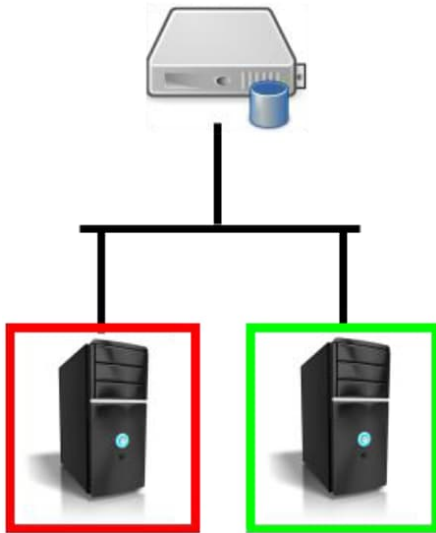


MODULE 4 SQL 2016 FAILOVER CLUSTER INSTANCES:

Please keep in mind that the SQL Fail Over Cluster Instance is a grouping of resources and dependencies such as was discussed in the module on Windows Server Failover Cluster (WSFC) and that all you learned in that module applies here. SQL FCI is wholly dependent on WSFC and as such cannot be implemented without a WSFC.

FAILOVER CLUSTER INSTANCE



As stated in module 2: Failover Cluster Instance (FCI) is a single instance of SQL Server that is installed across Windows Server Failover Clustering (WSFC) nodes.

Most organizations use clustering as a method to implement High Availability supported by a SAN backend to mitigate the chances of any disk failures. With clustering we can bring in another server that connects to the same SAN and is up and running before we bring the first server down. The Node 2 (green in above picture) server will talk with the SAN and keep all operations going while the Node 1 (red in above picture) server is down. This configuration of two servers is known as a Failover Cluster (pictured above).

AS A FCI APPEARS TO A CLIENT:

On the network, an FCI appears to be an instance of an SQL Server running on a single computer. The clients connect to a single virtual network name (VNN) for the FCI.

When FCI fails over from one WSFC node to another, the clients use the same VNN to connect to the SQL Server instance even after a failover.

SQL Server data for the instance is stored in the shared storage.

On failover the second node connects to the shared storage and presents the data back to the user.

There is no data duplication/ redundancy within the failover cluster configuration.

TABLE OF ALWAYS ON COMPARISON

From previous module. In this module, we are on the FCI highlighted in yellow below. We are working with an entire instance of SQL server and all of the databases in it.

Failover Cluster Instances	Availability Group
Passive Secondary Nodes	Active Secondary Replicas
Enhanced under Always On	Introduced in SQL 2012
Failover takes 30s to a couple of minutes (server restart)	Failover takes less than 30s (secondary replicas are online)
Shared Storage	Direct attached storage
Require Windows Server Failover Cluster	Require Windows Server Failover Cluster
Server Failover	Multi-database failover

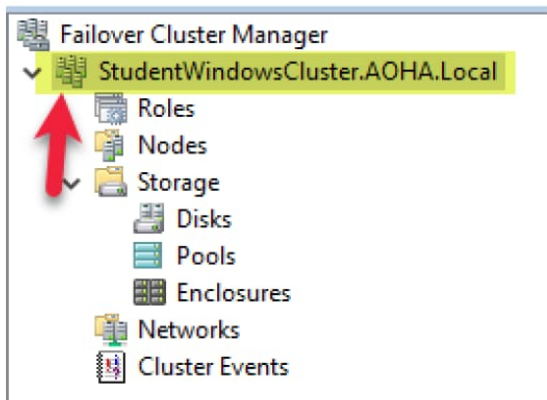
Lab Preconditions: We have created a Windows Cluster using SQL1-SQL3. On the iSCSI server, we created a iSCSI shared drive to simulate the SAN and added the three SQL servers as initiators. So far, we have only the SQL Server Management Studio installed on SQL1 and iSCSI. During the configuration of the labs the database mdf files were added to all of the servers in a folder c:\DatabasesMDF. This because of convenience as we have not designated a preferred owner so we do not know for sure which server will be the one where we can add the MDF files to SQL.

