

Hyper-V

Microsoft Hyper-V

<u>Developer(s)</u>	<u>Microsoft</u>
Initial release	July 26, 2008 (KB950050) ^{<u>[1]</u>^{<u>[2]</u>}}
<u>Stable release</u>	R2 Service Pack 1 (KB976932) ^{<u>[3]</u>^{<u>[4]</u>}} / March 15, 2011; 15 months ago
<u>Operating system</u>	Windows 8 (both its server and client versions) (future) and Windows Server 2008 or standalone
<u>Type</u>	<u>Virtual machine</u>
<u>License</u>	<u>Proprietary</u>

Microsoft Hyper-V

- Microsoft **Hyper-V**,
 - ◆ codenamed **Viridian**
 - ◆ and formerly known as **Windows Server Virtualization**,
 - ◆ **is a hypervisor-based virtualization system for x86-64 systems**
- A **beta version of Hyper-V** was shipped with certain x86-64 editions of Windows Server 2008, and the finalized version (automatically updated through Windows Update) was released on June 26, 2008
- **Hyper-V has since been released in a free stand-alone version**, and has been upgraded to **Release 2 (R2)** status

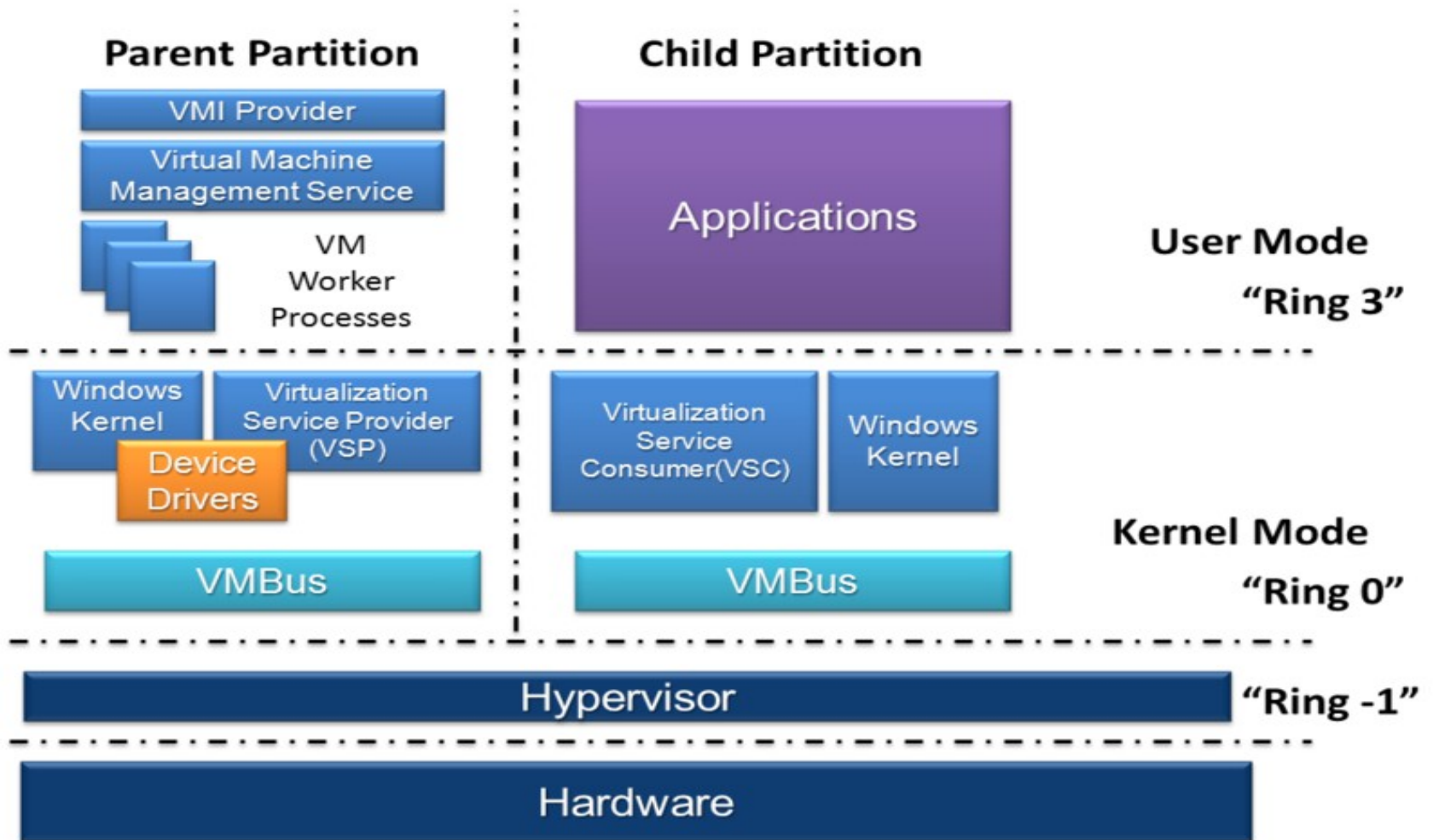
Versions and variants

- **Hyper-V exists in two variants:**
 - ◆ as a stand-alone product called Microsoft Hyper-V Server 2008 (Hyper-V Server 2008 R2 for the second release),
 - ◆ and as an installable role in Windows Server 2008 R2 and Windows Server 2008 (the former containing the later release of Hyper-V).
- **The stand-alone version of Hyper-V is free**, and was released on October 1, 2008.
- It is a variant of the core installation of Windows Server 2008 that includes full Hyper-V functionality; other Windows Server 2008 roles are disabled, and there are limited Windows Services.
- The **free Hyper-V Server 2008 variant is limited to a command line interface (CLI)**, where configuration of the "Host" or "Parent" (Hyper-V Server 2008) OS, physical hardware and software is done using shell commands.
- A new menu driven CLI interface does simplify initial configuration considerably, and some freely downloadable script files extend this concept.
- Administration and configuration of the "Host" (Hyper-V Server 2008 OS) and the "guest" or virtual OSes is generally done by downloading extended Microsoft Management Consoles that are installed onto a Windows 7 PC or Windows 2008 Server (32 or 64 bit) or System Center Virtual Machine.

Versions and variants

- Alternatively, another Windows Server 2008 computer, **with the Hyper-V role installed**, can be used to manage Hyper-V Server 2008 by redirecting the management console.
- **Other administration** and configuration of Hyper-V Server 2008 can be done using a Remote Desktop RDP session (though still CLI) or redirected standard management consoles (MMC) such as "Computer Management" and "Group Policy (Local)" from a Vista PC or a full installation of Windows 2008 Server.
