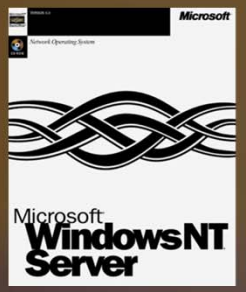
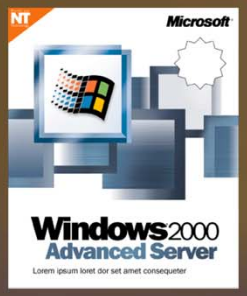
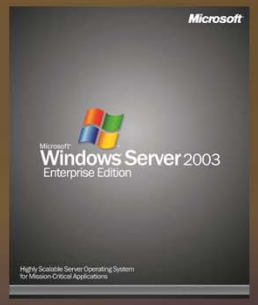
Windows Failover Clustering Basics for the DBA

Allan Hirt
Cluster MVP
e-mail: allan@sqlha.com
Website: http://www.sqlha.com
Blog: http://www.sqlha.com/blog
Twitter: SQLHA

Windows Clustering Technologies

- Two kinds:
  - Failover Clustering
    - SQL Server's clustering is built on top of this
    - Purely an availability solution; scale up (scale out via application specific methods)
  - Network Load Balancing (NLB)
    - Limited scenarios for SQL Server
    - Used for scalability as well as availability (example: web servers)

Terminology Changes Over the Years

Beta	1997	2000	2003	2008 R2
				Microsoft Windows Server Failover Clustering
Wolfpack	Microsoft Cluster Service (MSCS)	Server Clustering	Failover Clustering (WSFC)	

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W2K8, Clustering, and SQL Server

- Use Windows Server 2008 R2 at this point
  - 64-bit only
  - Will need Windows Server 2008 RTM-based install if still need a 32-bit
    - 32-bit clustered SQL instances not supported on a 64-bit OS
- Clustering still an Enterprise or Datacenter feature of Windows
- 2005/2008/2008 R2 supported in a side-by-side configuration
- Core variant not supported for SQL Server 2008 R2 or earlier (slated for support with Denali; watch the CTPs)
- No rolling upgrade from W2K3 → W2K8 (RTM or R2)

	Windows Server 2008 RTM/SP2	Windows Server 2008 R2
SQL Server 2005	SP2+	SP3+
SQL Server 2008	RTM	SP1+
SQL Server 2008 R2	RTM	RTM