Installing the SQL FCI will make it a role in Windows Cluster. As a role the SQL binaries for a single instance will be monitors so that the failure of a instance will result in the transfer of that instance to another SQL server that is in the FCI.

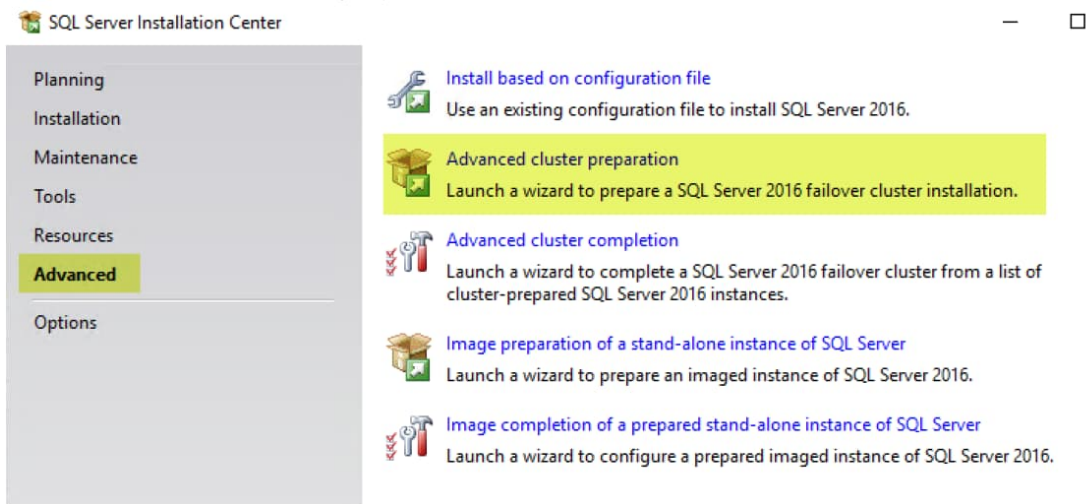
We are going to use three techniques in this lab to demonstrate what is available to you from the installation media.

LAB: CREATE A CONFIGURATION FILE BY RUNNING THE ADVANCED CLUSTER PREPARATION WIZARD

1. Using **Hyper-V Manager**, switch to **SQL1** virtual machine (if logon is required, log on as Student).
2. In **Server Manager**, navigate to the pane on the left and click to select **Local Server**.
3. Ensure that the **Firewalls** are turned **Off**.
4. Ensure that **IE Enhanced Security Configuration** is **Off**.
5. Switch to **Failover Cluster Manager**.
6. Ensure that the cluster is healthy (NO red icon on the cluster symbol).



7. Minimize the **Failover Cluster Manager**.
8. Use **File Explorer** to start the **SQL setup.exe**.
9. In the **SQL Server Installation Center** dialog box, click the **Advanced** tab.
10. Click the **Advanced cluster preparation** link.



11. In **Product Key** dialog box, click **Next**.
12. In the **License Terms** dialog box, accept the license terms, then click **Next**.
13. In the **Microsoft Update** dialog box, click **Next**.
14. In the **Feature Selection** dialog box, place a check in the **Database Engine Services** check box.
15. Click **Next**.
16. In **Instance Configuration** dialog box, click **Next**.
17. In **Server Configuration** dialog box, add the AOHA\Student account and Passw0rd to BOTH the **SQL Server Agent** and the **SQL Server Database Engine** service rows.

Service Accounts **FILESTREAM**

Microsoft recommends that you use a separate account for each SQL Server service.

Service	Account Name	Password	Startup Type
SQL Server Agent	AOHA\Student	••••••••	Manual <input type="button" value="v"/>
SQL Server Database Engine	AOHA\Student	••••••••	Manual <input type="button" value="v"/>
SQL Full-text Filter Daemon Launc...	NT Service\MSSQLFDLa...		Manual
SQL Server Browser	NT AUTHORITY\LOCAL ...		Automatic <input type="button" value="v"/>



Note that this setup is just for learning. In the real world you need to follow the Microsoft security guidelines for this setting.

