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# Installing and Configuring a SQL Server 2016 Failover Clustered Instance on Windows Server 2016

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**Edwin M Sarmiento**

**Applies to:**

- SQL Server 2016
- Windows Server 2016

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## Introduction

This guide is intended for experienced Windows Server system administrators, IT professionals and SQL Server database administrators who need to install and configure a 2-node Windows Server 2016 Failover Cluster (WSFC) that will host a SQL Server 2016 failover clustered instance (FCI).

## Assumptions

When using this guide, a few assumptions have been made:

- Windows Server 2016 is installed on each server that will be used for the failover cluster and that they are joined to the same Active Directory domain.
- Installation and configuration of the shared storage used for the cluster is outside the scope of this document. Enlist the assistance of your storage vendors and engineers to accomplish this task.
- You have decided which quorum model will be used by the WSFC. This document will use a disk witness as the quorum model.

## Cluster Configuration Details

Prior to building your WSFC, it is important to have all the details in place to make sure that installation and configuration will go smoothly. The following details will be used to build and configure a SQL Server 2016 FCI.

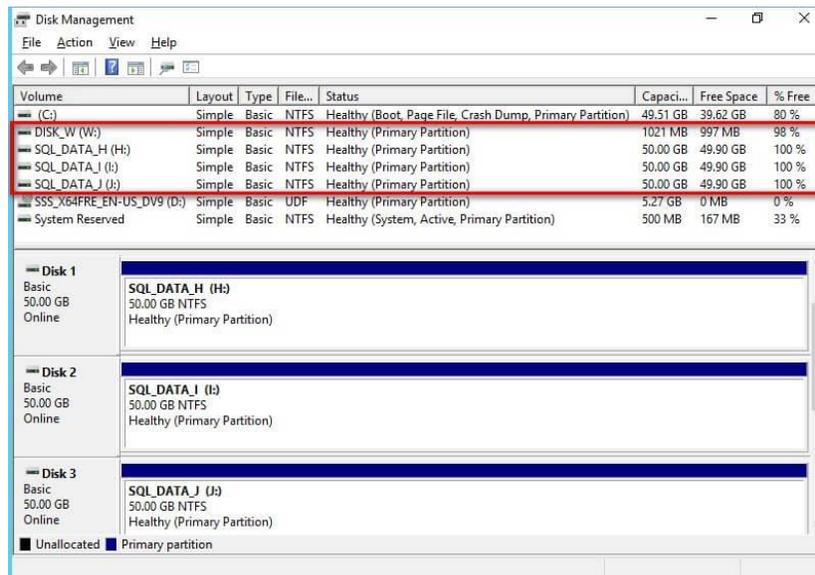
- **Active Directory Domain Name:** TESTDOMAIN.COM
- **Cluster Nodes:** WSFC2016-NODE1 & WSFC2016-NODE2
- **Cluster Disks:** W:\, H:\, I:\ & J:\
- **Windows Server Failover Cluster Name and IP Address:** WIN2K16CLUSTER  
(172.16.0.33)
- **SQL Server Failover Cluster Virtual Server Name and IP Address:** SQL2016FCI  
(172.16.0.35)
- **SQL Server Service Account:** TESTDOMAIN\sqlservice

## Preparing Shared Storage

It is assumed that the underlying shared storage has already been physically attached to all of the WSFC nodes and that the hardware meets the requirements defined in the Microsoft TechNet article [Failover Clustering Hardware Requirements and Storage Options](#).

Managing shared storage requires an understanding of your specific storage product which is outside the scope of this document. Consult your storage vendor for more information.

This particular environment has four (4) shared storage volumes configured - SQL\_DATA\_H, SQL\_DATA\_I and SQL\_DATA\_J allocated for the SQL Server databases and DISK\_W for the witness disk.



The screenshot shows the Windows Disk Management console. A table at the top lists the volumes, and a detailed view below shows the configuration for three disks.

Volume	Layout	Type	File...	Status	Capaci...	Free Space	% Free
(C:)	Simple	Basic	NTFS	Healthy (Boot, Page File, Crash Dump, Primary Partition)	49.51 GB	39.62 GB	80 %
DISK_W (W:)	Simple	Basic	NTFS	Healthy (Primary Partition)	1021 MB	997 MB	98 %
SQL_DATA_H (H:)	Simple	Basic	NTFS	Healthy (Primary Partition)	50.00 GB	49.90 GB	100 %
SQL_DATA_I (I:)	Simple	Basic	NTFS	Healthy (Primary Partition)	50.00 GB	49.90 GB	100 %
SQL_DATA_J (J:)	Simple	Basic	NTFS	Healthy (Primary Partition)	50.00 GB	49.90 GB	100 %
SSS_X64FRE_EN-US_DV9 (D:)	Simple	Basic	UDF	Healthy (Primary Partition)	5.27 GB	0 MB	0 %
System Reserved	Simple	Basic	NTFS	Healthy (System, Active, Primary Partition)	500 MB	167 MB	33 %

Disk	Volume	Layout	Type	File...	Status	Capaci...	Free Space	% Free
Disk 1	SQL_DATA_H (H:)	Simple	Basic	NTFS	Healthy (Primary Partition)	50.00 GB	49.90 GB	100 %
Disk 2	SQL_DATA_I (I:)	Simple	Basic	NTFS	Healthy (Primary Partition)	50.00 GB	49.90 GB	100 %
Disk 3	SQL_DATA_J (J:)	Simple	Basic	NTFS	Healthy (Primary Partition)	50.00 GB	49.90 GB	100 %

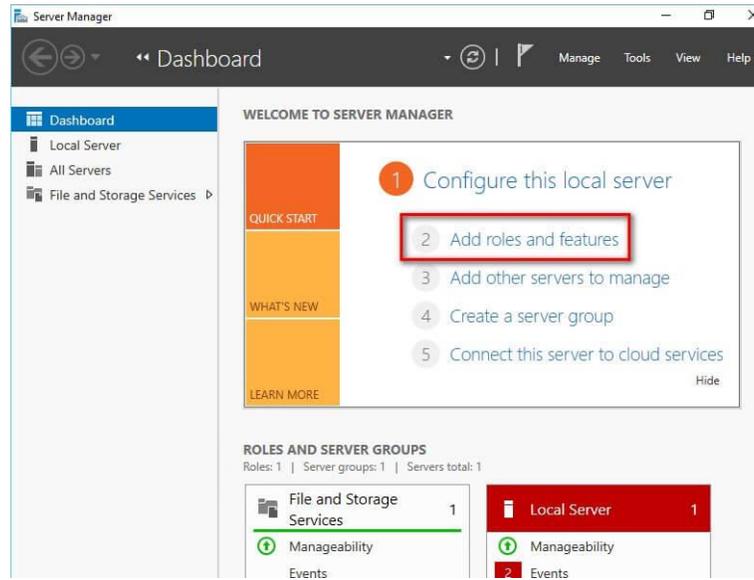
The goal here is to provision shared storage both for capacity and performance. Perform the necessary storage stress tests to make sure that you are getting the appropriate amount of IOPs as promised by your storage vendor.

## Adding the Failover Clustering Feature

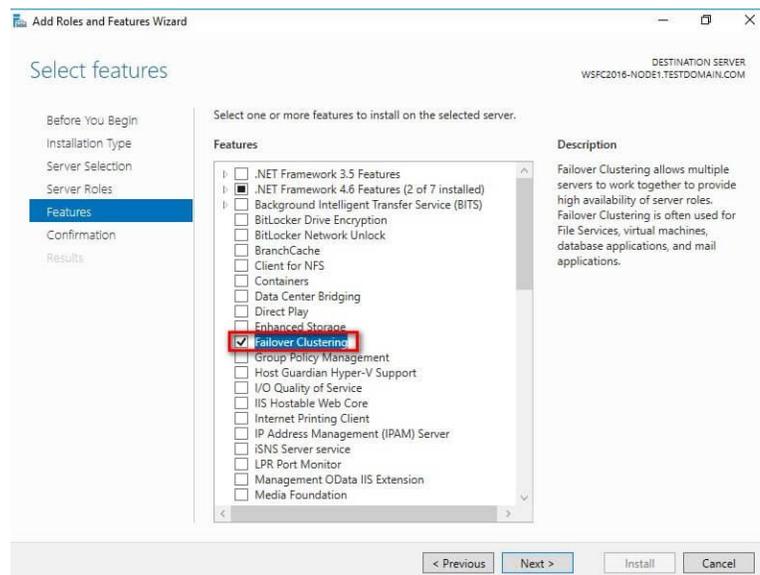
In this section, the Failover Clustering feature is added to create and configure the WSFC:

**NOTE:** Perform these steps on all of the servers that you intend to join in your WSFC.

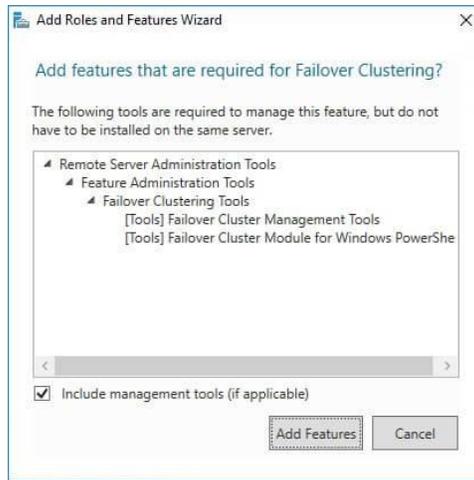
1. Open the **Server Manager Dashboard** and click the **Add roles and features** link. This will run the **Add Roles and Features Wizard**



2. In the **Select Features** dialog box, select the **Failover Clustering** checkbox and click **Next**.

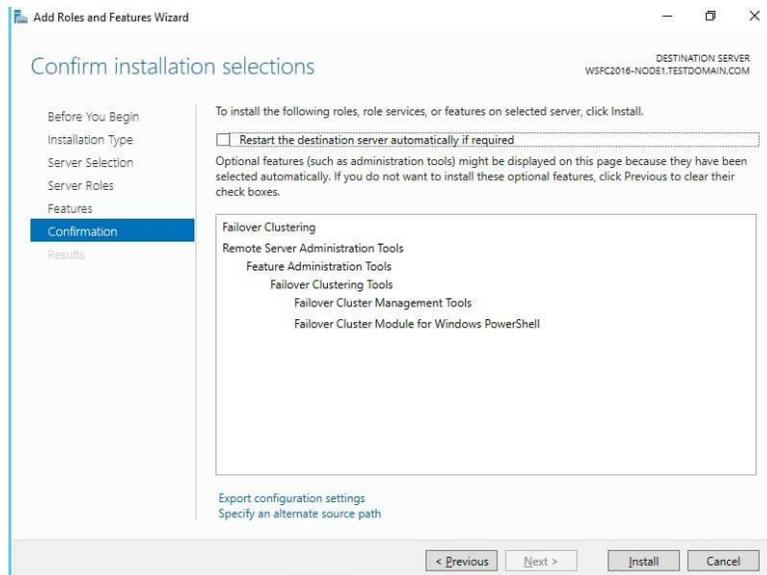


When prompted with the **Add features that are required for Failover Clustering** dialog box, click **Add Features**. Click **Next**.



**NOTE:** In previous versions of SQL Server, you were required to install the .NET Framework 3.5 with SP 1. This is no longer the case with SQL Server 2016.

3. In the **Confirm Installation Selections** dialog box, click **Install** to confirm the selection and proceed to do the installation.

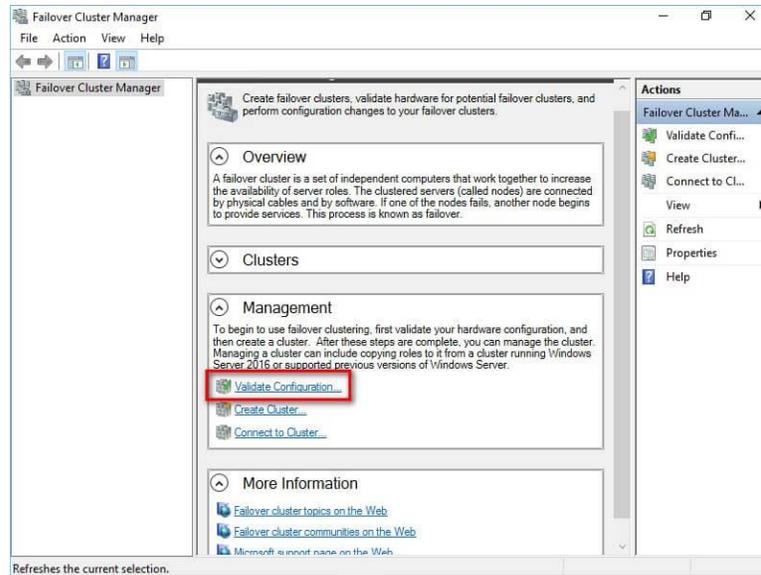


## Running the Failover Cluster Validation Wizard

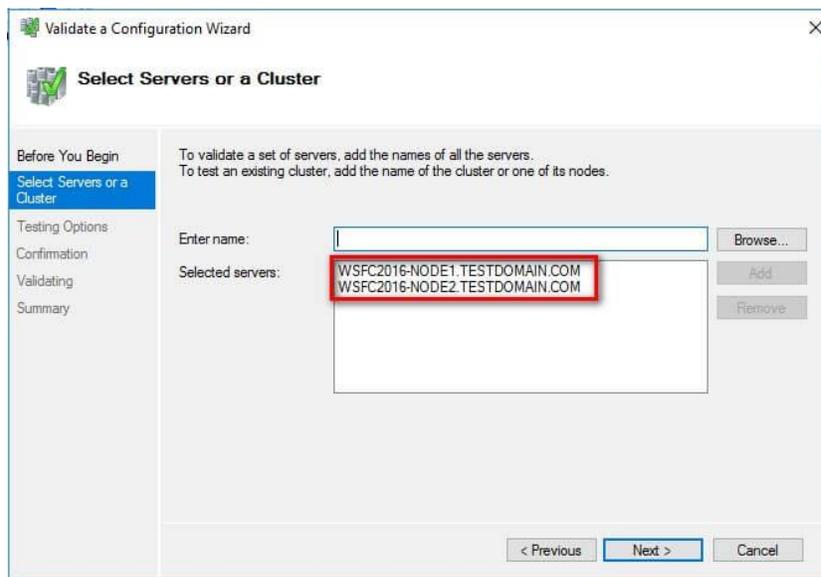
In this section, you will run the Failover Cluster Validation Wizard from the **Failover Cluster Management** console. You can launch the tool from the **Server Manager** dashboard, under **Tools** and select **Failover Cluster Manager**.

