Windows Server® 2008 Hyper-V™ Resource Kit

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This chapter contains an overview of the Hyper-V features available as a role in a full installation of Windows Server 2008, as a Server Core role, and in Microsoft Hyper-V Server 2008. In order to provide a robust virtualization platform that abstracts physical hardware dependencies and scales to support numerous concurrent workloads, Hyper-V is based on a hypervisor-based architecture that enables standard services and resources to create, manage, and execute virtual machines. Hyper-V offers a standard virtual hardware environment, virtual hard disks (VHD), and virtual networks that enable virtual machine execution, storage, and communications, respectively. Integration Services (IS) and Integration Components (IC) support critical processes and enhance the performance of virtual machines. Hyper-V Manager, a Microsoft Management Console (MMC) snap-in, is available to perform Hyper-V management and virtual machine configuration functions. The Hyper-V Manager provides a primary interface to create, inspect, and configure virtual machines, virtual hard disks, and virtual networks, as well as to assign virtual machine memory and processor allocations. Hyper-V properties are also modified through the Hyper-V Manager. Virtual Machine Connection (VMC) is integrated into the Hyper-V Manager to provide remote access to virtual machines from within the console and is also available as a stand-alone application. In addition, Hyper-V offers an extensive Windows Management Instrumentation (WMI) interface that you can leverage using various scripting and development languages, including PowerShell, to programmatically and remotely control the deployment, administration, and configuration of virtual machines.
Hyper-V Background

In February 2003, Microsoft entered the virtualization arena with the acquisition of Connectix software virtualization technology. In October 2004, Microsoft released Virtual Server 2005, an enterprise infrastructure virtualization solution for the x86 platform with support for 32-bit virtual machines. Virtual Server 2005 represents a hosted virtualization architecture because it runs in conjunction with a host Windows operating system and depends on it to arbitrate hardware resource access. In November 2005, Virtual Server 2005 Release 2 (R2) was released with several performance-enhancing features, as well as support for x64 host operating systems, iSCSI connectivity, Non-Uniform Memory Access (NUMA), Pre-Execution Environment (PXE) booting, and Virtual Server host clustering. The last major release, Virtual Server 2005 R2 Service Pack 1 (SP1), occurred in June 2007. In this release, Microsoft added support for Intel VT and AMD-V processors and provided the ability to control hardware virtualization on an individual virtual machine (VM) basis. Finally, in May 2008, an update was released (KB948515) to extend Virtual Server 2005 R2 SP1 support to Windows XP SP3, Windows Vista SP1, and Windows Server 2008, both as host and guest operating systems.

In parallel with Virtual Server 2005 R2 SP1, Microsoft worked on the development of its next generation enterprise virtualization product, Windows Server 2008 Hyper-V, released in June 2008. Figure 2-1 shows the basic Hyper-V architecture, which is based on a 64-bit microkernel hypervisor, the Windows Hypervisor. The Windows Hypervisor runs directly above the hardware, enables multiple operating systems to run concurrently within partitions, and ensures strong isolation between the partitions by enforcing access policies for critical system resources such as memory and processors. Unlike Windows operating systems such as Windows Server 2003 and earlier versions, the Windows Hypervisor does not contain any third-party device drivers or code, which minimizes its attack surface and provides a more secure architecture.

**NOTE** Based on the microkernel architecture of the Windows Hypervisor, including the fact that it does not encompass Windows drivers, the Windows Hypervisor is less than 1 megabyte (MB) in size.

In addition to the Windows Hypervisor, there are two other major elements in Hyper-V: a parent partition and child partitions. The parent partition is a special virtual machine that runs Windows Server 2008, controls the creation and management of child partitions, and maintains direct access to hardware resources. This requires that device drivers for physical devices be installed in the parent partition. Finally, the role of a child partition is to provide a virtual machine environment for the installation and execution of guest operating systems and applications.
Hyper-V allows high-speed communication between the parent and child partitions through the VMBus. The VMBus supports dedicated point-to-point channels for secure interpartition communications between Virtualization Service Providers (VSP) in the parent partition and Virtualization Service Clients (VSC) in the child partitions. VSPs are software components that manage input/output (I/O) requests from the VSCs in the virtual machines and channel the requests to physical hardware through the device drivers. VSCs are synthetic drivers, basically software components without physical counterparts that provide high-performance access to networking, video, storage, and human-interface devices in virtual machines. In the current release of Hyper-V, VSCs are available for a subset of Windows operating systems and for Suse Linux Enterprise Server 10, which has a Xen hypervisor-aware kernel. When running on Hyper-V, Suse Linux Enterprise Server 10 uses a Hypercall Adapter to translate Xen hypervisor calls (hypercalls) into Hyper-V hypervisor calls, enabling high-performance execution.

MORE INFO For a complete list of the Windows operating systems that support VSCs, refer to Chapter 5, “Hyper-V Advanced Features.”

Virtual machines that run guest operating systems without VSC support use emulation (or legacy) drivers to provide access to virtualized hardware devices. The parent partition monitors and intercepts I/O requests to virtualized hardware devices and channels the requests to physical hardware.
Hyper-V Core Features

Table 2-1 summarizes the basic features found in Windows Server 2008 Hyper-V editions and Hyper-V Server 2008. Hyper-V VMs support both 32-bit and 64-bit guest operating systems and the allocation of up to four virtual processors and 64 gigabytes (GB) of memory for Hyper-V servers running on Windows Server 2008 Enterprise or Datacenter edition. In its original release, Hyper-V supported 16 processor cores and 128 virtual machines. However, a subsequent update (KB956710) increased Hyper-V support to 24 logical processors and a maximum of 192 concurrent virtual machines.

**TABLE 2-1 Hyper-V Basic Features Comparison**

<table>
<thead>
<tr>
<th>FEATURES</th>
<th>MICROSOFT HYPER-V SERVER 2008</th>
<th>WINDOWS SERVER 2008 STANDARD</th>
<th>WINDOWS SERVER 2008 ENTERPRISE</th>
<th>WINDOWS SERVER 2008 DATACENTER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>x86 Support</strong></td>
<td>Guest OS Only</td>
<td>Guest OS Only</td>
<td>Guest OS Only</td>
<td>Guest OS Only</td>
</tr>
<tr>
<td><strong>x64 Support</strong></td>
<td>Host and Guest</td>
<td>Host and Guest</td>
<td>Host and Guest</td>
<td>Host and Guest</td>
</tr>
<tr>
<td><strong># of VMs—x64 Host</strong></td>
<td>192 (Max)</td>
<td>192 (Max)</td>
<td>192 (Max)</td>
<td>192 (Max)</td>
</tr>
<tr>
<td><strong>Host Memory Support</strong></td>
<td>32 GB</td>
<td>32 GB</td>
<td>1 terabyte</td>
<td>1 terabyte</td>
</tr>
<tr>
<td><strong>Host Processor Support</strong></td>
<td>24 Cores (Max) (See Note)</td>
<td>24 Cores (Max) (See Note)</td>
<td>24 Cores (Max) (See Note)</td>
<td>24 Cores (Max) (See Note)</td>
</tr>
<tr>
<td><strong>Virtual Networks</strong></td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>Unlimited</td>
</tr>
<tr>
<td><strong>Guest VM Memory</strong></td>
<td>32 GB (Max)</td>
<td>32 GB (Max)</td>
<td>64 GB (Max)</td>
<td>64 GB (Max)</td>
</tr>
<tr>
<td><strong>Guest Virtual Processor</strong></td>
<td>4 per VM</td>
<td>4 per VM</td>
<td>4 per VM</td>
<td>4 per VM</td>
</tr>
<tr>
<td><strong>Guest Virtual NICs</strong></td>
<td>4 Legacy 8 Synthetic</td>
<td>4 Legacy 8 Synthetic</td>
<td>4 Legacy 8 Synthetic</td>
<td>4 Legacy 8 Synthetic</td>
</tr>
<tr>
<td><strong>Guest Storage Adapters</strong></td>
<td>2 IDE 4 SCSI</td>
<td>2 IDE 4 SCSI</td>
<td>2 IDE 4 SCSI</td>
<td>2 IDE 4 SCSI</td>
</tr>
<tr>
<td><strong>Guest Storage Devices</strong></td>
<td>4 IDE 256 SCSI</td>
<td>4 IDE 256 SCSI</td>
<td>4 IDE 256 SCSI</td>
<td>4 IDE 256 SCSI</td>
</tr>
<tr>
<td><strong>Cluster Support</strong></td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Quick Migration</strong></td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Included Use Licenses</strong></td>
<td>None</td>
<td>1 Physical 1 VM</td>
<td>1 Physical 4 VM</td>
<td>1 Physical Unlimited VMs</td>
</tr>
</tbody>
</table>
**NOTE** If you are going to install and use Hyper-V on a physical server with 24 cores, you must download and install KB956710 for Windows Server 2008 Hyper-V from http://support.microsoft.com/kb/956710.

