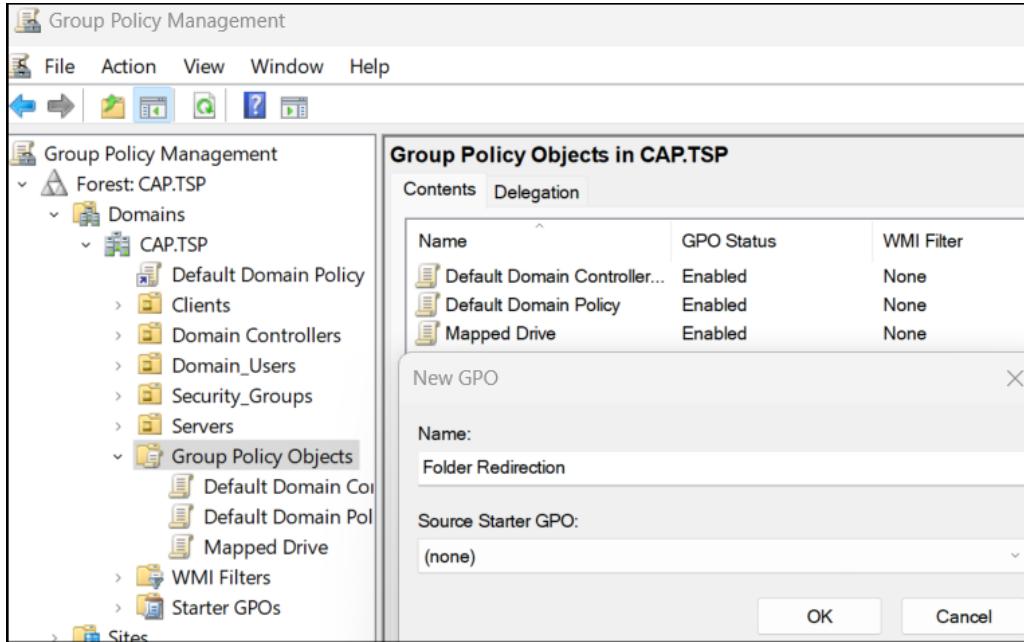
All shares | 4 total

Filter

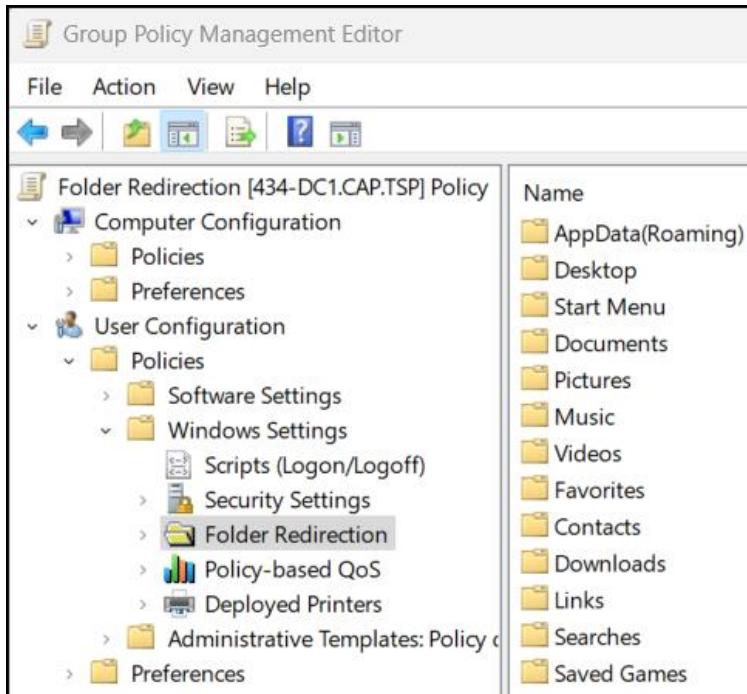
Share	Local Path	Protocol	Availability
434-DC1 (2)			
434-FS (2)			
Company_Data\$	D:\Company_Data	SMB	Clustered
HomeDir\$	D:\HomeDir	SMB	Clustered

CAPSTONE PROJECT

To make a folder redirection GPO, open **Group Policy Management** in Server Manager.

