



Poster Companion Reference: Hyper-V and Failover Clustering

Virtual Machine Priorities		Cluster Shared Volumes	
	Cluster-Aware Updating		Virtual Machine Live Migrations

Introduction

This document is part of a companion reference that discusses the Windows Server 2012 Hyper-V Component Architecture Poster.

This document refers to the section titled "Hyper-V and Failover Clustering" and discusses virtual machine queuing for live migration, failover cluster validation, Cluster-Aware Updating, virtual machine priorities, and improved features for Cluster Shared Volumes. It includes other related information as well.

1. [Understanding Failover Clustering](#)
2. [Failover Clustering and Virtualized Workloads](#)
3. [Failover Cluster Requirements](#)
4. [Virtual Machine Live Migrations](#)
5. [Hyper-V Application Monitoring](#)
6. [Support for Guest Clustering Using Fibre Channel](#)
7. [Failover Cluster Validation](#)
8. [Migrate a Cluster Wizard](#)
9. [Virtual Machine Priorities](#)
10. [Cluster-Aware Updating](#)
11. [Windows PowerShell Support](#)
12. [Failover Cluster Scalability](#)
13. [Cluster Shared Volumes](#)
14. [Security and Encryption](#)
15. [Backup within Cluster Shared Volumes](#)
16. [Windows Server Component Architecture Posters](#)

You can obtain the Windows Server 2012 Hyper-V Component Architecture Poster from the Microsoft Download Center. This is a free resource. You can download it here:

<http://www.microsoft.com/download/en/details.aspx?id=29189>

1. Understanding Failover Clustering

Server availability is a higher priority than ever whether your business is on-premises or operating from the cloud. A “24/7” global marketplace means that downtime can equate to lost customers, revenue, and productivity. To help deliver high availability, Windows Server 2012 provides enhanced failover clustering functionality, which provides organizations with protection against:

- Application and service failure.
- System and hardware failure (such as CPUs, drives, memory, network adapters, and power supplies).
- Site failure (which could be caused by natural disaster, power outages, or connectivity outages).

You can use failover clusters to provide support for mission-critical applications—such as databases, messaging systems, file and print services, custom applications and virtualized workloads—that require high availability, scalability, and reliability.

A failover cluster is a group of independent computers, or nodes, that are physically connected by a local area network (LAN) or a wide area network (WAN), and are programmatically connected by cluster software. An administrator manages the group of nodes as a single system. The group usually includes multiple network connections and data storage that are connected to the nodes through storage area networks (SANs). The failover cluster operates by moving resources between nodes to provide service if system components fail.

Normally, if a server that is running a particular application or server role fails, the application will be unavailable until the server is fixed. Failover clustering addresses this situation by detecting hardware or software faults and immediately restarting the application or server role on another node without requiring administrative intervention—a process known as failover.

Users can continue to access the service and may be completely unaware that it is now being provided from a different server. This concept is extended when you enable your workloads to be virtualized using Hyper-V and managed within a failover cluster.

2. Failover Clustering and Virtualized Workloads

Microsoft has a long history of involvement in providing high-availability technology and solutions. Windows Server 2008 provided many enhanced configuration, management, and diagnostic features to the Failover Clustering feature, which made setting up and managing failover clusters much easier. Windows Server 2008 R2 enhanced the cluster validation process for new or existing clusters, simplified the management of clustered virtual machines (on a server running Hyper-V), provided a Windows PowerShell interface, and included more options for migrating settings from one cluster to another.

Failover Clustering has supported Hyper-V workloads since Hyper-V was originally released. The layering of virtual workloads in a cluster may seem unusual at first, but there are many benefits of using these technologies together. For example, Hyper-V virtual machine workloads assist in delivering high availability and enable access to your server-based applications, in both planned and unplanned downtime. In Windows Server 2012, Hyper-V has been significantly enhanced to help provide high availability for mission-critical workloads. It utilizes many of the new cluster technologies, including queuing live migration, cluster validation, virtual machine priorities, Cluster Shared Volumes, and Cluster-Aware Updating.

3. Failover Clustering Requirements

The following is required to utilize the functionality of Failover Clustering with your virtual machines in Windows Server 2012.

- Windows Server 2012 with the Hyper-V role and Failover Clustering feature.
- A network infrastructure that connects your servers (nodes) into a cluster. In this network infrastructure, you should avoid having single points of failure. This means that you need to include additional hardware infrastructure to increase your availability - for example, you could use shared network adapters (or NIC teaming).
- Storage capacity that is accessible by the servers in your cluster.
- Device controllers or appropriate adapters for your storage. These can be Serial Attached SCSI (SAS), Fiber Channel, Fibre Channel over Ethernet (FcoE), or iSCSI. Alternatively, your Hyper-V clusters also have a capability to use SMB storage if required.