**IMPORTANT** The Windows license allows you to run one virtual machine in Windows Server 2008 Standard, four VMs in Windows Server 2008 Enterprise, and an unlimited number of VMs in Windows Server 2008 Datacenter. Because Microsoft Hyper-V Server 2008 is not a Windows edition, you do not receive any Windows licenses with it, and therefore you must have a valid Windows license for each Windows-based VM running on it.

### AMD-V and Intel VT Support

Hyper-V requires an x64 AMD-V or Intel VT processor that supports hardware-assisted virtualization and hardware-based Data Execution Prevention (DEP). You must ensure that both of these options are enabled in the Basic Input/Output System (BIOS), as they may be disabled by default. Specifically for DEP, you must enable the AMD No-Execute (NX) bit, or Intel Execute-Disable (XD) bit, which assists in preventing buffer overflow exploits. Other advantages of running on an AMD-V or Intel VT x64 platform include access to a larger address space and a higher partition density. Hyper-V does not support Itanium or x86-based systems.

**NOTE** You may have to shut down and restart after you enable the AMD NX of Intel XD bit on your physical system for the change to take effect.

### Full Installation and Server Core Installation Support

Hyper-V can be installed as a role in either a full installation or a Server Core installation of 64-bit Windows Server 2008 Standard, Enterprise, and Datacenter editions. In a full installation of Windows Server 2008, you can use the Initial Configuration Tasks or the Server Manager to add the Hyper-V role to your system. The Windows Hypervisor is present and enabled only after the Hyper-V role is installed on Windows Server 2008. Furthermore, when you select and add the Hyper-V role, all of the Hyper-V components are installed on your system. This also includes Hyper-V management tools such as the Hyper-V Manager MMC snap-in and the Virtual Machine Connection application, which allows you to remotely access virtual machines. Installing the Hyper-V role in a full installation of Windows Server 2008 requires that you restart the computer before it will boot the Windows Hypervisor.

Windows Server 2008 Server Core is a new feature that allows you to install a minimal server configuration that includes only the subset of binaries that are required to run one of the supported roles. A key advantage of Server Core is the reduction in operating system
maintenance (i.e., fewer updates) and management requirements based on the smaller number of files and services included in the installation.

There are nine Server Core roles: Hyper-V, File Services, Active Directory Domain Services, Active Directory Lightweight Directory Services, DHCP Server, DNS Server, Print Services, Streaming Media Services, and Web Server. The default management interface for a Windows Server 2008 Server Core installation is a command prompt, since it does not install the Explorer shell graphical user interface (GUI). Therefore, you must rely on command-line options to enable the Hyper-V role in a Server Core installation. However, a Windows Server 2008 Server Core installation can be managed remotely using the standard MMC tools from a server with a full installation of Windows Server 2008. You can also use the Remote Server Administration Tools (RSAT) to manage your Server Core installations from 32-bit and 64-bit editions of Windows Vista Business with Service Pack 1 (SP1), Windows Vista Enterprise with SP1, and Windows Vista Ultimate with SP1.

**NOTE** If you are going to install and use RSAT to manage a Windows Server 2008 Server Core installation, you must download and install KB941314 from http://support.microsoft.com/kb/941314.

**MORE INFO** For detailed installation procedures of the Hyper-V role in either a full installation or Server Core installation of Windows Server 2008, refer to Chapter 4, “Hyper-V Installation and Configuration.”

**Microsoft Hyper-V Server 2008**

Microsoft Hyper-V Server 2008 is a stand-alone product based on the same virtualization architecture available in Windows Server 2008 Hyper-V. However, it has been simplified and optimized to run Hyper-V only. Similar to a Server Core installation of Windows Server 2008, it provides only a command-line user interface and can be administered remotely using the Hyper-V management tools and RSAT.

Microsoft Hyper-V Server 2008 is available as a free download from the Microsoft Web site. It is a good choice for single virtualization host deployments that do not require enterprise-class features such as high availability, and for virtual machines that need less than 32 GB of memory. You may also want to consider using Windows Hyper-V Server 2008 in nonproduction, development, and test environments. There is no software upgrade path from Microsoft Hyper-V Server 2008 to Windows Server 2008 Hyper-V. However, virtual machines are compatible between the two products and can be migrated using Hyper-V virtual machine export and import features, which will be discussed later in this chapter.
Microsoft Hyper-V Server 2008 includes a command-line, menu-driven configuration tool called HVConfig.cmd to permit the configuration of basic connectivity and features required to use it in a managed environment. HVConfig.cmd supports the following configuration and actions:

- Domain or workgroup membership
- Computer name
- Network settings
- Local administrators
- Windows Update settings
- Download and install Windows Updates
- Remote Desktop
- Regional and language options
- Date and time
- Log Off User
- Restart Server
- Shut Down Server
- Exit To Command Line

HVConfig.cmd actually executes a Visual Basic Script file called HVConfig.vbs that contains all the functionality. HVConfig.cmd launches every time that you log on to the system.

**Access Control Using Authorization Manager**

Hyper-V leverages Authorization Manager (AzMan) to provide role-based access control to Hyper-V and virtual machines. This allows you to create job definitions and translate them into a role with a limited set of operations and tasks. You can assign individual users or groups to appropriate roles, allowing them to fulfill their job responsibilities while restricting their access to only the required Hyper-V resources, operations, and tasks.

**MORE INFO** For more details on how to use AzMan with Hyper-V and the types of roles that might be useful to define for Hyper-V and virtual machine management, refer to Chapter 6, “Hyper-V Security.”
Live Backup with Volume Shadow Copy Service

Volume Shadow Copy Service (VSS) support in Hyper-V provides stateful, host-side backups, eliminating the need to load an agent in each virtual machine. Any VSS-aware application, such as System Center Data Protection Manager (DPM) 2007 SP1, can leverage this functionality to provide VSS snapshot backup services if it utilizes the VSS writer interface implemented in Hyper-V. Any virtual machine running a VSS-aware guest Windows operating system (Windows Server 2003 and later) can be backed up in a live state. Any other guest operating system (Windows 2000, Linux, and so on) will need to be in saved state prior to the VSS snapshot. Because VSS snapshots are performed through an extremely fast process (they take seconds), virtual machine downtime is minimized. Additionally, with VSS support, the number of steps involved in archive or restore operations is reduced and the consistency of the data is ensured.

MORE INFO For more details on performing live backups using VSS, refer to Chapter 13, “Hyper-V Backup and Recovery.”

High Availability Using Failover Clustering

Hyper-V supports Windows Failover Clustering to implement a high-availability strategy that can manage both unplanned and planned downtime. There are two levels at which you can implement a failover cluster with Hyper-V: at the guest operating system level, and at the virtualization host level. A guest operating system failover cluster requires cluster-aware applications running in virtual machines. In addition, you have to run an operating system in the virtual machine that supports failover clustering, such as Windows Server 2003 (for up to an 8-node cluster) or Windows Server 2008 Enterprise or Datacenter edition (for up to a 16-node cluster). The second failover cluster option consists of two or more Windows Server 2008 Hyper-V servers, each configured as a cluster node. This type of configuration allows you to provide a high-availability solution for both non-cluster-aware guest operating systems and applications that run in virtual machines.