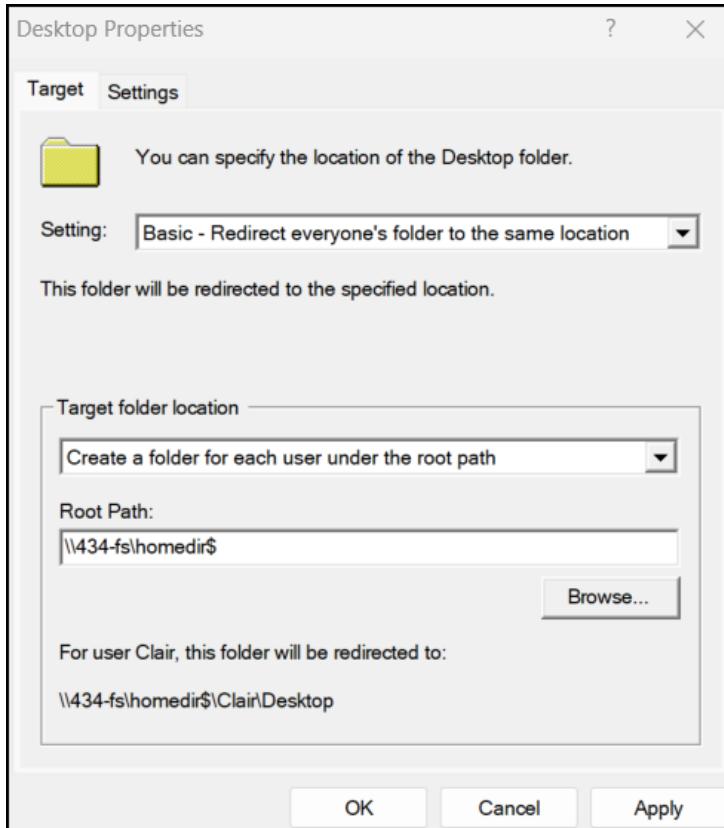


Right-click the GPO you just created and select **Edit** to open Group Policy Management Editor. Select **User Configuration -> Policies -> Windows Settings -> Folder Redirection**

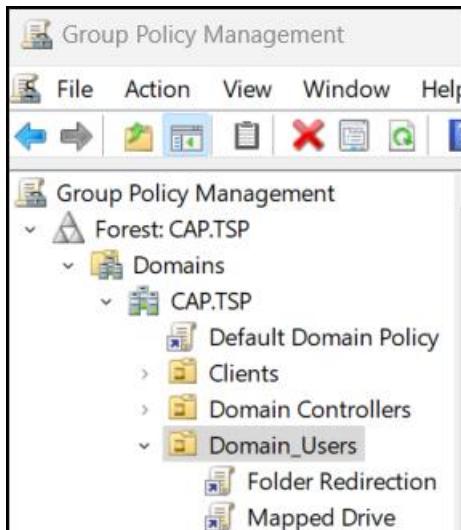


CAPSTONE PROJECT

Right-click **Desktop** and click **Properties**. Choose **Basic** for Setting, **Create a folder for each user under the root path** for Target folder location, and specify the root path to the share **HomeDir**. Repeat this for **Documents**.



Link this GPO to the **Domain_Users** OU.



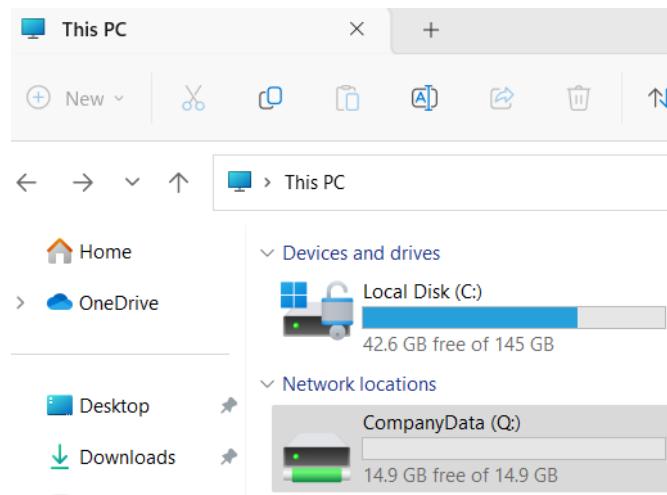
CAPSTONE PROJECT

Open PowerShell as administrator on your host machine and run the command **gpupdate /force** to update the group policy.

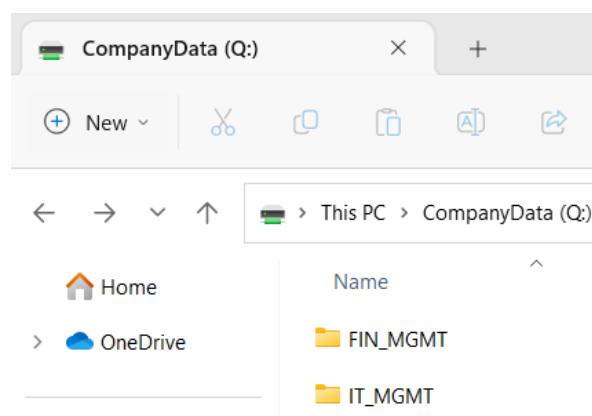
```
PS C:\WINDOWS\system32> gpupdate /force
Updating policy...
Computer Policy update has completed successfully.
User Policy update has completed successfully.
```

Test Share and Folder NTFS Permission Through a Group Policy-Mapped Drive

Log in with your Finance Administrator account to run tests. I log in as Aaron. Open **This PC**. You should see the mapped drive **CompanyData** to the share **Company_Data**.

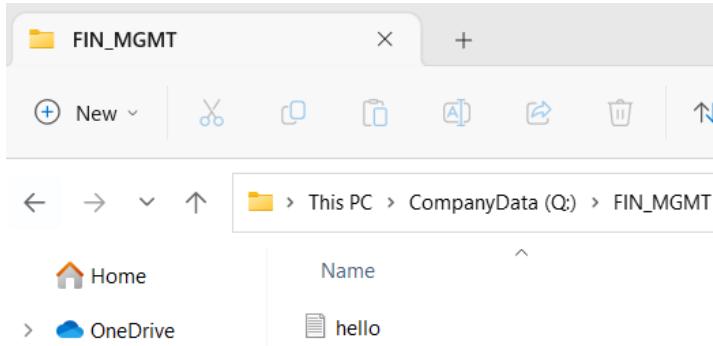


Access **CompanyData** drive. You should only see **FIN_MGMT** and **IT_MGMT** directories due to access-based enumeration.

