Windows Server 2008 R2 : Hyper-V Component Architecture

Architecture

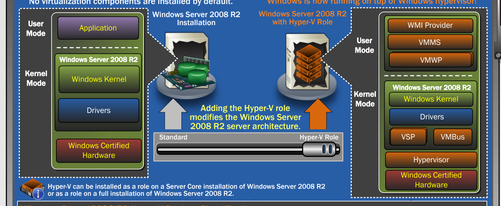
How Installing the Hyper-V Role Changes Architecture

You can install Hyper-V as a role in Windows Server 2008 R2. It installs all the components of the Hyper-V technology, including the remote management tools. Hyper-V introduces architectural changes to Windows Server 2008 R2.

Windows Server 2008 R2 Installation | **Windows Server 2008 R2 with Hyper-V Role**

No virtualization components are installed by default.

Windows is now running on top of Windows Hypervisor!



Hyper-V can be installed as a role on a Server Core installation of Windows Server 2008 R2 or as a role on a full installation of Windows Server 2008 R2.

Windows Server 2008 R2 Hyper-V Product Classification

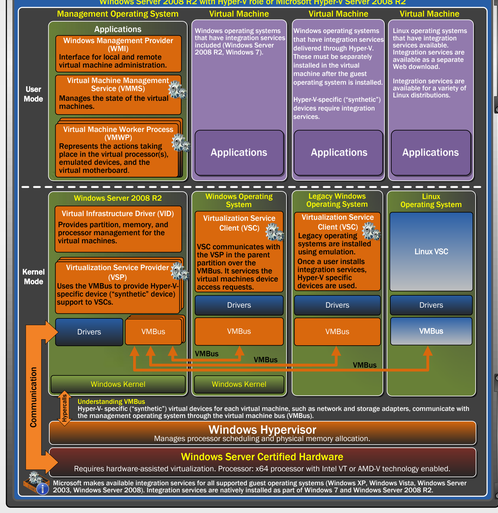
Windows Server 2008 R2 includes a hypervisor-based server virtualization technology that can be installed as a role in Windows Server 2008 R2.

Microsoft Hyper-V Server 2008 R2 is a stand-alone server virtualization product. It includes the Windows hypervisor, the Windows Server driver model, and virtualization components.

Windows Server 2008 R2 Detailed Hyper-V Architecture

When the Hyper-V role is added to Windows Server 2008 R2, Windows hypervisor takes control of the physical computer and creates partitions. The parent partition becomes a special virtual machine that runs the management operating system (Windows Server 2008 R2), which you use to manage virtual machines. You can create virtual machines that run guest operating systems in the child partitions.

Windows Server 2008 R2 with Hyper-V role or Microsoft Hyper-V Server 2008 R2



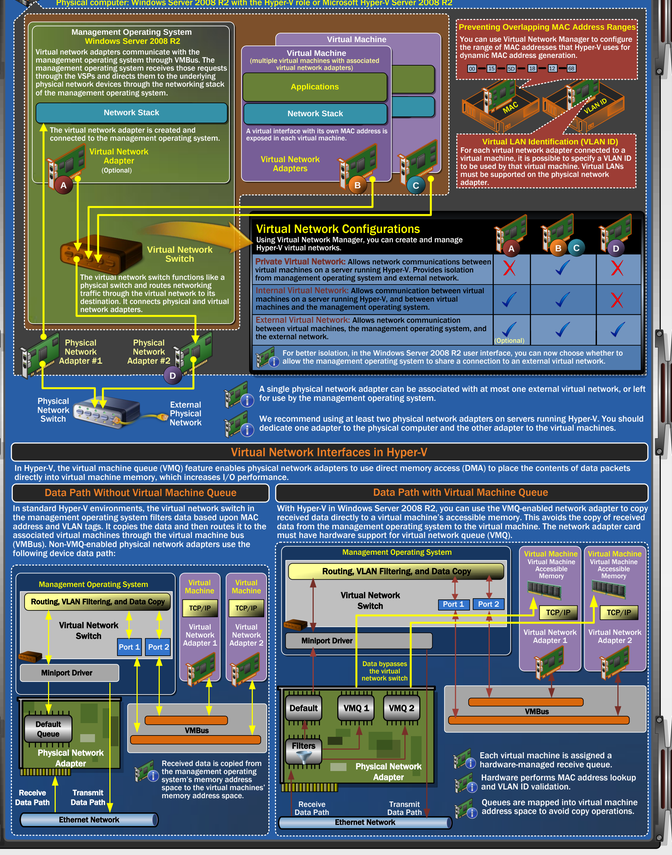
Microsoft makes available integration services for all supported guest operating systems (Windows XP, Windows Vista, Windows Server 2003, Windows Server 2008). Integration services are natively installed as part of Windows 7 and Windows Server 2008 R2.