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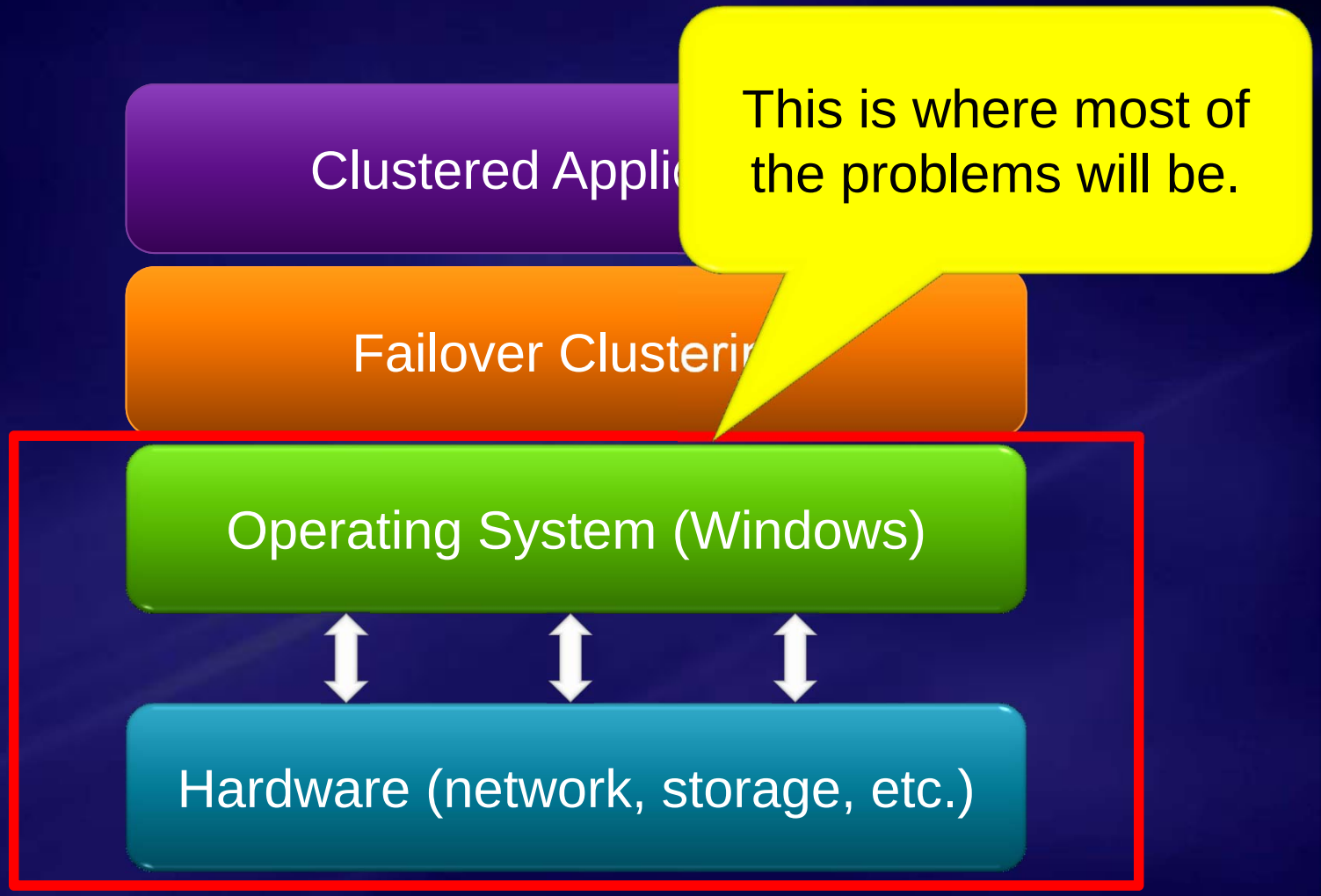
The Clustering Stack (High Level)



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Failover Cluster Components 1

- Node = server
- Networks
  - Public – used by external connections (and the cluster)
  - Private/Heartbeat – cluster communications only
- Storage
  - “Shared nothing”
  - Cluster Shared Volume (Hyper-V *only*)

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Failover Cluster Components 2

- Quorum
  - Determines at what point the cluster will stop running based on the number of available voters
  - Helps avoid “split brain”
- Quorum types in W2K8
  - No majority (same as the old “disk only”)
    - All nodes can fail except 1 if the witness disk is online
    - Not recommended; witness disk is single point of failure

Failover Cluster Components 3

- Quorum types cont'd
  - Node Majority (same as W2K3 Majority Node Set)
    - Failure calculation: ½ nodes (rounding up) – 1
  - Node and Disk Majority
    - Combination of No Majority + Node Majority; removes single point of failure
    - Failure calculations:
      - Witness disk available: ½ nodes (rounding up)
      - Witness disk unavailable: ½ nodes (rounding up) – 1
  - Node and File Share Majority
    - Same as Node and Disk Majority, but with file share-based witness instead of a shared disk

Failover Cluster Components 4

- Resource
  - Physical or logical component providing some use in the cluster
  - Owned by one node at a time
- Resource Groups = Services/Applications in W2K8
  - Collection of resources
  - Resources cannot be shared across groups
- Dependencies
  - A resource can be a dependency of another
  - If a resource is a dependency, the child resource cannot come online until the parent is online

