Windows Server 2008 with Hyper-V

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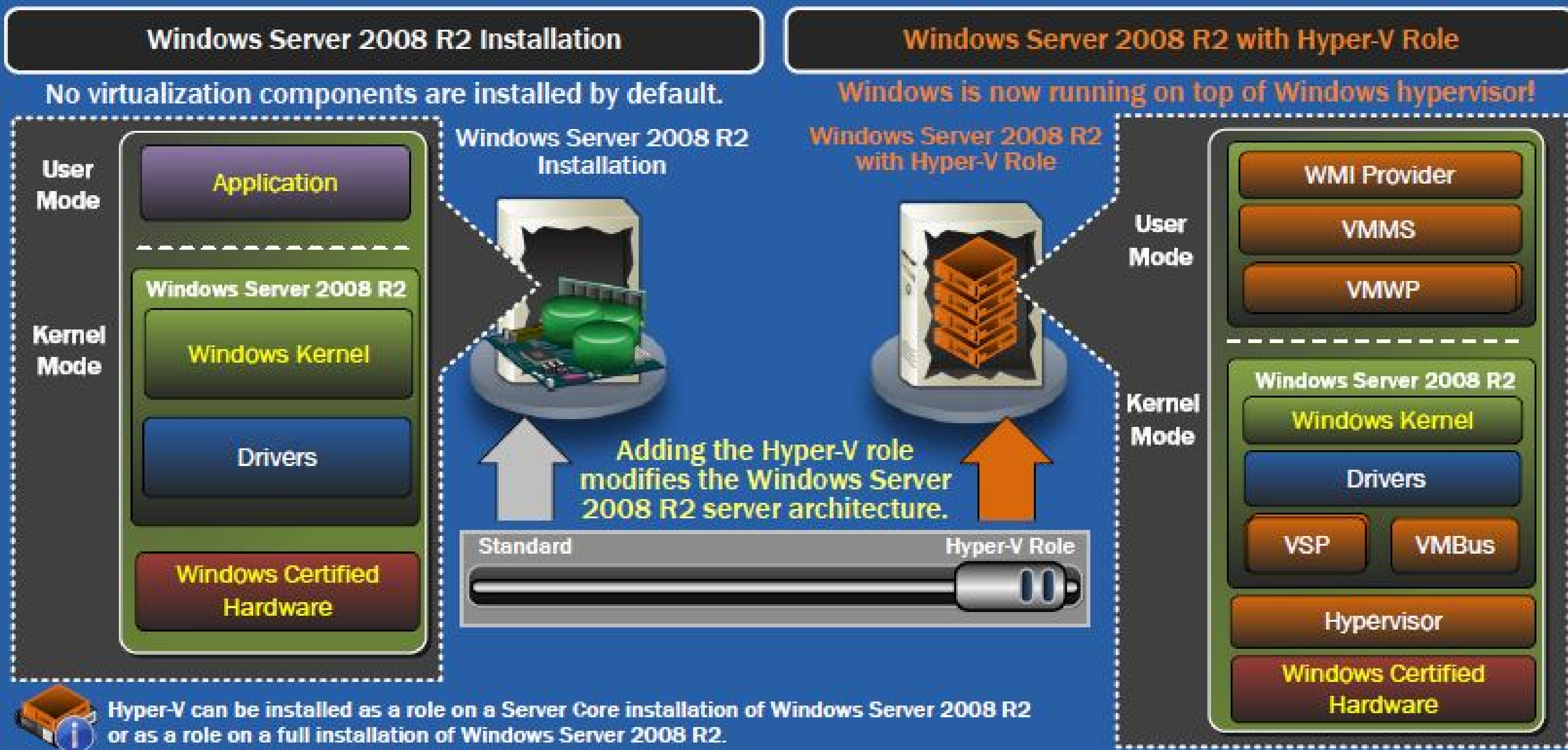
Surat.

Architectural Change in Windows Server 2008 R2

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

Architectural Change in Windows Server 2008 R2

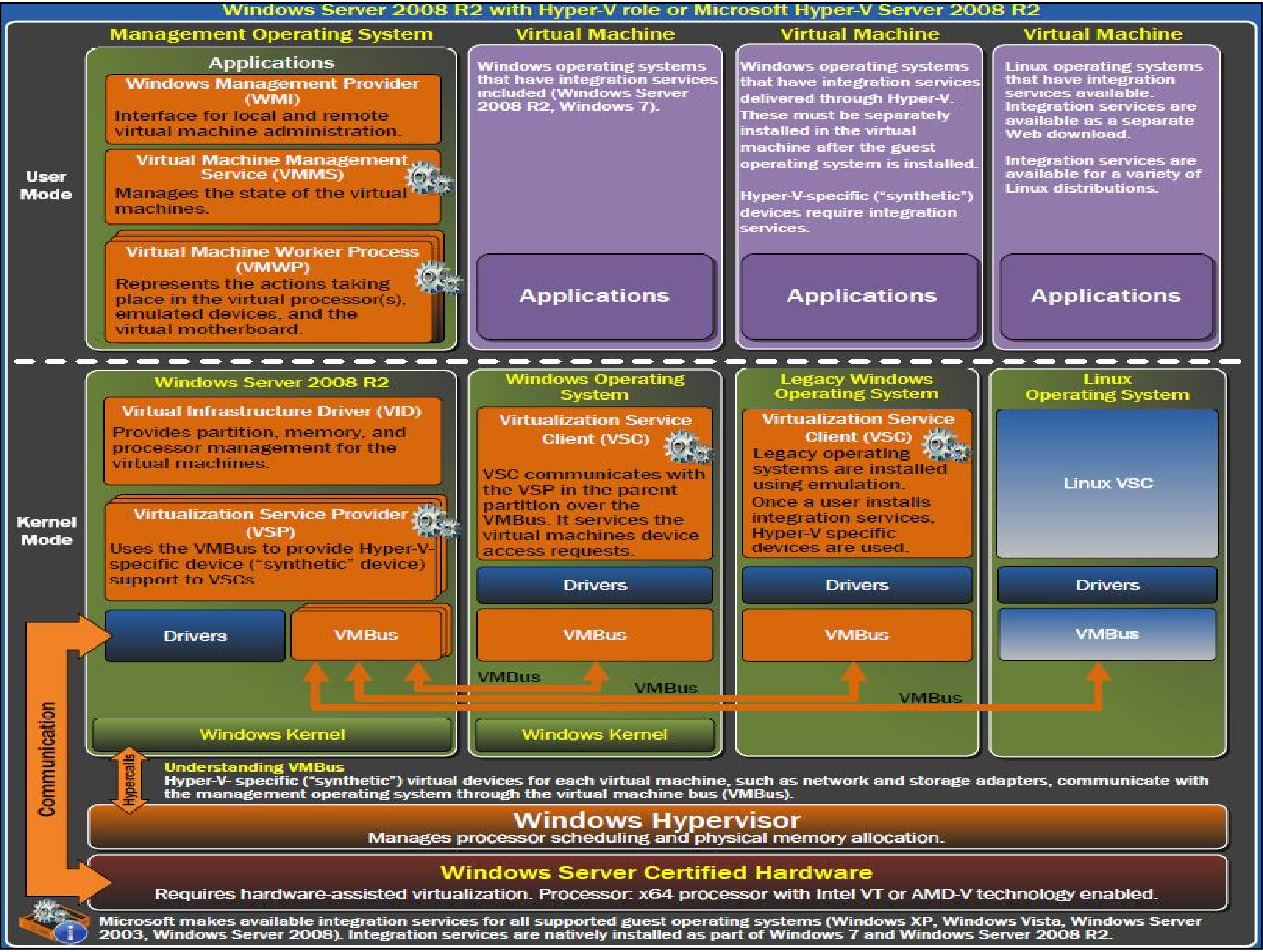


Windows Server 2008 R2 Hyper-V Product Classification

- Windows Server 2008 R2 includes a hypervisor-based server virtualization technology that can be installed as a role in Windows Server 2008 R2.
- Microsoft Hyper-V Server 2008 R2 is a stand-alone server virtualization product. It includes the Windows hypervisor, the Windows Server driver model, and virtualization components.

