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Setting up a **Windows Server Failover Cluster (WSFC)** and a **SQL Server Failover Cluster Instance (FCI)** requires careful planning and the fulfillment of certain prerequisites.

Below is a detailed guide on the **minimum requirements** for both the Windows Failover Cluster and the SQL Server Failover Cluster setup.

1. Windows Server Failover Cluster (WSFC) Minimum Requirements

1.1. Supported Windows Server Versions

To create a Windows Server Failover Cluster, the servers must be running a supported version of the Windows Server operating system. The most commonly used versions are:

- **Windows Server 2022**
- **Windows Server 2019**
- **Windows Server 2016**

All editions except **Windows Server Essentials** support Failover Clustering.

1.2. Hardware Requirements

Failover clustering requires that all servers (nodes) in the cluster meet certain hardware requirements.

- **Number of Nodes:** A minimum of **two servers** is required for a failover cluster. WSFC supports up to **64 nodes** in a single cluster (in more advanced configurations).
- **Network Interfaces:**
 - Each node should have at least **two network adapters (NICs)**:
 - **One for the public network:** To communicate with client applications and the external network.
 - **One for the private network:** To handle internal cluster communication (heartbeat).
- **Cluster Storage:**
 - For a traditional failover cluster, shared storage is required:
 - **Storage Area Network (SAN)** is typically used as the shared storage solution.
 - Microsoft also supports using **Storage Spaces Direct (S2D)** for shared storage.
 - In newer versions of Windows Server (2016 and above), **Cloud Witness** or **File Share Witness** can be used as quorum witnesses, reducing dependency on shared storage for witness configurations.
- **Quorum:** The cluster needs a **quorum** configuration, which helps ensure that the cluster remains operational in case of node failures.
 - A quorum is configured as a majority node set, node and disk majority, or node and file share majority, depending on your cluster setup.

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1.3. Active Directory

- **Active Directory Domain Services (AD DS)** are required for Windows Failover Clustering. All nodes in the cluster must be members of the same Active Directory domain.
- Each node must use **domain accounts** for cluster service and SQL Server service accounts.

1.4. Storage Requirements

- **Shared Disk:** For a SQL Server Failover Cluster, you must use shared storage (except for newer diskless configurations using **Storage Spaces Direct** or cloud-based options).
 - The storage should be accessible by all nodes in the cluster, and all nodes must have access to the same shared volumes.
 - **Disk Format:** Shared disks must be formatted with **NTFS** or **ReFS** for use in Windows Failover Clustering.
 - **Clustered Disks:** The disks must be configured as **clustered disks** for WSFC to properly manage failover.

1.5. Network Requirements

- All cluster nodes should be on the same **Windows domain**.
- Nodes should have:
 - **Static IP addresses:** Required for both public and private networks.
 - **DNS resolution:** Proper DNS configuration is essential for node-to-node communication.
 - **Heartbeat Network:** A separate network interface is recommended for node heartbeat communication, ensuring the cluster monitors node availability efficiently.

2. SQL Server Failover Cluster Instance (FCI) Minimum Requirements

After setting up the WSFC, the next step is to configure a SQL Server Failover Cluster Instance (FCI). FCI provides **high availability** at the SQL Server instance level by allowing SQL Server to failover between nodes in a Windows cluster.

2.1. Supported SQL Server Editions

SQL Server Failover Cluster Instances are available in the following SQL Server editions:

- **SQL Server Enterprise Edition:** Supports unlimited failover cluster nodes (limited by WSFC).
- **SQL Server Standard Edition:** Supports a maximum of **two nodes** for FCI.

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2.2. Operating System Compatibility

- SQL Server FCI requires the underlying Windows Server operating system to be compatible with the SQL Server version being deployed.
- For instance, SQL Server 2019 is supported on Windows Server 2016, 2019, and later versions.