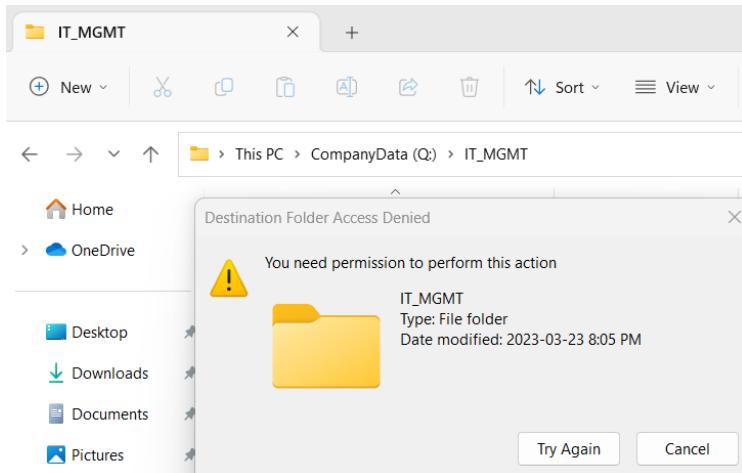


CAPSTONE PROJECT

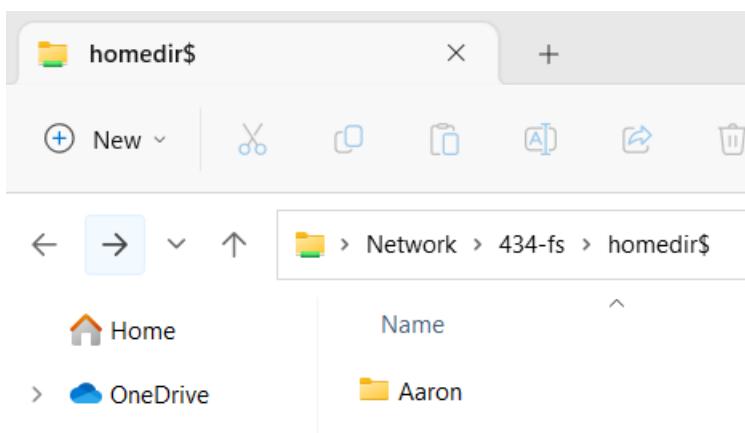
Access **FIN_MGMT** and create a file. You should be successful.



Access **IT_MGMT** and try to create a file. You should be denied a permission to do so due to having **Read** rights only.

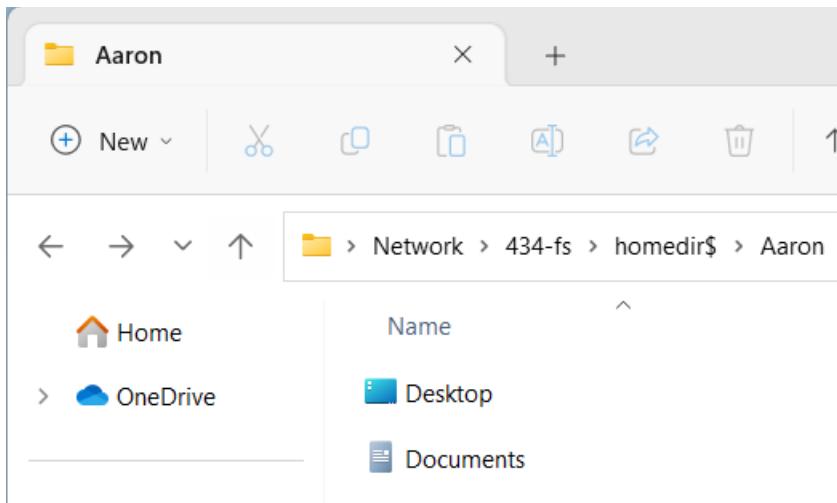


Type **\434-FS\HomeDir\$** in the address bar of File Explorer. You should see a directory with the account's username.