Windows Server 2008 R2 Detailed Hyper-V Architecture

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



Windows Server 2008 R2 with Hyper-V role or Microsoft Hyper-V Server 2008 R2
Management Operating System
Virtual Machine
Virtual Machine
Virtual Machine
User Mode
Applications
Windows Management Provider (WMI)
Interface for local and remote virtual machine administration.
Virtual Machine Management Service (VMMS)
Manages the state of the virtual machines.
Virtual Machine Worker Process (VMWP)
Represents the actions taking place in the virtual processor(s), emulated devices, and the virtual motherboard.
Windows operating systems that have integration services included (Windows Server 2008 R2, Windows 7).
Applications
Windows operating systems that have integration services delivered through Hyper-V. These must be separately installed in the virtual machine after the guest operating system is installed.
Hyper-V-specific ("synthetic") devices require integration services.
Applications
Linux operating systems that have integration services available. Integration services are available as a separate Web download.
Integration services are available for a variety of Linux distributions.
Applications
Kernel Mode
Windows Server 2008 R2
Virtual Infrastructure Driver (VID)
Provides partition, memory, and processor management for the virtual machines.
Virtualization Service Provider (VSP)
Uses the VMBus to provide Hyper-V-specific device ("synthetic" device) support to VSCs.
Drivers
VMBus
Windows Kernel
Windows Operating System
Virtualization Service Client (VSC)
VSC communicates with the VSP in the parent partition over the VMBus. It services the virtual machines device access requests.
Drivers
VMBus
Windows Kernel
Legacy Windows Operating System
Virtualization Service Client (VSC)
Legacy operating systems are installed using emulation.
Once a user installs integration services, Hyper-V specific devices are used.
Drivers
VMBus
Linux Operating System
Linux VSC
Drivers
VMBus
VMBus
VMBus
VMBus
Communication
Hypercalls
Understanding VMBus
Hyper-V- specific ("synthetic") virtual devices for each virtual machine, such as network and storage adapters, communicate with the management operating system through the virtual machine bus (VMBus).
Windows Hypervisor
Manages processor scheduling and physical memory allocation.
Windows Server Certified Hardware
Requires hardware-assisted virtualization. Processor: x64 processor with Intel VT or AMD-V technology enabled.
Microsoft makes available integration services for all supported guest operating systems (Windows XP, Windows Vista, Windows Server 2003, Windows Server 2008). Integration services are natively installed as part of Windows 7 and Windows Server 2008 R2.

Virtual Network Architecture

- Hyper-V supports three types of virtual networks:
  - Private virtual networks
  - Internal virtual networks
  - External virtual networks
- The virtual network switch forms the center of all Hyper-V virtual networks.
- It never appears as a physical entity—it is a software representation.

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

Management Operating System
Windows Server 2008 R2

Virtual network adapters communicate with the management operating system through VMBus. The management operating system receives those requests through the VSPs and directs them to the underlying physical network devices through the networking stack of the management operating system.

Network Stack

The virtual network adapter is created and connected to the management operating system.

Virtual Network Adapter (Optional)

A

Virtual Machine

Virtual Machine
(multiple virtual machines with associated virtual network adapters)

Applications

Network Stack

A virtual interface with its own MAC address is exposed in each virtual machine.

Virtual Network Adapters

B

C

Virtual Network Switch

The virtual network switch functions like a physical switch and routes networking traffic through the virtual network to its destination. It connects physical and virtual network adapters.

Physical Network Adapter #1

Physical Network Adapter #2

D

Physical Network Switch

External Physical Network

Preventing Overlapping MAC Address Ranges

You can use Virtual Network Manager to configure the range of MAC addresses that Hyper-V uses for dynamic MAC address generation.

00 – 15 – 5D – 18 – 12 – 68

MAC

VLAN ID

Virtual LAN Identification (VLAN ID)

For each virtual network adapter connected to a virtual machine, it is possible to specify a VLAN ID to be used by that virtual machine. Virtual LANs must be supported on the physical network adapter.

Virtual Network Configurations

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

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

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

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

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

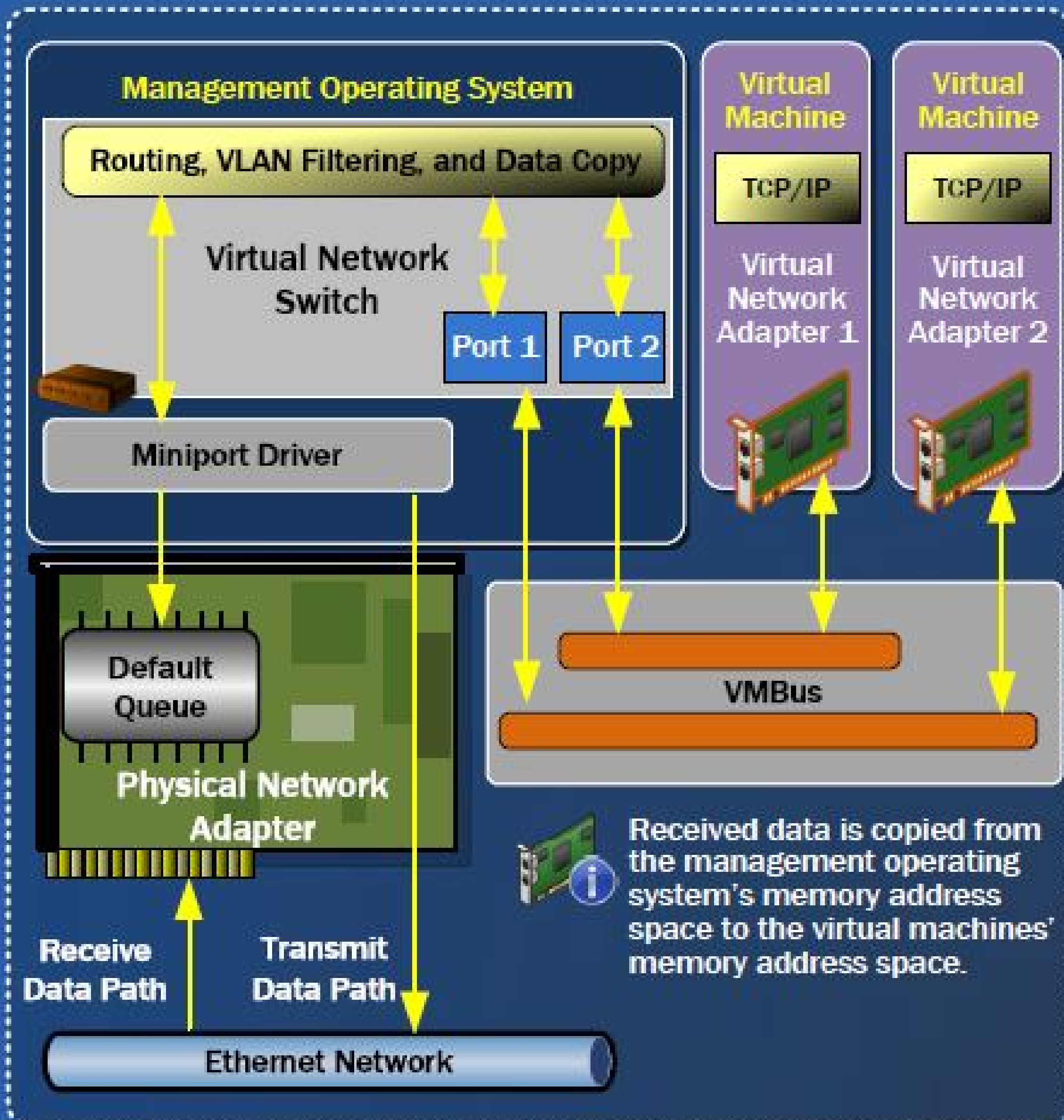
Virtual Network Interfaces in Hyper-V

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

Data Path Without Virtual Machine Queue

- In standard Hyper-V environments, the virtual network switch in the management operating system filters data based upon MAC address and VLAN tags. It copies the data and then routes it to the associated virtual machines through the virtual machine bus (VMBus).