MORE INFO For more details on how to configure guest and host failover clusters, refer to Chapter 5.

Quick Migration

Hyper-V also supports Quick Migration, the ability to move a virtual machine across cluster nodes without data loss and with minimal service interruption. To accomplish this, a virtual machine is placed in saved state, active memory and processor state are captured to disk, and storage resources ownership is transferred to another node in the cluster. On the new
node, the virtual machine active memory and processor state are reloaded and processing is resumed. Depending on the underlying storage and the size of the state data, the entire process can take place in a matter of seconds or minutes.

**MORE INFO**  For more details on Quick Migration, refer to Chapter 14, “Server Migration Using System Center Virtual Machine Manager.”

### Integration Services

In Hyper-V, Integration Services (IS) provide support for five unique components that require a secure interface between a parent and child partition. These functions are:

- Time synchronization
- Heartbeat
- Shutdown
- Key/value pair exchange
- Volume Shadow Copy Service (VSS)

Integration Services target very specific areas that enhance the functionality or management of supported guest operating systems. In addition to these services, Integration Services provide the synthetic or high-performance drivers for networking, video, storage, and human-interface devices. If you install Windows Server 2008 in a virtual machine, the Integration Services are pre-installed. However, you should update them to the latest version. For other operating systems, you should install the Integration Services after the operating system installation is complete. It is important to note that only a subset of Integration Services may be supported for some legacy or non-Windows guest operating systems.

**MORE INFO**  For more details on Integration Services, refer to Chapter 3 and Chapter 5.

### Virtual Machine Import and Export

The import and export features in Hyper-V are meant to move and copy virtual machines between Hyper-V servers. These features do not provide a solution to export or import virtual machines between other virtualization applications like Virtual Server 2005 R2. In addition, you can export only a virtual machine that is in saved state or that is shut down.

### Virtual Hard Disk Management

Hyper-V provides several options to manage virtual hard disks (VHD), accessible through the Hyper-V Manager console. The VHD management options include:
- **Compact**  Provides the ability to shrink the size of a VHD by removing blank space that remains after data is deleted from the VHD file

- **Convert**  Provides the ability to transfer a dynamically expanding VHD to a fixed-size VHD or vice versa

- **Expand**  Provides the ability to increase the storage capacity of a dynamically expanding VHD or fixed-size VHD

- **Merge**  Provides the ability to combine the content of a child differencing disk with the parent differencing disk

- **Reconnect**  Provides the ability to reconnect a child differencing disk to the parent disk

The options that are available depend on the type of VHD that you select and also on the status of that VHD.

**MORE INFO**  For more details on the VHD management options, refer to Chapter 5.

### Virtual Machine Snapshots

The Hyper-V snapshot feature allows you to capture the configuration and state of a virtual machine at any particular point in time, and provides you with the ability to reload any existing snapshot within a matter of seconds. Hyper-V snapshots can be extremely useful in scenarios for which you need to make incremental changes to a virtual machine with the ability to roll back to a previous state. The Hyper-V snapshot feature is principally designed for use in test and development environments, not in a production infrastructure.

**MORE INFO**  For more details on virtual machine snapshots, refer to Chapter 5.

### Virtual Machine Connection

Virtual Machine Connection (VMC) is a remote administration tool provided with Hyper-V. VMC uses the Windows Remote Desktop Protocol to allow remote access to the guest operating system running in a virtual machine. It is embedded in the Hyper-V Manager MMC and is available as a stand-alone application. VMC provides access to the video frame buffer of the video machine from the moment a virtual machine is powered on so that you have access during the boot process.

**MORE INFO**  For more details about using VMC, refer to Chapter 11, "Hyper-V Single Server Management."
Microsoft has made a big investment in developing Windows Server 2008 Hyper-V, a virtualization platform that provides flexibility and performance for IT organizations to consolidate their workloads. Although this book provides an excellent in-depth look at various aspects of the Hyper-V platform, Microsoft continues to enhance and evolve Hyper-V with features and capabilities. Here is a sneak peek at some capabilities of Windows Server 2008 R2 Hyper-V, the next release of the Windows Server Virtualization platform.

Live Migration of Virtual Machines

Windows Server 2008 provides Quick Migration to move VMs between hosts in a cluster with minimal service interruption. However, this capability requires pausing the virtual machine momentarily while the saved state is moved from the source to the destination node. A virtual machine in saved state does not run during this period (called the “blackout” period), in effect causing downtime for the virtual machine. In today’s IT environment, downtime even for short periods is problematic. In order to address this issue, Microsoft is enhancing the Hyper-V product with the Live Migration capability. With Live Migration, there is no perceived downtime in the workloads running in the VM, and network connections to and from the migrated VM stay connected. As with Quick Migration, Live Migration will be possible between nodes within a failover cluster. In effect, the infrastructure investment made in order to use Quick Migration will be enhanced through Live Migration. In addition, Microsoft is adding Clustered Shared Volumes to failover clusters, which allow multiple VHDS for different VMs to be stored on a single Logical Unit Number (LUN). This not only simplifies management of shared storage for a cluster, it also provides a significant reduction in the blackout period for VMs moved through Live Migration.

Support for Enhanced Hardware Virtualization Features

Over the years, hardware vendors such as AMD and Intel have made significant enhancements (such as AMD-V and Intel VT) to processors and chipsets with capabilities specifically targeting virtualization. Continuing with these enhancements, AMD and Intel support Nested Page Tables (NPT) and Extended Page Tables (EPT), respectively. These capabilities improve the performance of memory address translations. Without these hardware enhancements, each time a guest page faults, it requires a context switch to the hypervisor to handle the page fault. With NPT and EPT, a guest can handle page faults directly, eliminating the need for a costly context switch to the hypervisor and reducing virtualization overhead for memory translations.
Addition and Removal of Virtual Storage

Virtualization decouples the software running on a system from the hardware and makes it convenient for IT organizations to deploy and manage their environments. With this flexibility, it is inevitable that customers also seek the ability to expand and reduce storage coupled with virtual machines. With Windows Server 2008 R2 Hyper-V, Microsoft is adding the ability to add and remove virtual hard disks from a virtual machine while it is in operation. This capability opens up a range of possibilities for backup storage solutions and so on.

Networking Enhancements

Networking vendors have also made enhancements to hardware that benefit virtualized platforms. Two such key technologies are TCP Offload Engine (TOE) and Virtual Machine Queues (VMQ).

TCP Offload Engine refers to the offloading of TCP/IP processing to the network interface card (NIC). This technology is not specific to virtualized platforms, as non-virtualized operating systems and applications can also benefit by using it. A generally well-accepted rule of thumb is that 1 Hertz (Hz) of CPU processing is required to send or receive 1 bit of TCP/IP data. For high speed NICs, the overhead associated with processing TCP/IP traffic can be substantial. Windows Server 2008 R2 Hyper-V will support offloading the TCP/IP processing from virtual machines onto supported NICs, reducing the overhead for network processing. This has the benefit to free up processor cycles for additional work.

VMQ provides multiple queues and sorting algorithms in the NIC. One or more queues can be assigned by the hypervisor to individual virtual machines. The NIC sorts incoming network traffic and places it in the appropriate queues for the virtual machines. Since this processing happens in the NIC hardware, it reduces the hypervisor overhead and again frees up processor cycles for other work.

In addition, Microsoft is also adding support for jumbo frames that enable large send and receive payloads. A jumbo frame is an Ethernet frame with up to 9000 bytes of data payload as opposed to the traditional 1500 bytes. This reduces the overhead incurred per transferred byte. Coupled with large send offload (LSO), which is the ability of the operating system to transfer large chunks of data to the NIC to create Ethernet frames, and large receive offload (LRO), which allows the creation of a single large data buffer from multiple incoming Ethernet frames, this provides additional reductions of network processing overhead.