Failover Cluster Components 5

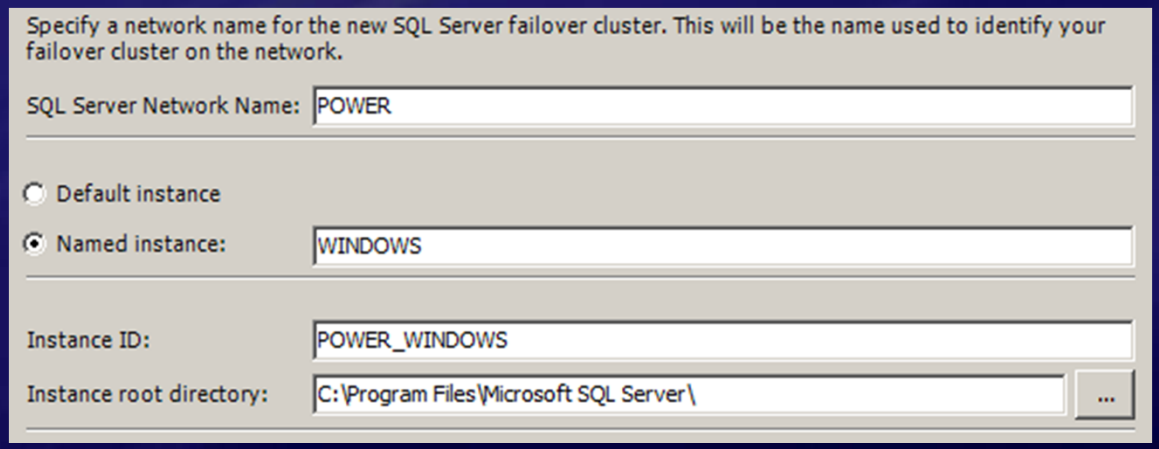
- Two main health checks
  - LooksAlive – cluster only (“Are you there?”)
  - IsAlive – Application specific
    - For SQL Server, it is a SELECT @@version query
    - Not configurable
- Cluster Service service on each node
  - Sub-components: event processor, database manager, node manager, global update manager, communication manager, resource manager

Clustered Applications

- Old terminology: virtual server
- Comprised of:
  - 1+ cluster disks (NOTHING LOCAL)
  - Network Name
  - 1 or more IP addresses
  - Cluster resources which reside in a resource group
    - Resources can have dependencies

What's In A Name?

- You need lots of 'em – all unique
  - One for each cluster node (unique in the domain)
  - One for the Windows failover cluster (unique in the domain)
  - One for each clustered application
    - This is what applications/users connect to



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How Does It All Work?

- Nodes monitor health of other nodes
- If that node fails, health monitoring will cause a failover of the resource
- Another node starts the application and reads the last saved information from the storage
- Clients experience a slight interruption in service

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What Happens in SQL Server During a Failover?

- Resources start in dependency order
- Stop and start, so SQL Server goes through normal recovery
  - SQL Server considers itself up when the system databases are up
  - Reality: not up until the user databases are online
  - Crucial not to have a lot hanging around in the t-logs
- No name or IP address changes

Applications and Failover Clustering

- Due to the recovery process in a failover, SQL Server has no data loss and is transactionally consistent to the point of failure
- Just to reiterate: connect to the clustered SQL Server instance name or IP
  - Not the node name/IP or the Windows failover cluster name/IP
- Not an automatic reconnect
  - Retry logic
  - Code application to be cluster-aware (Platforms SDK)

Networking 1

- Need a unique IP address for:
  - Each node
  - Windows failover cluster
  - Each SQL Server instance
- NIC teaming fully supported under W2K8 and up (not under W2K3) – KB254101
  - Test before going into production
- SQL Server 2008 and earlier requires a VLAN for a geographically dispersed cluster
  - Does not support OR
  - Denali fixes this

Networking 2

- Minimum of 2 networks + corresponding NICs
  - Externally facing/public
  - Internal*
  - Storage (iSCSI) requires its own dedicated network
  - Hyper-V should get its own (if using it)
- Rename the networks with friendly names
- Need redundancy at the physical layer, too
  - Example: Don’t plug all NICs into the same switches

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Security 1

- Windows
  - Domain account needed for cluster creation and administration – THAT'S IT
    - Requires Create Computer Objects right on Computers OU
    - If cannot give CCO, create the Cluster Name Object (CNO) and Virtual Computer Obeject (VCO) manually
  - Domain account NOT used to run the cluster service – runs under a special context
- SQL Server
  - Still requires service accounts
  - Use a Service SID; do not have to use domain groups
  - No local Administrator requirements unless using something like xp_cmdshell (off by default)
- Never use a domain admin account or assign domain admin privileges – THEY ARE NOT NEEDED