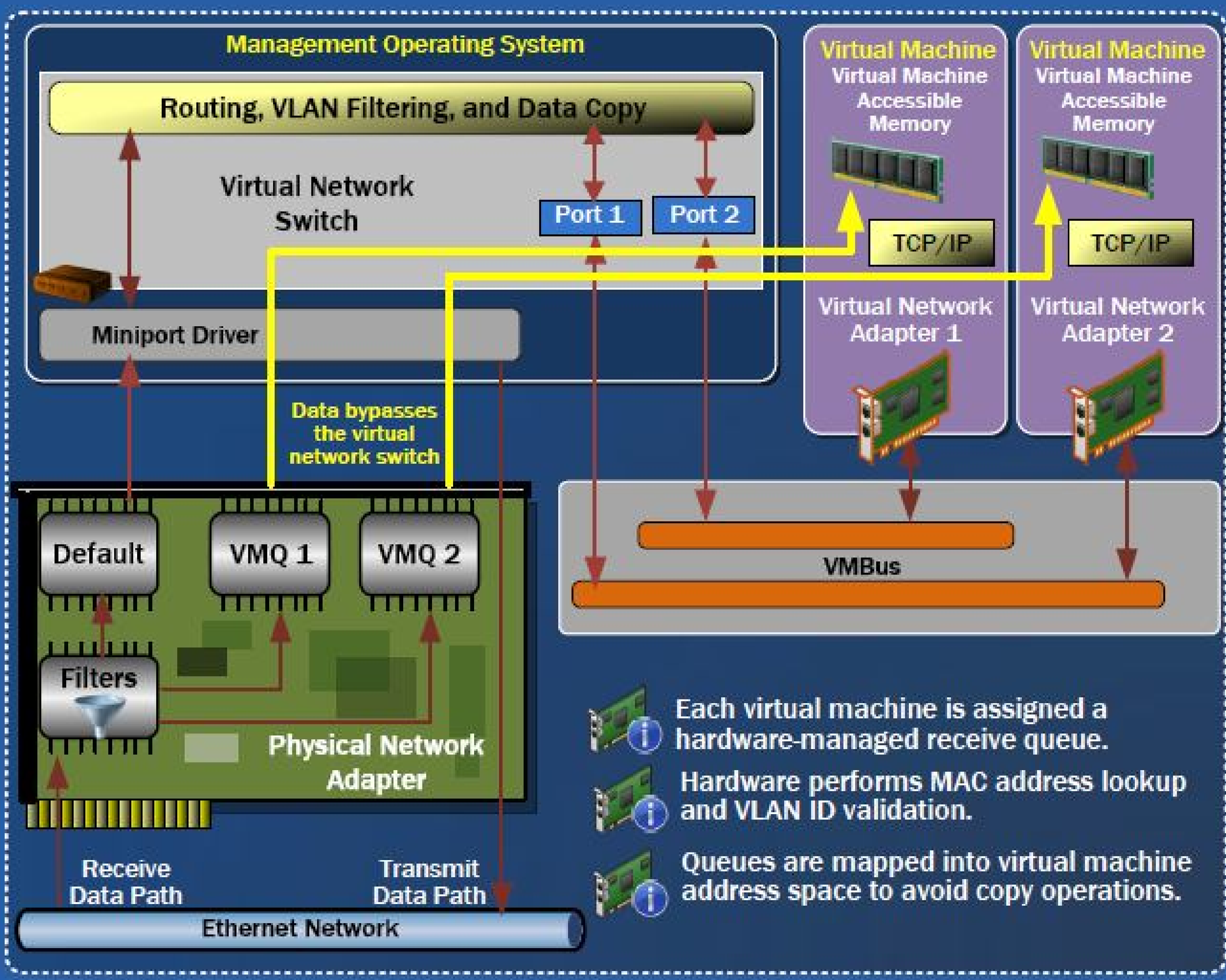
Data Path Without Virtual Machine Queue



Data Path with Virtual Machine Queue

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

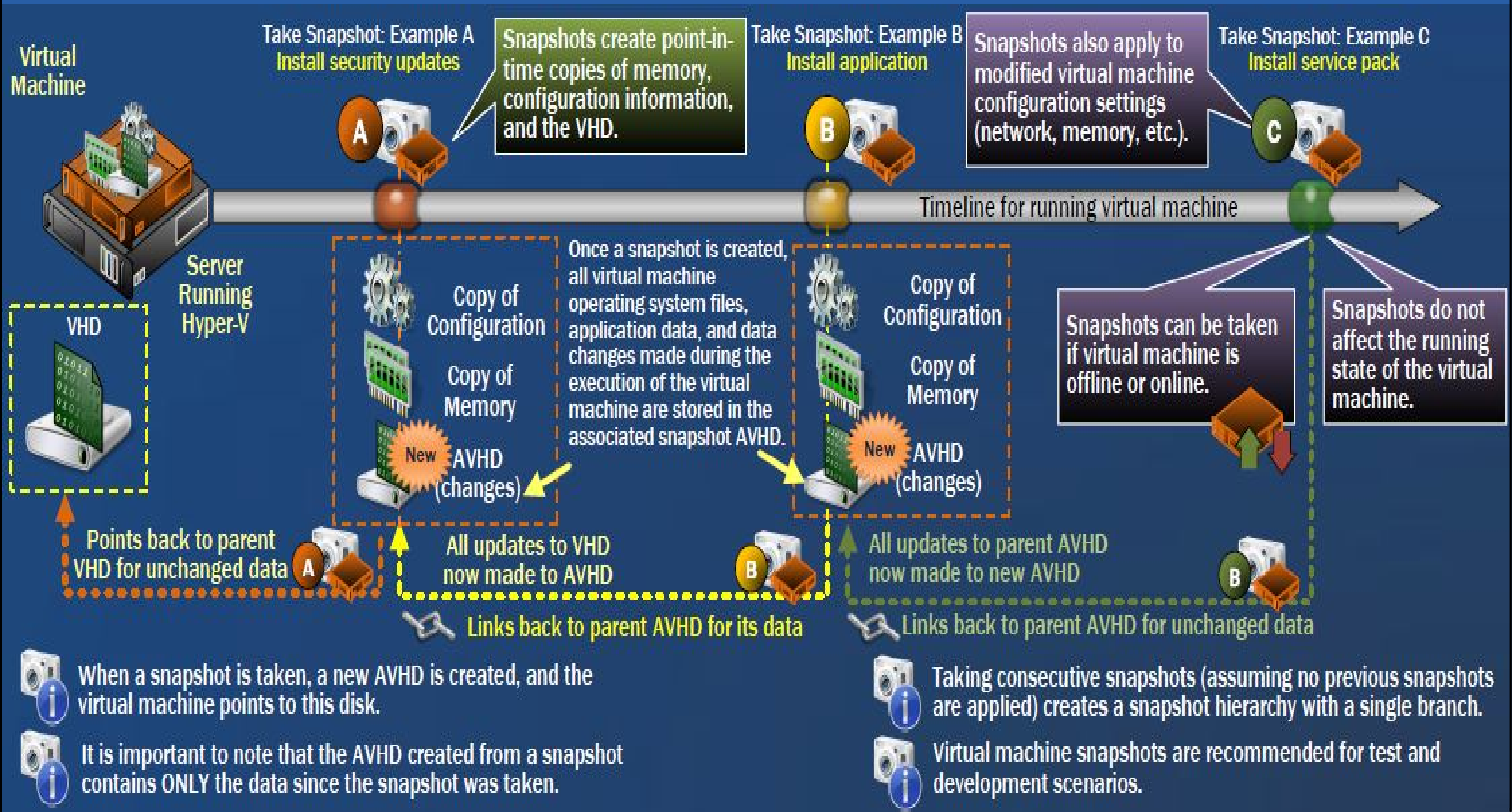
Data Path with Virtual Machine Queue



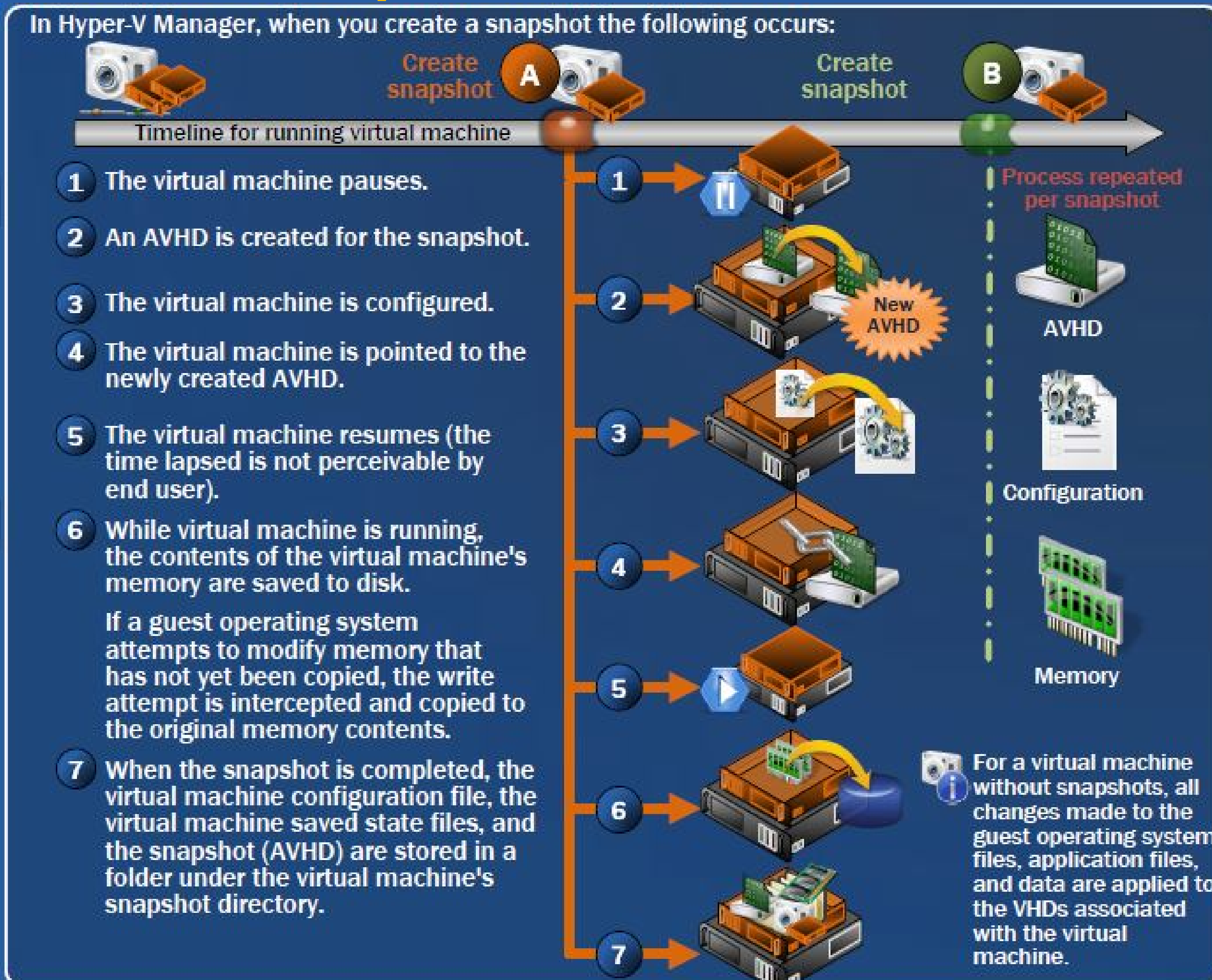
Virtual Machine Snapshots

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

Virtual Machine Snapshots



Snapshot Creation



Snapshot Deletion

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

When you delete a snapshot, the following occurs:

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

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

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

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

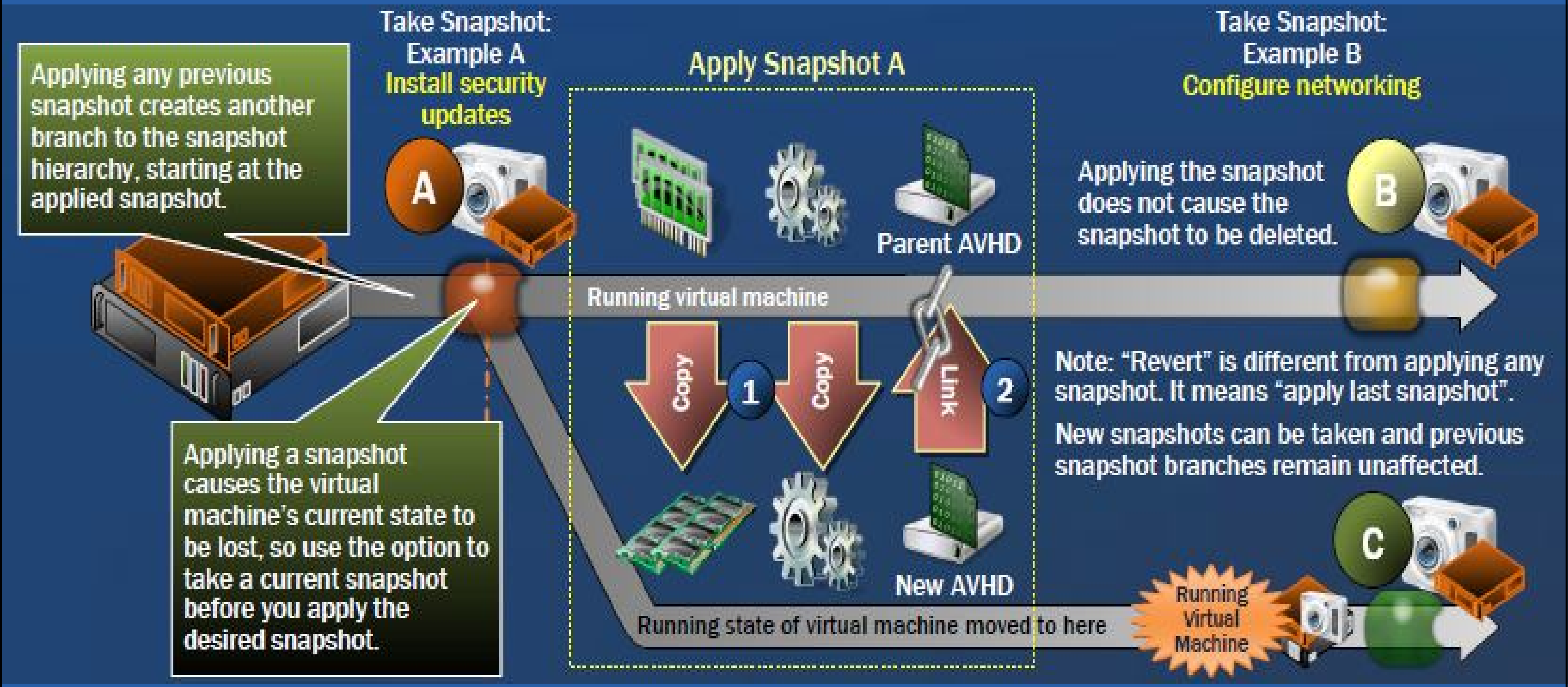
Applying Virtual Machine Snapshots

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

Applying Virtual Machine Snapshots

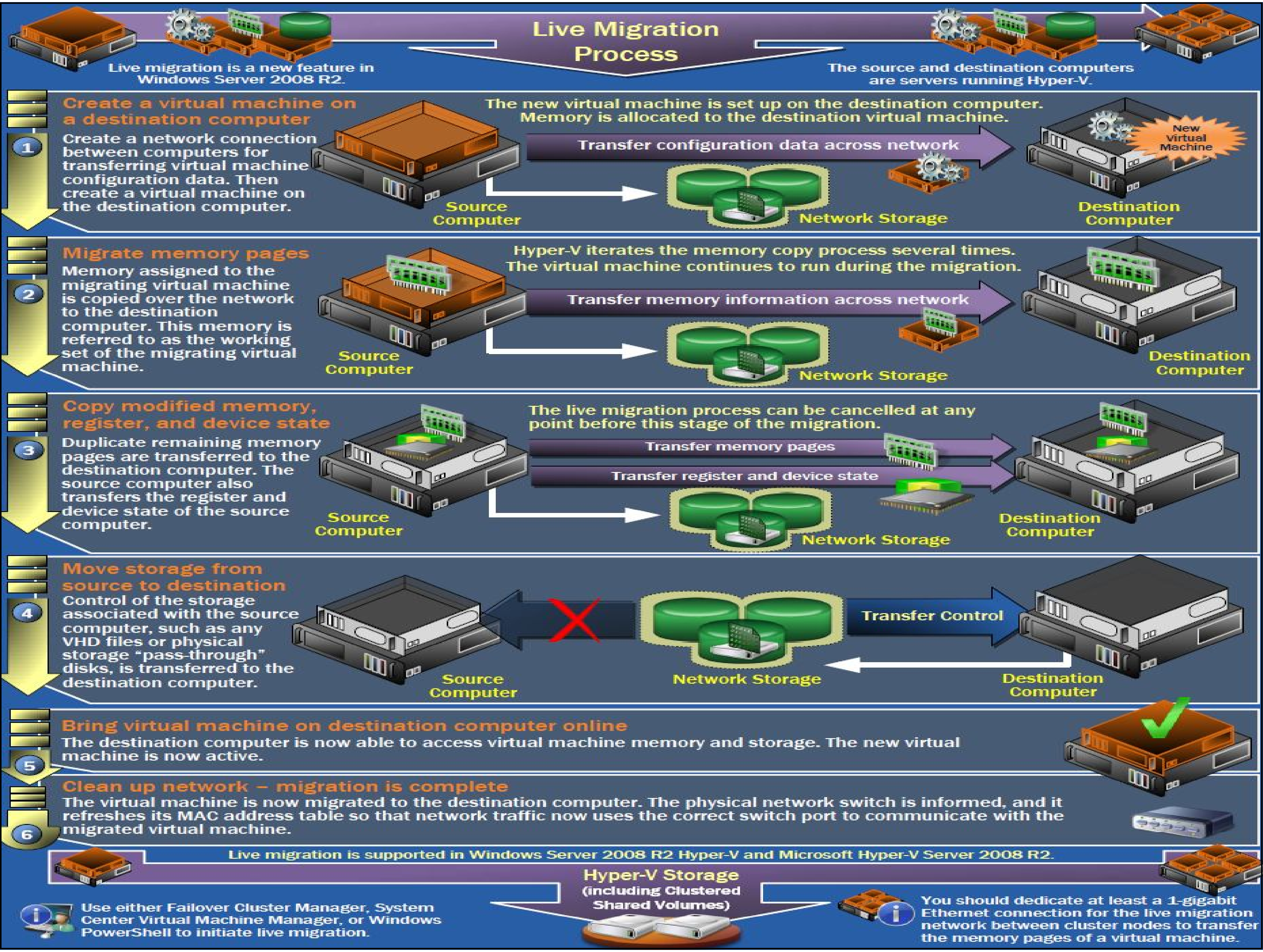
- When you apply a snapshot of a running virtual machine, the following occurs:
  - The virtual machine saved state files (.bin, .vsv) are copied.