Power Management Enhancements

Recognizing the fact that data center power distribution and cooling infrastructure for the computing infrastructure are uppermost in IT staff minds, the next generation of the Windows Hypervisor has enhancements to reduce the power footprint of virtualized workloads. These capabilities include the use of “core parking,”
which allows the hypervisor to proactively consolidate idle workloads onto fewer cores. The unused processors can then be put into a deep sleep state, effectively reducing the power consumption of the server. In addition, the virtual management infrastructure, more specifically System Center Virtual Machine Manager (SCVMM), also can assist through optimal workload placement that reduces the overall power consumption of workloads.

Remote Desktop Connection Broker
The Remote Desktop Connection Broker creates a unified administrative experience for traditional session-based (i.e., Terminal Services) remote desktops and for virtual machine-based remote desktops in a Virtual Desktop Infrastructure (VDI). The two key deployment scenarios supported by the Remote Desktop Connection Broker are persistent (permanent) VMs and pooled VMs. Using a persistent VM, a user is assigned a dedicated VM that can be personalized and customized, and that preserves any changes made by the user. With a pooled VM, a single VM image is replicated as needed for users. User state can be stored using profiles and folder redirection, but it does not persist on the VM after the user logs off.

Host Operating System Support
The following list includes all the currently supported 64-bit host operating systems for Hyper-V:

- Windows Server 2008 Standard Edition
- Windows Server 2008 Enterprise Edition
- Windows Server 2008 Datacenter Edition
- Microsoft Hyper-V Server 2008

Guest Operating System Support
The following list includes all the supported x86 guest operating systems that can be used with Windows Server 2008 Standard, Enterprise, and Datacenter editions, as well as Microsoft Hyper-V Server 2008:

- Windows 2000 (support for one virtual processor)
  - Windows 2000 Server with SP4
  - Windows 2000 Advanced Server with SP4
- Windows Server 2003 x86 (support for one or two virtual processors)
  - Windows Server Web Edition with SP2
  - Windows Server Standard Edition with SP2
• Windows Server Enterprise Edition with SP2
• Windows Server Datacenter Edition with SP2

- Windows Server 2003 R2 x86 (support for one or two virtual processors)
  • Windows Server Web Edition with SP2
  • Windows Server Standard Edition with SP2
  • Windows Server Enterprise Edition with SP2
  • Windows Server Datacenter Edition with SP2

- Windows Server 2003 x64 (support for one or two virtual processors)
  • Windows Server Standard Edition with SP2
  • Windows Server Enterprise Edition with SP2
  • Windows Server Datacenter Edition with SP2

- Windows Server 2003 R2 x64 (support for one or two virtual processors)
  • Windows Server Standard Edition with SP2
  • Windows Server Enterprise Edition with SP2
  • Windows Server Datacenter Edition with SP2

- Windows Server 2008 x86 (support for one, two, or four virtual processors)
  • Windows Server 2008 Standard Edition
  • Windows Server 2008 Enterprise Edition
  • Windows Server 2008 Datacenter Edition
  • Windows Web Server 2008 Edition
  • Windows Server 2008 Standard Edition without Hyper-V
  • Windows Server 2008 Enterprise Edition without Hyper-V
  • Windows Server 2008 Datacenter Edition without Hyper-V

- Windows Server 2008 x64 (support for one, two, or four virtual processors)
  • Windows Server 2008 Standard Edition
  • Windows Server 2008 Enterprise Edition
  • Windows Server 2008 Datacenter Edition
  • Windows Web Server 2008 Edition
  • Windows Server 2008 Standard Edition without Hyper-V
  • Windows Server 2008 Enterprise Edition without Hyper-V
  • Windows Server 2008 Datacenter Edition without Hyper-V

- Windows HPC Server 2008 (support for one, two or four virtual processors)

- Suse Linux Enterprise Server 10 x86 (support for one virtual processor)
  • SUSE Linux Enterprise Server 10 with SP1
• SUSE Linux Enterprise Server 10 with SP2
  - Suse Linux Enterprise Server 10 x64 (support for one virtual processor)
  - SUSE Linux Enterprise Server 10 with SP1
  - SUSE Linux Enterprise Server 10 with SP2

• Windows XP Professional x86
  - Windows XP Professional with SP2 (support for one virtual processor)
  - Windows XP Professional with SP3 (support for one or two virtual processors)

• Windows XP Professional x64
  - Windows XP Professional with SP2 (support for one or two virtual processors)

• Windows Vista x86 (support for one or two virtual processors)
  - Windows Vista Business Edition with SP1
  - Windows Vista Enterprise Edition with SP1
  - Windows Vista Ultimate Edition with SP1

• Windows Vista x64 (support for one or two virtual processors)
  - Windows Vista Business Edition with SP1
  - Windows Vista Enterprise Edition with SP1
  - Windows Vista Ultimate Edition with SP1

**Reviewing Hyper-V**

Windows Server 2008 Hyper-V and Microsoft Hyper-V Server 2008 are both hypervisor-based virtualization platforms. Hyper-V is multithreaded and concurrently runs one or more virtual machines (workloads), each in its own thread of execution. Each virtual machine presents a set of virtualized or synthetic devices to the guest operating system and applications that abstracts the underlying physical hardware, providing workload portability between dissimilar physical servers running Hyper-V.

**Virtual Machine Hardware Environment**

Table 2-2 lists the standard set of virtualized components that a virtual machine exposes to a guest operating system and application stack. These devices are detected and appear to be the physical hardware resources available to the running workload. When a virtual machine workload requests access to the virtualized resources, Hyper-V works in conjunction with the parent partition to translate the requested operation from the virtual hardware environment to the physical hardware, and access is achieved via the standard kernel device drivers installed in the parent partition. This approach provides virtual machine workloads the ability to run across a wide variety of server hardware without requiring any modifications to the workload configuration.
### TABLE 2-2 Virtualized Hardware Components

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>VIRTUALIZED HARDWARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic input/output system (BIOS)</td>
<td>American Megatrends (AMI) BIOS with Intel 440BX chip set and PIIX4 ACPI including:</td>
</tr>
<tr>
<td></td>
<td>- Complementary metal oxide semiconductor (CMOS)</td>
</tr>
<tr>
<td></td>
<td>- Real-time clock</td>
</tr>
<tr>
<td></td>
<td>- RAM and video RAM (VRAM)</td>
</tr>
<tr>
<td></td>
<td>- Memory controller</td>
</tr>
<tr>
<td></td>
<td>- Direct memory access (DMA) controller</td>
</tr>
<tr>
<td></td>
<td>- PCI bus</td>
</tr>
<tr>
<td></td>
<td>- ISA bus</td>
</tr>
<tr>
<td></td>
<td>- SM bus</td>
</tr>
<tr>
<td></td>
<td>- Power management</td>
</tr>
<tr>
<td></td>
<td>- 8259 programmable interrupt controller (PIC)</td>
</tr>
<tr>
<td></td>
<td>- Programmable interrupt timer (PIT)</td>
</tr>
<tr>
<td>Floppy disk drive</td>
<td>Single 1.44- MB floppy disk drive that maps to a floppy drive image.</td>
</tr>
<tr>
<td>Serial (COM) port</td>
<td>Dual serial ports that can be connected to local named pipes.</td>
</tr>
<tr>
<td>Printer (LPT) port</td>
<td>None</td>
</tr>
<tr>
<td>Mouse</td>
<td>Standard PS/2 Microsoft IntelliMouse pointing device mapped to the PS/2 device on the physical computer. Synthetic mouse device (requires Integration Services installation).</td>
</tr>
<tr>
<td>Keyboard</td>
<td>Standard PS/2 101-key Microsoft keyboard that can be mapped to a PS/2 keyboard on the physical computer. Synthetic keyboard device (requires Integration Services installation).</td>
</tr>
<tr>
<td>Network adapter (multifunction)</td>
<td>Up to four legacy Multiport DEC/Intel 21140 Ethernet network adapters.</td>
</tr>
<tr>
<td></td>
<td>Up to eight synthetic network adapters (requires Integration Services installation).</td>
</tr>
<tr>
<td>Processor</td>
<td>Up to four processors that are the same as the physical computer processors.</td>
</tr>
</tbody>
</table>
Virtual Machine Hardware Environment

CHAPTER 2

COMPONENT VIRTUALIZED HARDWARE

Memory
- Up to 64 GB of RAM per virtual machine for Windows Server 2008 Hyper-V Enterprise and Datacenter editions.