- **This allows much easier "point and click" configuration**, and monitoring of the Hyper-V Server 2008.
- Hyper-V Server Release 2 (R2) was made available in September 2009, its main feature being the inclusion of Windows Powershell v2 for greater CLI control, and the updated Windows Server 2008 R2 code base.

Architecture



Hyper-V architecture

- **Hyper-V supports isolation in terms of a *partition*.** A partition is a logical unit of isolation, supported by the hypervisor, in which operating systems execute. A hypervisor instance has to have at least one ***parent partition***, running a supported version of Windows Server (2008, 2008 R2, or 2012).
- The **virtualization stack runs in the parent partition and has direct access to the hardware devices.** The parent partition then creates the *child partitions* which host the guest OSs. A parent partition creates child partitions using the *hypercall* API, which is the application programming interface exposed by Hyper-V
- **A virtualized partition does not have access to the physical processor, nor does it handle its real interrupts.** Instead, it has a virtual view of the processor and runs in *Guest Virtual Address*, which, depending on the configuration of the hypervisor, might not necessarily be the entire virtual address space. A hypervisor could choose to expose only a subset of the processors to each partition.
- The **hypervisor handles the interrupts to the processor**, and redirects them to the respective partition using a logical *Synthetic Interrupt Controller (SynIC)*.
- **Hyper-V can hardware accelerate the address translation of Guest Virtual Address-spaces** by using second level address translation provided by the CPU, referred to as EPT on Intel and RVI (formerly NPT) on AMD.

Hyper-V architecture

- Child partitions **do not have direct access to hardware resources**, but instead have a virtual view of the resources, in terms of *virtual devices*. Any request to the virtual devices is redirected via the **VMBus** to the devices in the parent partition, which will manage the requests.
- The **VMBus is a logical channel** which enables inter-partition communication. The response is also redirected via the VMBus. If the devices in the parent partition are also virtual devices, it will be redirected further until it reaches the parent partition, where it will gain access to the physical devices.
- Parent partitions run a **Virtualization Service Provider (VSP)**, which connects to the VMBus and handles device access requests from child partitions.
- Child partition virtual devices internally run a **Virtualization Service Client (VSC)**, which redirect the request to VSPs in the parent partition via the VMBus. This entire process is transparent to the guest OS.

