SQLskills Immersion Event

IECAG: Clustering and Availability Groups

Module 2: Failover Clustered Instances

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Overview

- Failover Clustered Instance overview
- Storage planning for SQL Server
- Choosing the proper service account
- Installation of Failover Clustered Instance
- Configuration options to consider
- Multiple instance considerations
- Patching and rolling updates
- Clustered instance upgrades

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Failover Clustered Instance Overview

High-Availability Feature	Failover Clustering
Standby type	Hot
Failure detection	Automatic
Automatic failover	Yes
Protects against failed server process	Yes
Protects against failed disk	No (but possible with mirroring/AGs/S2D)
Transactionally consistent	Yes
Transactionally current	Yes
Performance impact	None (possibly during failover)
Time to failover	Depends on restart recovery
Locations	Nearby
Hardware Requirements	Must pass CVTs
Multiple standby/secondary nodes	16 (SQL Server 2008+/Windows 2008+) 64 (SQL Server 2012+/Windows 2012+)
Standby available for reporting, etc.	No
Cost	High
Complexity	High

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Failover Clustered Instance Overview

- **Instance level protection from server hardware failure built on Windows Server Failover Clustering**
  - Protects system databases as well as user databases
  - Only native HA option for distribution database in SQL Server before SQL Server 2017 CU6 and SQL Server 2016 SP2-CU3
- **Requires shared storage for SQL Server installation**
  - SAN disk (iSCSI, FC, or vSAN)
  - Cluster Shared Volumes (CSV)
  - SMB file share storage
  - Storage Spaces Direct (S2D) clustered volume
- **Typically only maintains a single copy of the databases on the shared storage**
  - Potentially single point of failure
  - Exception to this: SQL Server 2016 on Windows Server 2016 using S2D (Storage Spaces Direct) or on 3rd-party filter drivers (SIOS Datakeeper)

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Planning for Failover Clustering
SMB Storage in SQL Server 2012+

- **Skip Cluster Validation Disk checks**
- **Use Node and File Share quorum configuration if an even number of nodes are participating in the cluster**
  - Requires that the Virtual Computer Object (VCO) for the cluster have Full Control over the share
  - Can not be used in Active Directory disconnected clusters
- **During SQL Server cluster installation specify UNC paths for the file location configuration**
  - Requires that the service account for the Database Engine has Full Control permission over the share locations
- **Blog post:**
  - https://sqlskills.com/help/2012onSMB

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Planning for Failover Clustering
Storage: Mount Points or Drive Letters

- **Each instance requires at least one disk that has a drive letter assigned to it**
  - Configuring MSDTC within the SQL resource group eliminates the need for an additional drive for MSDTC
- **SMB storage allows up to 50 instances to be configured in a cluster in SQL Server 2012+**
- **SQL Server 2012+ supports tempdb on local SSD storage**

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Service Account Considerations

- **Virtual Accounts**
  - Auto-managed account in the format NT SERVICE\<SERVICENAME>
  - Accesses network resources under the COMPUTER$ account
- **Domain Accounts**
  - Minimally privileged domain user to allow access to network service and domain resources
- **Group Managed Service Accounts**
  - Active Directory managed account for use by services running on multiple servers with automatic password changes managed by AD
  - SQL Server 2014+ supports group managed service accounts on Windows Server 2012 R2 and later for standalone instances, failover cluster instances, and availability groups
  - Requires Windows Server 2012 R2 with KB 2998082 applied or Windows Server 2016

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Configuring a GMSA

- **Requires Windows Server 2012 or higher DC in the domain**
- **Requires Key Distribution Services (KDS) Root Key**
- **Create a security group in AD**
- **Add computer objects allowed to use the gMSA to the group**
  - Requires reboot of each server to pickup group membership change
- **Create the gMSA in AD and assign the security group to it**
  - New-ADServiceAccount in powershell
- **Configure the gMSA on each server in the cluster**
  - Install-AdServiceAccount <gMSA>
  - Test-AdServiceAccount <gMSA>
- **Configure the gMSA for the SQL Services in SQL Configuration Manager**

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SQL Server Installation
Adding a Node

- **Setup must be run on each node that an instance is able to failover to**
- **Install the SQL Server prerequisites on the node**
  - Choose "Add node to SQL Server failover cluster" as the setup option
  - On the Cluster Node Configuration page select the name of the SQL Server failover cluster instance to add in the drop down
  - Configure the appropriate service accounts
  - Restart the server if required when installation completes
- **Don't forget to install the SQL Server tools if you plan to manage the server using the UI on each node (separate installation now)**

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SQL Server Installation
Removing a Node