Video card
- VESA compatible emulated graphics adapter with 4 MB of VRAM, VGA, and SVGA support compliant with VESA 1.2, 2-D graphics accelerator and hardware cursor, and support for DirectX.
- Synthetic video adapter (requires Integration Services installation).

IDE/ATAPI storage
- Dual IDE channels that support hard drives, CD-ROM or DVD-ROM drives, and ISO images. Each IDE channel supports two disks.

SCSI storage
- Up to four synthetic SCSI adapters, each supporting 64 disks (requires Integration Services installation).

Sound card
- None

A few limitations are imposed on virtual machine workloads based on the virtual hardware environment. Operating systems or applications that require direct access to a hardware device that is not listed in Table 2-2 cannot execute in a virtual machine. Because virtual machines expose only four CPUs to a hosted workload, applications that require symmetric multiprocessing (SMP) can be assigned one, two, or four processors in a virtual machine.

Virtual Hard Disks

Virtual hard disks (VHDs) are single file representations of a physical hard disk that encapsulate virtual machine data. Virtual hard disks reflect the same internal structure as a physical hard disk, including block allocation tables, data blocks, and sectors. Table 2-3 provides a list of virtual hard disk types available in Hyper-V.

<table>
<thead>
<tr>
<th>DISK TYPE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed</td>
<td>Virtual hard disk file with all data blocks allocated on the host disk subsystem at creation time. A 10-GB fixed disk consumes 10 GB on the host physical disk where it is created.</td>
</tr>
</tbody>
</table>
**DISK TYPE** | **DESCRIPTION**
---|---
Dynamically Expanding | Virtual hard disk file that is preallocated with no data blocks reserved and grows as data is written until it reaches full size. A 10-GB dynamically expanding disk takes less than 2 MB initially and grows to 10 GB in 2-MB data block increments. In Hyper-V, the maximum size for this VHD type is 127 GB.

Differencing | Virtual hard disk file that is tied to an existing “parent” virtual hard disk file as an overlay. All writes are made to the differencing disk, the “child,” whereas reads come from the parent and the child. Differencing disks are created as dynamically expanding disks.

Linked | A physical disk volume that you want to convert to a virtual hard disk. Linked disks exist only to perform the migration from physical to virtual hard disk.

Within a virtual machine, a virtual hard disk is represented as a physical disk. On a Hyper-V server physical disk, a virtual hard disk is stored as a file with a .vhd extension. Virtual machines connect to a virtual hard disk through a virtualized Integrated Drive Electronics (IDE) or Small Computer System Interface (SCSI) adapter. Hyper-V is responsible for mapping the virtual hard disk to the .vhd file on the physical disk. A VHD can be stored on any IDE, SCSI, iSCSI, storage area network (SAN), or Network-Attached Storage (NAS) storage system supported by the Windows Server 2008 operating system.

Virtual hard disks are created using either the Hyper-V Manager or through the WMI application programming interface (API). A virtual machine can support a maximum of 260 virtual hard disks through a combination of IDE and SCSI-connected VHDs.

**NOTE** Virtual hard disk specifications are independent of the bus type used to connect to the virtual machine. However, the bus type does impose a size limitation on virtual hard disks. Virtual hard disks connected via IDE cannot exceed 127 GB. Virtual hard disks connected via SCSI cannot exceed 2040 gigabytes.

**Pass-Through Disks**

Using Hyper-V, you can expose a disk to a virtual machine that is connected to the physical server without creating a volume on it. This is referred to as a pass-through disk. Pass-through disks can be physically connected to the Hyper-V server or as a LUN on a SAN. One of the advantages of pass-through disks is that they are not subject to the 2040-gigabyte size limitation that is imposed on VHDs. In contrast, pass-through disks do not support dynamically expanding VHDs, differencing VHDs, or Hyper-V snapshots.

**Virtual IDE Interface**

A virtual machine provides built-in primary and secondary virtual IDE interfaces. In Hyper-V, you can boot a virtual machine only from a virtual hard disk that is connected through the virtual IDE interface. Each virtual IDE interface can support two devices attached to it, for a
Virtual Machine Hardware Environment

Chapter 2

The total of four IDE devices for every virtual machine. Either virtual hard disks or virtual CD-ROMs can be connected to an IDE interface. By default, the first virtual CD-ROM is attached to the secondary interface as the master device.

Virtual SCSI Interface

Contrary to the built-in virtual IDE interfaces exposed within the virtual machine environment, virtual SCSI interfaces are optional components that must be installed in a virtual machine before they can be used. A virtual machine supports up to four virtual SCSI adapters. Each virtual SCSI adapter can have up to 64 devices attached, for a total of 256 SCSI devices for every virtual machine.

Because virtual SCSI adapters are implemented as synthetic devices that load after the guest operating system loads, SCSI-attached VHDs cannot be used to boot a virtual machine.

iSCSI Disks

Another option to expose storage devices to a virtual machine is to install an iSCSI initiator in the guest operating system and connect directly to an iSCSI target. However, Hyper-V does not support booting from iSCSI-connected disk; therefore, you will still need to connect your boot disk through the virtual IDE interface. Using iSCSI-connected disks requires that you dedicate a NIC in the Hyper-V server for iSCSI communications.

Virtual Networks

A virtual network is a software emulation of a Layer 2 network switch with unlimited ports and a switched uplink that can connect to an external physical network through a physical network adapter or remain disconnected to create an isolated internal network. For each virtual network that you create in Hyper-V, a new software-based switch is created. In addition, each virtual network port simulates a 10-gigabit Ethernet port. Hyper-V supports an unlimited number of virtual networks with an unlimited number of ports for virtual machine connections.

Hyper-V provides three types of virtual networks: External, Private, and Internal. An external virtual network is used to provide connectivity to a physical network. When you create a new external virtual network, a virtual NIC is created in the Hyper-V parent partition with all the basic network bindings. The virtual NIC connects to a new virtual network switch, and the virtual network switch connects to the physical NIC that you select. If there are multiple physical NICs installed in a Hyper-V server, you can choose the one to bind to the new external virtual network. The physical NIC will have all network bindings removed with the exception of the Microsoft Virtual Network Switch Protocol. When a new virtual machine is connected to the external virtual network, a new network port is added to the virtual network switch.

An internal virtual network provides a means to allow virtual machines to communicate with the Hyper-V server, but it does not provide access to physical networks. In this case, a virtual NIC is again created in the Hyper-V parent partition and is connected to a port on a new virtual network switch. However, the new virtual network switch is not connected to any
of the physical NICs installed in the Hyper-V server. When a new virtual machine is connected
to the internal virtual network, a new network port is added to the virtual network switch.

A private virtual network allows multiple virtual machines to communicate with each other,
but not with the Hyper-V server or with any host connected on an external physical network.
Essentially, when you create a new private virtual network, a new virtual network switch is cre-
ated, but no virtual NIC is created in the Hyper-V parent partition. As you add new virtual ma-
chine connections to the new virtual network switch, additional network ports are added to it.

All three types of virtual network can be created through the Hyper-V Manager MMC or
using WMI.

Virtual Network Adapters
There are two types of supported virtual network adapters in Hyper-V: legacy (emulated) and
synthetic. A legacy network adapter emulates a virtual Multiport DEC 21140 network adapter.
Using a legacy network adapter will increase the processor overhead because device access
requires context switching that is not required with the synthetic network adapter. A syn-
thetic network adapter provides higher performance because virtual machine device access
requests are made through the high-speed VMBus to the parent partition. In order to use a
synthetic network adapter, the guest operating system in the virtual machine must support
the installation of Integration Services.