Hyper-V architecture

- **Virtual devices** can also take advantage of a Windows Server Virtualization feature, named **Enlightened I/O, for storage, networking and graphics subsystems**, among others.
- Enlightened I/O is specialized virtualization-aware implementation of high level communication protocols like SCSI to take advantage of VMBus directly, that allows bypassing any device emulation layer.
- **This makes the communication more efficient**, but requires the guest OS to support Enlightened I/O.
- Windows Server 2008 R2, Windows Server 2008, Windows 7, Windows Vista, Red Hat Enterprise Linux, and SUSE Linux are currently the only operating systems that support Enlightened I/O, allowing them therefore to run faster as guest operating systems under Hyper-V than other operating systems that need to use slower emulated hardware.

System requirements / specifications

■ Host operating system:

- ❖ To install the Hyper-V role, Windows Server 2008 (64-bit only) or 2008 R2 Standard, Enterprise or Datacenter edition is required. Installation on the Web and/or Foundation editions is not possible; neither is it possible on 32-bit (x86-32) versions of Windows Server 2008 nor IA64 editions.
- ❖ It can be installed regardless of whether the installation is a full or core installation.

■ Processor:

- ❖ An x86-64 processor
- ❖ Hardware-assisted virtualization. This is available in processors that include a virtualization option; specifically, Intel VT or AMD Virtualization (AMD-V, formerly code-named "Pacifica").
- ❖ A NX bit-compatible CPU must be available and Hardware Data Execution Prevention (DEP) must be enabled.
- ❖ Although this is not an official requirement, Windows Server 2008 R2 and a CPU with Extended Page Table support are recommended for workstations

System requirements / specifications

■ Memory

- ❖ Minimum 2 GB. (Each virtual OS requires its own memory, and so realistically much more.)
- ❖ Windows Server 2008 Standard (x64) Hyper-V full GUI or Core supports up to 31 GB of memory for running VMs, plus 1 GB for the Hyper-V parent OS
- ❖ Maximum total memory per system for Windows Server 2008 R2 hosts: 32 GB (Standard) or 2 TB (Enterprise, Datacenter)

■ Guest operating systems

- ❖ Hyper-V supports virtual machines with up to 4 processors each (1, 2, or 4 processors depending on guest OS-see below)
- ❖ Hyper-V supports up to 384 VMs per system
- ❖ Hyper-V supports both 32-bit (x86) and 64-bit (x64) guest VMs

Microsoft Hyper-V Server

- The **stand-alone Hyper-V Server** variant does not require an existing installation of Windows Server 2008 nor Windows Server 2008 R2.
- The standalone installation **is called Microsoft Hyper-V Server for the non-R2 version** and Microsoft Hyper-V Server 2008 R2.
- Microsoft Hyper-V server is built with components of Windows and has a Windows Server Core user experience.
- **None of the other roles** of Windows Server are available in Microsoft Hyper-V Server.
- This version supports up to 64 VMs per system.
- **System requirements of Microsoft Hyper-V server** are the same for supported guest operating systems and processor, but differ in the following:
 - ✦ RAM: Minimum: 1 GB RAM; Recommended: 2 GB RAM or greater; Maximum 1 TB.
 - ✦ Available disk space: Minimum: 8 GB; Recommended: 20 GB or greater

Supported guests

- The following is a table of supported guest operating systems.
- Other guest operating systems such as Ubuntu Linux 6.06/6.10/7.10 or Fedora 8/9 are unsupported; however, they have been reported to run
- Desktop virtualization (VDI) products are available from third-party companies,
 - ◆ Quest Software vWorkspace,
 - ◆ Citrix XenDesktop,
 - ◆ Systancia AppliDis Fusion and
 - ◆ Ericom PowerTerm WebConnect,
- that provide the ability to host and centrally manage desktop virtual machines in the data center while giving end users a full PC desktop experience.

Supported guests

- **Guest operating systems with *Enlightened I/O*** and a hypervisor-aware kernel such as Windows Server 2008 and later server versions, Windows Vista SP1 and later clients and offerings from Citrix XenServer and Novell will be able to use the host resources better since VSC drivers in these guests communicate with the VSPs directly over VMBus.
- **Non-enlightened operating systems** will run with emulated I/O; however, *integration components* (which include the VSC drivers) are available for Windows Server 2003 SP2, Windows Vista SP1 and Linux to achieve better performance.
- **Xen-enabled Linux guest distributions** can also **be paravirtualized in Hyper-V**. Currently, only SUSE Linux Enterprise Server 10 SP1/SP2 x86 and x64 Editions are officially supported by Microsoft in this way, though any Xen-enabled Linux should be able to run.
- In February 2008, **Red Hat and Microsoft** signed a virtualization pact for hypervisor interoperability with their respective server operating systems, to enable Red Hat Enterprise Linux 5 to be officially supported on Hyper-V