Virtual Networking

Virtual Network Architecture

Hyper-V supports three types of virtual networks: private virtual networks, internal virtual networks, and external virtual networks. The virtual network switch forms the center of all Hyper-V virtual networks. It never appears as a physical entity—it is a software representation.

Physical computer: Windows Server 2008 R2 with the Hyper-V role or Microsoft Hyper-V Server 2008 R2



Virtual Network Configurations

Using Virtual Network Manager, you can create and manage Hyper-V virtual networks.

	A	B	C	D
Private Virtual Network: Allows network communications between virtual machines on a server running Hyper-V. Provides isolation from management operating system and external network.	X	✓	✓	X
Internal Virtual Network: Allows communication between virtual machines on a server running Hyper-V, and between virtual machines and the management operating system.	✓	✓	✓	X
External Virtual Network: Allows network communication between virtual machines, the management operating system, and the external network.	✓ (Optional)	✓	✓	✓

For better isolation, in the Windows Server 2008 R2 user interface, you can now choose whether to allow the management operating system to share a connection to an external virtual network.

A single physical network adapter can be associated with at most one external virtual network, or left for use by the management operating system.

We recommend using at least two physical network adapters on servers running Hyper-V. You should dedicate one adapter to the physical computer and the other adapter to the virtual machines.

Virtual Network Interfaces in Hyper-V

In Hyper-V, the virtual machine queue (VMQ) feature enables physical network adapters to use direct memory access (DMA) to place the contents of data packets directly into virtual machine memory, which increases I/O performance.

Data Path Without Virtual Machine Queue

In standard Hyper-V environments, the virtual network switch in the management operating system filters data based upon MAC address and VLAN tags. It copies the data and then routes it to the associated virtual machines through the virtual machine bus (VMBus). Non-VMQ-enabled physical network adapters use the following device data path:

Received data is copied from the management operating system's memory address space to the virtual machines' memory address space.

Data Path with Virtual Machine Queue

With Hyper-V in Windows Server 2008 R2, you can use the VMQ-enabled network adapter to copy received data directly to a virtual machine's accessible memory. This avoids the copy of received data from the management operating system to the virtual machine. The network adapter card must have hardware support for virtual network queue (VMQ).

Each virtual machine is assigned a hardware-managed receive queue.

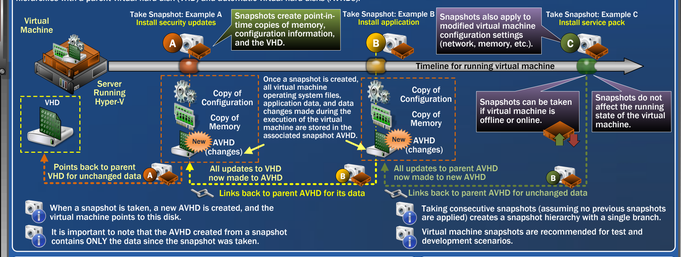
Hardware performs MAC address lookup and VLAN ID validation.

Queues are mapped into virtual machine address space to avoid copy operations.

Virtual Machine Snapshots

Virtual Machine Snapshots

Snapshots are read-only, "point-in-time" images of a virtual machine. You can capture the configuration and state of a virtual machine at any point in time, and return the virtual machine to that state with minimal interruption. Multiple snapshots can be created, deleted, and applied to virtual machines. Snapshots form parent-child hierarchies with a parent virtual hard disk (VHD) and automatic virtual hard disks (AVHDs).



When a snapshot is taken, a new AVHD is created, and the virtual machine points to this disk.

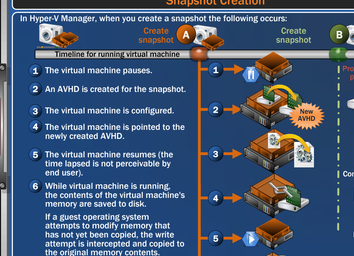
It is important to note that the AVHD created from a snapshot contains ONLY the data since the snapshot was taken.