Virtual machines support a maximum of four virtual legacy network adapters and eight
synthetic network adapters. Only the legacy network adapter supports the Pre-boot Execu-
tion Environment protocol (PXE), allowing virtual machines to be provisioned using standard
image-deployment tools such as Windows Deployment Services (WDS) or other third-party
applications. This is the case because the synthetic network adapter is loaded only after the
virtual machine has booted.

When a legacy network adapter is added to a virtual machine, you can define the virtual
network to connect it to or leave the virtual machine disconnected from any virtual network.
Hyper-V allocates a new dynamic media access control (MAC) address to the new virtual
network adapter from its pool of available addresses. It is also possible to provide a virtual
network adapter with a static MAC address that is manually configured. With Hyper-V, both
legacy and synthetic network adapters provide support for virtual LAN (VLAN) identifi-
cation.

**IMPORTANT** Although the virtual Multiport DEC 21140 network adapter defines a
10/100 megabit Ethernet interface, there is no network bandwidth limitation imposed
on virtual machine workloads. If the underlying physical network adapter is capable of
achieving higher network performance (for example, gigabit speed), the virtual machine
workload has the ability to exceed the 100-megabit specification.
Using the Hyper-V Manager Console

The Hyper-V Manager MMC is installed when the Hyper-V role is configured in a full installation of Microsoft Windows Server 2008. It is the default graphical user interface that allows you to manage and configure Hyper-V servers and virtual machines. It is also available for Microsoft Vista with SP1 (x86 and x64) as a download from the Microsoft Web site.

NOTE If you are interested in running Hyper-V Manager on Microsoft Vista with SP1, it is available for download from http://support.microsoft.com/kb/952627.

The Hyper-V manager allows an administrator to manage multiple Hyper-V servers; however, it is meant to be the primary management tool only for small virtualization deployments. If you are deploying Hyper-V in a large or complex environment, you should use an enterprise-class management application like System Center Virtual Machine Manager.

You can launch Hyper-V Manager from the Start menu by selecting Hyper-V Manager from the Administrative Tools menu as shown in Figure 2-2. In a default full installation of Windows Server 2008, you can also invoke it using the Start menu Run option or from a command prompt by typing C:\Program Files\Hyper-V\virtmgmt.msc.

FIGURE 2-2 Launching Hyper-V Manager from the Start menu
As shown in Figure 2-3, the Hyper-V Manager console is divided into three sections. The left pane displays the tree view of managed Hyper-V servers. The center pane displays existing virtual machines and their state, as well as a tree view of existing snapshots and a minimized view of the virtual machine console when a virtual machine is selected. The right pane contains the list of actions available to manage the Hyper-V servers and virtual machines. The list of virtual machine actions is displayed only after a virtual machine is created or added on the Hyper-V server.

![Hyper-V Manager default view](image)

**FIGURE 2-3** Hyper-V Manager default view

**Managing Multiple Hyper-V Servers**

Although the Hyper-V Manager allows only a single Hyper-V server to be managed at a time, it is a simple matter to connect to and switch the management focus to a different Hyper-V server. Figure 2-4 shows the Select Computer dialog box that is displayed when you right-click Hyper-V Manager in the left tree view pane and select Connect To Server. This dialog box is where you can specify the name or IP address of a Hyper-V server that you would like to manage.
In this dialog box, you also have the option to select Another Computer and browse for Hyper-V servers that you want to manage from your console.

Managing Virtual Machines

The Hyper-V Manager allows you to create, delete, export and import, or configure virtual machines on the managed Hyper-V server. You manage the virtual machines by selecting the desired management option and then providing or changing information through simple wizards.

Creating Virtual Machines

In order to create a new virtual machine, you can select the New option directly under the Hyper-V server name in the Actions pane and then choose the Virtual Machine menu option, as shown in Figure 2-5.
Hyper-V provides the New Virtual Machine Wizard, shown in Figure 2-6, to guide you through the process of configuring and creating a new virtual machine.

The wizard gathers basic information about the new virtual machine configuration, including the virtual machine name and storage location, memory to assign to the virtual machine, the virtual network to connect to the virtual machine, and whether you want to create a new virtual hard disk, use an existing virtual hard disk, or attach a virtual hard disk at a later time. Finally, you can specify the guest operating system installation options that include install-
ing the guest operating system later, installing the guest operating system from a boot CD or DVD-ROM, installing the guest operating system from a boot floppy disk, or installing a guest operating system from a network-based installation server. When you have made your selections, you will have an opportunity to review the settings and select whether or not to start the virtual machine after it is created.

When the information in the wizard is submitted to Hyper-V, a new virtual machine configuration file (.xml) that contains the settings information is created. The new virtual machine is registered and visible in the Hyper-V Manager; a new virtual hard disk is created, if specified; and a virtual network adapter is connected to the virtual machine. The new virtual machine is then ready to boot and install a new operating system or load an existing operating system.

**Virtual Machine Export and Import**

If you want to export a virtual machine, right-click the virtual machine in Hyper-V Manager or select the Export option from the Actions pane. You will then see the Export Virtual Machine dialog box shown in Figure 2-7. It is important to note that you can export only a virtual machine that is in a saved state or is powered off.

![Figure 2-7 The Export Virtual Machine dialog box in Hyper-V Manager](image)

In the Export Virtual Machine dialog box, you can browse to specify the location to save the virtual machine export files. There is also an option to export only the virtual machine configuration file (.exp), but not other files, such as saved state files or VHDs.

After you have moved or copied the virtual machine export files and you are ready to import the virtual machine into Hyper-V, select the Import Virtual Machine option from the
Actions pane under the server name. As shown in Figure 2-8, you must enter the path to the export files in the Import Virtual Machine dialog box or browse to select it.

![Figure 2-8: The Import Virtual Machine dialog box in Hyper-V Manager](image)

You also need to decide whether or not to reuse the VM ID, which is the Global Unique Identifier (GUID) assigned when a new VM is created. If you are making a copy of an existing virtual machine, you should generate a new virtual machine ID and will leave this option unchecked. If you are moving a virtual machine or restoring a backup copy of a virtual machine, then you should reuse the old virtual machine ID.

**NOTE** If you select to reuse the old virtual machine ID and the original virtual machine is still present on the Hyper-V server, the import operation will fail because the virtual machine ID has to be unique.

When you import a virtual machine, it will be left in the import path location, and it will not be possible to move the virtual machine after import. Therefore, you should ensure that you move the exported virtual machine files to the destination storage location before you import the virtual machine.

**Virtual Machine Snapshots**
The Hyper-V snapshot feature allows you to capture the configuration and state of a virtual machine at any point in time and return it to that state without noticeable interruption. Hyper-V allows you to create a snapshot whether the virtual machine is running, in saved state, or powered off.
In order to create a snapshot of a virtual machine in Hyper-V Manager, right-click the virtual machine and select the Snapshot option from the menu, as shown in Figure 2-9.

Figure 2-10 illustrates the changes in the Hyper-V Manager console when the snapshot completes. The Snapshots section in the center pane now displays a tree structure that reflects the virtual machine snapshot hierarchy. The root node of the tree is the snapshot that was just created and includes the creation time stamp. Under the root node, there is a child named Now that represents the running version of the virtual machine.
As you make changes to the configuration of a virtual machine, you can create and save additional snapshots. Figure 2-11 shows that another snapshot was generated after the initial one, and they are displayed in a parent and child hierarchy that also reflects the relationship of the differencing disks that are created for each snapshot to capture changes to the virtual machine operating system, applications, and data.

![Figure 2-11 Snapshot hierarchy display in the Hyper-V Manager console](image)

If after making a series of changes to a virtual machine, you decide that you want to reload the previous snapshot, use the Hyper-V Revert option, as shown in Figure 2-12. After the Revert option is applied to a virtual machine, the resulting configuration and state of the virtual machine are returned to the settings saved in the snapshot files.