**NOTE:** These steps can be performed on any of the servers that will act as nodes in your failover cluster. The steps below are performed on **WSFC2016-NODE1**.

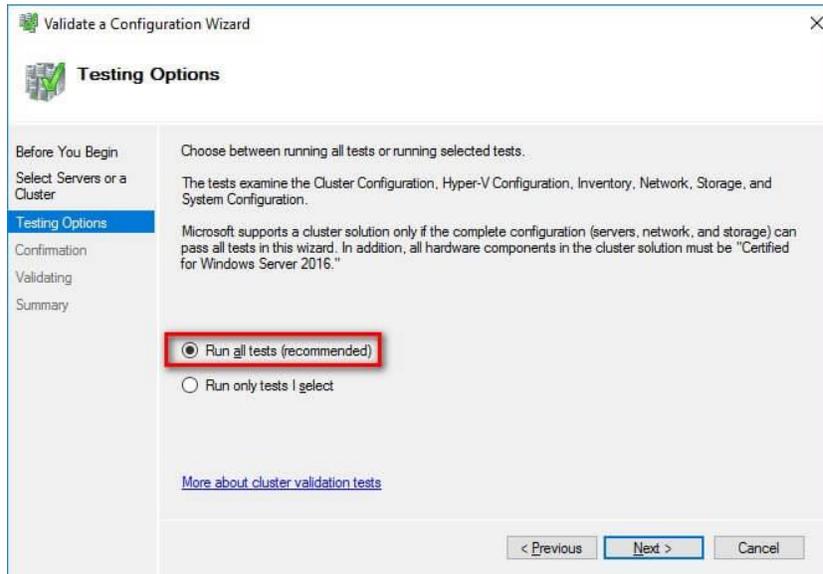
1. In the **Failover Cluster Management** console, under the **Management** section, click the **Validate Configuration** link. This will run the **Validate a Configuration Wizard**.



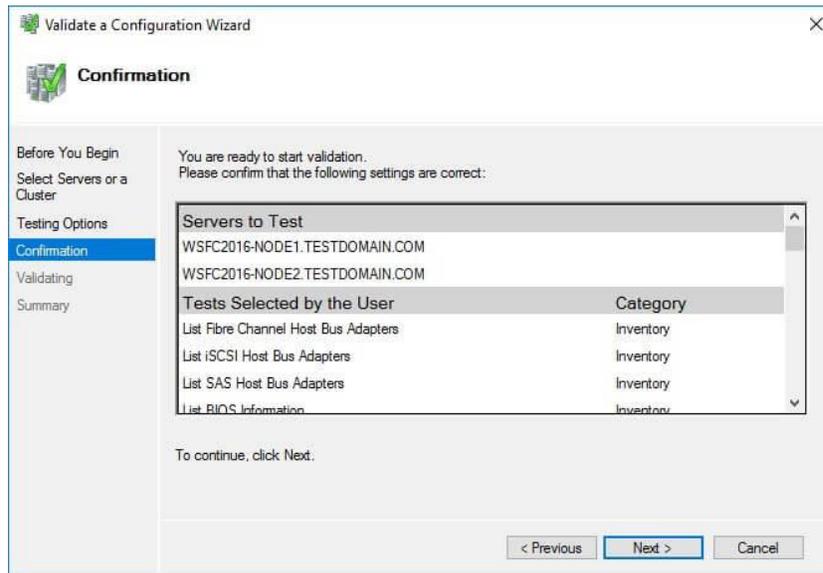
2. In the **Select Servers or a Cluster** dialog box, enter the hostnames of the nodes that you want to add as members of your WSFC. Click **Next**.



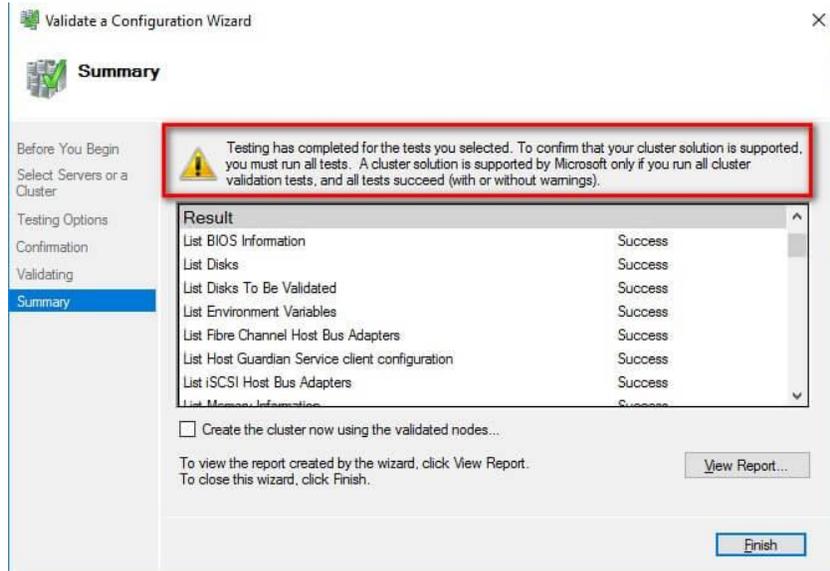
3. In the **Testing Options** dialog box, accept the default option **Run all tests (recommended)** and click **Next**. This will run all the necessary tests to validate whether or not the nodes are OK for the WSFC.



4. In the **Confirmation** dialog box, click **Next**. This will run all the necessary validation tests.

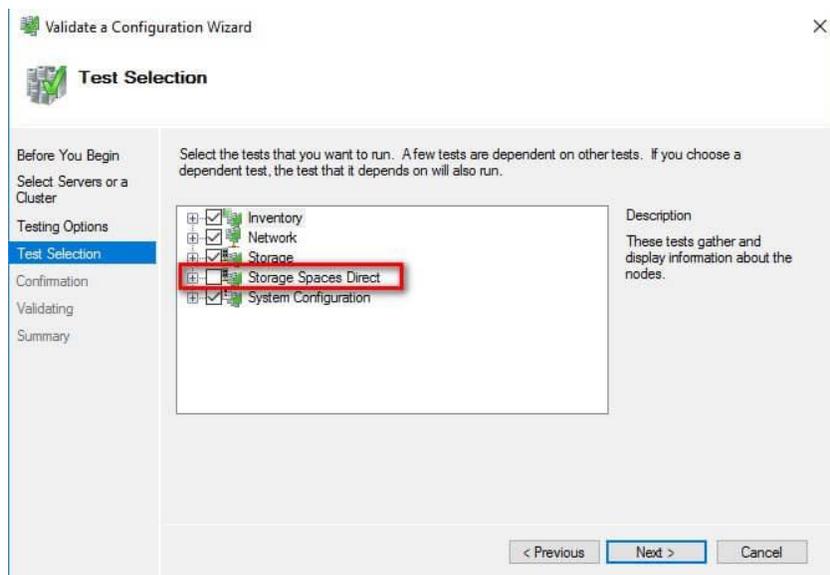


5. In the **Summary** dialog box, verify that all the report returns successful.



**A note on the results:** In the past, the **Cluster Validation Wizard** may report **Warning** messages pertaining to network and disk configuration issues, missing security updates, incompatible drivers, etc. The general recommendation has always been to resolve all errors and issues that the Cluster Validation Wizard reports prior to proceeding with the next steps. And it still is.

With Windows Server 2016, checks for Storage Spaces Direct have been included in the Cluster Validation Wizard. Despite choosing the **Run all tests (recommended)** option, the Cluster Validation Wizard will exclude those checks.



This is why you will get a Warning message in the cluster validation report despite having all selected default checks return successful results.

Microsoft Home

## Failover Cluster Validation Report

**Node:** WSFC2016-NODE1.TESTDOMAIN.COM Validated  
**Node:** WSFC2016-NODE2.TESTDOMAIN.COM Validated  
**Started**  
**Completed**

The Validate a Configuration Wizard must be run after any change is made to the configuration of the cluster or hardware. For more information, see <http://go.microsoft.com/fwlink/?Linkid=280145>.

### Results by Category

Name	Result Summary	Description
<a href="#">Inventory</a>		Success
<a href="#">Network</a>		Success
<a href="#">Storage</a>		Success
<a href="#">System Configuration</a>		Success

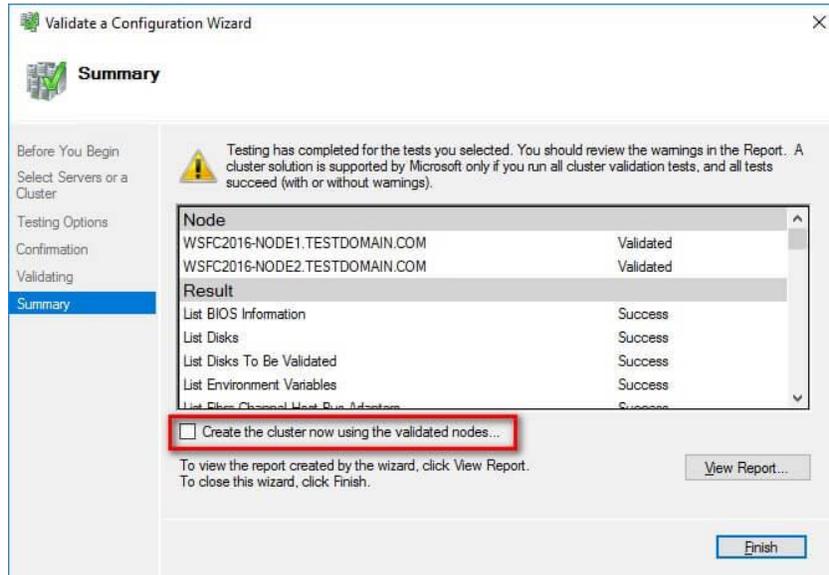
6. To create the WSFC using the servers you've just validated, select the **Create the cluster now using the validated nodes...** checkbox and click **Finish**.

Another way of running the Failover Cluster Validation is by using the [Test-Cluster](#) PowerShell cmdlet.

```
Test-Cluster -Node WSFC2016-NODE1, WSFC2016-NODE2
```

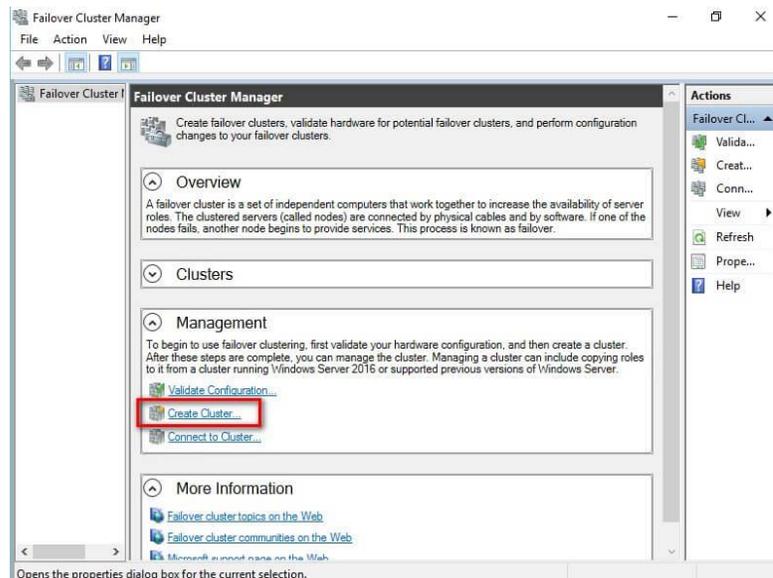
# Creating the Windows Server 2016 Failover Cluster

In this section, you will create a Windows Server 2016 Failover Cluster from the **Failover Cluster Management** console. You can launch the tool from the **Server Manager** dashboard, under Tools and select **Failover Cluster Manager**. Alternatively, you can run the **Create Cluster Wizard** after running the **Failover Cluster Validation Wizard**. Be sure to check the **Create the cluster now using the validated nodes...** checkbox.