  - A new AVHD is created, and then linked to the parent AVHD.

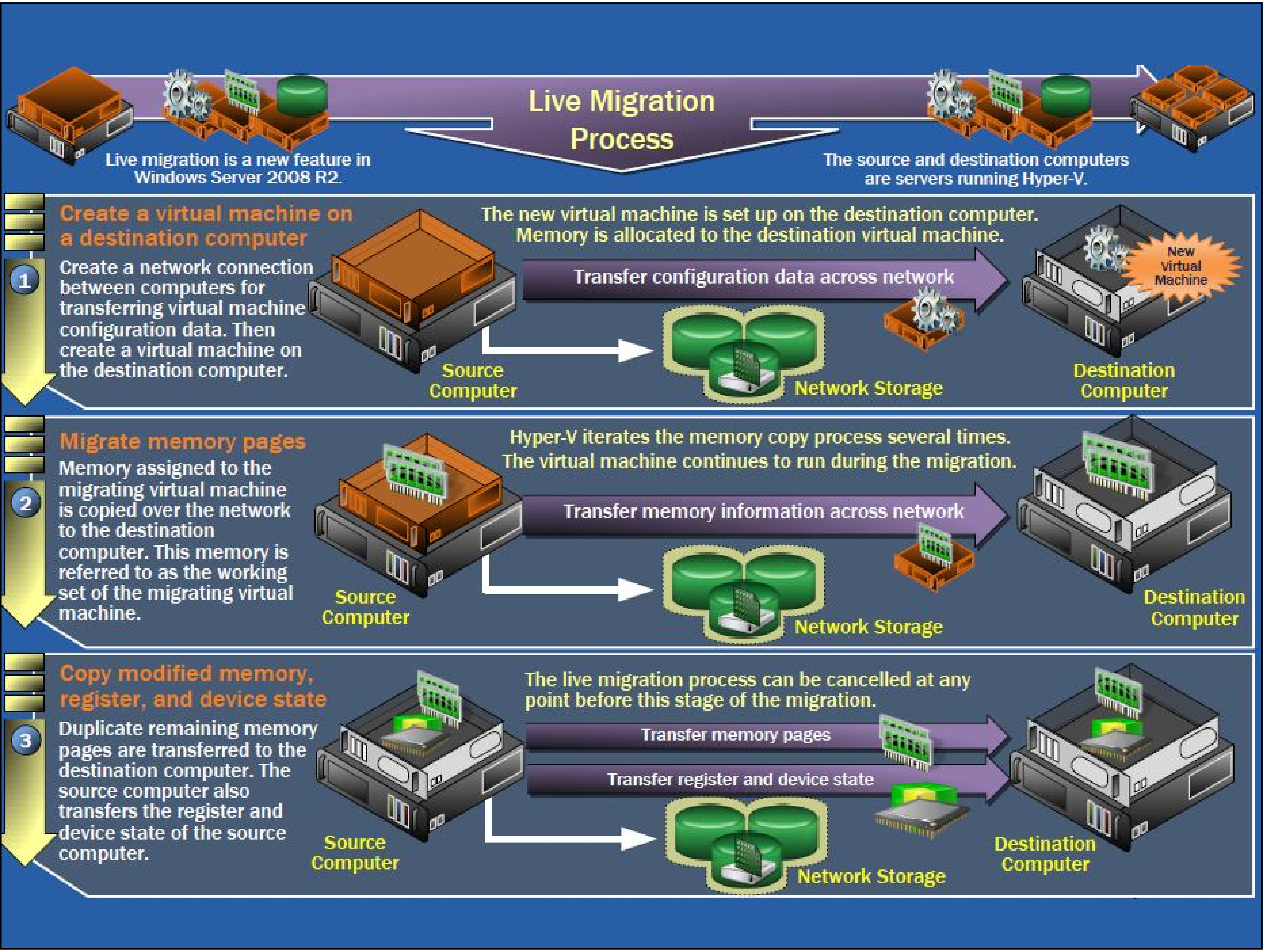
Applying Virtual Machine Snapshots



Applying Virtual Machine Snapshots

- When a snapshot is applied, the original snapshot remains and is not modified when applied.
- Snapshots should NOT be used as a substitute for backups because virtual machine snapshots are not the same as backups created by a Volume Shadow Copy Service (VSS) writer.
- It is not recommend to use virtual machine snapshots as a permanent data or system recovery solution.