Taking consecutive snapshots (assuming no previous snapshots are applied) creates a snapshot hierarchy with a single branch.

Virtual machine snapshots are recommended for test and development scenarios.

Snapshot Creation

In Hyper-V Manager, when you create a snapshot the following occurs:

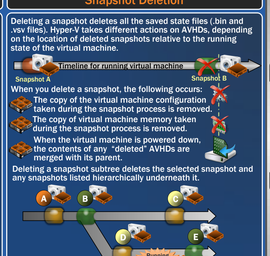


1. The virtual machine pauses.
2. An AVHD is created for the snapshot.
3. The virtual machine is configured.
4. The virtual machine is pointed to the newly created AVHD.
5. The virtual machine resumes (the time lapsed is not perceivable by end user).
6. While virtual machine is running, the contents of the virtual machine's memory are saved to disk.
   If a guest operating system attempts to modify memory that has not yet been copied, the write attempt is intercepted and copied to the original memory contents.
7. When the snapshot is completed, the virtual machine configuration file, the virtual machine saved state files, and the snapshot (AVHD) are stored in a folder under the virtual machine's snapshot directory.

For a virtual machine without snapshots, all changes made to the guest operating system files, application files, and data are applied to the VHDs associated with the virtual machine.

Snapshot Deletion

Deleting a snapshot deletes all the saved state files (.bin and .vsv files). Hyper-V takes different actions on AVHDs, depending on the location of deleted snapshots relative to the running state of the virtual machine.



When you delete a snapshot, the following occurs:

- The copy of the virtual machine configuration taken during the snapshot process is removed.
- The copy of virtual machine memory taken during the snapshot process is removed.
- When the virtual machine is powered down, the contents of any "deleted" AVHDs are merged with its parent.

Deleting a snapshot subtree deletes the selected snapshot and any snapshots listed hierarchically underneath it.

B — Deleting a snapshot between the first snapshot and the running state of the virtual machine preserves AVHDs. When the virtual machine is shut down, the data in the AVHDs is merged with the parent.

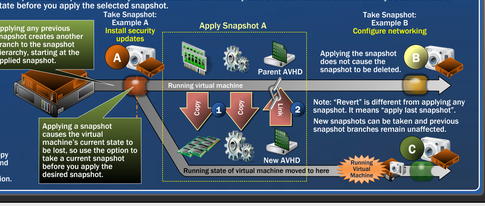
E — If the deleted snapshot exists on a different branch or the same branch but at a point in time after the running state of the virtual machine, then the AVHD is deleted immediately.

Applying Virtual Machine Snapshots

Applying a snapshot to a virtual machine basically means copying the complete virtual machine state from the selected snapshot to the active virtual machine. This effectively returns your current working state to the previous snapshot state. Any unsaved data in the currently active virtual machine will be lost if you do not take a new snapshot of the current virtual machine state before you apply the selected snapshot.

When you apply a snapshot of a running virtual machine, the following occurs:

1. The virtual machine saved state files (.bin, .vsv) are copied.
2. A new AVHD is created, and then linked to the parent AVHD.



Note: "Revert" is different from applying any snapshot. It means "apply last snapshot."

New snapshots can be taken and previous snapshot branches remain unaffected.

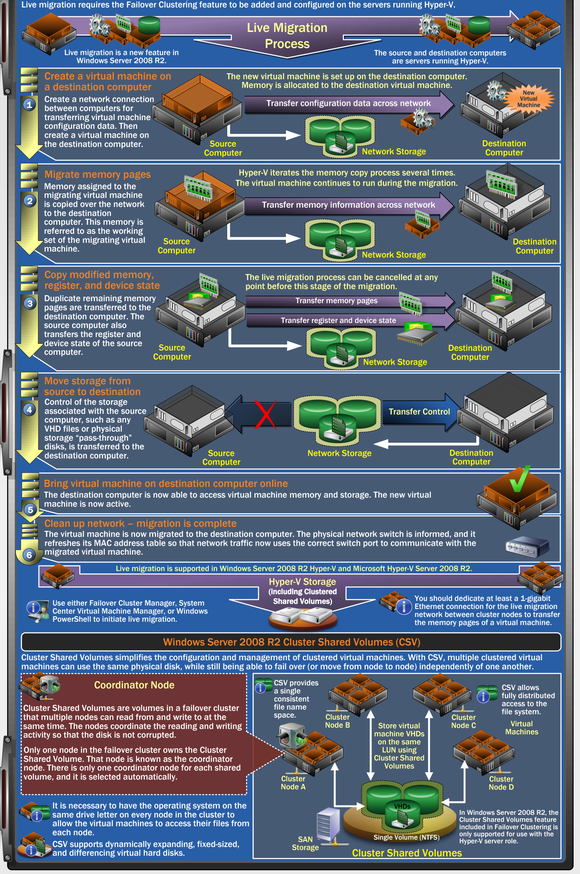
When a snapshot is applied, the original snapshot remains and is not modified when applied.