Supported guests

Guest OS	Virtual processors	Edition(s)
Windows 7	1,2,3 or 4	Both x86-32 and x86-64 , all editions except home editions (the home editions are Home Premium, Home Basic, and Starter)
Windows Server 2008 R2	1,2,3 or 4	x64, Web, Standard, Enterprise, Datacenter
Windows Server 2008	1,2,3 or 4	Both x86 and x64, Web, HPC, Standard, Enterprise, Datacenter, with or without Hyper-V
Linux (only including SUSE Linux Enterprise Server 10 with SP3 or version 11, Red Hat Enterprise Linux versions 5.2-6.1 and CentOS 5.2-6.1)	1,2 or 4	Both x86 and x64
Windows Server 2003	1 or 2	Both x86 and x64, Standard, Enterprise, Datacenter, SP2 required
Windows Server 2003 R2	1 or 2	Web, Standard, Enterprise, Datacenter, both x86 and x64 except for Web whose 64-bit version is not supported
Windows 2000 Server	1	Server, Advanced Server, SP4 required
Windows Vista	1 or 2	Both x86 and x64, all editions except home editions
Windows XP	1 or 2	x86, Professional edition only, SP3 required (SP2 only supports 1 virtual CPU)
Windows XP x64 Edition	1 or 2	x64, Professional edition only, SP2 required
Windows Small Business Server 2011	1, 2 or 4	Essentials, Standard (Essentials supports only 2 virtual CPUs)
Windows Home Server 2011	1, 2 or 4	Standard
Windows Storage Server 2008 R2 Essentials	1, 2 or 4	Essentials
Others (any officially unsupported operating system)	1	N/A

Linux support

- In July 2009 Microsoft submitted **Hyper-V drivers to the kernel**, which **improve the performance of virtual Linux guest systems** in a Windows hosted environment.
- Microsoft was forced to submit the code when it was discovered that **Microsoft had incorporated a Hyper-V network driver with GPL-licensed components statically linked to closed-source binaries**.
- Hyper-V provides basic virtualization support for Linux guests out of the box. Paravirtualization support is, however, available by installing the Linux Integration Components or Satori InputVSC drivers.
- On July 20, 2009, **Microsoft submitted these drivers for inclusion in the Linux kernel under the terms of the GPL**, so that kernels from 2.6.32 may include inbuilt Hyper-V paravirtualization support

VHD compatibility with Virtual Server 2005 and Virtual PC 2004/2007

- Hyper-V, like Virtual Server 2005 and Virtual PC 2004/2007, saves each guest OS to a single virtual hard disk file with the extension .VHD
- This file contains the entire guest OS, though other files can also be configured to allow "undo information" etc.
- Older .vhd files from Virtual Server 2005 and Virtual PC 2004/2007 can be copied and used by Hyper-V, but the old "Virtual Machine add-ons" require removing prior to migration.
- After the migrated guest OS is configured and started using Hyper-V, the guest OS will detect changes to the (virtual) hardware.
- Installing "Hyper-V Integration Services" installs five services to improve performance, at the same time adding the new Guest Video and Network Card drivers. Consequently later versions of Windows may require re-activation. Virtual Server 2005 R2 SP1 supports guest operating systems OS/2 4.5 and Solaris 10 while Hyper-V does not.

Limitations

■ USB passthrough

- Hyper-V **does not support virtualized USB ports or COM ports**. This fact makes it very inconvenient to run software protected by dongles in the guest. However, a workaround to access USB drives in Windows guest VMs involves using the **Microsoft Remote Desktop Client** to "share" host drives with guests over a Remote Desktop Connection
- Other techniques exist to allow USB utilization, an example would be using a **network-to-USB device (USB over IP)**, a **Digi AnywhereUSB** or **free USBIP**.

■ Audio

- **Audio hardware is not virtualized by Hyper-V** although the above Remote Desktop workaround may be used.

■ Optical drives pass-through

- Optical drives virtualized in the guest VM are read-only. Hyper-V does not support the host/root operating system's optical drives to pass-through in guest VMs. **As a result, burning to discs**, audio CDs, video CD/DVD-Video playback **are not supported**.