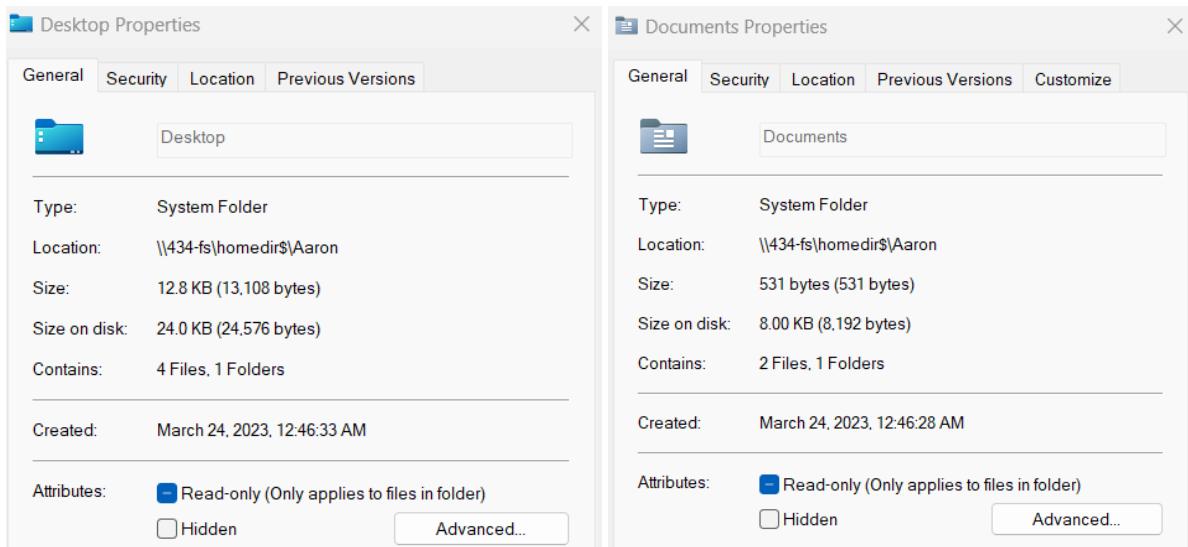


CAPSTONE PROJECT

Open the folder. You should see **Desktop** and **Documents**.

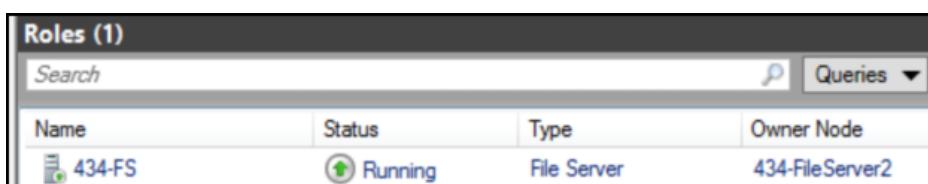


Right-click **Desktop** and **Documents** in the left pane of File Explorer to confirm the location. The test is complete. Sign out and log back with your own domain administrator account.



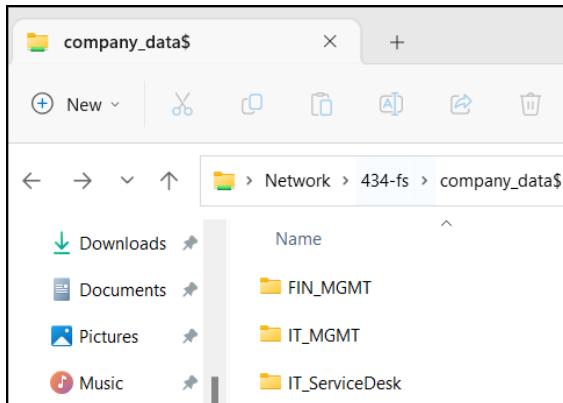
Test File Server Failover.

Open Failover Cluster Manager for **434-FileServer**. Click **Roles** and check the current **Owner Node**.

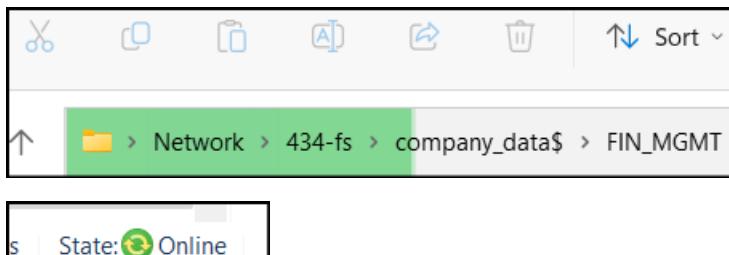


CAPSTONE PROJECT

Access the **Company_Data** share (**\\\434-FS\Company_Data\$**). Keep the windows open to check failover.



Back to Failover Cluster Manager, click **Nodes** in the left pane. Select the current owner node and click **Pause -> Drain Roles** in the right pane. You will see green buffer for a while but **434-FS** does not go down.



Owner node is now only available file server.

Roles (1)			
Name	Status	Type	Owner Node
434-FS	Running	File Server	434-FileServer1

Click **Resume -> Fail Roles Back** in the right pane. **434-FileServer2** retakes the owner node role.

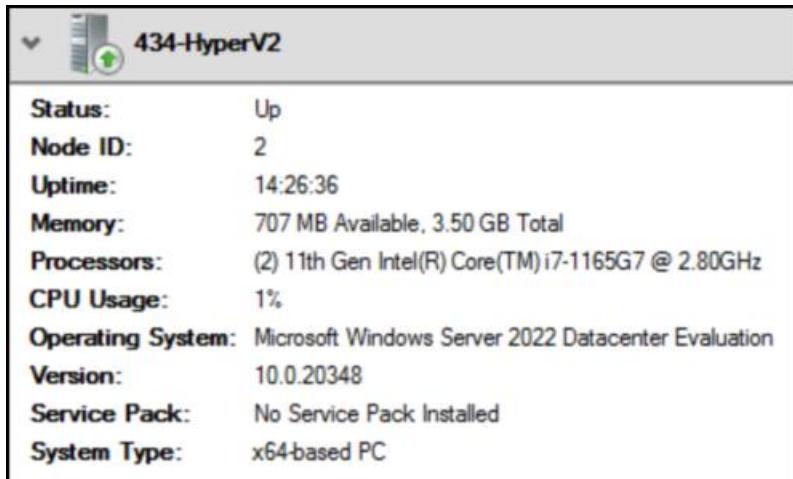
Roles (1)			
Name	Status	Type	Owner Node
434-FS	Running	File Server	434-FileServer2

