# Standard Operating Procedure (SOP) for Electric-Petrol.ie Hyper-V Cluster Upgrade with Clustered Shared Storage

## Overview and Goals

This design report explains how to add a third virtualisation server to each branch of the customer's service station, set up Clustered Shared Storage (CSV) using Hyper-V on Windows Server 2019, and make sure that operations can continue even if one server goes down. The solution changes the current VMware-based configuration into a Hyper-V failover cluster, adds the Active Directory domain to the electric-petrol.ie domain tree, and uses existing hardware and software to create a solution that is cost-effective, strong, and can grow. The goals are:

* Adding a third server to each site to make it more fault tolerant.
* Using Cluster Shared Volumes (CSV) with Hyper-V Failover Clustering to share storage.
* Making sure that the system is always available, even if one server goes down.
* Rebuilding the Active Directory domain so that it can join the electric-petrol.ie domain tree.
* Using best practices to get the most out of performance and dependability without spending more money.

## The current situation

At the moment, each branch location has two Dell R440 servers running VMware ESXi with the following specs:

Hardware:

* CPU: Not given (assumed to be multi-core with support for Intel VT-x/EPT).
* Memory: 256GB (16GB DIMMs).
* 2 x 240GB SSD in RAID 1 for the operating system.
* 4 x 1TB HDDs in RAID 5 for data, which gives you about 3TB of usable space.

Network:

* Two 1Gb/s Ethernet cards built in.
* There are two 10Gb/s Ethernet cards on a mezzanine board.

Operating System:

* Windows Server 2019 Datacentre (on virtual machines).

Virtual Machines (for each host):

* DCx is a Windows Server 2019 Domain Controller with 4GB of RAM that is coupled to the Galleon NTS-6002-GPS time server.
* FSx is a Windows Server 2019 file server with 8GB of RAM.
* DBx: A database server for Windows Server 2019 that runs MSSQL and has 24GB of RAM.
* SLx: 8GB of RAM and an Ubuntu 20.04 Syslog Server.

Network Setup:

* The subnet is thought to be 192.168.146.0/24 (based on the SOP given).
* The gateway is 192.168.146.1.
* DNS: DNS that works with Active Directory.
* Time Synchronisation: Galleon NTS-6002-GPS time server.

## What the customer wants

1. Add a Third Virtualisation Server: Set up a third server at each site to make things more reliable.
2. Set up clustered shared storage: Use Hyper-V with Cluster Shared Volumes (CSV) to let all nodes access the same storage.
3. High Availability: Make sure the site keeps running even if one server goes down.
4. Active Directory Integration: Change the Active Directory domain so that it can join the electric-petrol.ie domain tree.
5. Management Implementation: Make plans for the cluster to be managed from one place.
6. Best Ways: Find more technical benefits without having to pay more.
7. Windows Services: List any extra services that Windows servers need to provide.

## Suggested Solution

**Switch to Hyper-V Failover Cluster**

A Hyper-V Failover Cluster operating on Windows Server 2019 Datacentre will take the place of the current VMware ESXi environment. This will use the existing licenses. There will be three nodes in the cluster: two existing servers and one new server. The nodes will all use Cluster Shared Volumes (CSV) for shared storage to make sure that the cluster is always available. The solution stores data on the existing hardware's RAID 5 array, which is set up as a CSV, and works with the electric-petrol.ie domain tree.

**Hardware and Software Requirements for Existing Servers (Node1 and Node2)**

Upgrades to the hardware:

* Storage: Change the 4 x 1TB HDDs in RAID 5 to a Cluster Shared Volume (CSV) configured with NTFS (this is better for Hyper-V CSV because it supports more features).
* Network: Set aside one 10Gb/s NIC for cluster communication and CSV traffic, one 10Gb/s NIC for live migration, and one 1Gb/s NIC for management traffic. Set up the second 1Gb/s NIC to handle VM traffic or as a backup.
* CPU/Memory: No upgrades needed; the current 256GB of RAM and multi-core CPUs are enough.

Upgrades for Software:

* On each server, add the roles for Hyper-V and Failover Clustering.
* Uninstall VMware ESXi and install Windows Server 2019 Datacenter as the main operating system.
* Set up the network settings so that the cluster can talk to each other, then use the Cluster Validation Wizard to make sure the hardware is compatible.

Third Server (Node3) : Model: Dell PowerEdge R450 (the R440's replacement, which makes sure it works with it).

Specifications:

* Intel Xeon Silver 4310 CPU with 12 cores, 2.1 GHz, and SLAT support for Hyper-V.
* **Memory**: 256GB (16 x 16GB DIMMs) to work with the servers that are already there.
* **Storage:** Two 240GB SSDs in RAID 1 for the operating system.
* 4 x 1TB HDDs in RAID 5 for data, which is the same as the servers we now have and will help with CSV.
* **Network:** Two 1Gb/s Ethernet cards built in.
* Two 10Gb/s Ethernet cards (mezzanine board).
* **Cost Estimate:** About 5,000 to 7,000, depending on the provider and how it is set up.