- **Prior to evicting a node from the cluster using the Cluster Administrator run SQL Server setup to remove the SQL instance(s) from the node**
  - If the node is being formatted or repurposed this is not required
  - Run SQL Server setup
  - On the Cluster Node Configuration page select the name of the SQL Server failover cluster instance to remove in the drop down
  - Restart the server if required when installation completes
- **Evict the node from MSCS using the Cluster Administrator**

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Planning for Failover Clustering
Workgroup and Multi-domain Clusters

- **All servers must be running Windows Server 2016**
- **A local account must be created on all nodes of the cluster**
  - Username and Password must be the same on all nodes
  - Must be a member of the Local Administrators group
  - The LocalAccountTokenFilterPolicy registry policy must be set to 1
    - HKLM:\SOFTWARE\Microsoft\Windows\CurrentVersion\Policies\System
- **The cluster must be an Active Directory Detached cluster with a Cluster Network Name of type DNS**
  - DNS must be working properly and all nodes must have a primary DNS suffix
  - Multi-Domain cluster nodes should have the DNS suffix of all domains in the cluster on all nodes
- **SQL Authentication is recommended for client connections**

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Configuration Considerations
Multi-instance Memory Management

- **When multiple instances can failover to a single cluster node memory resources will be constrained during the failure**
  - Instance memory = (memory for thread stack) + (memory for buffer pool) + (memory for plan cache) + (memory for multipage allocators)
    - Memory for thread stack = (max worker threads) *(stack size)
    - x86 = 512KB; x64 = 2MB; ia64 = 4MB
- **Buffer pool memory usage is limited by the 'max server memory' sp_configure option and the buffer pool will grow/shrink based on OS memory availability**

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Configuration Considerations
Multi-instance Memory Management

- **The 'min server memory' sp_configure option can be used to guarantee a minimum amount of memory to the buffer pool after memory ramp up**
- **For multi-instance configurations 'min server memory' should be set for each of the instances based on their priority/importance to guarantee a minimum amount of buffer pool memory**
  - The aggregated total of 'min server memory' values should always be lower than the total server memory installed to prevent memory pressure and paging problems especially when using Lock Pages in Memory
  - Memory\Available Mbytes > 150-300MB
- **Aaron Bertrand's blog post on automating reconfiguration:**
  - https://sqlskills.com/help/AutoMemConfig

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Configuration Considerations
Multi-instance Memory: Lock Pages in Memory

- **Lock Pages in Memory allows SQL Server to allocate memory using AllocateUserPhysicalPages () instead of VirtualAlloc ()**
- **Required for AWE on 32-bit instances**
- **Prevents paging of the buffer pool on 64-bit instances**
  - Does not require configuration of "AWE enabled" in SQL Server
  - Trace flag -T845 required for Standard Edition instances for SQL 2008 R2 and earlier
- **Detected at startup only**

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Configuration Considerations
Multi-instance Memory: Large Pages

- **For 32-bit the OS page size is 4KB**
- **64-bit can use large pages (2-16MB)**
  - Helps avoid translation look-aside buffer (TLB) misses
- **Requires**
  - Enterprise Edition
  - Locked Pages In Memory
  - Trace flag -T834
  - http://support.microsoft.com/kb/920093
- **All memory allocated at startup, and must be contiguous**
  - For this reason, large pages should not be enabled for multi-instance configurations where two instances can run on a single node at the same time

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Configuration Considerations
MSDTC

- **MSDTC is not required to be clustered for SQL Server any longer**
- **If you want to cluster MSDTC for distributed transactions, it must be configured as a cluster resource using the Cluster Administrator**
- **MSDTC can be installed after SQL Server as a resource in the instance cluster group**
  - Allows multi-instance clusters to have separate DTCs per instance
  - Ensures that the instance and DTC resource run on the same cluster node and failover together
- **Blog by Cindy Gross:**
  - https://sqlskills.com/help/msdtc

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How Failover Works
Failure Detection

- **Node failure is detected by MSCS when a node misses 6 consecutive heartbeats**
- **Resource failure is detected through IsAlive and LooksAlive checks provided by the Resource DLL**
  - SQL Server performs the LooksAlive check every 5 seconds and validates that the SQL Server service status matches the status reported by the Service Control Manager (SCM)
  - SQL Server performs the IsAlive check every 60 seconds by executing the command SELECT @@SERVERNAME against the instance
- **Intervals for the IsAlive and LooksAlive checks and the number of missed heartbeats to trigger failure can be configured using the Failover Cluster Manager**

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How Failover Works
Instance Failover