CAPSTONE PROJECT

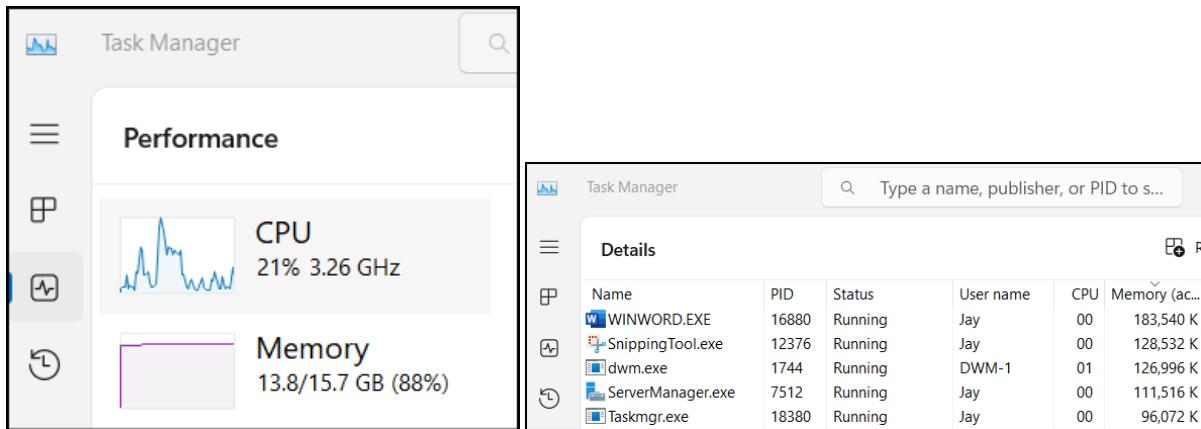
Configurations for file servers are complete. Shut down both file servers, reduce RAM to minimum 512 MB, and start them again.

Create a Secondary Server Domain Controller

Before creating a secondary DC, check your RAM status. Hyper-V servers were assigned 3.5 GB of RAM each and both have around only 700 MB of RAM available while running one file server.



I had around 2 GB of RAM available when I had only VMs and Microsoft word running. I decided to assign 4 GB RAM to each Hyper-V servers instead of 3.5 GB.



To do that:

- Shut down both file servers first.
- Then, shut down both Hyper-V servers.
- Increase RAM and start servers in reverse order.

CAPSTONE PROJECT

Open Failover Cluster Manager from one of the Hyper-V servers. And shut down file servers one by one.

Then open Hyper-V Manager on your host machine and shut down Hyper-V VMs one by one.

The screenshot shows the 'Hyper-V Manager' window. On the left, a tree view lists 'Hyper-V Manager' and three hosts: '434-HYPERV1', '434-HYPERV2', and '434-JAY'. On the right, a table titled 'Virtual Machines' lists several VMs:

Name	State
434-DC1	Running
434-DHCP	Running
434-FW	Running
434-HyperV1	Off
434-HyperV2	Off
434-SAN	Running

Increase RAM for both Hyper-V servers (I ended up giving 4200MB to each Hyper-V server later).

The screenshot shows the 'Settings for 434-HyperV2 on 434-JAY' dialog. In the 'Hardware' section, under 'Memory', it shows 'RAM: 4096 MB'. A note below says: 'Dynamic Memory' and 'You can allow the amount of memory available to this virtual machine to dynamically within the range you set.'

Restart Hyper-V Servers. Check Server Manager to see that iSCSI connection is established.

The screenshot shows the 'VOLUMES' page in Server Manager. It displays 17 total volumes. The table includes columns: Volume, Status, File System, Label, Provisioning, Capacity, and Free Space. The volumes are categorized into two main groups: '434-SAN (5)' and 'HyperVCluster (1)'. The '434-SAN' group includes volumes C:, D:, \\?\Volume{60..., \\?\Volume{80..., and E:. The 'HyperVCluster' group includes volume C:\ClusterStora... with a capacity of 98.3 GB and free space of 75.9 GB.

Volume	Status	File System	Label	Provisioning	Capacity	Free Space
C:	VMStorage			Fixed	126 GB	117 GB
D:	VMStorage			Fixed	99.9 GB	28.3 MB
\\?\Volume{60...				Fixed	96.0 MB	68.1 MB
\\?\Volume{80...				Fixed	524 MB	83.0 MB
E:	HyperVWitness			Fixed	4.94 GB	22.0 MB
C:\ClusterStora...	VMStorage			Fixed	98.3 GB	75.9 GB

CAPSTONE PROJECT

Reboot file servers from Failover Cluster Manager.