Security 2

- Still prefers dynamic DNS
- Firewall
  - By default, it's on – and there can be up to 3
  - Use common sense and follow your corporate security guidelines
  - If on, can cause things like:
    - Unwanted RPC errors
    - Inability for Management Studio to see SQL Server instances hosted on a particular cluster node
  - If left on, make exceptions (both inbound and outbound rules) for things like the SQL Server port number
- New cluster security for users
- IPv6 support in W2K8/R2

Security 3

- Anti-virus and SQL Server Failover Clustering
  - Not recommended if not needed
  - If required, set exclusions:
    - .mdf (data), .ldf (log), .ndf (additional data)
    - .bak (default backup extension), .trn (default t-log backup extension)
    - All directories with Analysis Services data, log, temporary files, backups
    - Entire quorum/witness disk
    - \MSDTC directory for MSDTC disks (if used)
    - \Cluster subdirectory under %windir%
- SQL Server & anti-virus KB 309422
- Cluster & anti-virus KB 250355

Storage Configuration

- Drive types supported: only SAS, iSCSI, Fibre; no old parallel SCSI
  - Storage must be SCSI-3 SPC-3 command compliant
  - Storage must support persistent reservations
- Still need at least one drive letter per clustered instance of SQL Server 2008
  - Can use mount points for everything else
- Cluster Shared Volumes (CSV) *not* supported for SQL Server use; Hyper-V only
- Can select multiple drives during SQL Server install
  - Rename drives to make them easier to discern

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Cluster Validation 1

- W2K8 no longer relies on the HCL/Server Catalog
- Hardware must be logoed for W2K8/R2
- Must re-run with hardware or major config change
- Run via Failover Cluster Manager or PowerShell (PS is W2K8 R2 only)
- TIP: great way to document your servers and check for changes over time

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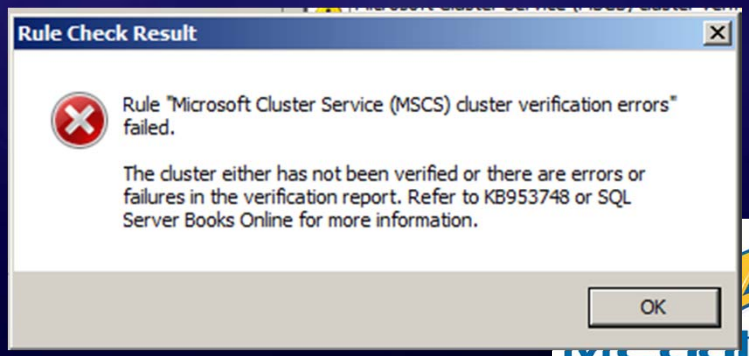
Cluster Validation 2

- Different types of tests run (storage, networking, etc.)
  - Report location: %windir%\Cluster\Reports
  - Pass, Warning, Fail
  - Warning not fatal, but must investigate
  - Fix any problems and re-run
  - TIP: Re-run failed tests first, then re-run full suite
- Additional validation tests if run after configured in Windows Server 2008 R2
- SQL Server relies on a successful result
  - Prevent a false positive



MSDTC, SQL Server 2008/R2, and Windows Server 2008

- OS supports multiple DTCs – no longer need to share one per Windows failover cluster
- Installation options
  - Old way: DTC in its own group (with its own IP, disk)
  - One DTC per SQL Server instance
    - Old way + bind to instance
    - Put in same group with SQL Server
  - Do not cluster DTC at all; clustered SQL Server will "negotiate down" to use a local DTC if nothing clustered