**Software:**

* Windows Server 2019 Datacentre (the current license includes extra nodes).
* Set up the roles for Hyper-V and Failover Clustering.

Storage that is shared

* Setup: Format the RAID 5 arrays (4 x 1TB HDDs) on all three servers as Cluster Shared Volumes (CSV) using NTFS. This lets all nodes use the same storage at the same time without using additional SAN or iSCSI storage, thanks to a "shared nothing" approach.
* Benefits: CSVs make it easy to failover quickly without having to remount drives, which makes management easier and HA better.
* Setup: On each server, set up the RAID 5 array and format it as NTFS.
* Use Failover Cluster Manager to add the arrays to the cluster as CSVs.

**Setting Up High Availability**

Failover Clustering:

* A Hyper-V Failover Cluster will be made up of all three nodes (Node1, Node2, and Node3).
* Set up a Cloud Witness in Azure for quorum (cost-effective, no extra hardware needed) to keep the cluster stable with three nodes.
* Set up Hyper-V High Availability for all VMs (DCx, FSx, DBx, SLx) so that they will automatically switch to another node if one fails.

Failover Behaviour:

* If one server goes down, the VMs on that server will resume on another server within seconds, which keeps downtime to a minimum. Please keep in mind that VMs will restart from a cold boot because Hyper-V doesn't provide fault tolerance (running without restarting) like VMware Fault Tolerance does.
* The cluster can still work and keep quorum with three nodes, even if one of them goes offline.

Live Migration:

* Set up live migration so that VMs can migrate between nodes without any downtime during planned maintenance. Use the dedicated 10Gb/s NIC for migration traffic.

**Integrating with Active Directory**

Current Setup:

* Each site has a Windows Server 2019 Domain Controller (DCx) that is connected to a local Active Directory domain.

Electric-petrol.ie is going through a redesign:

* Make a new domain siteX.electric-petrol.ie for each branch site. The siteX part should be a unique identifier, such dublin.electric-petrol.ie.
* Add the existing Domain Controller (DCx) as a child domain to the electric-petrol.ie domain tree.
* Steps:

1. Use the Active Directory Domain Services (AD DS) role to make DCx the domain controller for siteX.electric-petrol.ie.
2. Set up DNS so that it can find electric-petrol.ie and send siteX.electric-petrol.ie to DCx.
3. Set up a trust connection between the root electric-petrol.ie domain and the child domain of the site.
4. Make sure that your Group Policy Objects (GPOs) follow your company's rules.

Time Synchronisation:

* Make sure that DCx keeps syncing with the Galleon NTS-6002-GPS time server so that AD time is always correct.

Pros:

* easier authentication across sites, centralised identity management, and conformance with the structure of the corporate domain.

**Putting Management into Action**

* Tool: Use Windows Admin Centre to manage the Hyper-V cluster, nodes, and VMs from one place.
* Setup: You can host Windows Admin Centre on a management VM or a separate Windows Server 2019 instance (Node1 can host it).  
  Set up access so that you may manage all three nodes and the cluster.  
  You may use Windows Admin Centre to keep an eye on CPU, RAM, disc space, and network performance, as well as to undertake live migrations and maintenance on clusters.
* Advantages: it has a browser-based interface, doesn't cost anything extra for licenses, and works with Hyper-V and Failover Clustering technologies.

**Setting Up a Virtual Machine**

Existing VMs:

* Use a program like Microsoft Virtual Machine Converter or do it by hand to move existing VMs (DCx, FSx, DBx, SLx) from VMware to Hyper-V.
* The specifications for the VM stay the same:
* DCx has 4GB of RAM, 2 vCPUs, and 20GB of disc space.
* FSx has 8GB of RAM, 2 vCPUs, and a 50GB disc.
* DBx has 24GB of RAM, 4 vCPUs, and 100GB of disc space.
* SLx has 8GB of RAM, 2 vCPUs, and a 20GB disc.
* For high availability, keep all VMs on the CSV.

Setting Up the Network:

* Use PowerShell to make a virtual switch (vSwitch) called "Cluster-vSwitch" on each node: *New - MSwitch -Name "Cluster-vSwitch" -NetAdapterName "10GbE1" -AllowManagementOS $true*
* Assign VMs to the "Cluster-vSwitch" so that all nodes can access the network in the same way.

## Tasks that need to be done for the upgrade

1. Set Up the Servers You Already Have:

* Use the backup tools you already have (such Storware, as per SOP) to back up all VMs.
* Uninstall VMware ESXi from Node1 and Node2.
* Put Windows Server 2019 Datacenter on both of the nodes.
* Use Server Manager or PowerShell to add the Hyper-V and Failover Clustering roles: *Install-WindowsFeature -Name Hyper-V, Failover-Clustering -IncludeManagementTools*
* Set up RAID 5 arrays as NTFS volumes for CSV.
* Set static IPs:
* Node1: 192.168.146.101
* Node2: 192.168.146.102
* Set up network adapters:
* 10Gb/s NIC1: Traffic from the cluster and CSV.
* 10Gb/s NIC2: Moving things around in real time.
* 1Gb/s NIC1: Management.
* Connect both nodes to the domain siteX.electric-petrol.ie.