The screenshot shows the Failover Cluster Manager interface. On the left, there's a navigation pane with options like File, Action, View, Help, and a toolbar with icons for back, forward, search, and refresh. The main area is titled "Roles (2)". It contains a table with columns: Name, Status, Type, and Owner Node. There are two entries: 434-FileServer1 (Status: Off, Type: Virtual Machine, Owner Node: 434-HyperV2) and 434-FileServer2 (Status: Off, Type: Virtual Machine, Owner Node: 434-HyperV1).

Create a new Core VM for your secondary DC. (434-DC2)

This screenshot shows the "New Virtual Machine" dialog box. At the top, it says "Select the target cluster node for Virtual Machine creation." Below that is a "Look for:" search bar and a "Cluster nodes:" table. The table lists two nodes: 434-HyperV1 and 434-HyperV2, both with an "Up" status. The "Name" column has a tooltip: "Specify the amount of memory to allocate to this virtual machine. 1 MB through 251658240 MB. To improve performance, 1 GB is recommended for the operating system." Below the table, the "Startup memory:" field is set to 512 MB, and there's a checkbox for "Use Dynamic Memory for this virtual machine." At the bottom, a note says "Each new virtual machine includes a network adapter, a virtual switch, or it can remain disconnected." and the "Connection:" dropdown is set to LANBridge.

CAPSTONE PROJECT

Assign static IP. DNS server must be set to your **DC1**.

```
=====
          Network adapter settings
=====

NIC index:      1
Description:   Microsoft Hyper-V Network Adapter
IP address:    192.168.10.2,
               fe80::efb9:a17d:fe97:26f
Subnet mask:   255.255.255.240
DHCP enabled: False

Default gateway: 192.168.10.14
Preferred DNS server: 192.168.10.1
Alternate DNS server:

  1) Set network adapter address
  2) Set DNS servers
  3) Clear DNS server settings

Enter selection (Blank=Cancel):
```

Do other post-installation tasks and join it to domain.

```
PS C:\Users\Administrator> Rename-NetAdapter -Name Ethernet -NewName LAN
PS C:\Users\Administrator> -
PS C:\Users\Administrator> Add-Computer -DomainName CAP.TSP -NewName (Read-Host -Prompt 'enter the name')
enter the name: 434-DC2

cmdlet Add-Computer at command pipeline position 1
Supply values for the following parameters:
Credential
WARNING: The changes will take effect after you restart the computer WIN-UH73PVRJOD3.
PS C:\Users\Administrator> Rename-LocalUser -Name Administrator -NewName _LSysadmin
PS C:\Users\Administrator> Restart-Computer -Force
```

Attach separate vhdx to **434-DC2** and create a new volume for ADDS data.

```
PS C:\Users\jay> get-disk

Number Friendly Name Serial Number          HealthStatus     OperationalStatus   Total Size Partition
                                         Style
----- ----- -----
0      Msft Virtu...                   Healthy        Online           127 GB GPT
1      Msft Virtu...                   Healthy        Offline          20 GB RAW

PS C:\Users\jay> Initialize-Disk 1
PS C:\Users\jay> New-Partition -DiskNumber 1 -UseMaximumSize -AssignDriveLetter

  DiskPath: \\?\scsi#disk&ven_msft&prod_virtual_disk#5&31f2c053&0&000001#{53f56307-b6bf-11d0-94f2-00a0c91efb8b}

PartitionNumber DriveLetter Offset          Size Type
----- ----- -----
2                  D      16777216       19.98 GB Basic

PS C:\Users\jay> Format-Volume -DriveLetter D

DriveLetter FriendlyName FileSystemType DriveType HealthStatus OperationalStatus SizeRemaining   Size
----- -----
D                 NTFS      Fixed     Healthy      OK            19.93 GB 19.98 GB
```

CAPSTONE PROJECT

Install the **ADDS** role with the following command:

Install-ADDSDomainController

```
-NoGlobalCatalog:$false `

-CREATEDNSDelegation:$false `

-Credential (Get-Credential) `

-CriticalReplicationOnly:$false `

-DatabasePath "D:\NTDS" `

-DomainName "CAP.TSP" `

-InstallDns:$true `

-LogPath "D:\NTDS" `

-NoRebootOnCompletion:$false `

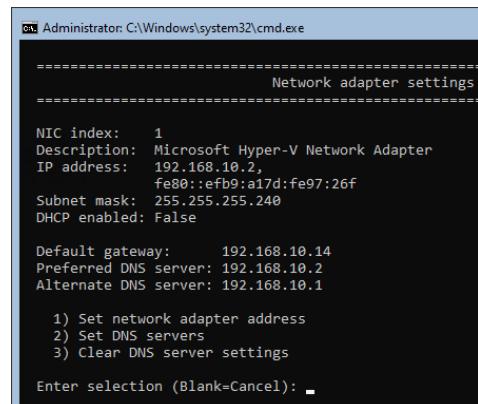
-SiteName "Default-First-Site-Name" `

-SysvolPath "D:\SYSVOL" `

-Force:$true
```

```
PS C:\Users\jay> Install-ADDSDomainController `>> -NoGlobalCatalog:$false `>> -CREATEDNSDelegation:$false `>> -Credential (Get-Credential) `>> -CriticalReplicationOnly:$false `>> -DatabasePath "D:\NTDS" `>> -DomainName "CAP.TSP" `>> -InstallDns:$true `>> -LogPath "D:\NTDS" `>> -NoRebootOnCompletion:$false `>> -SiteName "Default-First-Site-Name" `>> -SysvolPath "D:\SYSVOL" `>> -Force:$true
```

After restart, change DNS settings for **DC1** and **DC2**. (Primary DNS server is itself and Secondary is other DC)



CAPSTONE PROJECT

Check ADUC.