Snapshots should NOT be used as a substitute for backups because virtual machine snapshots are not the same as backups created by a Volume Shadow Copy Service (VSS) writer. We do not recommend using virtual machine snapshots as a permanent data or system recovery solution.

Live Migration

Live Migration Operations

With live migration, you can move a running virtual machine from one physical server to another without interruption of service. Live migration requires the Failover Clustering feature to be added and configured on the servers running Hyper-V.



Windows Server 2008 R2 Cluster Shared Volumes (CSV)

Cluster Shared Volumes simplifies the configuration and management of clustered virtual machines. With CSV, multiple clustered virtual machines can use the same physical disk, while still being able to fail over (or move from node to node) independently of one another.

Coordinator Node

Cluster Shared Volumes are volumes in a failover cluster that multiple nodes can read from and write to at the same time. The nodes coordinate the reading and writing activity so that the disk is not corrupted.

Only one node in the failover cluster owns the Cluster Shared Volume. That node is known as the coordinator node. There is only one coordinator node for each shared volume, and it is selected automatically.

It is necessary to have the operating system on the same drive letter on every node in the cluster to allow the virtual machines to access their files from each node.

CSV supports dynamically expanding, fixed-sized, and differencing virtual hard disks.

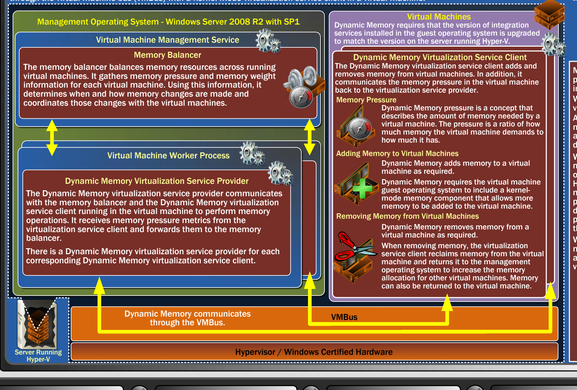
In Windows Server 2008 R2, the Cluster Shared Volumes feature included in Failover Clustering is only supported for use with the Hyper-V server role.

Dynamic Memory Architecture and Configuration

New in Windows Server 2008 R2 SP1

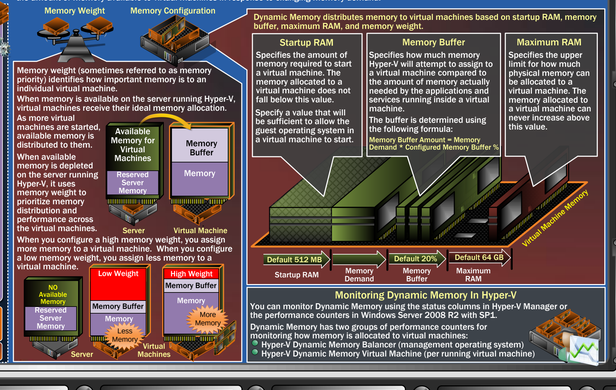
Dynamic Memory Architecture (Windows Server 2008 R2 SP1)

Dynamic Memory is implemented in the management operating system using a user-mode virtualization service provider that communicates through the virtual machine bus (VMBus) with a kernel-mode virtualization service client in a virtual machine.



Dynamic Memory Configuration (Windows Server 2008 R2 SP1)

Dynamic Memory is a new Hyper-V feature in Windows Server 2008 R2 Service Pack 1 (SP1). It enables servers running Hyper-V to dynamically adjust the amount of memory available to virtual machines in response to changing memory demand.