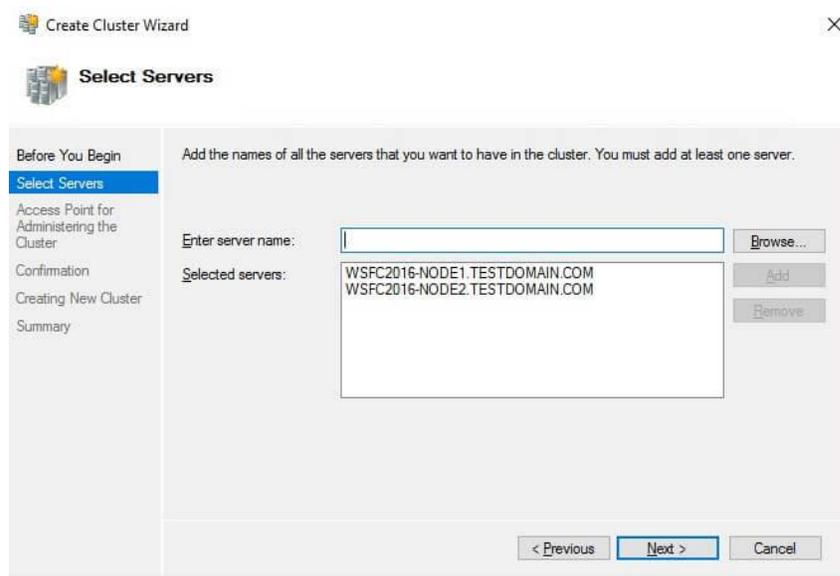


**NOTE:** These steps can be performed on any of the servers that will act as nodes in your WSFC. The steps below are performed on **WSFC2016-NODE1**.

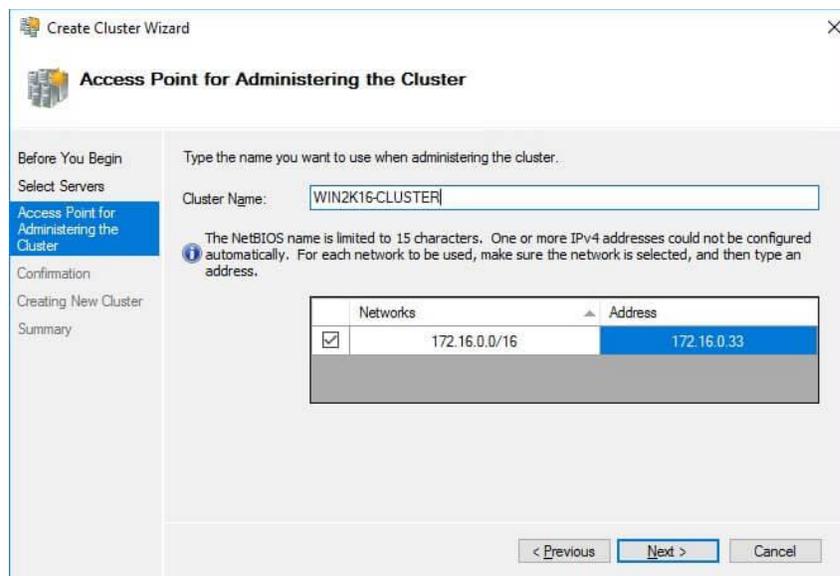
1. Under the **Management** section, click the **Create a Cluster** link. This will run the **Create Cluster Wizard**.



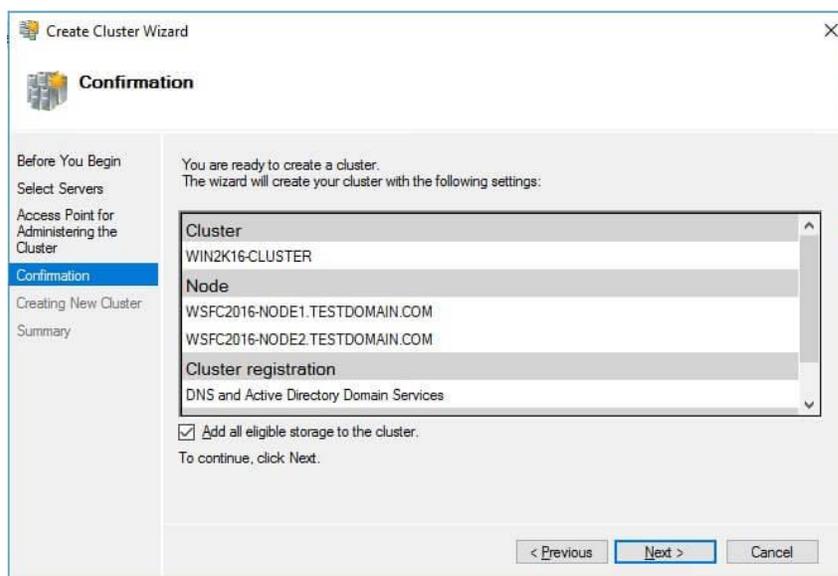
- In the **Select Servers** dialog box, enter the hostnames of the nodes that you want to add as members of your WSFC. Click **Next**.



- In the **Access Point for Administering the Cluster** dialog box, enter the virtual hostname and IP address that you will use to administer the WSFC. Click **Next**. Note that because the servers are located within the same network subnet, only one virtual IP address is needed. This is a typical configuration for local high availability.



- In the **Confirmation** dialog box, click **Next**. This will configure Failover Clustering on both of the servers that will act as nodes in your WSFC, add the configured shared storage, add Active Directory and DNS entries for the WSFC virtual server name.



**A word of caution before proceeding:** Before clicking **Next**, be sure to coordinate with your Active Directory domain administrators on the appropriate permissions that you need to create the computer name object in Active Directory. It will save you a lot of time and headache troubleshooting why you cannot create a WSFC. Local Administrator permission on the servers that you will use as nodes in your WSFC is not enough. Your Active Directory domain account needs the following permissions in the **Computers** Organizational Unit. By default, this is where the computer name object that represents the virtual hostname for your WSFC will be created.

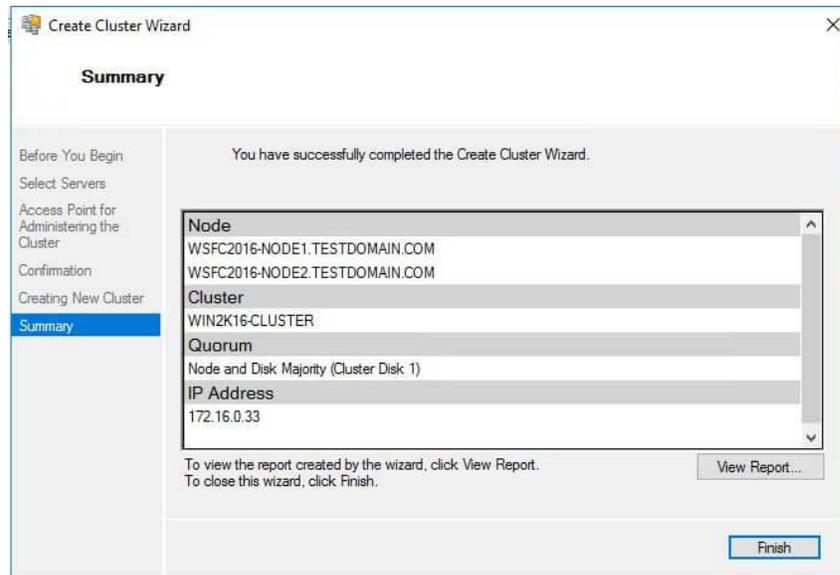
- Create Computer objects
- Read All Properties

For additional information, refer to the [Failover Cluster Step-by-Step Guide: Configuring Accounts in Active Directory](#) documentation.

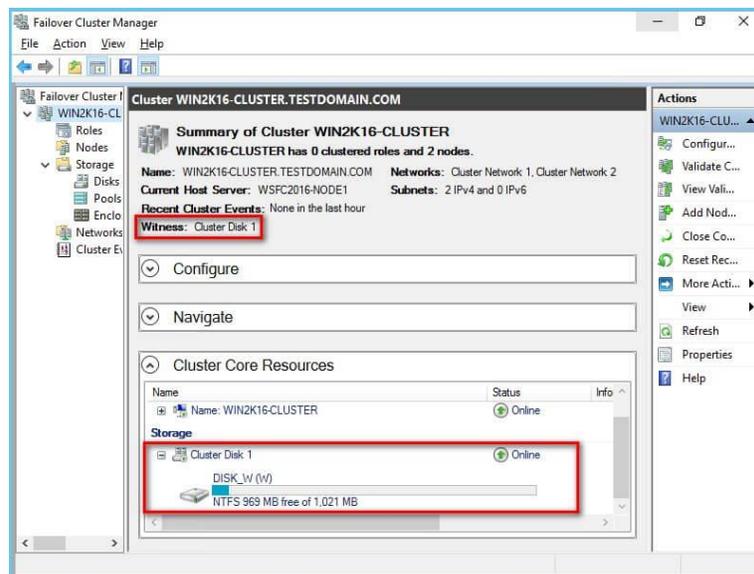
In a more restrictive environment where your Active Directory domain administrators are not allowed to grant you those permissions, you can request them to pre-stage the computer name object in Active Directory. Provide the [Prestage Cluster Computer Objects in Active Directory Domain Services](#) documentation to your Active Directory domain administrators.

This also applies to WSFC running Windows Server 2008 and higher.

5. In the **Summary** dialog box, verify that the report returns successful results. Click **Finish**.



6. Verify that the quorum configuration is using Node and Disk Majority - **Witness: Cluster Disk n** - using the appropriate drive that you configured as the witness disk.

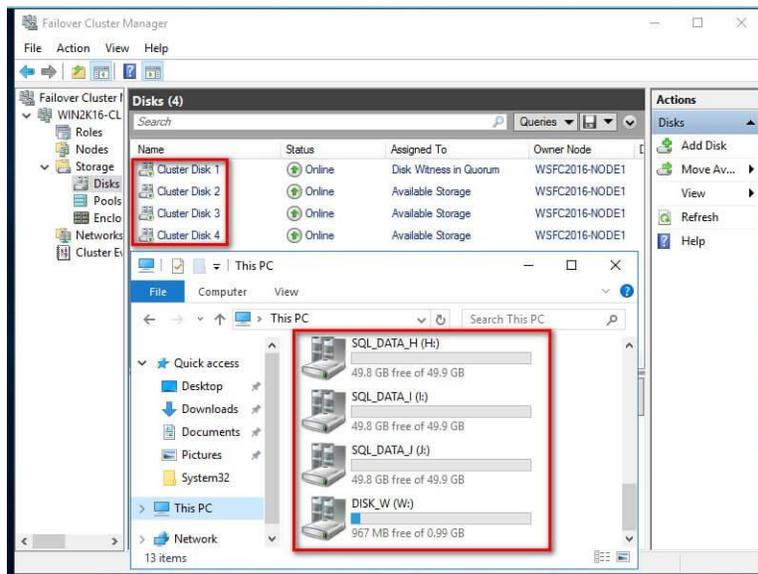


Another way of creating the WSFC is by using the [New-Cluster](#) PowerShell cmdlet.

```
New-Cluster -Name WIN2K16-CLUSTER -Node WSFC2016-NODE1, WSFC2016-NODE2 -StaticAddress 172.16.0.33
```

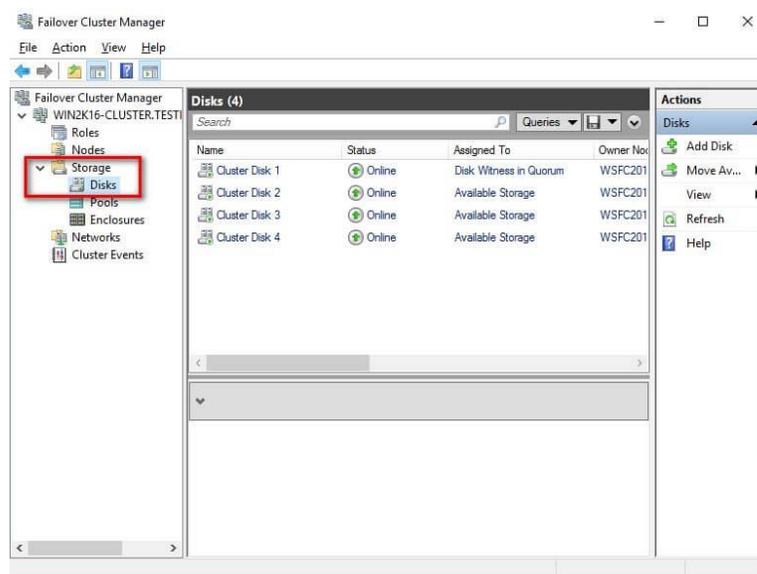
## Renaming Shared Storage Resources

As a best practice, you should rename your shared storage resources prior to installing SQL Server 2016. This makes it easy to identify what the disks are used for - data, log, backups, etc. - during the installation and later on when troubleshooting availability issues. And while you may have renamed the disks using the **Disk Management** console, you still have to rename them from the point-of-view of the WSFC. The default names of the shared storage will be **Cluster Disk n** where **n** is the number assigned to the disks.