The screenshot shows the Active Directory Users and Computers (ADUC) interface. The left navigation pane shows the tree structure: Active Directory Users and Computers > CAP.TSP > Domain Controllers. The main pane displays a table with columns: Name, Type, DC Type, and Site. There are two entries: 434-DC1 (Computer, GC, Default-First-Site) and 434-DC2 (Computer, GC, Default-First-Site).

Name	Type	DC Type	Site
434-DC1	Computer	GC	Default-First-Site
434-DC2	Computer	GC	Default-First-Site

Open DNS Manager and check **Properties** (mainly **Forwarders** settings).

The screenshot shows the properties dialog for the server 434-DC2.CAP.TSP. The tabs at the top are Debug Logging, Event Logging, Monitoring, Security, Interfaces, Forwarders, Advanced, and Root Hints. The Forwarders tab is selected. The description below the tabs states: "Forwarders are DNS servers that this server can use to resolve DNS queries for records that this server cannot resolve." The IP Address field contains 192.168.10.14 and the Server FQDN field contains <Unable to resolve>. At the bottom, there is a checkbox for "Use root hints if no forwarders are available" and an "Edit..." button.

Now all infrastructure is up and running. Lastly, create a firewall rule to block internet connectivity of secondary DC, Hyper-V servers, and SAN. Open web-configurator of pfSense and click **Firewall -> Aliases**.

The screenshot shows the pfSense web interface under the Firewall > Aliases section. The URL is https://192.168.10.14/firewall_aliases.php. The left sidebar has tabs for IP, Ports, URLs, and All. The main area shows a table for Firewall Aliases IP. A dropdown menu from the Firewall tab lists Aliases, NAT, Rules, Schedules, Traffic Shaper, and Virtual IPs. The Aliases option is highlighted.

CAPSTONE PROJECT

Click **Add**. Name the alias and enter hosts to the group. Save and apply changes.

Host(s)

Hint Enter as many hosts as desired. Hosts must be specified by their IP address or fully qualified domain name (FQDN). FQDN hostnames are periodically re-resolved and updated. If multiple IPs are returned by a DNS query, all are used. An IP range such as 192.168.1.1-192.168.1.10 or a small subnet such as 192.168.1.16/28 may also be entered and a list of individual IP addresses will be generated.

IP or FQDN	434-DC2.CAP.TSP	434-DC2	Delete
	192.168.10.4	434-SAN	Delete
	434-HyperV1.CAP.TSP	434-HyperV1	Delete
	434-HyperV2.CAP.TSP	434-HyperV2	Delete

Save Export to file Add Host

Click **Firewall -> Rules -> LAN** and click **Add** with upper-right arrow. Create a block rule that blocks any protocols beyond pfSense's LAN network. Add the alias you created to the source.

Firewall / Rules / Edit

Edit Firewall Rule

Action Block

Choose what to do with packets that match the criteria specified below.
Hint: the difference between block and reject is that with reject, a packet (TCP RST or ICMP port unreachable for UDP) is returned to the sender, whereas with block the packet is dropped silently. In either case, the original packet is discarded.

Disabled Disable this rule
Set this option to disable this rule without removing it from the list.

Interface LAN

Choose the interface from which packets must come to match this rule.

Address Family IPv4+IPv6

Select the Internet Protocol version this rule applies to.

Protocol Any

Choose which IP protocol this rule should match.

Source

Source Invert match Single host or alias NoInternetAccess /

Destination

Destination Invert match any Destination Address /

CAPSTONE PROJECT

Again, apply changes. Test by pinging Google.

The screenshot shows a network configuration interface for a firewall. At the top, there are tabs for 'Firewall / Rules / LAN'. Below this, there are sub-tabs: 'Floating', 'WAN', and 'LAN', with 'LAN' being the active tab. The main area is titled 'Rules (Drag to Change Order)' and contains a table of rules:

	States	Protocol	Source	Port	Destination	Port	Gateway	Queue	Schedule	Description	Actions
<input checked="" type="checkbox"/>	7 / 2.07 MiB *	*	*	*	LAN Address	443 * 80	*	*		Anti-Lockout Rule	
<input type="checkbox"/>	0 / 84 KiB *	IPv4+6	NoInternetAccess	*	*	*	*	none		No Internet for DC2, SAN, HyperV1&2	
<input type="checkbox"/>	13 / 198.45 MiB	IPv4 *	LAN net	*	*	*	*	none		Default allow LAN to any rule	
<input type="checkbox"/>	0 / 0 B	IPv6 *	LAN net	*	*	*	*	none		Default allow LAN IPv6 to any rule	

At the bottom right of the table are buttons for 'Add' (with up and down arrows), 'Delete', 'Save', and 'Separator'.