If you want to reload a snapshot that is two or more levels higher than the running virtual machine (represented by the Now marker in the Snapshot pane), you can right-click the snapshot and choose the Apply option from the menu, as shown in Figure 2-13.
FIGURE 2-12 The Snapshot Revert Option in the Hyper-V Manager console

FIGURE 2-13 The Snapshot Apply option in the Hyper-V Manager console
If you decide that you no longer need a snapshot or snapshot subtree, Hyper-V provides two different Delete options (shown in Figure 2-14) to permanently remove one or more snapshots from the snapshot hierarchy.

![Figure 2-14 The Delete Snapshot and Delete Snapshot Subtree options in the Hyper-V Manager console](image)

You can choose to delete a single snapshot or a snapshot subtree, as you can see in the shortcut menu shown in Figure 2-14. Deleting a single snapshot will not affect other snapshots in the hierarchy; however, it will immediately delete the configuration file and save state files associated with the snapshot. Deleting a snapshot subtree immediately deletes the configuration and save state files associated with all the snapshots in the subtree.

**Virtual Machine State**

Virtual machine state can be changed through the Hyper-V Manager. Figure 2-15 shows the menu options that are available after you right-click a running virtual machine. The menu options will differ based on the state of a virtual machine. For example, if a virtual machine is in the Off or Saved state, the Start option will appear on the menu.
The virtual machine state options that you can change through the Hyper-V Manager are:

- **Start**  
  Power on and boot a virtual machine

- **Turn Off**  
  Noncontrolled power-off of a virtual machine (equivalent to pulling the power cord on a physical computer)

- **Shut Down**  
  Controlled power-off of a virtual machine (requires Integration Services support)

- **Save**  
  Stop virtual machine processing and save the memory and processor state to file

- **Pause**  
  Suspend virtual machine processing

- **Resume**  
  Restart virtual machine processing after pausing it

- **Reset**  
  Noncontrolled restart of a virtual machine (equivalent to pushing the reset button on a physical computer)

**Managing Virtual Machine Configurations**

As shown in Figure 2-16, you can right-click a virtual machine and select Settings from the menu options to access the virtual machine settings in Hyper-V Manager.
Figure 2-17 shows an example of the virtual machine settings dialog box. The virtual machine hardware and management settings are displayed in the pane at left, divided by major component. The pane on the right displays the options that are available for each virtual machine hardware and management component.
Table 2-4 provides a list of virtual machine hardware configuration options and a description of the changes associated with each component.

<table>
<thead>
<tr>
<th>CONFIGURATION OPTION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add Hardware</td>
<td>Allows the addition of synthetic SCSI controllers, synthetic network adapters, and legacy (emulated) network adapters to a virtual machine.</td>
</tr>
<tr>
<td>BIOS</td>
<td>Allows the configuration of the Num Lock state (on or off), and the startup order of the devices (CD, IDE, legacy network adapter, floppy) at boot time.</td>
</tr>
<tr>
<td>Memory</td>
<td>Allows the specification of the virtual machine memory allocation.</td>
</tr>
<tr>
<td>Processor</td>
<td>Allows the specification of the virtual machine logical processor allocation, resource control, and processor functionality.</td>
</tr>
<tr>
<td>IDE Controller 0</td>
<td>Allows the addition of virtual hard drives or DVD drives attached to the virtual machine through IDE Controller 0.</td>
</tr>
<tr>
<td>Hard Drive</td>
<td>Allows the configuration of which virtual IDE or SCSI controller a hard drive is connected to and the position (location) where it is connected. Also provides access to the virtual hard drive management tools (compact, convert, expand, and so on), and allows the configuration of pass-through disks. Finally, allows removal of hard drives from the virtual machine.</td>
</tr>
<tr>
<td>IDE Controller 1</td>
<td>Allows the addition of virtual hard drives or DVD drives attached to the virtual machine through IDE Controller 1.</td>
</tr>
<tr>
<td>CD/DVD</td>
<td>Allows IDE-based CD/DVD drives to be attached to the virtual machine. The CD or DVD can be in the form of an ISO image or physical CD/DVD drive installed on the host. In addition, allows removal of CD/DVD drives from the virtual machine.</td>
</tr>
<tr>
<td>SCSI Controller</td>
<td>Allows the addition of virtual hard drives to the virtual machine that are connected using a SCSI Controller.</td>
</tr>
<tr>
<td>Legacy Network Adapter</td>
<td>Allows the addition, configuration, and removal of virtual network cards installed in the virtual machine. For each network adapter, you have options to specify the virtual network connection and whether the network adapter MAC address is assigned dynamically or statically. In addition, you can configure and enable virtual LAN (VLAN) identification.</td>
</tr>
</tbody>
</table>
### Configuration Option Description

<table>
<thead>
<tr>
<th>Configuration Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Adapter</td>
<td>Allows the addition, configuration, and removal of synthetic network cards installed in the virtual machine. For each network adapter, you have options to specify the virtual network connection and whether the network adapter MAC address is assigned dynamically or statically. In addition, you can configure and enable virtual LAN (VLAN) identification.</td>
</tr>
<tr>
<td>COM 1 and Com 2 Ports</td>
<td>Allows for the connection of COM ports to or the disconnection of COM ports from the virtual machine. COM ports can connect to a named pipe on the local or remote computer.</td>
</tr>
<tr>
<td>Diskette Drive</td>
<td>Allows the virtual floppy disk drive to connect to an existing floppy disk image.</td>
</tr>
</tbody>
</table>

Table 2-5 provides a list of virtual machine management configuration options and a description of the changes that are associated with each component.

### Table 2-5 Virtual Machine Management Configuration Options

<table>
<thead>
<tr>
<th>Configuration Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Allows the specification of a name for the virtual machine and a set of electronic notes about the virtual machine.</td>
</tr>
<tr>
<td>Integration Services</td>
<td>Allows the selection of the Integration Services components that Hyper-V will support for the virtual machine.</td>
</tr>
<tr>
<td>Snapshot File Location</td>
<td>Allows specification of the folder location used to store the snapshot files.</td>
</tr>
<tr>
<td>Automatic Start Action</td>
<td>Allows the configuration of the virtual machine start up action when the Hyper-V server starts. The action can be set to take no action, to start automatically if the virtual machine was running when the service stopped, or to always start the virtual machine automatically. In addition, there is an option to configure an automatic start delay to reduce resource contention between virtual machines.</td>
</tr>
<tr>
<td>Automatic Stop Action</td>
<td>Allows the configuration of the virtual machine stop action when the Hyper-V server shuts down. The action can be set to save the virtual machine state (saved state), turn off the virtual machine, or shut down the guest operating system. The Integrations Services component must be supported by the guest operating system.</td>
</tr>
</tbody>
</table>
Managing Virtual Hard Disks

The Hyper-V Manager allows you to create, inspect, and edit virtual hard disks and virtual floppy disks on the managed Hyper-V server. Just as a virtual hard disk is a single file representation of a physical hard disk, a virtual floppy disk is a single file representation of a physical floppy disk.

Creating Virtual Hard Disks

Virtual hard disk files are a main component of a virtual machine, encapsulating the guest operating system and application data. Within Hyper-V Manager, a virtual hard disk can be created separately from a virtual machine by clicking the New option in the Actions pane and selecting the Hard Disk option from the menu. Figure 2-18 shows the New Virtual Hard Disk Wizard that is launched. To create a virtual hard disk, you must define the virtual hard disk type (dynamically expanding, fixed size, or differencing), specify a name and storage location for the new VHD, and define the size of the new VHD. Optionally, you can specify to copy the contents of a physical disk to the new VHD.