Live Migration Process
Live migration is a new feature in Windows Server 2008 R2.
The source and destination computers are servers running Hyper-V.
1
Create a virtual machine on a destination computer
Create a network connection between computers for transferring virtual machine configuration data. Then create a virtual machine on the destination computer.
The new virtual machine is set up on the destination computer. Memory is allocated to the destination virtual machine.
Transfer configuration data across network
New Virtual Machine
Source Computer
Network Storage
Destination Computer
2
Migrate memory pages
Memory assigned to the migrating virtual machine is copied over the network to the destination computer. This memory is referred to as the working set of the migrating virtual machine.
Hyper-V iterates the memory copy process several times. The virtual machine continues to run during the migration.
Transfer memory information across network
Source Computer
Network Storage
Destination Computer
3
Copy modified memory, register, and device state
Duplicate remaining memory pages are transferred to the destination computer. The source computer also transfers the register and device state of the source computer.
The live migration process can be cancelled at any point before this stage of the migration.
Transfer memory pages
Transfer register and device state
Source Computer
Network Storage
Destination Computer
4
Move storage from source to destination
Control of the storage associated with the source computer, such as any VHD files or physical storage "pass-through" disks, is transferred to the destination computer.
Transfer Control
Source Computer
Network Storage
Destination Computer
5
Bring virtual machine on destination computer online
The destination computer is now able to access virtual machine memory and storage. The new virtual machine is now active.
6
Clean up network – migration is complete
The virtual machine is now migrated to the destination computer. The physical network switch is informed, and it refreshes its MAC address table so that network traffic now uses the correct switch port to communicate with the migrated virtual machine.
Live migration is supported in Windows Server 2008 R2 Hyper-V and Microsoft Hyper-V Server 2008 R2.
Hyper-V Storage (including Clustered Shared Volumes)
Use either Failover Cluster Manager, System Center Virtual Machine Manager, or Windows PowerShell to initiate live migration.
You should dedicate at least a 1-gigabit Ethernet connection for the live migration network between cluster nodes to transfer the memory pages of a virtual machine.



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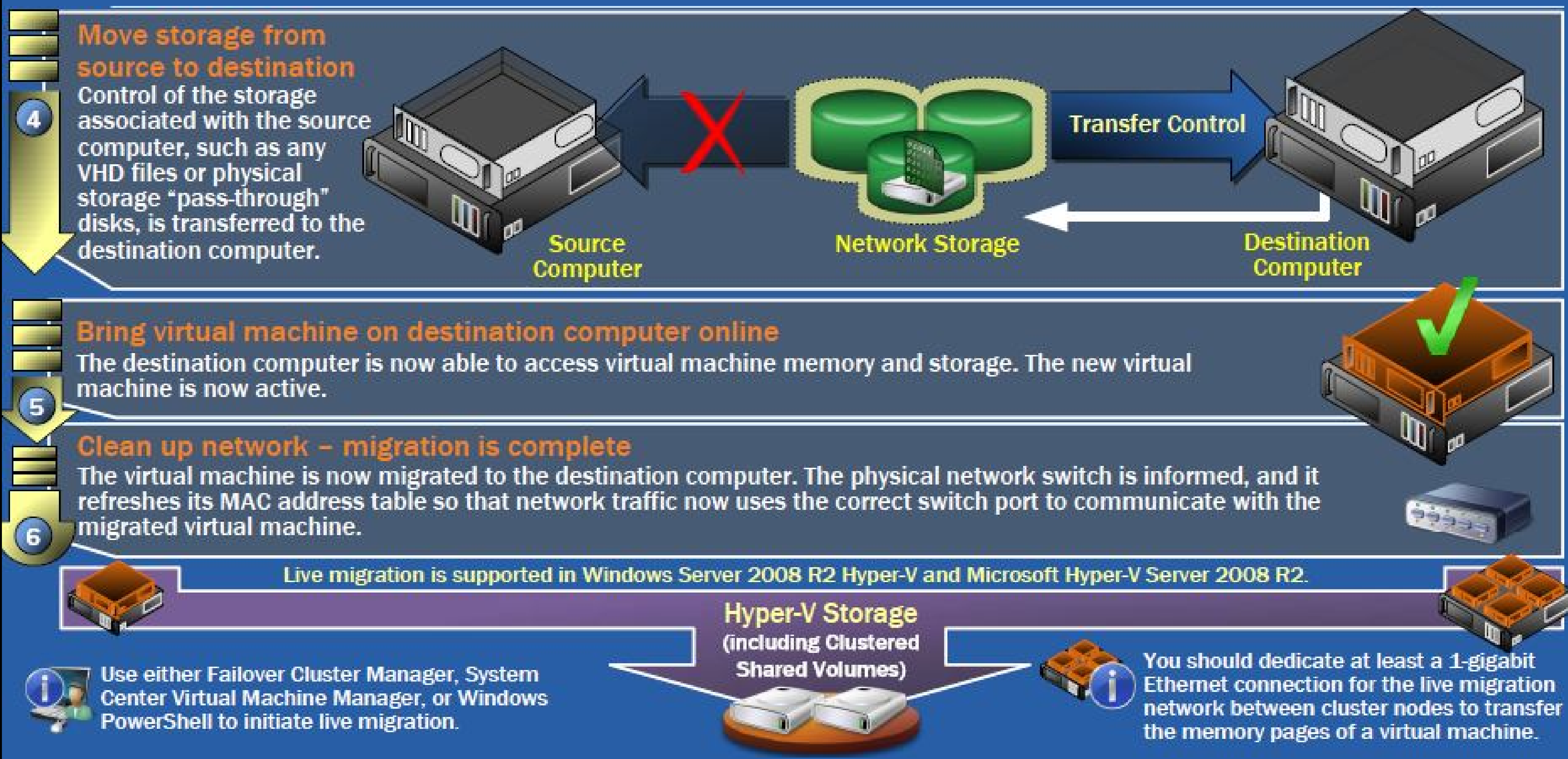
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Windows Server 2008 R2 Cluster Shared Volumes (CSV)

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

Windows Server 2008 R2 Cluster Shared Volumes (CSV)