4. Virtual Machine Live Migrations

Live migration was introduced in Hyper-V in Windows Server 2008 R2. It enables you to move a running virtual machine from one physical server to another without interruption of service. Live migration has evolved to work in multiple scenarios in Windows Server 2012, and does not always require clustering (as it did in Windows Server 2008 R2).

In Windows Server 2012, the Failover Clustering feature provides live migration queuing. This allows you to queue live migrations of your virtual machines. You can select multiple virtual machines and then initiate the live migration of those virtual machines at the same time. The failover cluster initiates as many live migrations as possible, and then queues the remaining virtual machines to be migrated. The remaining virtual machine live migrations start when the other live migration operations complete and when migration resources such as bandwidth become available. If necessary, the cluster also retries queued live migrations.

Queuing the live migration of virtual machines is also integrated with NUMA memory-aware virtual machine placement. NUMA (Non-Uniform Memory Access) refers to a multiprocessor architecture that groups memory and processors into compute nodes (which are different to cluster nodes). The time required for a processor to access memory within a node is faster than the time required to access memory across nodes. Hyper-V supports projecting a virtual NUMA topology within a virtual machine, which enables virtual machines with multiprocessors to scale better. The guest operating system and applications can take advantage of any NUMA performance optimizations. By default, the virtual NUMA topology within a virtual machine is optimized to match the NUMA topology in the server running Hyper-V.

In Windows Server 2012, live migrations in a clustered environment are now able to use higher network bandwidths (up to 10 GB) to complete migrations faster. This is a significant improvement and allows for much larger and more efficient workload migrations. It is also possible to view the detailed status of your ongoing or queued live migrations using Failover Cluster Manager.

5. Hyper-V Application Monitoring

Installing and configuring Hyper-V and Failover Clustering enables you to bring higher availability to traditional workloads that do not officially support clustering. By monitoring services and event logs inside the virtual machine, Hyper-V and Failover Clustering can detect whether your key services provided by a virtual machine are healthy. If they are not healthy, automatic corrective action can be taken (that is, restarting the virtual machine or moving it to a different server running Hyper-V).

6. Support for Guest Clustering Using Fibre Channel

Windows Server 2012 provides Fibre Channel ports within the guest operating system, which allows you to connect to Fibre Channel directly from within virtual machines. This feature lets you virtualize workloads that use direct access to Fibre Channel storage and cluster guest operating systems over Fibre Channel.

7. Failover Cluster Validation

In Windows Server 2012, there is an improved wizard to help you validate hardware and software for use in a failover cluster. You can perform a series of tests to determine whether your system, storage, and network configuration is suitable for a failover cluster. You can also verify that the nodes meet all of the operating system requirements, that your networks are configured correctly, that there is support for the failover of virtual machines from one host to another, and that the storage subsystem supports clustering. Many aspects of failover cluster validation have been improved. It is now much faster, especially for storage validation tests.

Windows Server 2012 provides some new validation tests for the Cluster Shared Volumes (CSV) feature to ensure your configuration meets all the requirements for using a CSV. There are new validation tests for Hyper-V and virtual machines. This ensures that the servers in your cluster support smooth failover of virtual machines from one server running Hyper-V to another.

For management requirements, the cluster validation status is now exposed through Windows Management Instrumentation (WMI), so that your applications and scripts can programmatically access it.

8. Migrate a Cluster Wizard

In Windows Server 2012, the Migrate a Cluster Wizard enables you to more easily migrate the configuration settings for clustered roles from one cluster to another (note that “clustered roles” are sometimes referred to as “clustered services and applications”). The Migrate a Cluster Wizard includes support for exporting and re-importing your Hyper-V virtual machines.

9. Virtual Machine Priorities

An innovative feature in Windows Server 2012 is the ability to assign and configure your virtual machines (and other clustered roles) with a priority. This priority setting controls the order in which virtual machines fail over or are started to help ensure that the highest priority virtual machines are started first. If there aren't enough resources to start all of the VMs, then the lowest priority virtual machines are saved so that the higher virtual machines can start. The saved virtual machines will be started once resources are available again.

You have a choice of four priorities. Priorities can be set as High, Medium, Low, or No Auto Start. When a virtual machine is made highly available in a failover cluster, the default priority is set to Medium. Using priorities, you can customize your environment to respond to a variety of situations depending on your organizational requirements.

It is important to understand that when the No Auto Start priority is applied to your virtual machine, it will not automatically start in the event of a cluster node failure.