Limitations

- **Graphics issues on the host**
- **On CPUs without Second Level Address Translation**, installation of most WDDM accelerated graphics drivers on the primary OS will cause a dramatic **drop in graphic performance**. This occurs because the graphics drivers access memory in a pattern that causes the Translation lookaside buffer to be flushed frequently
- **In Windows Server 2008**, Microsoft officially supported Hyper-V only with the **default VGA drivers**, which do not support Windows Aero, higher resolutions, rotation, or multi-monitor display. However, unofficial workarounds were available in certain cases. Older non-WDDM graphics drivers sometimes did not cause performance issues, though these drivers did not always install smoothly on Windows Server. Intel integrated graphics cards did not cause TLB flushing even with WDDM drivers. Some NVidia graphics drivers did not experience problems so long as Windows Aero was turned off and no 3D applications were running
- In Windows Server 2008 R2, **Microsoft added support for Second Level Address Translation to Hyper-V**. Since SLAT is not required to run Hyper-V with Windows Server, the problem will continue to occur if a non-SLAT CPU is used with accelerated graphics drivers. However, SLAT is required to run Hyper-V on client versions of Windows 8

Limitation - Live migration

- Hyper-V in Windows Server 2008 (not R2) **does not support "live migration"** of guest VMs (where "live migration" is defined as maintaining network connections and uninterrupted services during VM migration between physical hosts). Instead, Hyper-V on Server 2008 Enterprise and Datacenter Editions supports "quick migration", where a guest VM is suspended on one host and resumed on another host. This operation happens in the time it takes to transfer the active memory of the guest VM over the network from the first host to the second host
- **However, with the release of Windows Server 2008 R2, Live Migration is supported with the use of Cluster Shared Volumes (CSVs).** This allows for failover of an individual VM as opposed to the entire host having to failover (it seems that when a node (Hyper-V server, not a VM) fails then each "VM running on the failed node" may migrate to other live nodes independently of "other VMs on the same LUN running on other nodes that share the LUN with the failed node". In Hyper-V we are clustering the Hyper-V nodes not the VMs.). See also Cluster Shared Volumes
- **Windows Server 2012's implementation of Hyper-V supports live migration in the form of "shared nothing live migration".** With shared nothing live migration it is possible to migrate a running virtual machine from one Hyper-V host to another Hyper-V host (assuming adequate Windows permissions) without shutting down the VM, or without losing network connectivity to the VM.

Limitations

- **Degraded performance for Windows XP VMs**
- 32-bit Windows XP guests running on Hyper-V experience degraded CPU and I/O performance because the Windows XP kernel frequently accesses the CPU APIC's *Task Priority Register* (TPR) which Hyper-V intercepts putting more overhead on the hypervisor.
- While there is no resolution for this issue, some Intel CPUs include a technology called vTPR which works around this issue. AMD CPUs have a software workaround. 32-bit and 64-bit editions of Windows Server 2003, Windows XP x64 Edition and Windows Vista and later Windows versions are not affected.
- **NIC teaming**
- Network card teaming or link aggregation is only supported if the NIC manufacturer supplied drivers support NIC teaming
- **No Support For Windows Home Editions**
- The management tools for Hyper-V are not compatible with Windows Vista Home Basic or Windows Vista Home Premium. This is also the case for Windows 7 Home editions.

Future

- The Developer Preview of Windows Server 8 presented at the Microsoft Build Event contains the future version of Hyper-V. **Some of the new features are listed below**
 - ◆ Hyper-V Extensible Virtual Switch
 - ◆ Network virtualization
 - ◆ Multi-tenancy
 - ◆ NIC teaming as part of Windows Server 8 OS
 - ◆ Up to 160 logical processors per hypervisor instance
 - ◆ Up to 32 virtual processors per VM
 - ◆ Storage Resource Pools
 - ◆ .vhdx disk format supporting virtual hard disks as large as 16TB with power failure resiliency
 - ◆ Virtual Fibre Channel
 - ◆ Offloaded data transfer
 - ◆ Hyper-V replica
 - ◆ Cross-premise connectivity
 - ◆ Cloud backup
 - ◆ VMs can now access up to 512GB of memory each
 - ◆ Each hypervisor instance can now access up to 2TB of memory.
 - ◆ Up to 1024 total virtual processors per host
 - ◆ Up to 1024 active VMs per host
 - ◆ Up to 4000 active VMs per failover cluster
 - ◆ Shared nothing live migration

- The version of Hyper-V shipped with the client version of **Windows 8 requires a processor that supports SLAT and for SLAT to be turned on, while Windows Server 8 only requires it if the RemoteFX role is enabled**