![New Virtual Hard Disk Wizard](image)

**FIGURE 2-18** Creating a new virtual hard disk in Hyper-V Manager

---

**NOTE** Details for each virtual hard disk type are provided in Chapter 3 and Chapter 5.

A virtual machine exposes a single virtual floppy drive to the guest operating system. A virtual machine does not allow the removal of the virtual floppy drive, nor does it support additional floppy drives to be connected. Hyper-V Manager allows only the creation of a 1.44-GB virtual floppy disk. The virtual floppy disk is created by clicking the New option in the Actions pane, selecting the Floppy Disk menu option, and then specifying the file name and storage location for the new virtual floppy disk.
Inspecting and Editing Virtual Hard Disks

If you select the Inspect Disk option in the Actions pane, Hyper-V Manager will prompt you to identify the targeted virtual hard disk. Hyper-V opens the virtual hard disk, obtains the current and maximum size settings as well as the virtual hard disk type, and displays the information, as shown in Figure 2-19.

![Figure 2-19](image1.png)

**FIGURE 2-19** Inspecting a virtual hard disk in Hyper-V Manager

If you select the Edit Disk option in the Actions pane, Hyper-V Manager will launch the Edit Virtual Hard Disk Wizard shown in Figure 2-20.

![Figure 2-20](image2.png)

**FIGURE 2-20** Hyper-V Manager Edit Virtual Hard Disk Wizard

After you select the targeted virtual hard disk and depending on the type of VHD that it is, a list of potential actions is displayed. Table 2-6 contains the list of potential actions that are available for each type of virtual hard disk.
<table>
<thead>
<tr>
<th>ACTION</th>
<th>VHD TYPE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compact</td>
<td>Dynamically Expanding</td>
<td>Compact a dynamically expanding disk to regain unused space.</td>
</tr>
<tr>
<td></td>
<td>Differencing</td>
<td></td>
</tr>
<tr>
<td>Convert</td>
<td>Dynamically Expanding</td>
<td>Convert a dynamically expanding disk to a fixed-size disk, or</td>
</tr>
<tr>
<td></td>
<td>Fixed Size</td>
<td>a fixed-size disk to a dynamically expanding disk.</td>
</tr>
<tr>
<td>Expand</td>
<td>Dynamically Expanding</td>
<td>Increase the storage size of the virtual hard disks.</td>
</tr>
<tr>
<td></td>
<td>Fixed Size</td>
<td></td>
</tr>
<tr>
<td>Merge</td>
<td>Differencing</td>
<td>Merge the changes in a child disk into the parent disk or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>merge the parent and child disks into a new virtual hard disk.</td>
</tr>
<tr>
<td>Reconnect</td>
<td>Differencing</td>
<td>Reconnect a child differencing disk to a parent virtual hard</td>
</tr>
<tr>
<td></td>
<td></td>
<td>disk.</td>
</tr>
</tbody>
</table>

**Managing Virtual Networks**

The Hyper-V Manager allows the creation, addition, and configuration of virtual networks on the managed Hyper-V server. Virtual networks allow virtual machines to connect to each other, the host, and other physical or virtual machines on a physical network.

**Creating Virtual Networks**

To create a new virtual network, click the Virtual Network Manager menu option in the Hyper-V Manager Actions pane. Hyper-V Manager launches the Virtual Network Manager shown in Figure 2-21.

To create a new virtual network, you must select one from the three types available: External, Internal, and Private. An external virtual network provides virtual machine connectivity to external physical networks. This type of virtual network must be bound to a physical network adapter installed in the Hyper-V server. An internal virtual network provides connectivity between virtual machines and the Hyper-V server but does not provide access to any physical networks. In other words, no packets from any attached virtual machines or the Hyper-V server are transmitted on a physical network. A private virtual network is even more restrictive than an internal one, as it provides connectivity only between virtual machines. There is no access to any physical networks or to the Hyper-V server.
If you choose to add a new External virtual network, you will have to specify a name for the new virtual network and select the physical network adapter to bind the virtual network. As shown in Figure 2-22, there is a drop-down menu in the New Virtual Network pane that allows you to choose the desired physical network adapter from the list of available adapters.
If you select a new Internal or Private virtual network, you would choose the Internal Only or Private Virtual Machine Network options in the Connection Type section, respectively.

If you select a new External or Internal virtual network, you can also choose to enable and configure a virtual LAN identifier (VLAN ID). A VLAN ID can be used to isolate the network traffic from different virtual machines connected to the same virtual network. Virtual machines with the same VLAN ID can communicate with each other but not with any other system configured with a different VLAN ID. VLANs are not supported for Private virtual networks.

**Virtual Machine Connection Application**

You can remotely access a virtual machine using the Virtual Machine Connection (VMC) application that is embedded in the Hyper-V Manager. As shown in Figure 2-23, to launch the VMC and connect to a virtual machine, double-click the thumbnail at the bottom of the Hyper-V Manager center pane or right-click the name of a virtual machine and select the Connect option from the shortcut menu.

![FIGURE 2-23 Connection to a virtual machine using VMC in Hyper-V Manager](image)

VMC essentially frames a remote desktop session within a Hyper-V specific GUI and allows connection to a virtual machine for administrative or functional purposes. An example of a VMC is shown in Figure 2-24. The VMC GUI provides much of the functionality available in Hyper-V Manager to manage virtual machines. This includes providing actions to change the virtual machine state (e.g., Start, Turn Off, Save, and so on), access virtual machine settings, manage snapshots, manipulate the bindings of the virtual DVD and floppy disk drives to different media, and provide an option to install Integration Services.
The VMC allows client remote access and interaction with a virtual machine from the moment the virtual machine is powered on.

Managing Hyper-V Settings

The Hyper-V Manager also provides the ability to configure Hyper-V settings. Figure 2-25 shows the Hyper-V Settings dialog box that is displayed when you select the Hyper-V Settings option in the Actions pane menu.

There are two sets of Hyper-V settings that you can modify: Server and User. The Server settings allow you to specify the default folder location to store the virtual hard disk files and virtual machine configuration files. The User settings provide several options. The Keyboard component allows you to set the focus of Windows key combinations to either the physical server or a virtual machine. The Mouse Release Key provides you with a way to set the key combinations to use when Integration Services are not installed or supported in the guest operating system. The User Credentials allow you to specify whether the Virtual Machine Connection should automatically use your default credentials to connect to a running virtual machine. The Delete Saved Credentials component allows you to delete the credentials that you used to connect to a running virtual machine. Finally, the Reset Check Boxes feature allows you to restore default settings for Hyper-V confirmation messages and wizard pages hidden by selecting certain check boxes.
Outlining the WMI API

Hyper-V provides an extensive and powerful WMI API that can be used to programatically control and monitor Hyper-V as well as automate deployment and management of virtual machines. All of the features offered in Hyper-V Manager can be reproduced as scripts that leverage this development interface.

Scripts and self-developed applications can be created using a variety of languages, including C#, Perl, C++, or Visual Basic, to name just a few popular alternatives. Scripts can be executed using Microsoft Windows PowerShell, which provides you with the ability to run commands in a Windows Shell and immediately see the results.

NOTE The Hyper-V WMI API is discussed in detail in Chapter 16, "Hyper-V Management Using Windows PowerShell." Chapter 16 contains many scripts that you can use or modify to use in your environment.
Summary

Hyper-V provides many features, including virtual machines that expose a standard virtual hardware environment to their guest operating system and applications. Becoming familiar with the virtual hardware environment and new synthetic device model in Hyper-V is crucial to making competent decisions concerning physical workloads that can successfully be re-deployed as virtual machines.

Creation, inspection, and configuration of the main components of virtual machines, including virtual hard disks and virtual networks, can be accomplished through the Hyper-V Manager. You can also use the Hyper-V Manager to configure Hyper-V Settings.

Use the Virtual Machine Connection application from within Hyper-V (or as a stand-alone application) to access and manipulate virtual machines remotely from the moment they become active. If you anticipate having or already have a significant deployment of Hyper-V servers and virtual machines, leverage the WMI API to programmatically control the deployment, administration, and configuration of Hyper-V servers and virtual machines, or use System Center Virtual Machine Manager.

Additional Resources

The following resources contain additional information related to the topics in this chapter: