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Setting up **SQL Server Always On Availability Groups** between two replicas in a **multi-subnet environment** involves configuring a high-availability solution that spans across different geographical locations or different network subnets.

This setup helps achieve both high availability and disaster recovery (HA/DR) by distributing SQL Server instances across different subnets.

In this guide, we will walk through the **detailed steps** to set up SQL Server Always On Availability Groups between two replicas with **multi-subnet** configuration.

1. Prerequisites

1.1. SQL Server Version and Edition

- **SQL Server Enterprise Edition** is required to configure **Always On Availability Groups**.
- The SQL Server instances must be running on **Windows Server** (2012 and later versions).

1.2. Windows Server Failover Cluster (WSFC)

- SQL Server Always On Availability Groups rely on a **Windows Server Failover Cluster (WSFC)** for failover management.
- Both replicas must be part of the same WSFC.

1.3. Hardware and Network Requirements

- **Two replicas** (SQL Server instances) in **two different subnets**. For example:
    - Primary Replica in **Subnet 1**.
    - Secondary Replica in **Subnet 2**.
- Ensure that both subnets can communicate with each other (i.e., proper routing between subnets, VPN, or dedicated network).

1.4. Quorum Configuration

- Since you are deploying a multi-subnet setup, you'll need to configure a **Quorum Witness**. For multi-subnet configurations, it's recommended to use a **Cloud Witness** or **File Share Witness** instead of a **Disk Witness**.

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- Ensure that all cluster nodes can access the quorum witness.

1.5. DNS Configuration

- The **SQL Server Availability Group Listener** will use **multi-subnet DNS** to resolve its IP address across different subnets.
- Ensure that **Dynamic Updates** in DNS are supported or DNS entries are configured manually.

1.6. Permissions

- The SQL Server service accounts (running the SQL Server instances on each replica) need **appropriate permissions** in Active Directory and on the cluster nodes.

2. High-Level Overview of Steps

1. **Configure Windows Server Failover Clustering (WSFC) across multiple subnets**.
2. **Enable SQL Server Always On Availability Groups** on both replicas.
3. **Create and configure the Availability Group** across the two replicas.
4. **Create the Availability Group Listener** with multiple IP addresses (one for each subnet).
5. **Test and validate the failover** between subnets.

3. Detailed Steps

Step 1: Configure Windows Server Failover Clustering (WSFC)

Before configuring SQL Server Always On, you need to create a **Windows Server Failover Cluster** across the two nodes in different subnets.

1. **Install Failover Clustering Feature**:
    - On both Windows Servers (where SQL Server is installed), use the **Server Manager** to install the **Failover Clustering feature**.

Server Manager -> Manage -> Add Roles and Features -> Select Failover Clustering

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2. Create a Failover Cluster:

- Open the **Failover Cluster Manager** on one of the nodes and create a new cluster.
- Add both nodes (from different subnets) to the cluster.
- Run the **Cluster Validation Wizard** to ensure that both nodes meet the necessary requirements.

3. Configure Quorum:

- Once the cluster is created, configure the **quorum**.
- Go to **Cluster Properties -> More Actions -> Configure Cluster Quorum**.
- Use **File Share Witness** or **Cloud Witness** for multi-subnet clusters.

4. Configure Cluster Networks:

- Ensure that both subnets are listed as cluster networks.
- Ensure that each subnet has an IP address assigned in the cluster configuration.

Step 2: Enable SQL Server Always On Availability Groups

1. **Enable Always On Availability Groups**:
   - On both SQL Server instances (on each node), open **SQL Server Configuration Manager**.
   - Navigate to **SQL Server Services**, right-click the SQL Server instance, and go to **Properties**.
   - In the **Always On High Availability** tab, check the box **Enable Always On Availability Groups** and specify the WSFC cluster name.
   - Restart the SQL Server services to apply changes.

Step 3: Create and Configure Availability Group

1. **Prepare Databases**:
   - On the **primary replica** (the server that will host the primary database), ensure the databases are in **Full Recovery Model**.

     ALTER DATABASE [YourDatabaseName] SET RECOVERY FULL;

   - Take a **full backup** and a **transaction log backup** of the database.