10. Cluster-Aware Updating

Updating failover clusters with appropriate patching has long been a challenge for enterprise administrators. Windows Server 2012 helps to solve this issue. Cluster-Aware Updating (CAU) enables you to automatically update a failover cluster while maintaining a high level of service

availability. It provides a major benefit to enterprise environments by helping to maintain security and performance across servers within a failover cluster. CAU provides increased uptime of high availability services, ease-of-maintenance of failover clusters, and reliability and consistency of IT processes.

CAU pauses a cluster node, moves roles from the cluster node, installs any required updates, performs a restart if necessary, brings the cluster node back online, and moves on to service the next cluster node. CAU manages the update process on the cluster nodes using an "Update Coordinator"—either a cluster node running Windows Server 2012 (for self-updating mode), or a remote computer running Windows Server 2012 or Windows 8.

CAU is integrated into the existing Windows Update management infrastructure. You can also extend and automate it with Windows PowerShell.

11. Windows PowerShell Support

In addition to the PowerShell cmdlets in Windows Server 2008 R2, there are numerous new Windows PowerShell cmdlets available with Windows Server 2012. There are over 150 built-in Hyper-V cmdlets for Windows PowerShell. These cmdlets enable you to perform administrative tasks in Hyper-V Manager and Failover Cluster Manager, as well as several tasks exclusively in Windows PowerShell.

The following table outlines some of the new cmdlets for Failover Clustering:

New Windows PowerShell cmdlets	Purpose
Add-ClusterCheckpoint Get-ClusterCheckpoint Remove-ClusterCheckpoint	Manage cluster registry checkpoints, including cryptographic checkpoints.
Add-ClusterScaleOutFileServerRole	Create a file server for scale-out application data.
Add-ClusterVMMonitoredItem Get-ClusterVMMonitoredItem Remove-ClusterVMMonitoredItem Reset-ClusterVMMonitoredState	Monitor the health of services that are running inside a virtual machine.

Update-ClusterNetworkNameResource	Update the private properties of a Network Name resource.
	This also sends Domain Name System (DNS) updates.
Test-ClusterResourceFailure	Replace the Fail-Cluster Resource cmdlet.

12. Failover Cluster Scalability

In Windows Server 2012, you can use Failover Cluster Manager to manage high-performance, large-scale clustered virtual machines in your environments. You have access to enhanced functionality that allows you to search, filter, and create custom views to manage your clustered virtual machines or other clustered roles.

Windows Server 2012 also allows you to select multiple virtual machines, and then perform most needed operation across them—including live migration, save, shutdown, or start. This saves a great deal of time and extra effort. Additionally, you can view and configure clustered virtual machine settings and live migration queuing operations—and quickly perform live migrations.

In Windows Server 2012, failover clusters have been enhanced in scalability to include the following:

- Support for up to 64 physical nodes and up to 8,000 virtual machines per cluster (compared with 16 physical nodes and 1,000 virtual machines in Windows Server 2008 R2).
- Cluster integration with Windows Server 2012 Server Manager to discover and manage all the nodes of the cluster.
- Features for controlling the cluster management of virtual machines and other clustered roles, including the following:
 - Live migration of virtual machine storage (also known as storage migration).
 - Ability to assign priority and preemption settings to virtual machines.
 - Support for Hyper-V Replica (which provides automated replication of virtual machines between server, clusters, and data centers).
 - NUMA-aware virtual machine placement.

- Ability to queue live migrations and provide concurrent live migrations for virtual machines.
- Policies to fail back clustered roles to a node following maintenance operations.

13. Cluster Shared Volumes

The Cluster Shared Volumes (CSV) feature provides greater security and performance for your highly available applications or workloads. It was first introduced in Windows Server 2008 R2 and provides a distributed file access solution in which multiple nodes in a failover cluster can simultaneously access the same file system. Although not just for virtual machines, CSV simplifies the configuration and operation of virtual machines. It has now been improved for greater security and performance. Using CSV, multiple clustered virtual machines can use the same disk and still be able to live migrate from node to node independently of one another.

CSV delivers many advantages, including the following:

- Multiple virtual machines can share the same volume, so that each virtual machine can fail over, or be moved or migrated, independently of other virtual machines.
- CSV volumes do not need to be assigned a drive letter, so you are not restricted by the number of available drive letters.
- CSV allows you to make better use of your existing disk space because you do not need to place your virtual hard disk (VHD) files on a separate disk. Traditionally, you could have wasted space from setting up multiple disks to accommodate multiple virtual machines.
- CSV allows you to simplify configuration and management tasks because there are fewer disks required for hosting VHDs.

Windows Server 2012 provides several enhancements to CSV architecture and functionality. There is a new NTFS-compatible file system, known as the Cluster Shared Volume File System (CSVFS). CSV volumes now appear as CSV File System (CSVFS) instead of NTFS so that applications can discover that they are running on a CSV. However, the underlying technology is still the NTFS file system, and volumes are still formatted with NTFS.