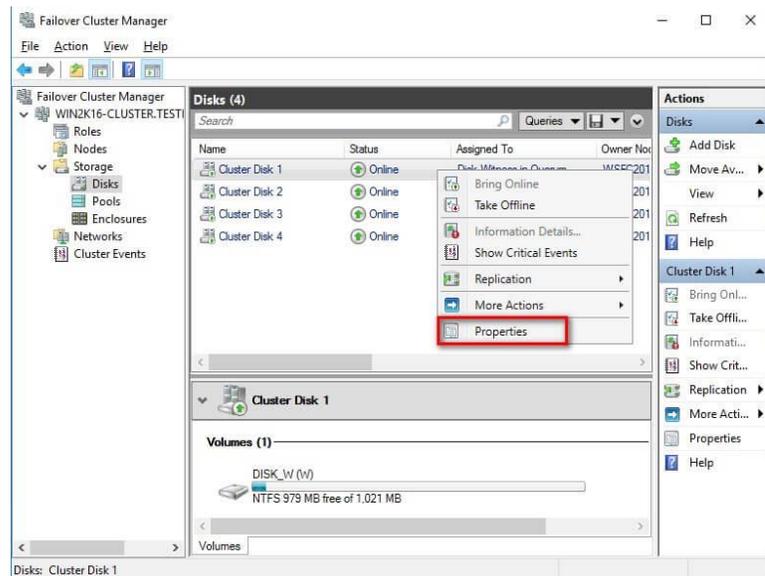


To rename the shared storage resources:

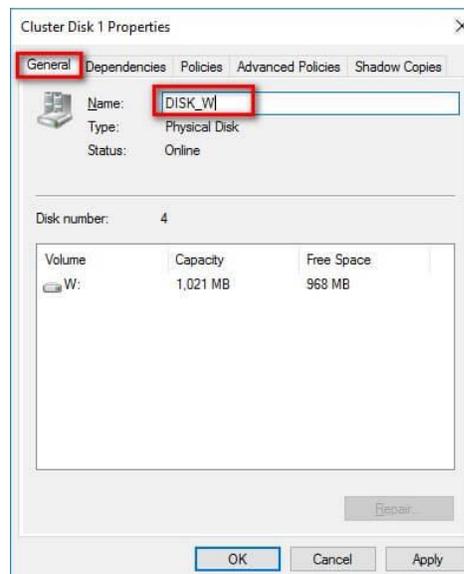
1. Within the **Failover Cluster Manager** console, under the **Storage** navigation option, select **Disks**. This will display all of the shared storage resources added to the WSFC.



- Right-click one of the shared disks and select **Properties**. This will open up the **Properties** page for that specific disk.



- In the **Properties** page, on the **General** tab, type the appropriate name for the shared disk in the **Name** textbox. Click **OK**.



Do this on all of the shared storage resources available on your WSFC.

Failover Cluster Manager

File Action View Help

Failover Cluster Manager  
WIN2K16-CLUSTER.TES

Roles  
Nodes  
Storage  
Disks  
Pools  
Enclosures  
Networks  
Cluster Events

**Disks (4)**

Name	Status	Assigned To	Owner Node
DISK_W	Online	Disk Witness in Quorum	WSFC2016-NODE1
SQL_DATA_H	Online	Available Storage	WSFC2016-NODE1
SQL_DATA_I	Online	Available Storage	WSFC2016-NODE1
SQL_DATA_J	Online	Available Storage	WSFC2016-NODE1

**SQL\_DATA\_J**

**Volumes (1)**

SQL\_DATA\_J (J)  
NTFS 49.9 GB free of 50.0 GB

Volumes

Disks: SQL\_DATA\_J

**Actions**

Disks

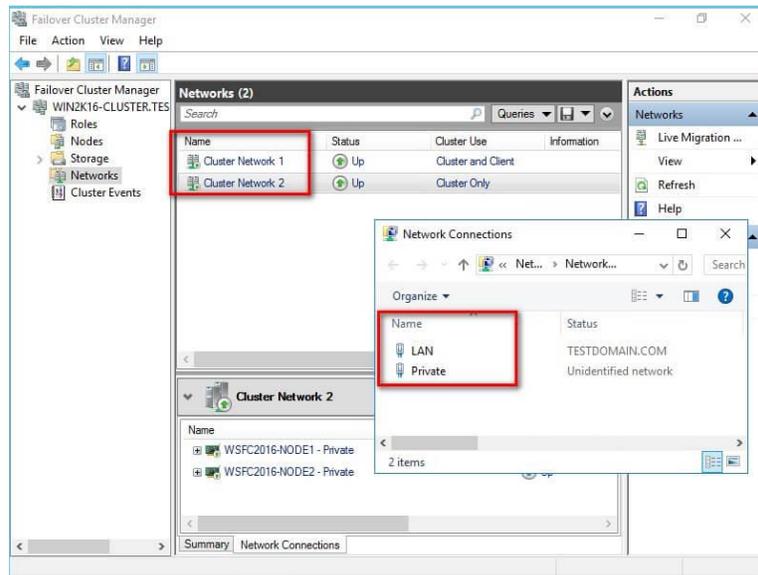
- Add Disk
- Move Availabl...
- View
- Refresh
- Help

**SQL\_DATA\_J**

- Bring Online
- Take Offline
- Add to Cluster ...
- Information D...
- Show Critical E...
- Replication
- More Actions
- Remove
- Properties
- Help

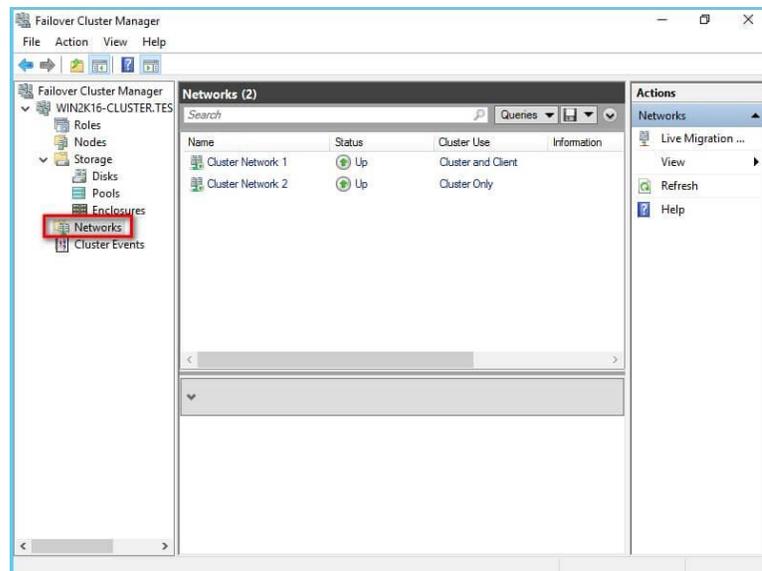
## Renaming Cluster Network Resources

Similarly, you should rename your cluster network resources prior to installing SQL Server 2016. And while you may have renamed the network adapters using the **Network Connections** management console, you still have to rename them from the point-of-view of the WSFC. The default names of the cluster network resources will be **Cluster Network n** where **n** is the number assigned to the cluster network adapter.

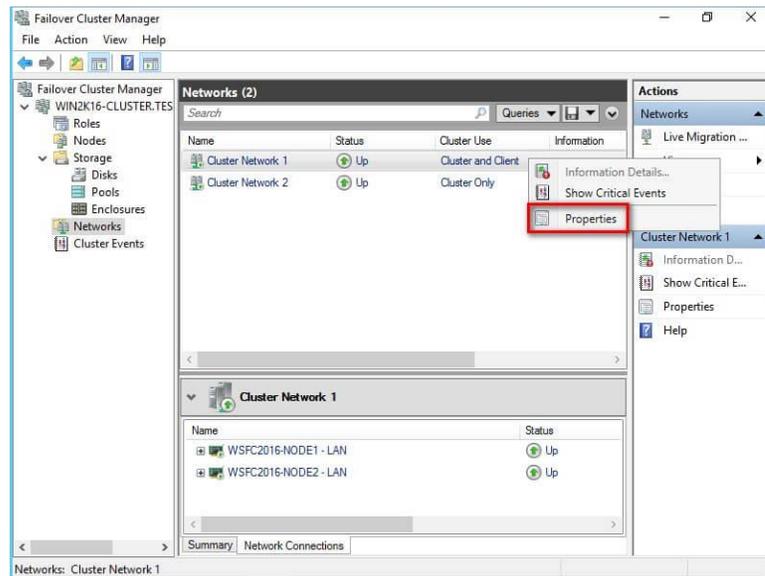


To rename the cluster network resources:

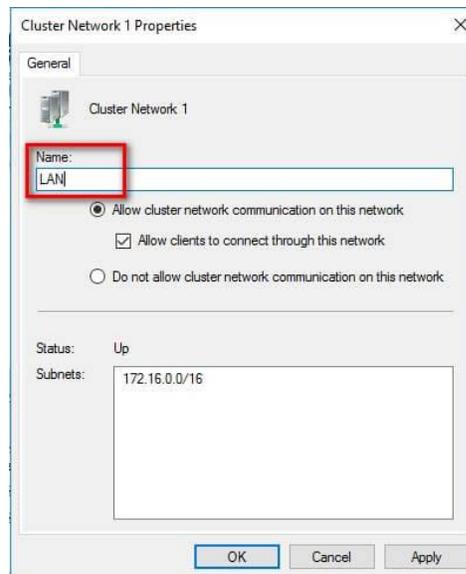
1. Within the **Failover Cluster Manager** console, select the **Networks** navigation option. This will display all of the cluster network resources added to the WSFC.



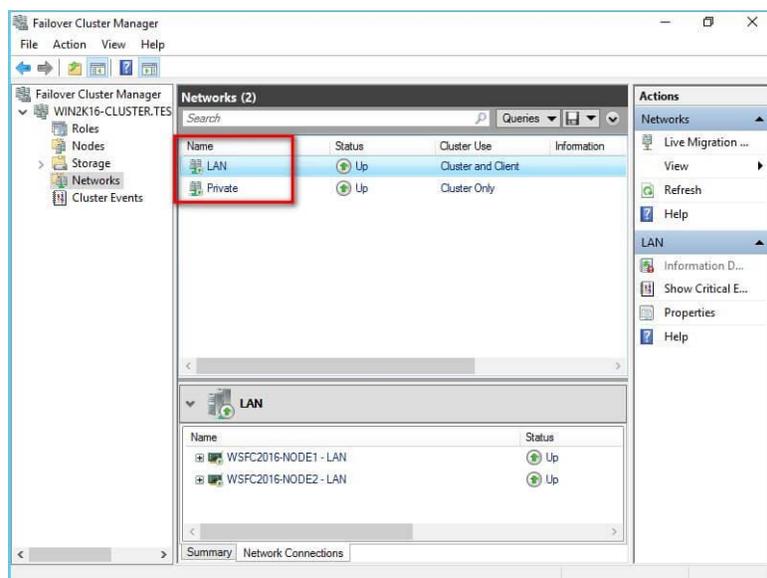
2. Right-click one of the cluster network adapters and select **Properties**. This will open up the **Properties** page for that specific cluster network resource.



3. In the **Properties** page, type the appropriate name for the cluster network resource in the **Name** textbox. Click **OK**.



Do this on all of the cluster network resources available on your WSFC.



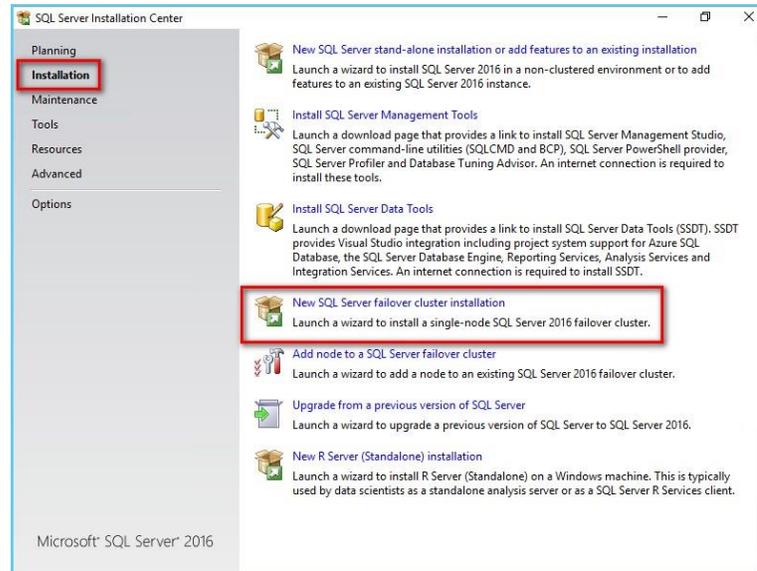
**NOTE:** The WSFC will detect whether or not client applications can connect thru the specific cluster network resource. This is determined based on whether or not a network adapter has a default gateway and can be identified via network discovery. This is why it is important to get your network administrators involved in properly assigning the IP address, the subnet mask and the default gateway values of all the network adapters used on the servers prior to creating the WSFC.

Also, by default, all available network adapters will be used for inter-node communication, or what is commonly known as private communication/heartbeat.

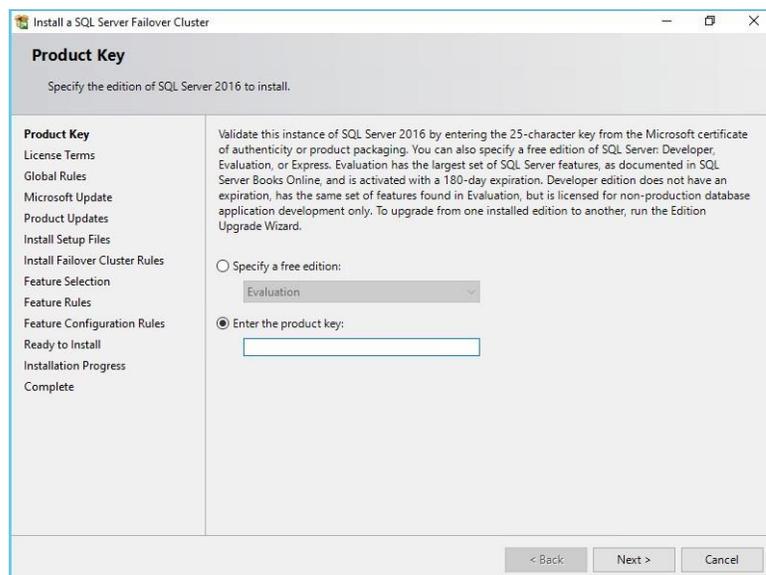
# Installing a SQL Server 2016 Failover Clustered Instance (FCI)

In this section, you will install a default instance of SQL Server 2016 FCI. You will run the installation process on the first node of your WSFC, **WSFC2016-NODE1**.

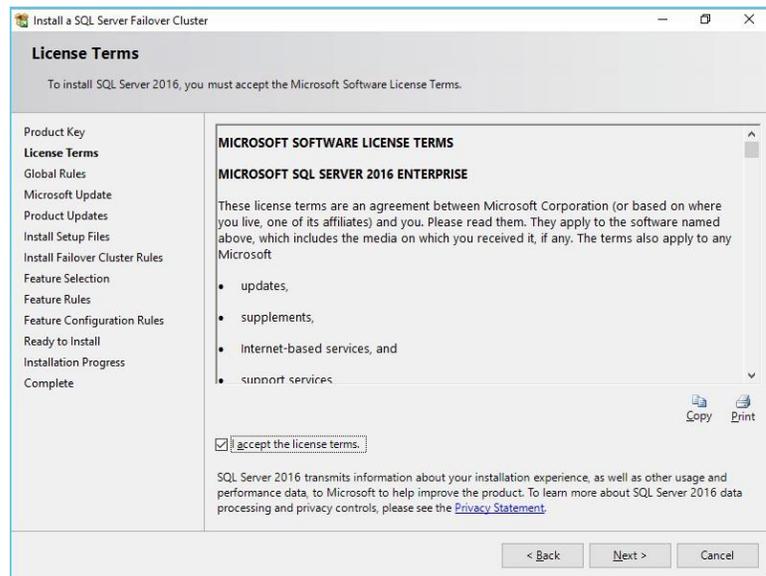
1. Run **setup.exe** from the SQL Server 2016 installation media to launch **SQL Server Installation Center**. Click on the **Installation** link on the left-hand side
2. Click the **New SQL Server failover cluster installation** link. This will run the SQL Server 2016 Setup wizard



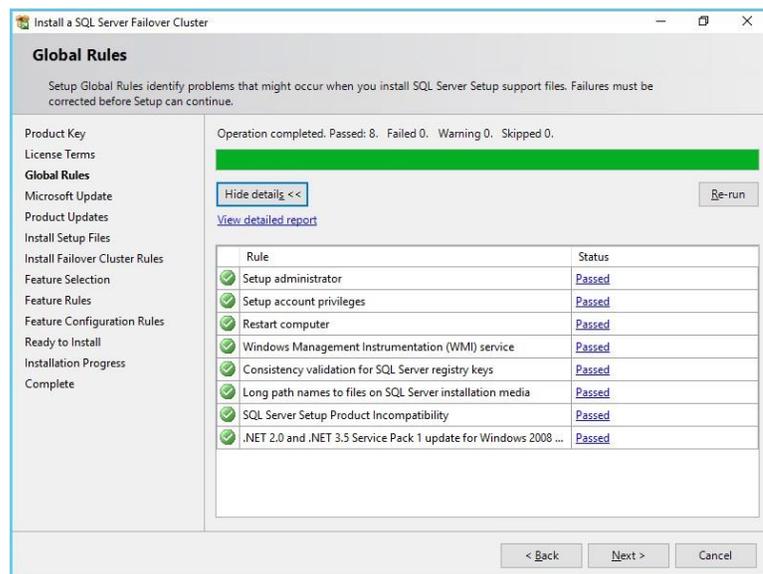
3. In the **Product Key** dialog box, enter the product key that came with your installation media and click **Next**.



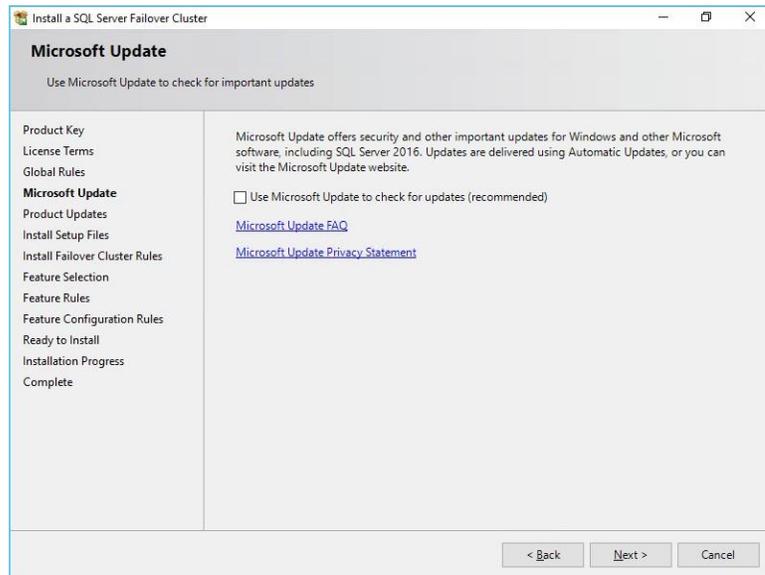
- In the **License Terms** dialog box, click the **I accept the license terms** check box and click **Next**.



- In the **Global Rules** dialog box, validate that the checks return successful results and click **Next**.



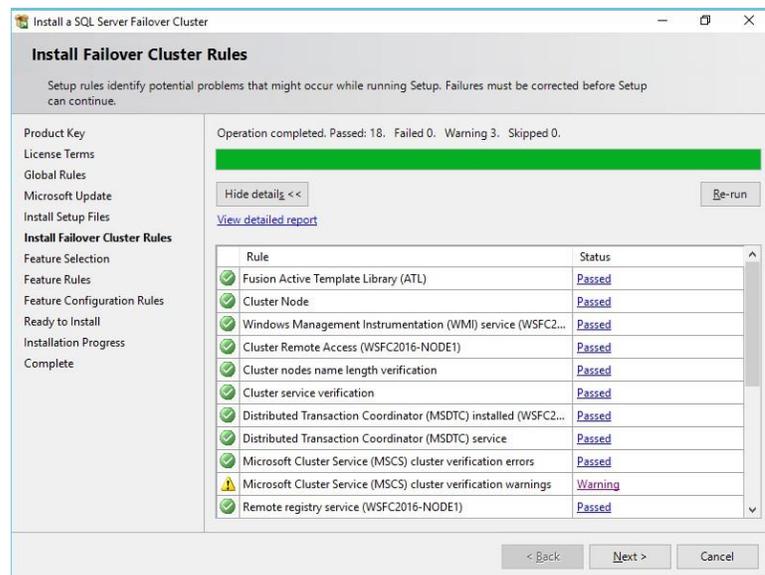
- In the **Microsoft Update** dialog box, you have the option to include SQL Server product updates like service packs and cumulative updates in the installation process. By default, it searches for product updates thru the Microsoft Updates service online, assuming that the server has access to the Internet. In cases where your servers do not have access to the internet, you can manually download the updates and store them on a network shared folder. You can, then, point the installation media to search the network shared folder instead. For this option, you will need to run **setup.exe** from the command-line, passing the **/UpdateSource** parameter. A more detailed approach to using this feature is outlined in this [Microsoft documentation](#). Click **Next**.



**NOTE:** Another way to include SQL Server service packs and cumulative updates in the installation process is to create a slipstreamed installation media.

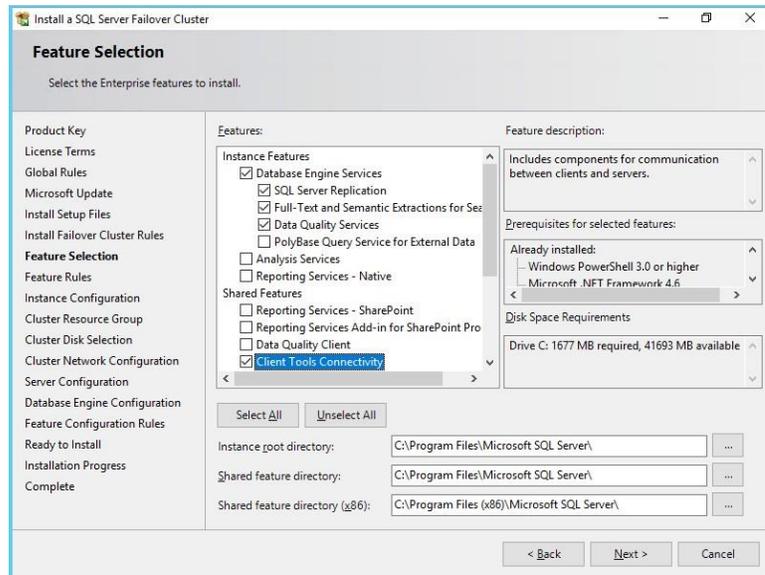
7. In the **Install Failover Cluster Rules** dialog box, validate that the checks return successful results. If the checks returned a few warnings, make sure you fix them before proceeding with the installation. Click **Next**.

Be aware that you will get a warning result for **Microsoft Cluster Service (MCS) cluster verification warnings** as a side effect of the storage spaces direct (S2D) checks.

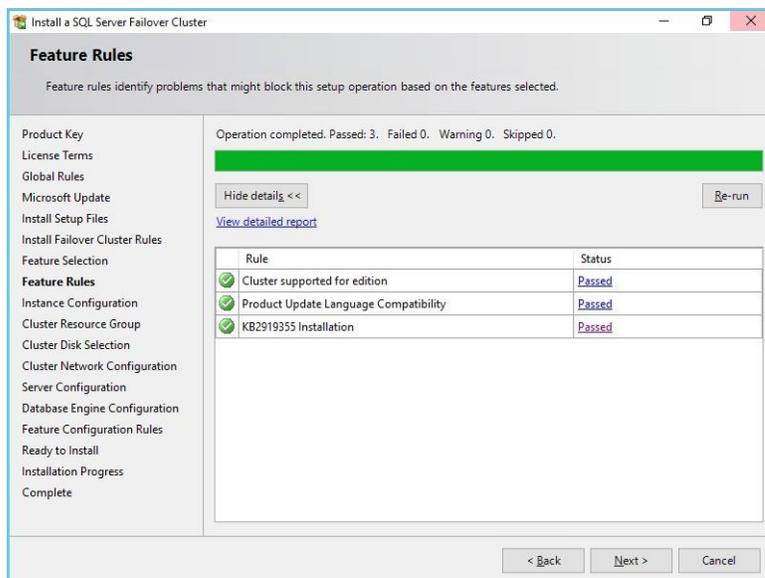


8. In the **Feature Selection** dialog box, select the following components – **Database Engine Services** and **Client Tools Connectivity**. Click **Next**.

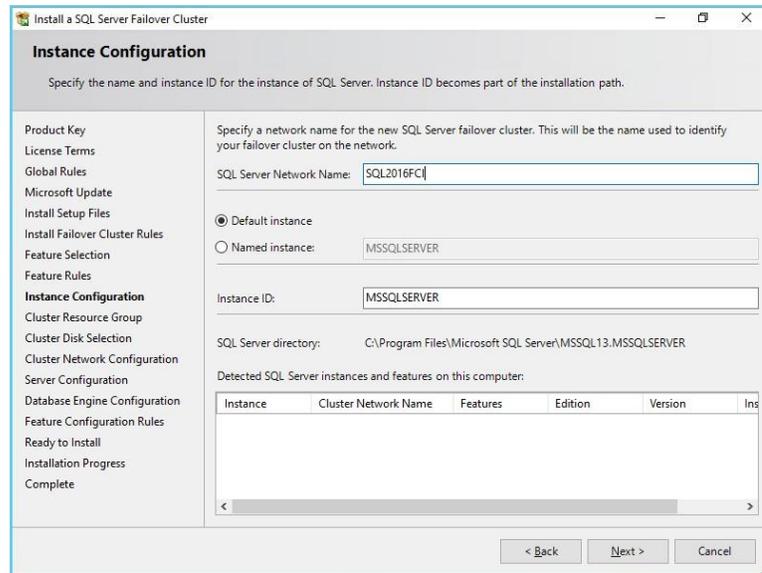
Note that SQL Server Management Studio is no longer included in the SQL Server 2016 installation media and have to be downloaded separately.



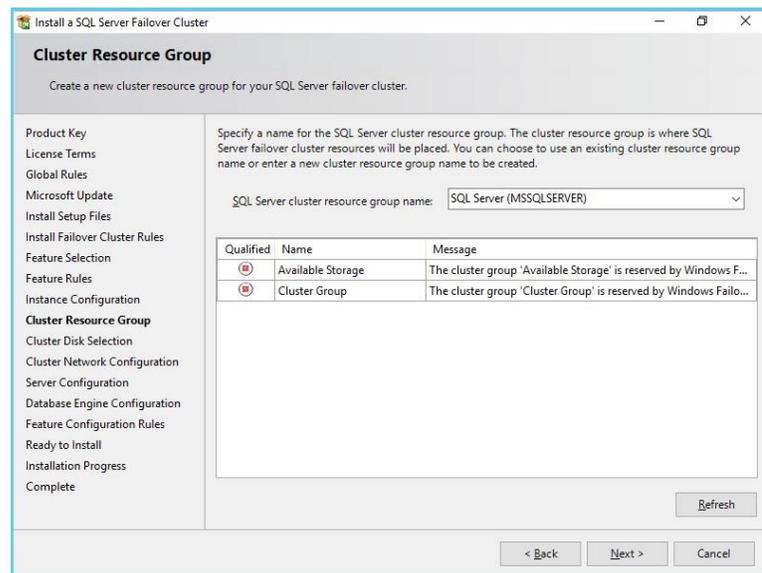
- In the **Feature Rules** dialog box, verify that all the rules have passed. If the rules returned a few warnings, make sure you fix them before proceeding with the installation. Click **Next**.



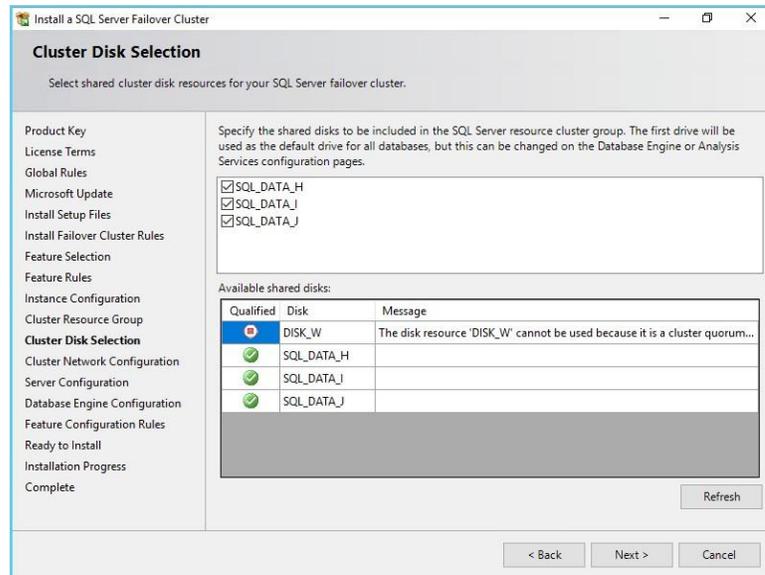
- In the **Instance Configuration** dialog box, enter the SQL Server Network Name. This is the name that the client applications will use to connect to this server. A couple of things need highlighting in this section. By default, the instance name is used as the **Instance ID**. This is used to identify installation directories and registry keys for this specific instance of SQL Server - very helpful when you want to run multiple instances in a WSFC. It applies to both the default instance and named instances. For a default instance, the instance name and instance ID would be **MSSQLSERVER**. To use a non-default instance ID, you should specify a value in the **Instance ID** box. Click **Next**.



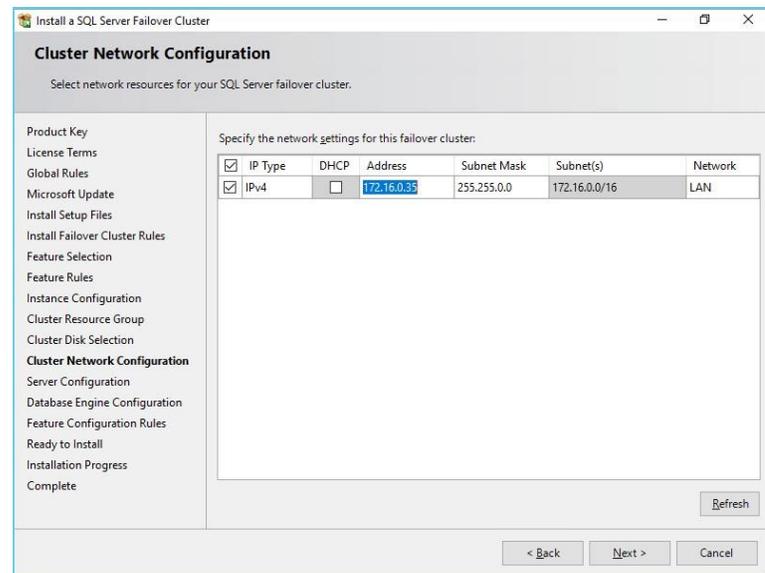
11. In the **Cluster Resource Group** dialog box, check the resources available on your WSFC. This tells you that a new Resource Group will be created on your WSFC for the SQL Server FCI. To specify the SQL Server cluster resource group name, you can either use the drop-down box to specify an existing group to use or type the name of a new group to create it. Accept all the defaults and click **Next**.



12. In the **Cluster Disk Selection** dialog box, select the available disk groups that are on the WSFC for the SQL Server FCI to use. Click **Next**.



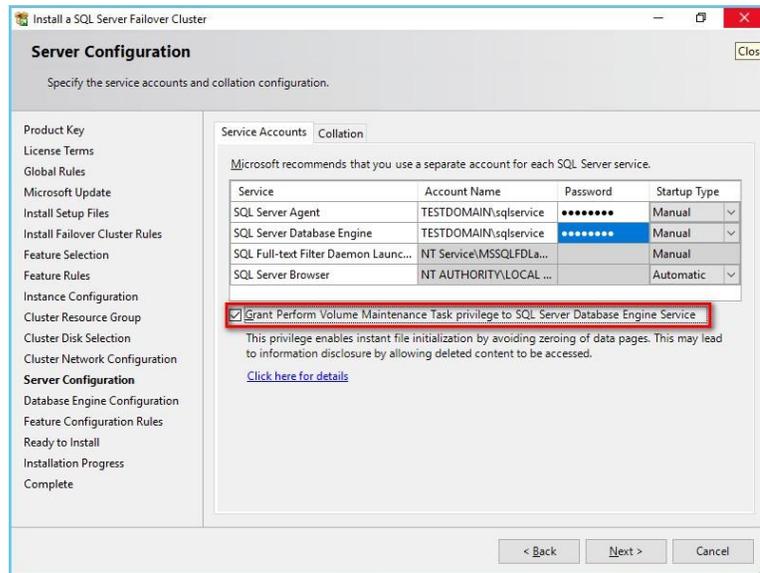
13. In the **Cluster Network Configuration** dialog box, enter the IP address and subnet mask that your SQL Server FCI will use. Be sure to deselect the checkbox under the DHCP column as you will be using static IP addresses. Click **Next**.



14. In the **Server Configuration** dialog box, provide the credentials for the SQL Server service accounts in the **Service Accounts** tab. Make sure that both the SQL Server Agent and SQL Server Database Engine services have a **Startup Type** of Manual. The WSFC will take care of stopping and starting these services.

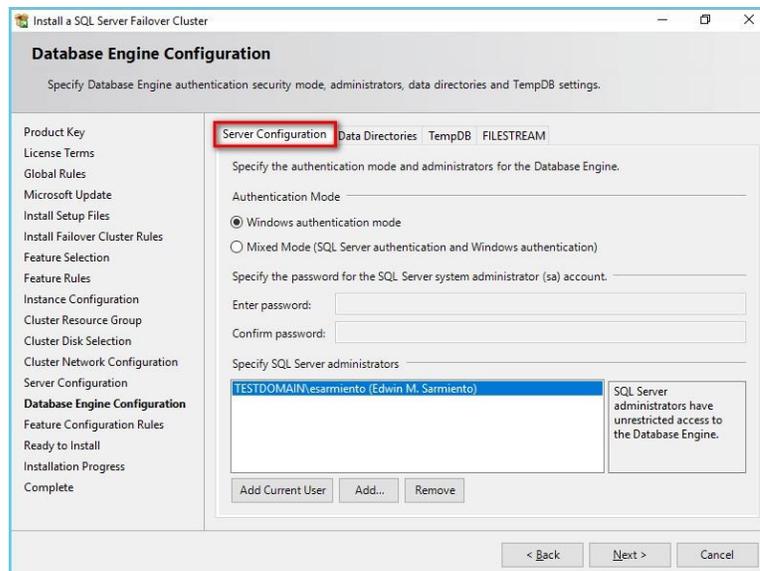
Select the checkbox **Grant Perform Volume Maintenance Task privilege to SQL Server Database Engine Service** - this is new in SQL Server 2016. This enables Instant File Initialization for SQL Server. Because this is a local permission assigned to an account, you need to explicitly do this on all of the nodes in the SQL Server FCI.

Click **Next**.

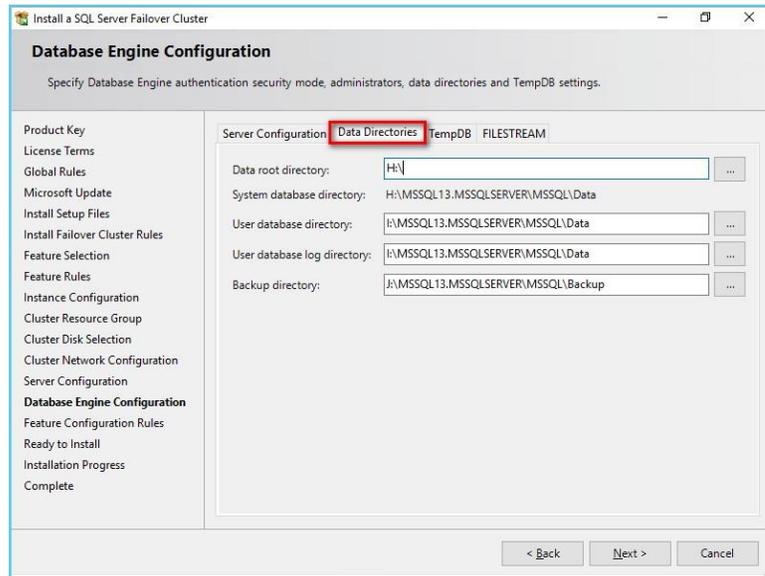


15. In the **Database Engine Configuration** dialog box, under the **Server Configuration** tab,

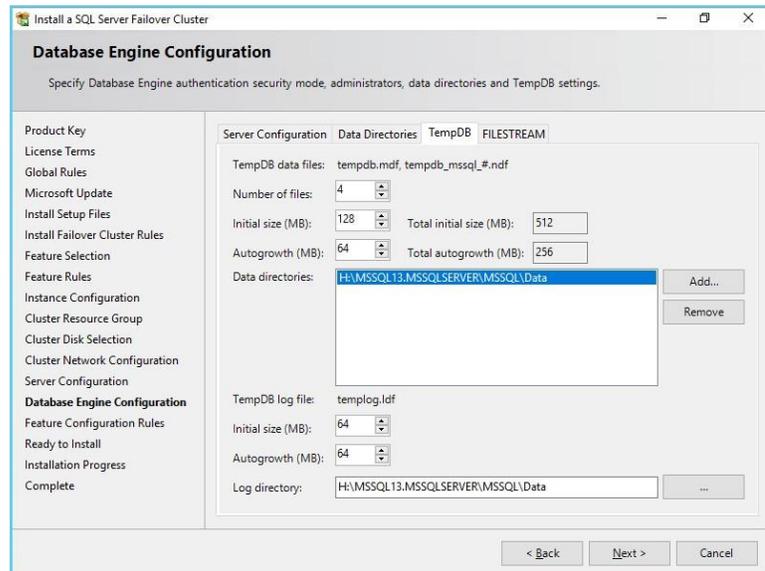
- Select **Windows authentication mode** in the **Authentication Mode** section. If required, you can change it later after the installation is complete.
- Add the currently logged on user to be a part of the SQL Server administrators group by clicking the **Add Current User** button in the **Specify SQL Server Administrators** section. You can also add Active Directory domain accounts or security groups as necessary.



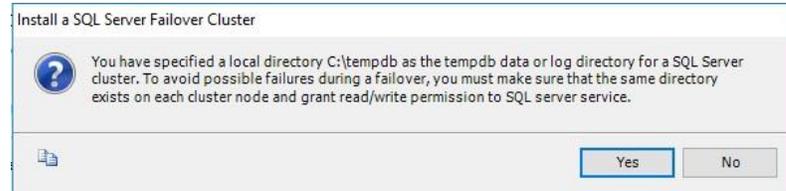
In the **Data Directories** tab, specify the location of the data files, the log files and the backup files.



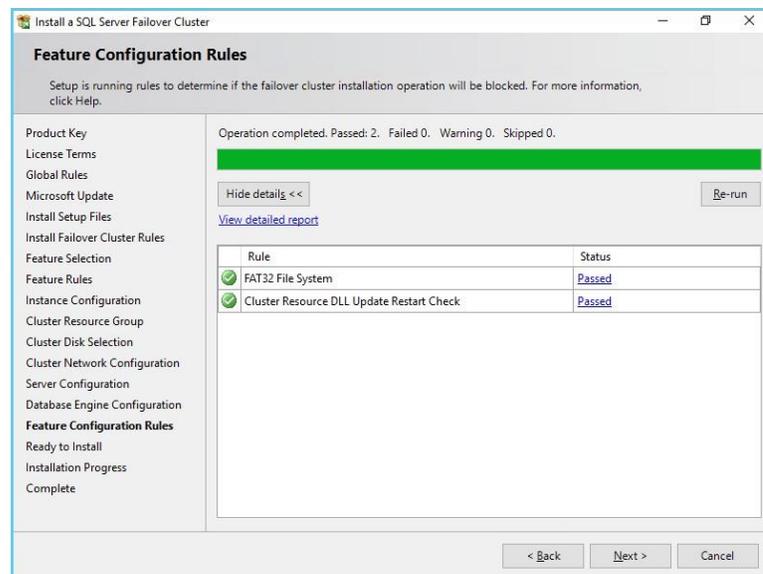
Also, new in SQL Server 2016 is the specific tab for **TempDB** configuration. You can set the number of tempdb data files, initial size and autogrowth settings of both data and log files as well as their corresponding locations.



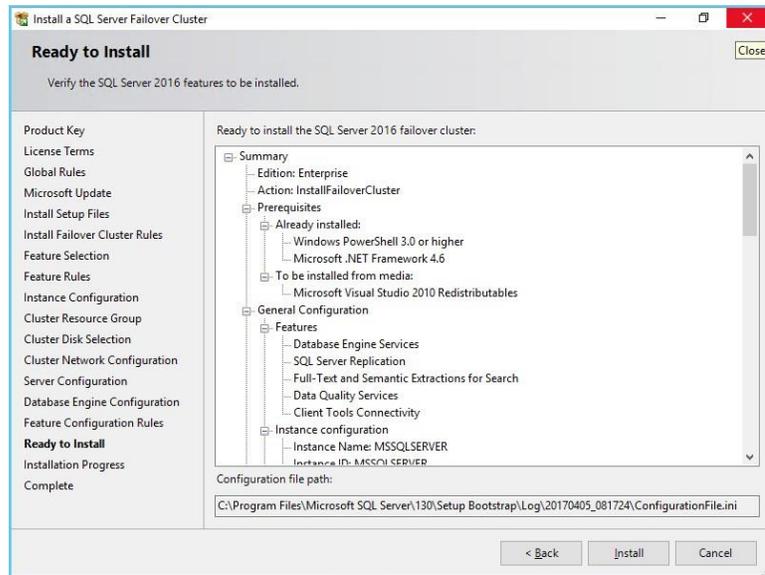
Note that, starting with SQL Server 2012, you have the option to store your tempdb database files on a local disk in a WSFC. You can still choose to host the tempdb database on shared storage like the one provided in this example. Should you decide to store tempdb on a local disk, you will get prompted to make sure that all of the nodes in the WSFC contain the same directory structure and that the SQL Server service account has read/write permissions on those folders.



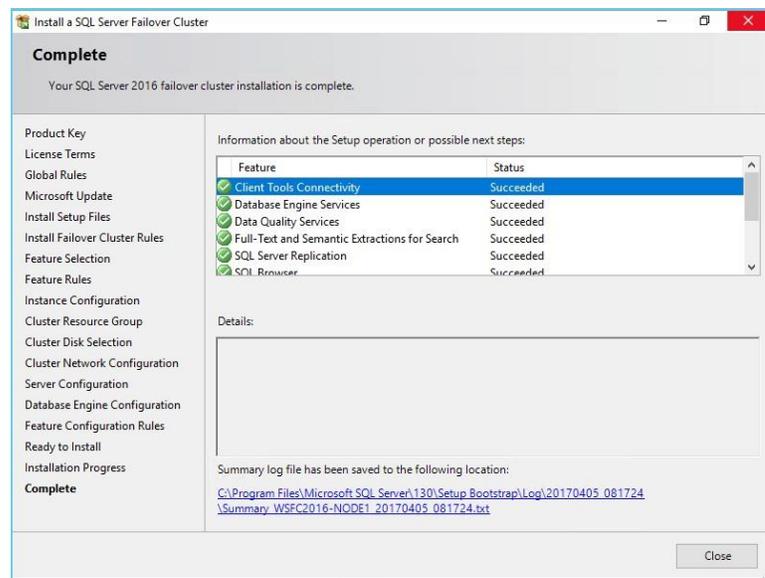
16. In the **Feature Configuration Rules** dialog box, verify that all checks are successful. Click **Next**.



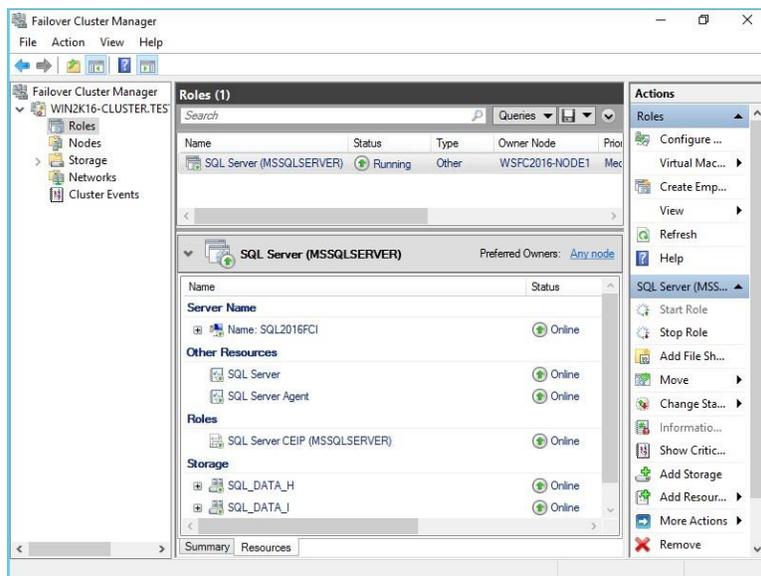
17. In the **Ready to Install** dialog box, verify that all configuration settings are correct. Click **Install** to proceed with the installation.



18. In the **Complete** dialog box, click **Close**. This concludes the installation of a SQL Server 2016 FCI.



At the completion of a successful installation and configuration of the node, you now have a fully functional SQL Server 2016 FCI. To validate, open the **Failover Cluster Manager** console and click on **SQL Server (MSSQLSERVER)** under **Roles**. Make sure that all dependencies are online.



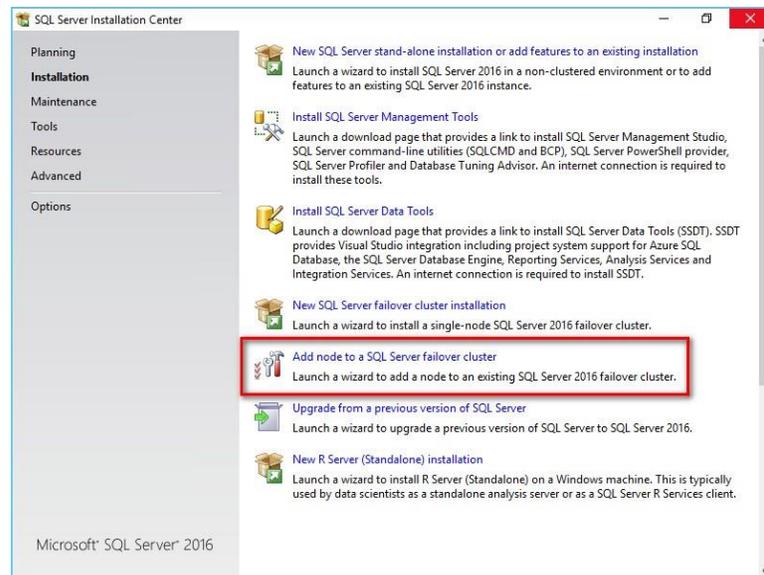
Also new in SQL Server 2016 FCI is the additional cluster resource named **SQL Server CEIP (MSSQLSERVER)** or the [Local Audit for SQL Server Usage Feedback Collection](#) feature. This additional cluster resource/role inside the SQL Server cluster resource group does not directly impact the SQL Server FCI. By default, failure of this resource does not cause a failover of the entire SQL Server cluster resource group. However, you still need to monitor whether this resource is online or not.

# SQL Server 2016 Failover Cluster Instance Installation - Install Secondary (Failover) Cluster Node

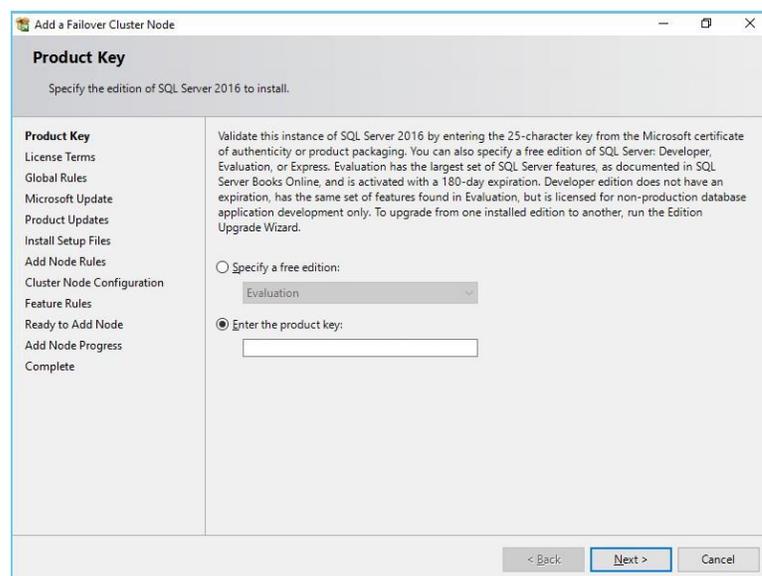
In this section, you will add a node to the SQL Server 2016 FCI on a WSFC. You will run the installation process on the second node of the cluster, **WSFC2016-NODE2**.

To add a node to an existing SQL Server 2016 FCI:

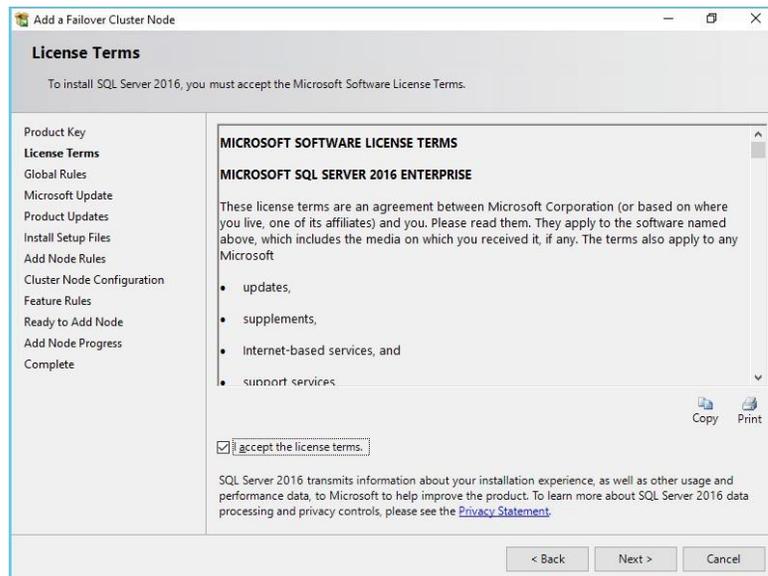
1. Run **setup.exe** from the installation media to launch SQL Server Installation Center.
2. Click on the **Installation** link on the left-hand side. Click the **Add node to a SQL Server failover cluster** link. This will run the SQL Server 2016 Setup wizard.



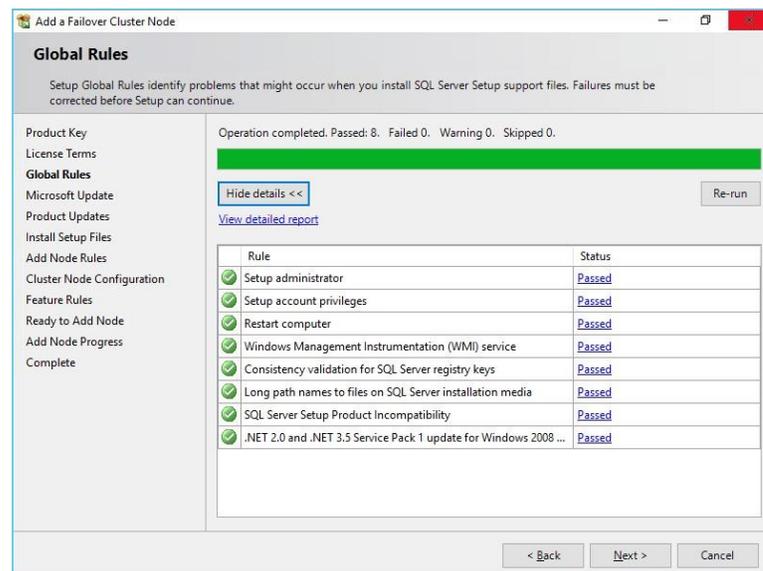
3. In the **Product Key** dialog box, enter the product key that came with your installation media and click **Next**.