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2. **Create Availability Group**:
    - In **SQL Server Management Studio (SSMS)**, connect to the primary replica and navigate to **Always On High Availability -> Availability Groups**.
    - Right-click **Availability Groups** and select **New Availability Group Wizard**.
    - Follow the wizard to:
        - Name the Availability Group.
        - Select the database(s) you want to add.
        - Define replicas:
            - Add the second SQL Server instance as a **Secondary Replica**.
            - Choose the **synchronization mode** (synchronous or asynchronous). For high availability, synchronous mode is recommended, but in some multi-subnet setups, **asynchronous** replication is preferred due to latency.
3. **Automatic or Manual Failover**:
    - Configure failover mode for each replica:
        - Primary: **Automatic Failover** (synchronous replication).
        - Secondary: **Manual Failover** (asynchronous replication).
4. **Backup Preferences**:
    - Set your **Backup Preferences** (prefer backups on the secondary replica to offload backup load from the primary replica).
5. **Join Secondary Replica**:
    - Choose a method for the secondary replica to catch up with the primary (e.g., full backup and restore, automatic seeding).

Step 4: Create Availability Group Listener with Multi-Subnet Configuration

An **Availability Group Listener** is a virtual network name that allows applications to connect to the SQL Server instance without needing to know which replica is currently the primary one. For multi-subnet clusters, the listener will have multiple IP addresses (one for each subnet).

1. **Create the Listener**:
    - After creating the availability group, right-click the availability group in **SSMS** and choose **Add Listener**.
    - In the dialog box:

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- Specify the **Listener DNS Name** (this is the name applications will use to connect to SQL Server).
- Choose the **Port** (default is 1433 for SQL Server).
- Add **multiple IP addresses**:
  - One for each subnet where the replicas are located.
- Ensure **MultiSubnetFailover=True** is enabled. This ensures faster failover times in multi-subnet environments.

2. **Configure DNS and Register IP Addresses**:
   - SQL Server will register all the IP addresses in DNS for the listener name.
   - If **Dynamic DNS Updates** are not enabled, you will need to manually register the IP addresses in DNS for the listener.

   Example:

   - **Subnet 1 (Primary)**: Listener IP - 192.168.1.10
   - **Subnet 2 (Secondary)**: Listener IP - 192.168.2.10
3. **Connection String Configuration**:
   - Applications connecting to the Availability Group should use the **MultiSubnetFailover=True** parameter in their connection strings to ensure that the application can fail over efficiently between subnets.

Data Source=AGListenerName;Initial Catalog=DatabaseName;Integrated Security=True;MultiSubnetFailover=True;

Step 5: Test and Validate Failover

1. **Test Failover**:
   - Perform a **manual failover** by moving the primary role to the secondary replica.
   - In SSMS, navigate to the availability group, right-click, and choose **Failover**.
   - Ensure that the secondary replica becomes the primary replica and the listener redirects traffic to the new primary.

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2. **Validate Listener Configuration**:
    - Check that the **Availability Group Listener** resolves to the correct IP address based on which replica is currently the primary.
    - Use the **ping** or **nslookup** command to verify DNS changes:

    nslookup AGListenerName

3. Test Application Failover:

- Test your application by disconnecting the primary node or performing manual failover to ensure that the **MultiSubnetFailover** connection string is working as expected.

6. Best Practices for Multi-Subnet Always On

- **Monitor Latency**: In multi-subnet configurations, network latency between subnets can affect replication performance. If using synchronous replication, ensure that latency is low enough to maintain performance.
- **Automatic Failover Configuration**: Automatic failover is only recommended if **synchronous replication** is used. Otherwise, use manual failover with asynchronous replication.
- **Regular Backups**: Always configure regular backups and ensure that the backups are tested to avoid data loss in case of disaster recovery scenarios.

7. Summary:

- Setting up **SQL Server Always On Availability Groups** across two replicas in a **multi-subnet environment** provides an excellent solution for both high availability and disaster recovery.
- By configuring WSFC, enabling SQL Server Always On, and setting up the listener with multi-subnet support, you can achieve automatic failover across geographically separated sites or data centers.
- Proper configuration and testing will ensure that the system is resilient to network and hardware failures while maintaining high availability for mission-critical applications.

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