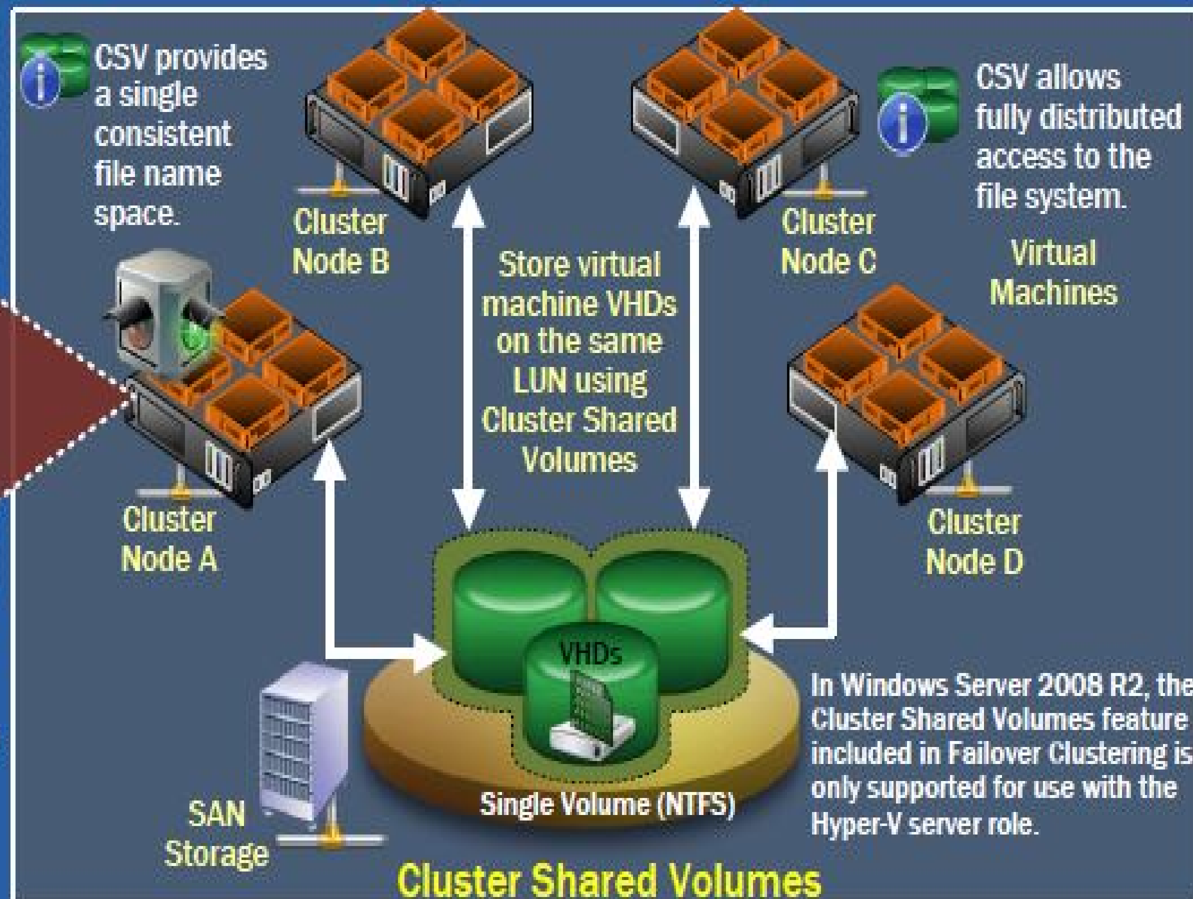
Coordinator Node

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

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

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

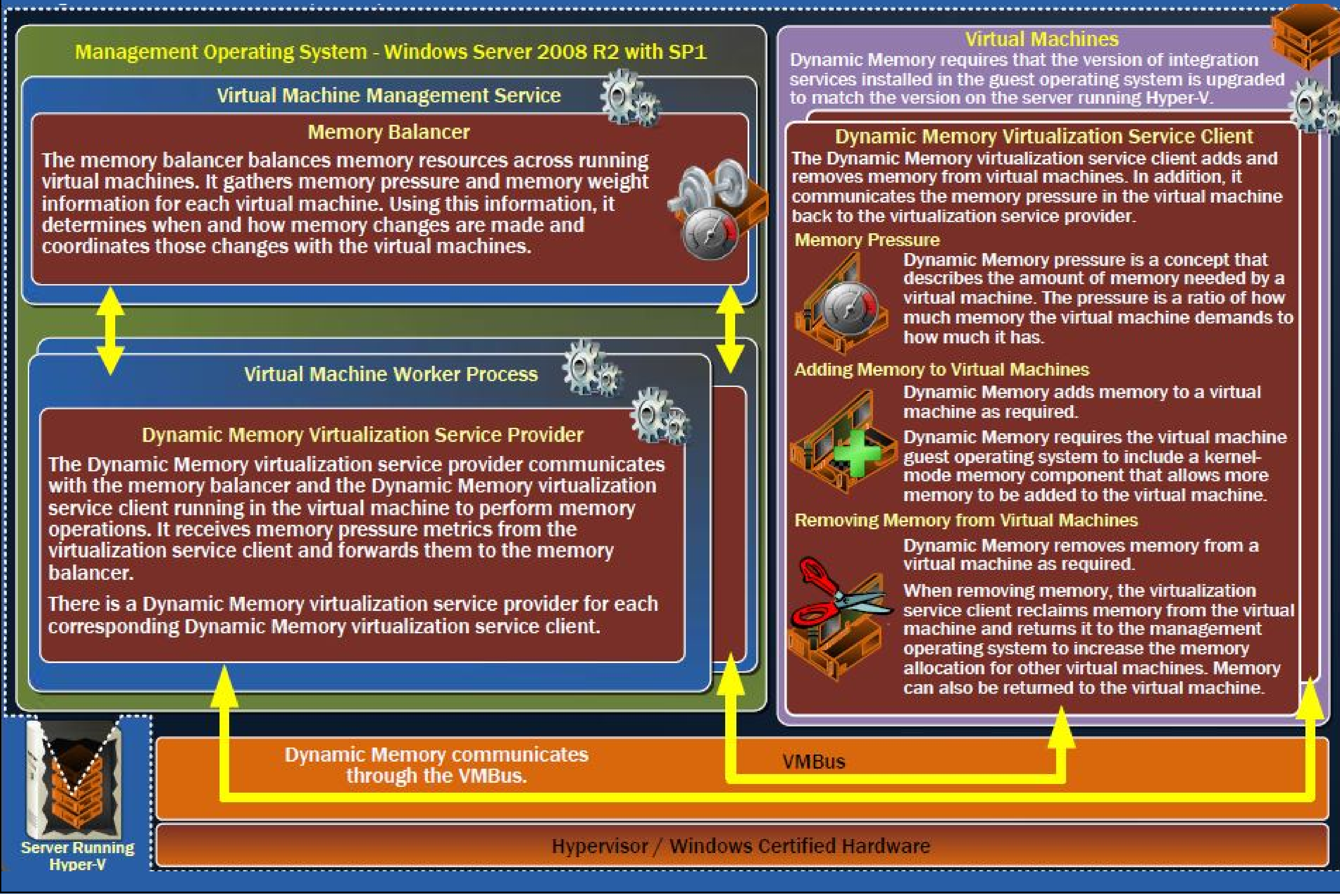
CSV supports dynamically expanding, fixed-sized, and differencing virtual hard disks.



Dynamic Memory Architecture (Windows Server 2008 R2 SP1)

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

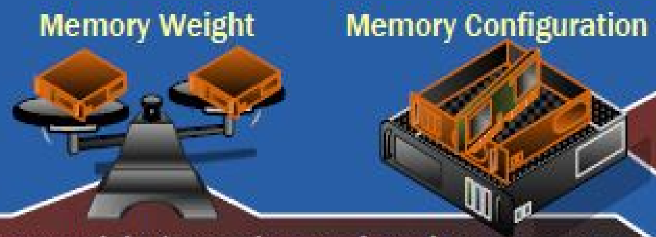
Dynamic Memory Architecture (Windows Server 2008 R2 SP1)



Dynamic Memory Configuration (Windows Server 2008 R2 SP1)

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

Dynamic Memory Configuration (Windows Server 2008 R2 SP1)

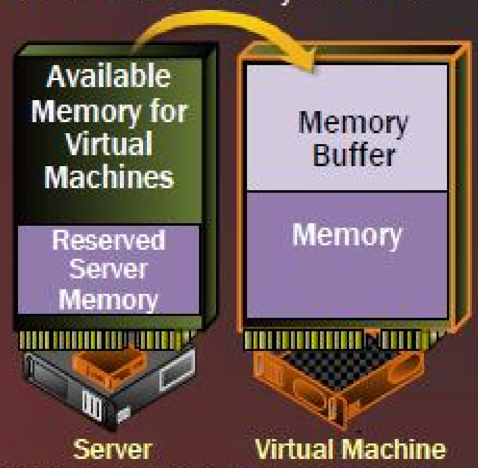


Memory weight (sometimes referred to as memory priority) identifies how important memory is to an individual virtual machine.