18. Click **Next**.
19. In the **Ready to Install** dialog box, review the settings, then click **Install**.
20. In the **Complete** dialog box, review the results, then click **Close**.

LAB: COMPLETE THE SQL CLUSTER INSTALLATION ON SQL1

1. On **SQL1**, back in the **SQL Server Installation Center** dialog box, verify you are still on the **Advanced** tab, then click **Advanced cluster completion**.
2. When the **Global Rules** dialog box opens, wait for the rules check.
3. In the Complete Failover Cluster Rules dialog box, review the status and notice everything **Passed** and there is only one **Warning**.
4. Click **Next**.
5. In the **Cluster Node Configuration** dialog box, move to the **SQL Server Network Name** text box and enter SQLFCI.

Complete a SQL Server Failover Cluster

Cluster Node Configuration

Select a cluster-prepared SQL Server instance and specify network name for the new SQL Server failover cluster.

Global Rules
Complete Failover Cluster Rules
Cluster Node Configuration
Feature Rules
Cluster Resource Group
Cluster Disk Selection
Cluster Network Configuration
Server Configuration
Database Engine Configuration
Feature Configuration Rules
Ready to Install
Installation Progress
Complete

To complete a SQL Server failover cluster, specify an existing SQL Server instance that has been prepared for clustering.

SQL Server instance name: MSSQLSERVER

Name of this node: SQL1

Specify a network name for the new SQL Server failover cluster. This will be the name used to identify your failover cluster on the network.

SQL Server Network Name: SQLFCI

Instance Name	Features	Nodes
MSSQLSERVER	SQLEngine, SQ...	SQL1

< Back Next > Cancel

6. Review the settings, then click **Next**.
7. In the **Cluster Resource Group** dialog box, note the **SQL Server cluster resource group name**.

Complete a SQL Server Failover Cluster

Cluster Resource Group

Create a new cluster resource group for your SQL Server failover cluster.

Global Rules
Complete Failover Cluster Rules
Cluster Node Configuration
Feature Rules
Cluster Resource Group
Cluster Disk Selection
Cluster Network Configuration
Server Configuration
Database Engine Configuration
Feature Configuration Rules
Ready to Install
Installation Progress
Complete

Specify a name for the SQL Server cluster resource group. The cluster resource group is where SQL Server failover cluster resources will be placed. You can choose to use an existing cluster resource group name or enter a new cluster resource group name to be created.

SQL Server cluster resource group name: SQL Server (MSSQLSERVER)

Qualified	Name	Message
	Available Storage	The cluster group 'Available Storage' is reserved by Windows Fai...
	Cluster Group	The cluster group 'Cluster Group' is reserved by Windows Failov...

8. Click **Next**.
9. In the **Cluster Disk Selection** dialog box, notice **Cluster Disk 1** is selected, and **Cluster Disk 2** shows unavailable because it is used by the Windows Cluster. If we had created more iSCSI targets they would be listed, however, as you remember we created only these two.

Complete a SQL Server Failover Cluster

Cluster Disk Selection

Select shared cluster disk resources for your SQL Server failover cluster.

Global Rules
Complete Failover Cluster Rules
Cluster Node Configuration
Feature Rules
Cluster Resource Group
Cluster Disk Selection
Cluster Network Configuration
Server Configuration
Database Engine Configuration
Feature Configuration Rules
Ready to Install
Installation Progress
Complete

Specify the shared disks to be included in the SQL Server resource cluster group. The first drive will be used as the default drive for all databases, but this can be changed on the Database Engine or Analysis Services configuration pages.

☒ Cluster Disk 1

Available shared disks:

Qualified	Disk	Message
<input checked="" type="checkbox"/>	Cluster Disk 1	
<input type="checkbox"/>	Cluster Disk 2	The disk resource 'Cluster Disk 2' cannot be used because it is a cluster quorum drive.

Refresh

< Back Next > Cancel

10. Click **Next**.



Before you proceed with an IP address we suggest pinging it to assure it is not in use as failure is not easily reversed. If the IP is in use the install will fail and you will need to remove this node, and if you already have other nodes prepared them also, then repeat the installation.

11. In the **Cluster Network Configuration** dialog box, place a check next to **IPv4** in the **192.168.1.0/24** subnet.

Specify the network settings for this failover cluster:

<input checked="" type="checkbox"/>	IP Ty...	DHCP	Address	Subnet Mask	Subnet(s)	Network
<input type="checkbox"/>	IPv4	<input type="checkbox"/>		255.0.0.0	10.0.0.0/8	Cluster Network 1
<input checked="" type="checkbox"/>	IPv4	<input type="checkbox"/>		255.255.255.0	192.168.1.0/24	Cluster Network 2
<input type="checkbox"/>	IPv6	<input type="checkbox"/>			::/64	Cluster Network 2

12. In the corresponding **Address** text box enter 192.168.1.70 (did you ping it?).

Specify the network settings for this failover cluster:

<input checked="" type="checkbox"/>	IP Ty...	DHCP	Address	Subnet Mask	Subnet(s)	Network
<input type="checkbox"/>	IPv4	<input type="checkbox"/>		255.0.0.0	10.0.0.0/8	Cluster Network 1
<input checked="" type="checkbox"/>	IPv4	<input type="checkbox"/>	192.168.1.70	255.255.255.0	192.168.1.0/24	Cluster Network 2
<input type="checkbox"/>	IPv6	<input type="checkbox"/>			::/64	Cluster Network 2

13. Place a check next to **IPv4** in the **10.0.0.0/8** subnet.

Specify the network settings for this failover cluster:

<input checked="" type="checkbox"/>	IP Ty...	DHCP	Address	Subnet Mask	Subnet(s)	Network
<input checked="" type="checkbox"/>	IPv4	<input type="checkbox"/>		255.0.0.0	10.0.0.0/8	Cluster Network 1
<input checked="" type="checkbox"/>	IPv4	<input type="checkbox"/>	192.168.1.70	255.255.255.0	192.168.1.0/24	Cluster Network 2
<input type="checkbox"/>	IPv6	<input type="checkbox"/>			::/64	Cluster Network 2

14. In the corresponding **Address** text box enter 10.0.0.70 (did you ping it?).

Specify the network settings for this failover cluster:

<input checked="" type="checkbox"/>	IP Ty...	DHCP	Address	Subnet Mask	Subnet(s)	Network
<input checked="" type="checkbox"/>	IPv4	<input type="checkbox"/>	10.0.0.70	255.0.0.0	10.0.0.0/8	Cluster Network 1
<input checked="" type="checkbox"/>	IPv4	<input type="checkbox"/>	192.168.1.70	255.255.255.0	192.168.1.0/24	Cluster Network 2
<input type="checkbox"/>	IPv6	<input type="checkbox"/>			::/64	Cluster Network 2

15. Click **Next**.
16. In the **Server Configuration** dialog box, review the collation, then click **Next**.
17. In the **Database Engine Configuration** dialog box, click the radio button to use **Mixed Mode**.
18. Enter and confirm Password in the two **password** text boxes.
19. Click **Add Current User**.

Specify SQL Server administrators

AOHA\Student (Student)

SQL Server administrators have unrestricted access to the Database Engine.

Add Current User

Add...

Remove

20. Examine the **Data Directories** tab and the **TempDB** tab.

- Here, if we had added multiple iSCSI targets we could change the location of our files.

Server Configuration | **Data Directories** | TempDB

Specify the authentication mode and administrators for the Database Engine.

Authentication Mode _____

☐ Windows authentication mode

☒ Mixed Mode (SQL Server authentication and Windows authentication)

Specify the password for the SQL Server system administrator (sa) account. _____

Enter password:

Confirm password:

Specify SQL Server administrators _____

AOHA\Student (Student)

SQL Server administrators have unrestricted access to the Database Engine.

Add Current User Add... Remove

21. Click **Next**.
22. In the **Ready to Install** dialog box, review the settings, then click **Install**.
23. In the **Complete** dialog box, review the results, then click **Close**.
24. Close the **SQL Server Installation Center** dialog box.

LAB: INSTALL THE CLUSTER ON SQL2 AND SQL3

1. Using **Hyper-V Manager**, switch to **SQL2** virtual machine (if logon is required, log on as Student).
2. In **Server Manager**, navigate to the pane on the left and click to select **Local Server**.
3. Ensure that the **Firewalls** are turned **Off**.
4. Ensure that **IE Enhanced Security Configuration** is **Off**.
5. Use **File Explorer** to start the **SQL setup.exe**.
6. In the **SQL Server Installation Center** dialog box, click the **Installation** tab.
7. Click **Add node to a SQL Server failover cluster**.
8. In **Product Key** dialog box, click **Next**.

9. In the **License Terms** dialog box, accept the license terms, then click **Next**.
10. In the **Microsoft Update** dialog box, click **Next**.
11. In the **Product Updates** dialog box, review the updates available, then click **Next**.
12. In the **Install Setup Files** dialog box, wait for the install to complete.
13. In the **Add Node Rules** dialog box, click **Next**.
14. In the **Cluster Node Configuration** dialog box, click **Next**.
15. In the **Cluster Network Configuration** dialog box, click **Next**.
16. In **Service Accounts** dialog box, enter Passw0rd in BOTH the **SQL Server Agent** and the **SQL Server Database Engine** service rows.

Add a Failover Cluster Node

Service Accounts

Specify the service accounts and collation configuration.

Microsoft recommends that you use a separate account for each SQL Server service.

Service	Account Name	Password	Startup Type
SQL Full-text Filter Daemon Launcher	NT Service\MSSQLFDLaun...		Manual
SQL Server Database Engine	AOHA\Student	••••••••	Manual
SQL Server Browser	NT AUTHORITY\LOCAL SE...		Automatic
SQL Server Agent	AOHA\Student	••••••••	Manual

☐ Grant Perform Volume Maintenance Task privilege to SQL Server Database Engine Service

This privilege enables instant file initialization by avoiding zeroing of data pages. This may lead to information disclosure by allowing deleted content to be accessed.

[Click here for details](#)

17. Click **Next**.
18. In the **Ready to Add Node** dialog box, review the settings, then click **Install**.
19. In the **Complete** dialog box, review the **Status**, then click **Close**.
20. Close the **SQL Server Installation Center** dialog box.
21. Repeat these steps on **SQL3** virtual machine.

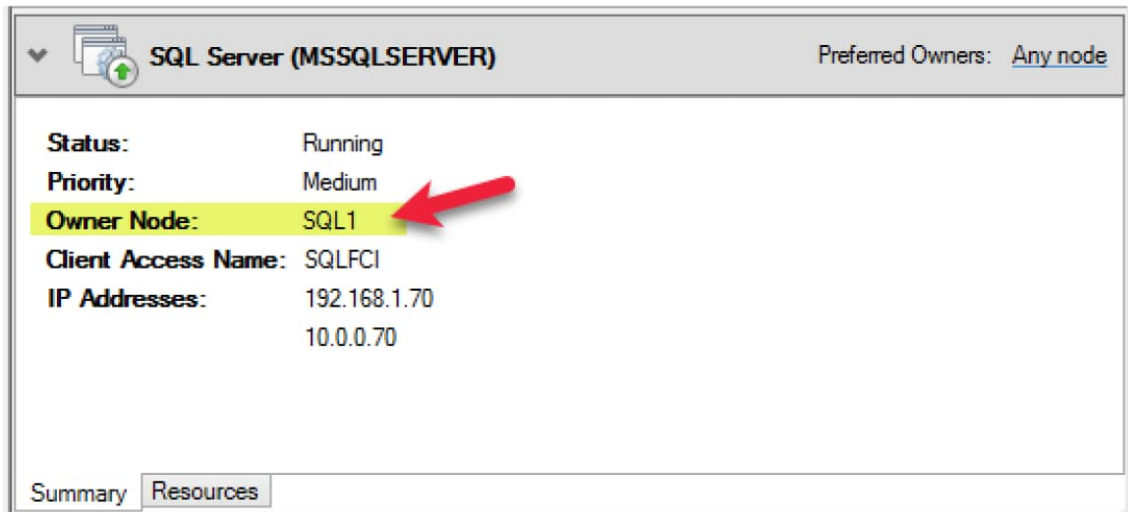
LAB: TEST THE SQL CLUSTER

1. Using **Hyper-V Manager**, switch to **SQL1** virtual machine (if logon is required, log on as Student).
2. Switch to **Failover Cluster Manager**.
3. In **Failover Cluster Manager**, expand **StudentWindowsCluster.AOHA.Local**.
4. Click to select **Roles**.

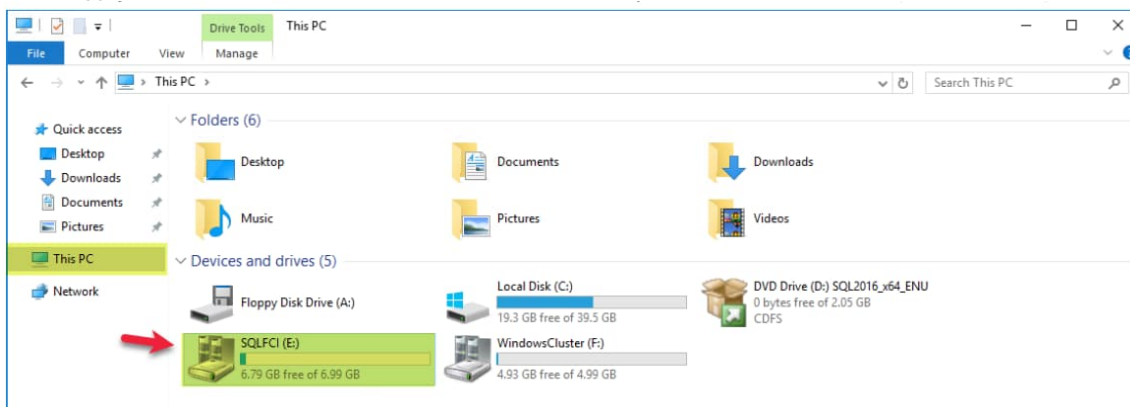
5. Move to the **Roles (1)** section in the center and click to select the one listed role.
6. In the bottom pane, you will see the **Owner Node** listed.



This is where we will need to copy some files for the database. If this node fails, you will see the new owner node listed here. Only the owner node exposes the shared storage location in Computer Management and File Explorer.



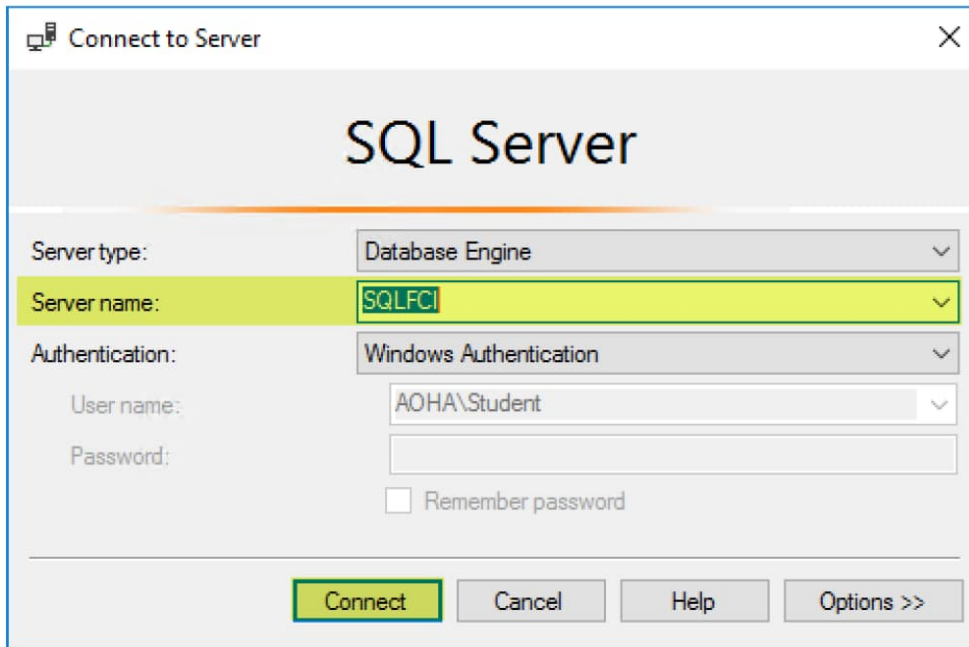
7. Ensure you are logged into the owner node, then start **File Explorer**.
8. When **File Explorer** opens, navigate to **C:\DatabaseMDF**.
9. Double-click **DatabaseMDF** to open the folder.
10. Right-click and **Copy** the **AdventureWorks2014.bak** file.
11. In **File Explorer**, click **This PC**, then double-click to open the **SQLFCI** drive (*Should be E*).



12. Navigate to **E:\MSSQL13.MSSQLSERVER\MSSQL\Backup**.
13. In the **Backup** dialog box advising **You don't currently have permission to access this folder**, click

Continue.

14. Once inside the **Backup** folder, paste in the **AdventureWorks2014.bak** file you had copied.
15. Start **SQL Server Management Studio**.
16. In the **Connect to Server** dialog box, connect to **SQLFCI**.



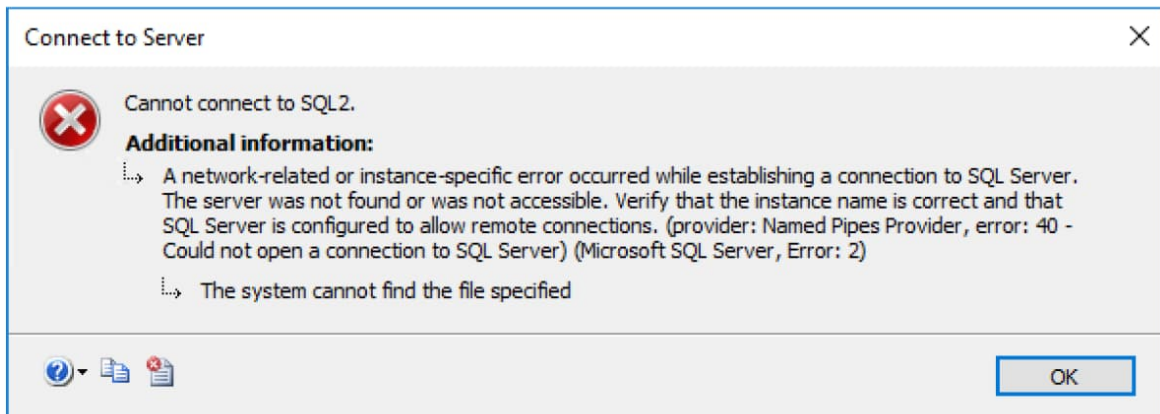
17. Move to the **Object Explorer** pane on the left, right-click **Databases**, then click **Restore Database....**
18. When the **Restore Database** dialog box opens, move to the **Source** section and click the radio button to use **Device**.
19. Click the corresponding ellipses.
20. When the **Select backup devices** dialog box opens, click **Add**.
21. In the **Locate Backup File – SQLFCI** dialog box, double-click the **AdventureWorks2014.bak** file.
22. Click **OK** twice.
23. In the **Microsoft SQL Server Management Studio** dialog box advising **Database ‘AdventureWorks2014’ restored successfully**, click **OK**.
24. Expand **Databases** folder and review the results.



If the AdventureWorks2014 database does not automatically appear in Object Explorer, right-click Databases, then click Refresh.

25. Expand **AdventureWorks2014** database.

26. Expand **Tables**.
27. Locate **Person.Address**, right-click the table and click **Select Top 1000 Rows**. Review the results.
28. Using **Hyper-V Manager**, switch to **iSCSI** virtual machine (if logon is required, log on as Student).
29. Start **SQL Server Management Studio**.
30. In the **Connect to Server** dialog box, move to the **Server name** setting, use the corresponding drop-down arrow and click to select **Browse for more....**
31. In the **Browse for Servers** dialog box, click the **Network Servers** tab.
32. Wait for the information to be retrieved (it will take a second or two to appear), then expand **Database Engine**.
33. Click to select **SQL2**.
34. Click **OK**.
35. Back in **Connect to Server** dialog box, click **Connect**.
36. Note that it errors because the only instance is part of the cluster.



37. Click **OK**.
38. In the **Connect to Server** dialog box, move to the **Server name** setting, use the corresponding drop-down arrow and click to select **Browse for more....**
39. In the **Browse for Servers** dialog box, click the **Network Servers** tab.
40. Wait for the information to be retrieved (it will take a second or two to appear), then expand **Database Engine**.
41. Click to select **SQLFCI**.
42. Click **OK**.
43. Back in **Connect to Server** dialog box, click **Connect**.
44. Move to the **Object Explorer** pane on the left, and expand **Databases**.

45. Expand **AdventureWorks2014** database.
46. Expand **Tables**.
47. Locate **Person.Address**, right-click the table and click **Select Top 1000 Rows**. Review the results.
48. Leave **SQL Server Management Studio** open and using **Hyper-V Manager**, switch to **SQL1** virtual machine (if logon is required, log on as Student).
49. Switch to **Failover Cluster Manager**.
50. Move to the pane on the left and expand **StudentWindowsCluster.AOHA.Local**.
51. Click to select **Nodes**.
52. Navigate to the **Nodes (3)** section in the center and click to select **SQL1**.
53. Move to the **Actions** pane on the right, locate the **SQL1** section and click **Pause | Drain Roles**.
54. Notice the **Status** column for that node now reflects **Paused**.
55. Using **Hyper-V Manager**, switch to **iSCSI**.
56. Back in **SQL Server Management Studio**, rerun the query by clicking **Execute**.



If the query does not execute, wait 10-20 seconds and repeat running the query. Repeat until the query executes successfully. This is the behavior of a failover role with SQLFCI.

This can take much longer to come back online.

57. Using **Hyper-V Manager**, switch to **SQL1** virtual machine (if logon is required, log on as Student).
58. Move to the **Actions** pane on the right, locate the **SQL1** section and click **Resume | Fail Roles Back**.
59. Notice the **Status** column for that node now reflects **Up**.
60. Using **Hyper-V Manager**, switch to either SQL2 or SQL3 (choose one or the other), then utilize the Failover Cluster Manager to Pause the node corresponding to the machine you chose.
 - SQL2 virtual machine = Pause SQL2 node
 - SQL3 virtual machine = Pause SQL3 node
61. Using **Hyper-V Manager**, switch to **iSCSI**.
62. Back in **SQL Server Management Studio**, rerun the query by clicking **Execute**. Note it returns almost immediately.
63. Using **Hyper-V Manager**, switch to **SQL1**.
64. Back in **Failover Cluster Manager**, look at the **Nodes** and their corresponding status noting the **Paused** node.

65. Right-click the **Paused** node, and click **Show Critical Events**.
66. Starting at the bottom, work your way up the list reviewing what happened.
67. Click **Close**.
68. Using **Hyper-V Manager**, switch to machine whose corresponding node is paused, then move to the **Actions** pane on the right, and click **Resume | Fail Roles Back**.
69. Using **Hyper-V Manager**, return to **SQL1**.
70. Back in **Failover Cluster Manager**, right-click **Nodes** then click **Refresh**.
71. Again, look at the **Show Critical Events** dialog box for the node you paused and review the new events.
72. Close **Critical events...** dialog box.

DISCUSSION AS A GROUP:

- What does Windows Cluster protect from?
- What does SQL Cluster protect from?