- **When instance failover occurs, the resource group for the instance is taken offline on the current owning node**
- **The Failover Manager performs arbitration to locate a new owner for the group and brings the resources online on the new node in dependency order**
- **When the SQL Server service starts up, instance recovery begins**
  - The SQL Resource DLL is up once the master database completes recovery
  - User databases become available when REDO completes for Enterprise Edition or after UNDO completes for Standard Edition
    - Called 'Fast Recovery'

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SQL Server 2012+ Flexible Failover

- User sets new cluster properties for HealthCheckTimeout and FailureConditionLevel
- IsAlive/LooksAlive result based on output from sp_server_diagnostics and FailureConditionLevel

Level	Failover Type	Description	Example
0	No automatic failover or restart	Never Fail, Log Only	
1	Failover or restart on SQL Server down	Server Down	Instance Not Starting
2	Failover or restart on SQL Server unresponsive	Server Hang	17884 Deadlock
3	Failover or restart on critical SQL Server errors	System Unhealthy	Stack Dumps Occurring
4	Failover or restart on moderate SQL Server errors	Resource Unhealthy	Low on Memory
5	Failover or restart on any qualified failure	QP Unhealthy	Queries Stalled

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How Failover Works

Instance Failover and SQL Agent

- By default SQL Agent failures will cause a failover of the SQL Server Cluster Resource Group
- If SQL Agent is not required in the environment, or failover should not occur if the SQL Agent service goes offline under normal operation, this should be changed for the environment

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SQL Server Installation
Non-Cluster Aware Components

- **Reporting Services**
  - Should be setup in a scale-out solution with network load balancing instead of failover clustering
- **Integration Services**
  - Possible to cluster manually
    http://msdn.microsoft.com/en-us/library/ms345193.aspx
- **Notification Services (SQL Server 2005)**

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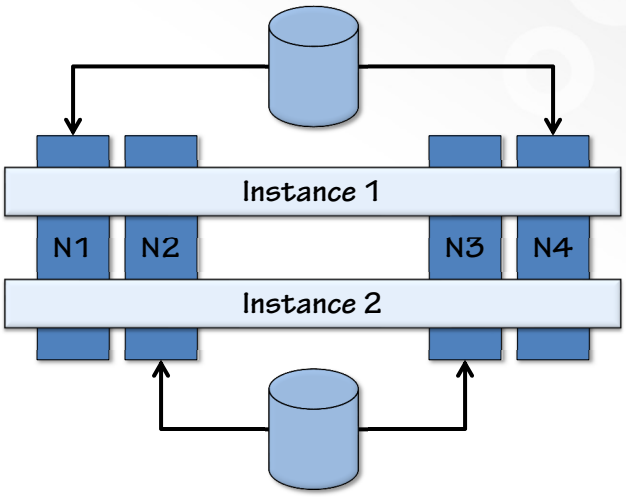
Patching a Clustered Instance

1. Remove N3 & N4 from possible owners
2. Patch N3 & N4
3. Add N3 & N4 to possible owners
4. Failover to N3 & N4, , remove N1 and N2 from possible owners
5. Patch N1 & N2
6. Add N1 & N2 back to possible owners



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Upgrading Failover Clustered Instances

- **Upgrading SQL Server Instance Installation**
  - In place upgrades are supported using the same Edition of SQL Server currently installed
  - Rolling upgrades are supported by running setup on the non-active (passive) nodes first
    - Upgraded nodes are removed from possible ownership by setup
    - Setup will failover to an upgraded node when half of the nodes or more have been upgraded
- **Upgrading Windows Server**
  - New feature in Windows Server 2016 allows rolling upgrade of cluster nodes from Windows Server 2012R2 without downtime
  - ClusterFunctionalLevel allows mixed-OS mode for cluster until changed with Update-ClusterFunctionalLevel PowerShell cmdlet

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FCI Concepts
Geo-Clustering SQL Server

- **Eliminates the SAN as a single point of failure**
- **Requires specific hardware from the Geographic Cluster Hardware Compatibility List for the solution to be supported (KB 280743)**
- **Requires a stretched VLAN in SQL Server 2008 R2 and prior**
  - Public and private networks must appear non-routed
  - Round trip latency must by under 500ms
- **SQL Server 2012+ allows OR dependency on IP Address for the cluster name resource allowing multiple subnets to be used**
- **Requires third party SAN replication technology**
- **SQL install must be started from the command line to skip Cluster_VerifyForErrors rule check**
  - Setup /SkipRules=Cluster_VerifyForErrors /Action=InstallFailoverCluster

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Key Takeaways

- Use Group Managed Service Accounts for new cluster installations whenever possible to simplify password management
- During rolling updates to SQL Server, while node(s) are being patched remove them from possible ownership to prevent a failover attempting to start the service during patching

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- Clustered instance upgrades

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