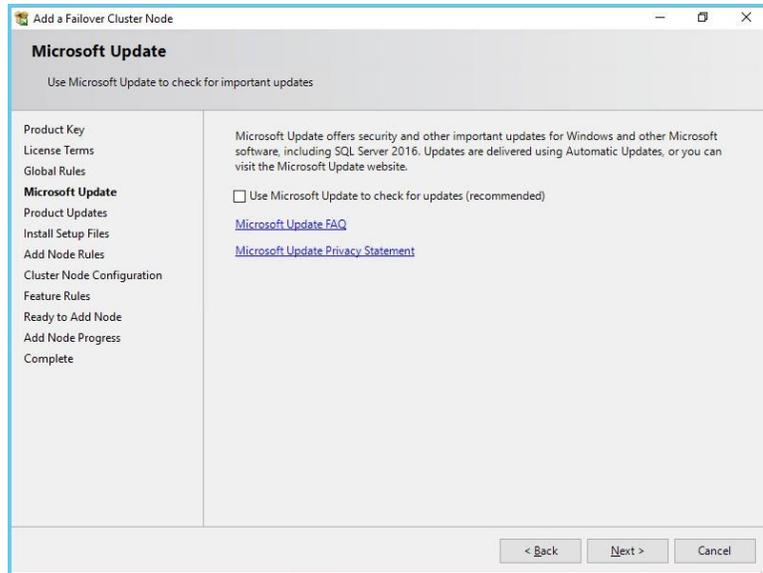
4. In the **License Terms** dialog box, click the **I accept the license terms** check box and click **Next**.



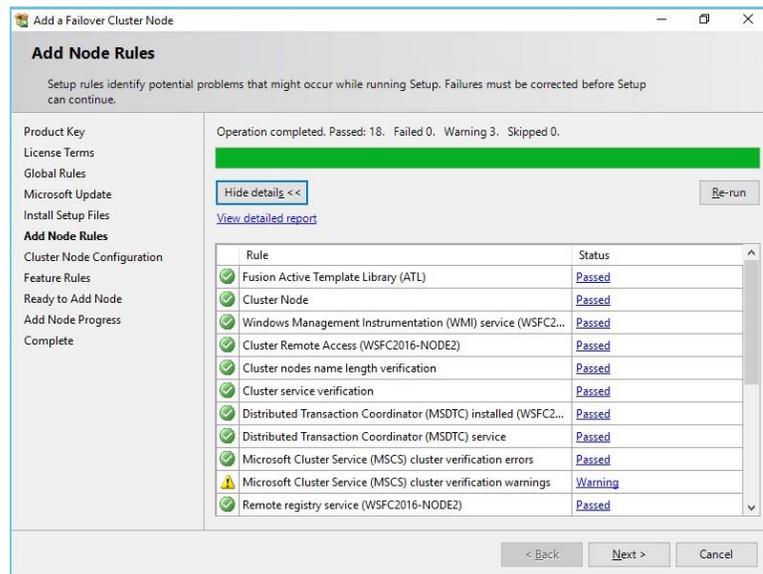
5. In the **Global Rules** dialog box, validate that the checks return successful results and click **Next**.



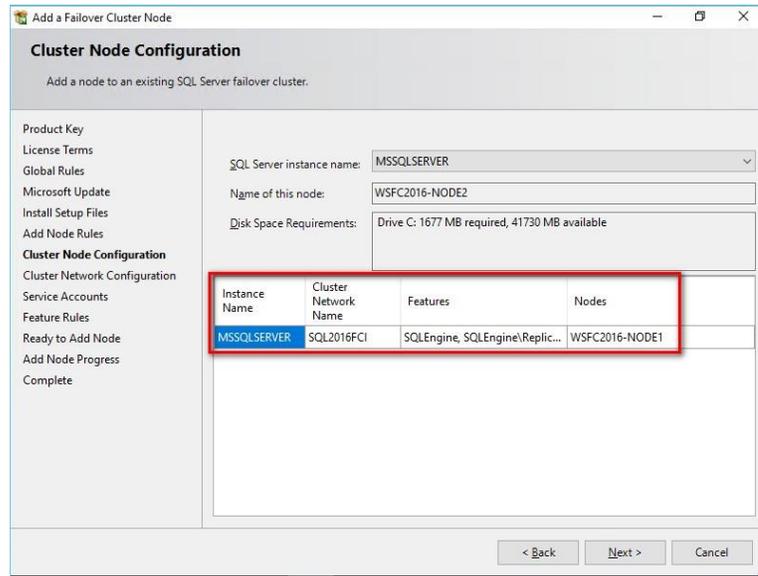
6. In the **Microsoft Update** dialog box, click **Next**.



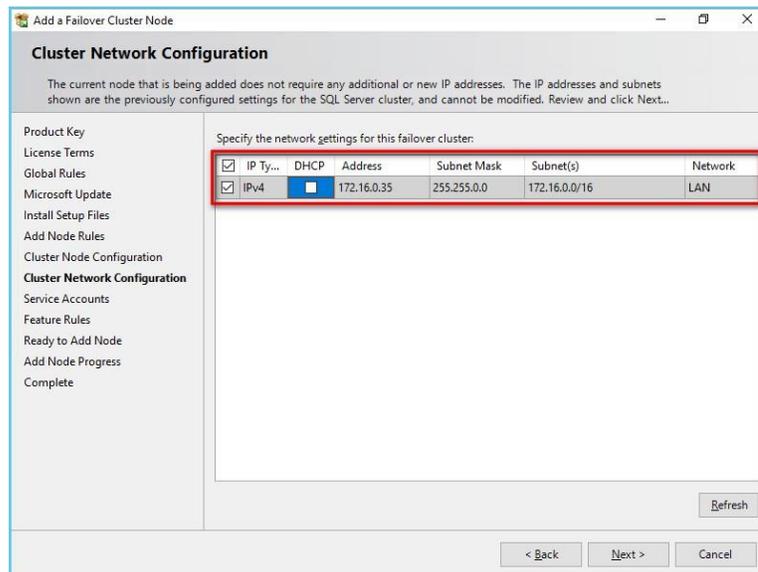
7. In the **Add Node Rules** dialog box, validate that the checks return successful results. If the checks returned a few warnings, make sure you fix them before proceeding with the installation. Click **Next**.



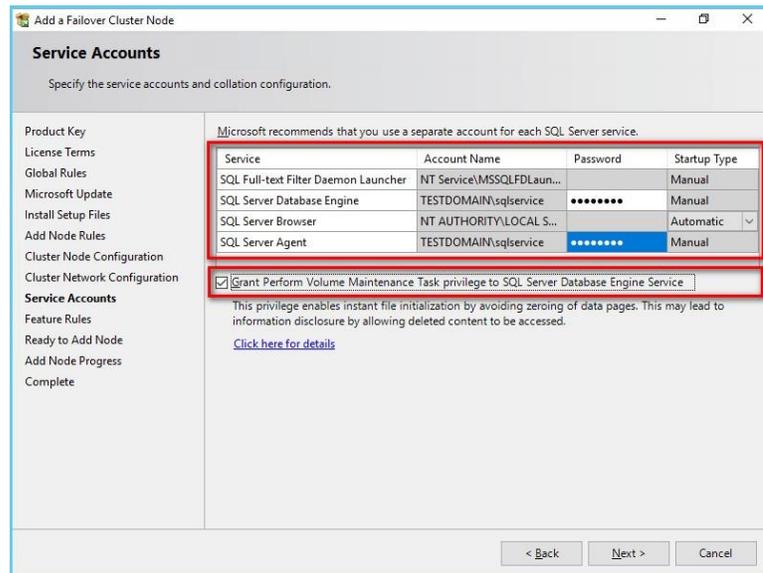
8. In the **Cluster Node Configuration** dialog box, validate that the information for the existing SQL Server 2016 FCI is correct. Click **Next**.



9. In the **Cluster Network Configuration** dialog box, validate that the IP address information is the same as the one you provided in the previous section.



10. In the **Service Accounts** dialog box, verify that the information is the same as what was used to configure the first node. Provide the appropriate credentials for the corresponding SQL Server service accounts.

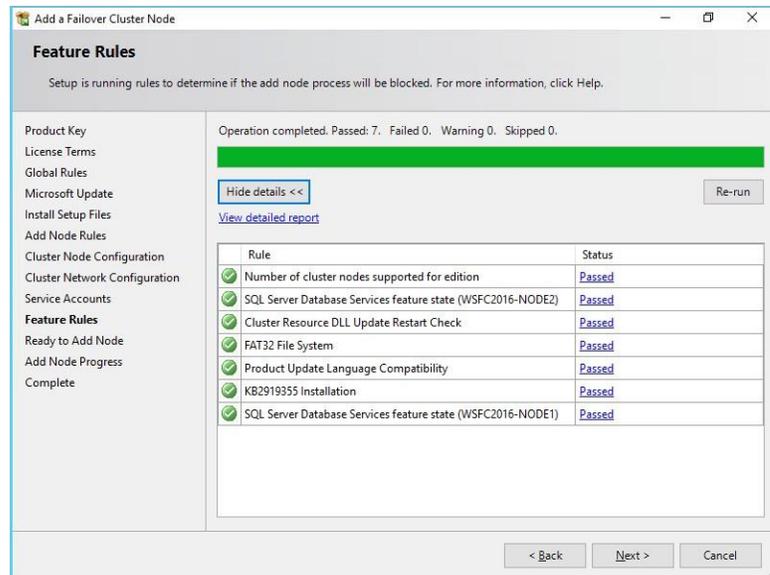


**NOTE:** Pay close attention to the order of the SQL Server services especially when you use different service accounts. In the previous section, you see the SQL Server Agent service come before the SQL Server Database Engine service. Here, it's the reverse - the SQL Server Database Engine service comes before the SQL Server Agent service. Be sure not to mix those two up.

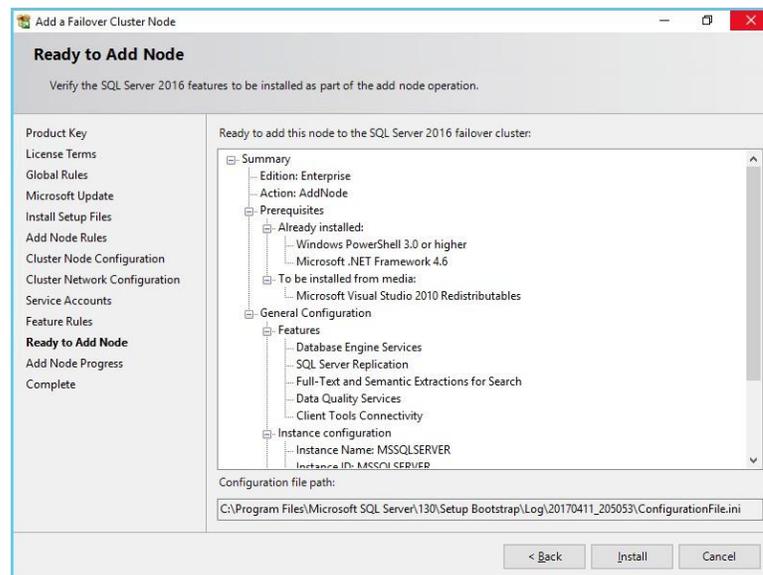
Select the checkbox **Grant Perform Volume Maintenance Task privilege to SQL Server Database Engine Service** to enable Instant File Initialization for SQL Server. Because this is a local permission assigned to an account, you need to explicitly do this on all of the nodes in the SQL Server FCI.

Click **Next**.

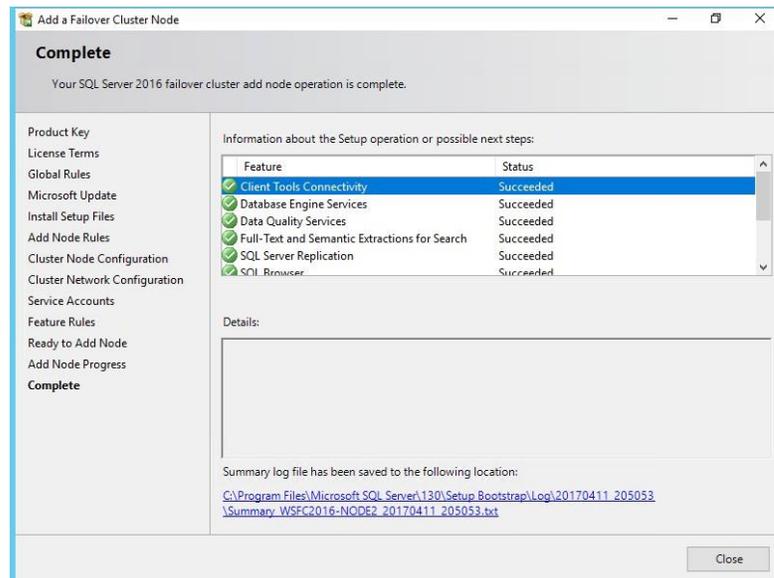
11. In the **Feature Rules** dialog box, verify that all checks are successful. Click **Next**.



12. In the **Ready to Add Node** dialog box, verify that all configuration settings are correct. Click **Install** to proceed with the installation.



13. In the **Complete** dialog box, click **Close**. This concludes adding a node to an existing SQL Server 2016 FCI.



To add more nodes to the SQL Server 2016 FCI, simply repeat steps #1 to #13.

At the completion of a successful installation and configuration of the node, you need to validate whether the SQL Server 2016 FCI will failover - either automatically or manually - to all of the available nodes.

## About The Author



**Edwin M Sarmiento** is a **Microsoft SQL Server MVP** and **Microsoft Certified Master** from Ottawa, Canada specializing in high availability, disaster recovery and system infrastructures running on the Microsoft server technology stack - ranging from Active Directory to SharePoint and anything in between. He is very passionate about technology but has interests in music, professional and organizational development, leadership and management matters when not working with databases. He lives up to his primary mission statement – *“To help people grow and develop their full potential as God has planned for them.”*

He wants the whole world to know that the FILIPINO is a world-class citizen and brings JESUS CHRIST to the world.

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