Reflective Writing

Through this project, I had learned various aspects of building a network infrastructure. The most obvious lesson is that planning is the most important piece. You might get away with jumping right into the task when the network is simple enough. However, as structure gets more complex and interconnected, it is very easy to be lost in your own project that you are destined to make a mistake or miss a necessary step. Having a network diagram is, therefore, a must so that you have something to reference time and time again to reassess what you are doing or what you are doing wrong. Another realization is that how much do resources dictate what the outcome or the finished product will be for a project. Given abundance of resources, one would never have to worry about or plan storage and RAM assignment to each VMs. With limited resources, I was constantly checking RAM usage on Task Manager through the project to avoid any bottleneck while the important configuration or installation is taking place.

The biggest problem I encountered during the project was the error with creating a failover cluster for Hyper-V Servers. Two Hyper-V servers will pass the validation test for clustering with no single warning, but whenever I tried to create their cluster in the Wizard, it failed. My first thought was to check any syntax errors or wrong static IP assignment, but there was none. My next approach was based on the prior experience which the whole class had with one of the assignments. We needed to assign "Create

CAPSTONE PROJECT

Computer object” permission on the cluster name object (CNO) to create a new role within a cluster. I suspected it was a similar case and followed a procedure I took in the old assignment after prestaging CNO for Hyper-V cluster. Unfortunately, the same error still occurred, and it was midnight which meant that the best thing to do was to step back and sleep. As anyone can guess, on the next day with a fresh mind, you think of something new, and it always work. I was able to create a cluster using two lines of PowerShell cmdlets with no issue. To sum up, it is important to know when to step back.

The most satisfying aspect about the finished product was redundancy. Through the course, we only worked in a sandbox environment (apart from bare metal OS installation) where there were no real consequences of a server breaking down, other than perhaps having to redo assignments. After finishing the project, I got to appreciate having multiple layers of redundancy which makes the infrastructure more robust and reliable. Servers must not go down. On the other hand, lack of RAM was the most frustrating part about the project. I know that sometimes, having limitations force you to be more creative, but in this case, we did not have many choices.

This project revealed that I sometimes struggle to get an initial momentum to push myself when the finish line seems so far, but it also proved that once I am on the track, I can completely immerse myself to what I set my mind on. Because of this project, I am more aware of my ability as an IT Professional and hope to be a constant learner of this exciting field.

Links to Reference Websites

iso Files:

<https://www.pfsense.org/download/>

<https://www.microsoft.com/en-us/evalcenter/evaluate-windows-server-2022>

<https://www.centos.org/download/>

How to SysPrep Windows Server Core 2016

<https://www.ntweekly.com/2017/11/08/sysprep-windows-server-core-2016/>

How to Rename NIC in Linux (CentOS / RHEL 7&8)

<https://tekneed.com/how-to-rename-nic-in-linux-centos-rhel-7-8/>

CAPSTONE PROJECT

Configuring Jumbo Frames with PowerShell in Windows Server 2012

<https://blog.workinghardinit.work/2012/06/11/configuring-jumbo-frames-with-powershell-in-windows-server-2012/>

Hyper-V Core - iSCSI Setup

<https://community.hpe.com/t5/array-setup-and-networking/hyper-v-core-iscsi-setup/mp/6982257/highlight/true#M312>

Prestage cluster computer objects in Active Directory Domain Services

<https://learn.microsoft.com/en-us/windows-server/failover-clustering/prestage-cluster-adds>

Test-Cluster

<https://learn.microsoft.com/en-us/powershell/module/failoverclusters/test-cluster?view=windowsserver2022-ps>

New-Cluster

<https://learn.microsoft.com/en-us/powershell/module/failoverclusters/new-cluster?view=windowsserver2022-ps>

Use Cluster Shared Volumes in a failover cluster

<https://learn.microsoft.com/en-us/windows-server/failover-clustering/failover-cluster-csvs>

A step-by-step guide to understand Hyper-V Live Migration

https://www.altaro.com/hyper-v/a-step-by-step-guide-hyper-v-live-migration/#Live_Migration

How to Perform Hyper-V Live Migrations Step by Step (2 Cases)

<https://www.backup.com/enterprise-backup/hyper-v-live-migrations.html>

CAPSTONE PROJECT

Deploying VHD Sets on Windows Server 2016 Hyper-V

<https://petri.com/deploying-vhd-sets-windows-server-2016-hyper-v/>

VHD Set feature in Microsoft Windows Server 2016

<https://www.starwindsoftware.com/resource-library/vhd-set-feature-in-microsoft-windows-server-2016/>

Bug causes script error in Group Policy Preferences (GPP) e.g. for Task Scheduler

<https://borncity.com/win/2022/12/06/bug-causes-script-error-in-group-policy-preferences-gpp-e-g-for-task-scheduler/>

How to Fix Script Error bug in Windows 11 22H2

<https://www.howto-connect.com/fix-script-error-bug-windows-11-22h2/>

Error in GPMC when trying to edit registry

<https://community.spiceworks.com/topic/2469050-error-in-gpmc-when-trying-to-edit-registry>