Monitoring Dynamic Memory In Hyper-V

You can monitor Dynamic Memory using the status columns in Hyper-V Manager or the performance counters in Windows Server 2008 R2 with SP1.

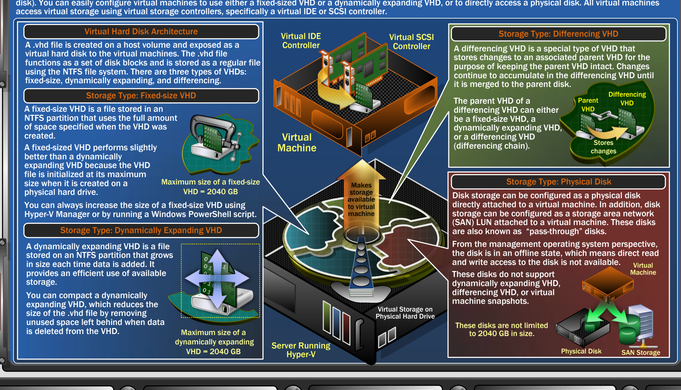
Dynamic Memory has two groups of performance counters for monitoring how memory is allocated to virtual machines:

- Hyper-V Dynamic Memory Balancer (management operating system)
- Hyper-V Dynamic Memory Virtual Machine (per running virtual machine)

Storage Types

Hyper-V Disk Storage Types

For data storage, virtual machines use either a virtual hard disk (VHD) or a physical disk that is directly attached to a virtual machine (also known as a "pass-through" disk). You can easily configure virtual machines to use either a fixed-sized VHD or a dynamically expanding VHD, or to directly access a physical disk. All virtual machines access virtual storage using virtual storage controllers, specifically a virtual IDE or SCSI controller.



Virtual Hard Disk Architecture

A .vhd file is created on a host volume and exposed as a virtual hard disk to the virtual machines. The .vhd file functions as a set of disk blocks and is stored as a regular file using the NTFS file system. There are three types of VHDs: fixed-size, dynamically expanding, and differencing.

Storage Type: Fixed-size VHD

A fixed-size VHD is a file stored on an NTFS partition that uses the full amount of space specified when the VHD was created.

A fixed-sized VHD performs slightly better than a dynamically expanding VHD because the VHD file is initialized at its maximum size when it is created on a physical hard drive.

Maximum size of a fixed-size VHD = 2040 GB

You can always increase the size of a fixed-size VHD using Hyper-V Manager or by running a Windows PowerShell script.

Storage Type: Dynamically Expanding VHD

A dynamically expanding VHD is a file stored on an NTFS partition that grows in size each time data is added. It provides an efficient use of available storage.

You can compact a dynamically expanding VHD, which reduces the size of the .vhd file by removing unused space left behind when data is deleted from the VHD.

Maximum size of a dynamically expanding VHD = 2040 GB

Storage Type: Differencing VHD

A differencing VHD is a special type of VHD that stores changes to an associated parent VHD for the purpose of keeping the parent VHD intact. Changes continue to accumulate in the differencing VHD until it is merged to the parent disk.

The parent VHD of a differencing VHD can either be a fixed-size VHD, a dynamically expanding VHD, or a differencing VHD (differencing chain).

Differencing VHD — Parent VHD — Stores changes

Storage Type: Physical Disk

Disk storage can be configured as a physical disk directly attached to a virtual machine. In addition, disk storage can be configured as a storage area network (SAN) LUN attached to a virtual machine. These disks are also known as "pass-through" disks.

From the management operating system perspective, the disk is in an offline state, which means direct read and write access to the disk is not available.

These disks do not support dynamically expanding VHD, differencing VHD, or virtual machine snapshots.

These disks are not limited to 2040 GB in size.

Hyper-V with RemoteFX

New in Windows Server 2008 R2 SP1

Hyper-V Architecture with RemoteFX Components (Windows Server 2008 R2 SP1)

Microsoft RemoteFX™ is a LAN-based, server-side rendering graphics feature that delivers a rich user experience to virtual machines. It virtualizes and shares the graphics processing unit (GPU). RemoteFX is a new feature in Windows Server 2008 R2 Service Pack 1 (SP1).

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