2.3. Instance Requirements

Each SQL Server Failover Cluster Instance needs to be deployed as a separate, unique instance with its own:

- **Virtual Network Name (VNN):** This is the name clients use to connect to the clustered SQL Server instance. It must be unique within the network.
- **SQL Server Instance Name:** If multiple FCIs are being deployed, each instance must have a unique instance name.
- **Virtual IP Address:** A static IP address is assigned to each FCI and is used during failover, so clients can connect regardless of which node is currently hosting the SQL Server instance.

2.4. SQL Server Service Accounts

- A **domain-level service account** is required to run the SQL Server services in the cluster.
- Separate service accounts for the **SQL Server Database Engine** and **SQL Server Agent** are recommended.
- These service accounts must have appropriate **permissions** in Active Directory and on each node in the cluster.

2.5. SQL Server Storage Requirements

- **Shared Storage:** SQL Server FCI requires shared storage for the database files, similar to WSFC.
 - Shared storage should be configured with high-performance, high-availability storage, typically SAN.
 - Storage must be accessible from all cluster nodes, and the SQL Server data files, log files, and system databases must reside on shared disks.
- **Cluster Shared Volumes (CSV):** SQL Server FCI supports CSV in later Windows versions, which can help improve scalability and availability in larger environments.
- **Disk Partitions:**
 - The shared disks must be formatted with NTFS or ReFS (for SQL Server 2012 and later).
 - The disk partitions should be configured as **Basic Disks** (not dynamic) for proper cluster failover.

2.6. SQL Server Installation Requirements

During installation, ensure the following:

- **Cluster Validation:** Before SQL Server FCI installation, you must run the **Cluster Validation Wizard** in WSFC to verify that the cluster configuration supports failover.

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- **SQL Server Setup:** SQL Server must be installed on each node of the cluster, but only one instance will be active at any given time. SQL Server Setup automatically integrates with the underlying WSFC to configure FCI.
- **Failover Cluster Role:** Ensure the Windows Failover Cluster role is configured and enabled on each node in the cluster.

2.7. SQL Server Licensing

- **Licensing** for SQL Server in a Failover Cluster setup is based on the **number of active cores** in the cluster. In the case of failover, only the active node's cores need to be licensed.
- **Passive Node Licensing:** SQL Server does not require additional licensing for passive nodes in an FCI, as long as the passive node is not processing workloads. However, the rules may vary based on your license agreement with Microsoft.

3. Best Practices for WSFC and SQL Server FCI Deployment

3.1. Quorum Configuration

- A correct **quorum configuration** is essential to ensure that the cluster can handle node failures effectively. Common quorum options include:
 - **Node Majority** (for odd number of nodes).
 - **Node and Disk Majority** (for even number of nodes with shared storage).
 - **Node and File Share Majority** or **Cloud Witness** (for clusters without shared storage).

3.2. Heartbeat Network

- Configure a **dedicated heartbeat network** for inter-node communication. This helps avoid unnecessary failovers due to temporary network outages.

3.3. Testing Failover

- Before putting the cluster into production, test the failover process by manually initiating a failover and verifying that SQL Server moves between nodes correctly and clients reconnect smoothly.

3.4. Monitoring and Maintenance

- Use **SQL Server Management Studio (SSMS)**, **Failover Cluster Manager**, and performance monitoring tools like **SQL Server Profiler** and **Windows Performance Monitor** to track the health of the cluster and SQL Server instances.

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3.5. Patching and Updates

- Regularly update both the operating system and SQL Server, ensuring that **patching** is performed in a rolling manner (one node at a time) to prevent downtime. SQL Server supports **rolling patch upgrades** for FCIs.

4. Summary

The combination of **Windows Server Failover Clustering (WSFC)** and **SQL Server Failover Cluster Instance (FCI)** provides a robust high availability solution for SQL Server.

Proper planning and understanding of the minimum requirements for hardware, storage, networking, and software are critical for a successful deployment.

Key factors such as shared storage, domain membership, and SQL Server licensing also need to be addressed early in the process.

While this guide covers the minimum requirements, following best practices and ensuring a proper validation and testing process will help ensure that your failover cluster environment runs efficiently and can handle node failures gracefully without affecting end-users or critical applications.