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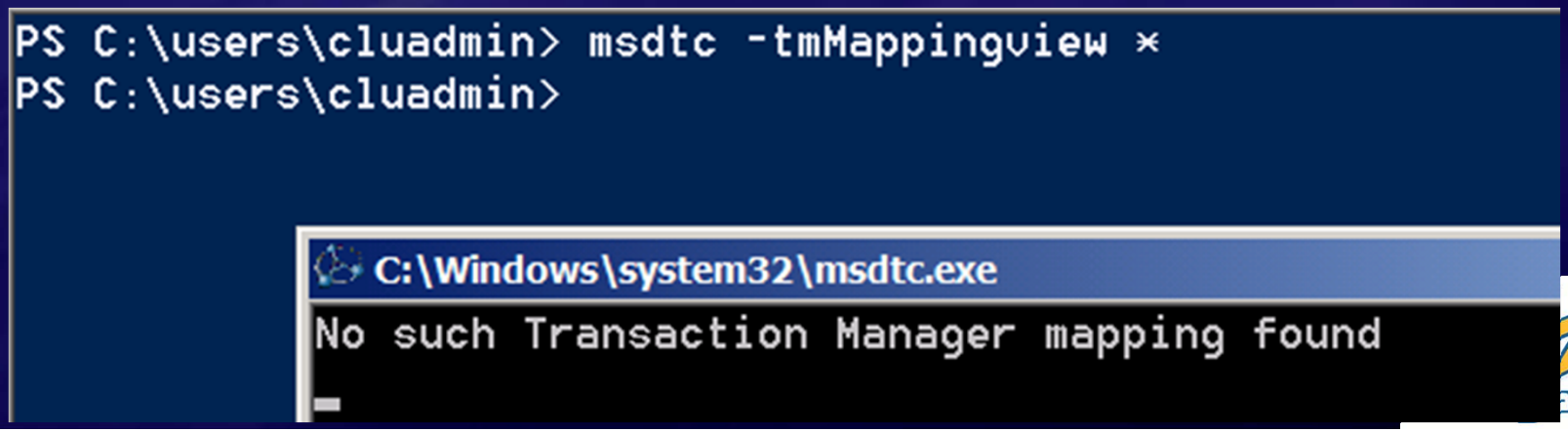

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Else

```
PS C:\> msdtc -tmMappingSet -name EquinoxDTC -service MSSQLSERVER -clusterResourceName "SQL Server"
PS C:\>
```

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MSDTC, SQL Server 2008/R2, and W

```
PS C:\> msdtc -tmMappingview *
PS C:\>
```

C:\Windows\system32\msdtc.exe

```
Key: HKLM\Cluster\MSDTC\TMMapping\Service\EquinoxDTC
Num of Values = 3

ValueName: ClusterResourceId
Value Type: 1
Value: SQL Server

ValueName: ApplicationType
Value Type: 4
Value: 1

ValueName: Name
Value Type: 1
Value: MSSQLSERVER

Operation succeeded
```

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    - Old v…
    - Put i…
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Use MSDTC instance installed to the local group

Else

Use the mapped instance of MSDTC

Else

Use the cluster's default instance of MSDTC

Else

Use the local machine's instance of MSDTC

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VMs as a "Guest Cluster"

- Supported as of May, 2009 (KB 956983)
- W2K8 OS for guests only
- SQL 2K5 or SQL 2K8
- Will need some sort of shared storage solution (most likely iSCSI)
- Recommendations:
  - Map virtual NICs to different networks/NICs at the hypervisor level
  - Place the VMs on separate hypervisors to prevent a single point of failure
- Bottom line: same rules as a physical cluster apply
  - Yes, you can technically have one note physical, one node virtual if you pass Validation

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Administration

- Tools
  - Failover Cluster Management (RTM)/Manager (R2)
    - No more Cluster Administrator
    - MMC snap-in
  - cluster.exe
    - Going away after W2K8 R2
  - PowerShell cmdlets (W2K8 R2 only)
- Debug logging
  - Based on event tracing – old cluster.log gone
  - Must turn on
  - Logs stored in %windir%\System32\winevt\logs
  - Up to 3 files (incremented on reboot)
  - Get-ClusterLog to dump to file similar to old cluster.log
  - Tracerpt.exe to dump trace session

Resources 1

- Pro SQL Server 2008 Failover Clustering (Apress, 2009)
- My blog – updated regularly with new stuff!
- SQL Server 2008 failover clustering whitepaper
- Windows Clustering Team Blog
- Microsoft Enterprise Platforms Support: Windows Server Core Team blog

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Resources 2

- KB Articles:
  - 956893 “Support policy for Microsoft SQL Server products that are running in a hardware virtualization environment”
  - 897615 Support policy for Microsoft software running in non-Microsoft hardware virtualization software
  - 943984 The Microsoft Support Policy for Windows Server 2008 Failover Clusters
  - 327518 The Microsoft SQL Server support policy for Microsoft Clustering
  - 958734 SQL Server 2008 failover clustering rolling patch and service pack process

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