1. Get and set up the third server (Node3):

* Buy a Dell PowerEdge R450 that has the same specs as the servers you already have.
* Put Windows Server 2019 Datacenter on your computer.
* Set up the roles for Hyper-V and Failover Clustering.
* Set up the RAID 5 array as an NTFS volume for CSV.
* Set the static IP to 192.168.146.103.
* Add Node3 to the domain siteX.electric-petrol.ie.

1. Set up Hyper-V Failover Cluster:

* Use Failover Cluster Manager to check the cluster configuration: *Test-Cluster -Node Node1, Node2, Node3*
* Make the cluster: *New-Cluster -Name "SiteX-Cluster" -Node Node1, Node2, Node3 -StaticAddress 192.168.146.100*
* Add CSVs for RAID 5 arrays: *Add-ClusterSharedVolume -Name "CSV1" -PhysicalDisk (Get-Disk | Where-Object { $\_.FriendlyName -eq "Clustered Disc" })*
* *Set-ClusterQuorum -CloudWitness -AccountName "<AzureStorageAccount>" -AccessKey "<AccessKey>" to set up Cloud Witness.*
* Use Failover Cluster Manager to turn on HA for VMs.

1. Move VMs:

* Use Microsoft Virtual Machine Converter to change VMware VMs into Hyper-V format.
* Put VMs on the CSV and set them up as roles that are highly available.

1. Reengineering Active Directory:

* Make DCx a domain controller for siteX. electric-petrol. Set up DNS and trust relationships with electric-petrol, for example. For example, check that the time is in sync with the Galleon NTS-6002-GPS server.

1. Setting up management:

* Put Windows Admin Centre on a VM that you use for management.
* Set up access to control the cluster and its nodes.

1. Testing:

* Shut down one node to test HA and make sure VM failover works.
* Use Windows Admin Centre to test live migration.
* Use the backup tools you already have to check that backup and restore work.

## What the Upgrade Means

* Downtime: There is very little downtime during VM migration and cluster setup because live migration and planned failovers are supported. To avoid problems, undertake migrations during maintenance windows.
* Performance: Adding a third node makes resources more available and helps balance the load. CSV lets multiple people access the same storage at the same time, which speeds it up.
* Cost: The only extra cost is buying the third server, which costs between 5,000 and 7,000. Licenses and hardware that are already in use are used again.
* Hyper-V Failover is hard. Clustering makes management harder, but Windows Admin Centre makes it easier.
* Scalability: You can add more nodes or storage to the three-node cluster to make it bigger in the future.
* Reliability: The solution makes sure that there is no single point of failure, which meets the customer's HA requirement.

## More Best Practices and Technical Benefits

Network Optimisation:

* Set up Quality of Service (QoS) rules to provide CSV and live migration traffic higher priority on the 10Gb/s NICs.
* PowerShell command example: New-NetQosPolicy -Name "CSVTraffic" -IPDstPrefix 192.168.146.0/24 -PriorityValue8021Action 3

Backup Plan:

* Keep utilising the same backup tools (like Storware) to back up the CSV every day.
* Implement incremental backups to reduce storage and time requirements.

Security:

* Set up Windows Firewall with rules that let clusters talk to one other (TCP/UDP 3343, 445, etc.).
* Use least-privilege roles to handle clusters in Windows Admin Centre.

Monitoring:

* Use Windows Admin Centre to set up alarms for CPU utilisation (over 80%), RAM, and disc health.
* Use Failover Cluster Manager to keep an eye on cluster events so you can do maintenance before it becomes necessary.

Resource Optimisation:

* Turn on Dynamic Memory for VMs to make the most of RAM (except for DBx, which needs fixed memory for MSSQL to work well).
* If you need more storage resiliency in the future, use Storage Spaces Direct (S2D) with the discs you already have.

## Duties and Roles

IT Administrator:

* Do the upgrade activities, set up the cluster, and take care of the VMs.
* Use Windows Admin Centre to keep an eye on the health and performance of your cluster.

Network Administrator:

* Set up DNS, network settings, and QoS policies for electric-petrol. Make sure that the firewall rules allow communication between clusters.

Owner of the system:

* Check that the upgraded system works and test what happens if it fails.
* Give the go-ahead for configurations and keep an eye on how well they meet business needs.

## In conclusion

This solution turns the customer's virtualisation infrastructure into a three-node Hyper-V Failover Cluster using Cluster Shared Volumes. This makes sure that the system is always available and works with the electric-petrol.ie domain tree. The solution makes use of hardware and licenses that are already in place. The only extra expense is the third server. Best practices like QoS, incremental backups, and centralised management make things more reliable and faster without costing more. The system fits the customer's needs for fault tolerance, scalability, and centralised management, making it a strong base for running their service station.