Windows Server 2012 also provides support for Server Message Block (SMB) 3.0 file-based storage, which can be used for Hyper-V and applications such as Microsoft SQL Server. The SMB protocol is a network file sharing protocol and is known as Microsoft SMB protocol in the Microsoft implementation (it is also referred to as the Common Internet File System (CIFS)).

In Windows Server 2012, SMB 3.0 is a major functionality for inclusion in failover cluster environments. You can store virtual machine files (configuration files, virtual hard disk files, and snapshots) on file servers using SMB 3.0. This is supported for clustered servers running Hyper-V where file storage is used as shared storage for the failover cluster.

Using the new features for Cluster Shared Volumes, you can provide easier CSV setup, broader workload support, enhanced security and performance, and greater file system availability.

14. Security and Encryption

In Windows Server 2012, Failover Clustering supports BitLocker Drive Encryption for both traditional clustered disks and CSV volumes. Within the failover cluster, each node performs decryption by using the computer account for the cluster itself. This account is also called the cluster name object (CNO).

When you increase security in this way, there is very minor impact to performance when using BitLocker encrypted cluster disks.

Using BitLocker for volume-level encryption in a failover cluster helps ensure that you deliver a more secure and highly available enterprise deployment. It is a critical component for any organization and for the cloud.

In Windows Server 2012, CSV has also been enhanced to integrate with SMB Multichannel. SMB Multichannel provides better throughput and redundant paths for the server running Hyper-V (or another server) to the storage on a remote SMB 3.0 share. If network path failures occur, they are automatically and transparently handled without application service disruption.

CSV traffic can also stream across multiple networks, which delivers improved I/O performance when in redirected mode. CSV also leverages SMB Direct (SMB over Remote Direct Memory Access (RDMA)), but note that this requires a network adapter that supports RDMA.

15. Backup with Cluster Shared Volumes

In Windows Server 2012, Clustered Shared Volumes helps you achieve an efficient backup experience for both backup applications and backup requestors. CSV now includes:

- Distributed CSV backup infrastructure for software snapshots and coordination of CSV snapshot creation.
- Support for parallel backups across CSV volumes and across cluster nodes.
- Application-consistent and crash-consistent Volume Shadow Copy Service (VSS) snapshot support with a full feature set.
- Increased support for both hardware and software backup of CSV volumes.
- Full compatibility support for requestors that are running Windows Server 2008 R2.
- Direct I/O mode for snapshot and backup operations.
- Support for using Windows Server Backup for CSVs.
- Support for incremental backups.
- Support for incremental backup of virtual hard disks while the virtual machine is running (with Hyper-V). During each incremental backup, only the differences are backed up.

16. Windows Server Component Architecture Posters

If you want to reference the previous component architecture posters that relate to Hyper-V in Windows Server 2008 R2, please see the following links.

[Windows Server 2008 R2: Hyper-V Component Architecture](#)

This poster provides a visual reference for understanding key Hyper-V technologies in Windows Server 2008 R2. It focuses on architecture, snapshots, live migration, virtual networking, storage, and import/export.



You can use this poster in conjunction with the previously published [Windows Server 2008 Feature Components poster](#) and [Windows Server 2008 R2 Feature Components poster](#).

[Windows Server 2008 R2 Hyper-V Component Architecture \(Service Pack 1\)](#)

This poster provides a visual reference for understanding key Hyper-V technologies in Windows Server 2008 R2 with Service Pack 1. It focuses on architecture, snapshots, live migration, virtual networking, storage, RemoteFX, and Dynamic Memory.



You can use this poster in conjunction with the Windows Server 2008 and Windows Server 2008 R2 component posters.

[Windows Server 2008 R2 Feature Components Poster](#)

This poster provides a visual reference for understanding key technologies in Windows Server 2008 R2. It focuses on Active Directory

Domain Services, Hyper-V, Internet Information Services, Remote Desktop Services (including Virtual Desktop Infrastructure (VDI)), BranchCache, and DirectAccess technologies. In addition, updates to core file services and server management are illustrated.



You can use this poster in conjunction with the Windows Server 2008 and Windows Server 2008 R2 component posters.

[Remote Desktop Services Component Architecture Poster](#)

This poster provides a visual reference for understanding key Remote Desktop Services technologies in Windows Server 2008 R2. It explains the functions and roles of Remote Desktop Session Host, Remote Desktop Virtualization Host, Remote Desktop Connection Broker, Remote Desktop Web Access, Remote Desktop Gateway, Remote Desktop Licensing, and RemoteFX.



You can use this poster in conjunction with the Windows Server 2008 and Windows Server 2008 R2 component posters.