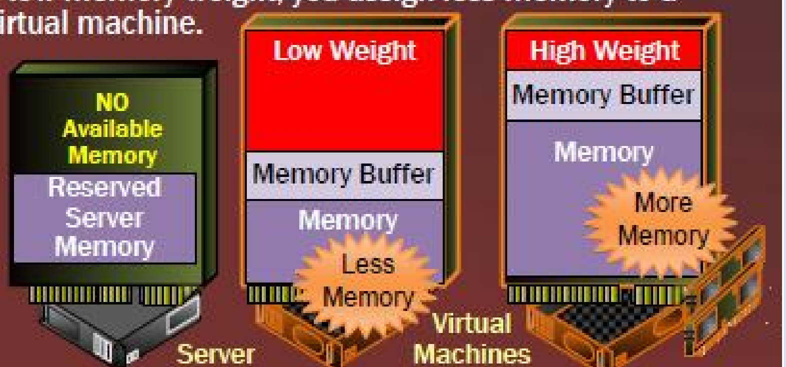
When memory is available on the server running Hyper-V, virtual machines receive their ideal memory allocation.

As more virtual machines are started, available memory is distributed to them.

When available memory is depleted on the server running Hyper-V, it uses memory weight to prioritize memory distribution and performance across the virtual machines.



When you configure a high memory weight, you assign more memory to a virtual machine. When you configure a low memory weight, you assign less memory to a virtual machine.



Dynamic Memory distributes memory to virtual machines based on startup RAM, memory buffer, maximum RAM, and memory weight.

Startup RAM

Specifies the amount of memory required to start a virtual machine. The memory allocated to a virtual machine does not fall below this value.

Specify a value that will be sufficient to allow the guest operating system in a virtual machine to start.

Memory Buffer

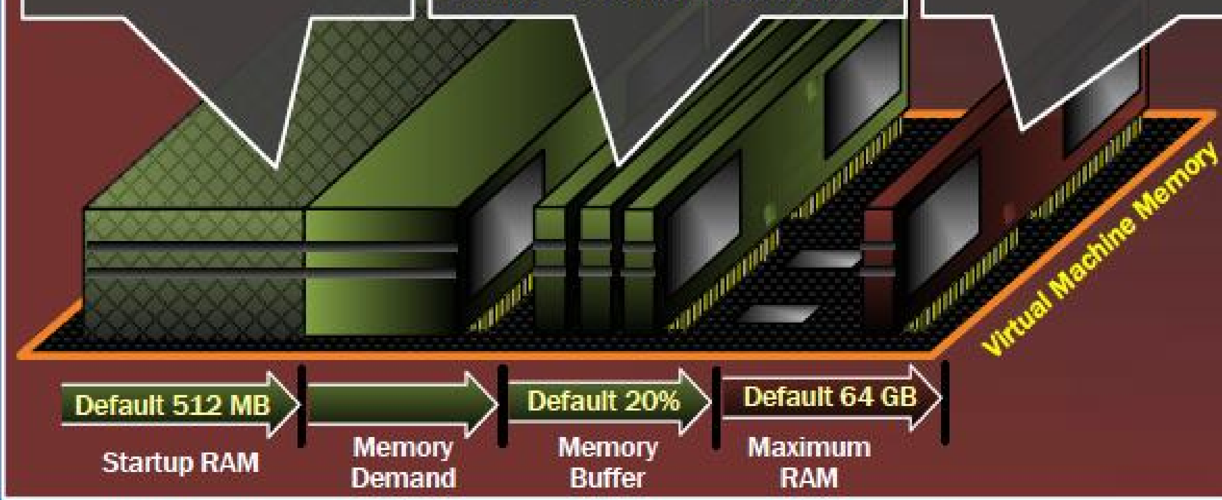
Specifies how much memory Hyper-V will attempt to assign to a virtual machine compared to the amount of memory actually needed by the applications and services running inside a virtual machine.

The buffer is determined using the following formula:

Memory Buffer Amount = Memory Demand * Configured Memory Buffer %

Maximum RAM

Specifies the upper limit for how much physical memory can be allocated to a virtual machine. The memory allocated to a virtual machine can never increase above this value.



Monitoring Dynamic Memory In Hyper-V

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

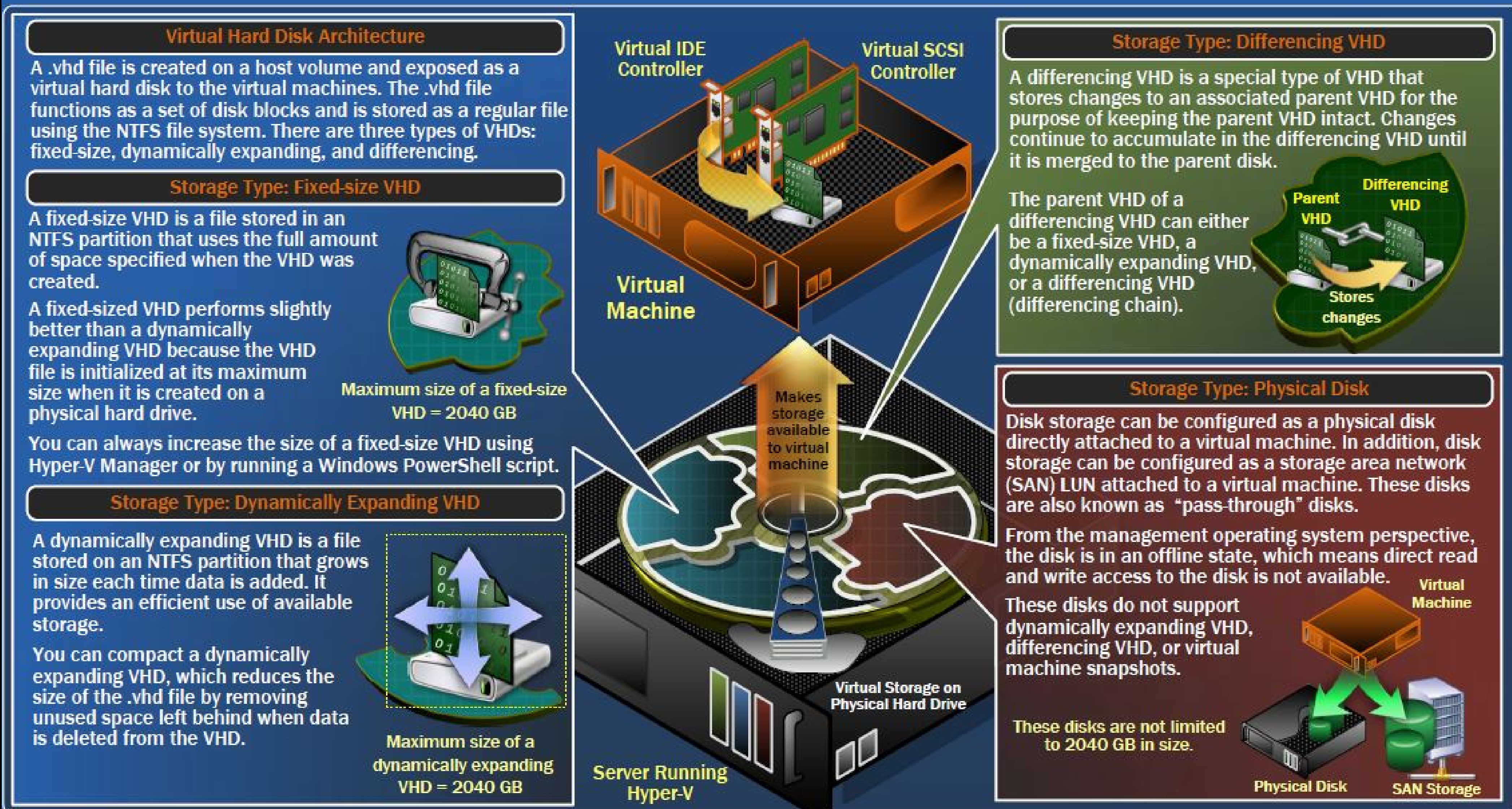
Dynamic Memory has two groups of performance counters for monitoring how memory is allocated to virtual machines:

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

Hyper-V Disk Storage Types

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

Hyper-V Disk Storage Types



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

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

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

Management Operating System - Windows Server 2008 R2 with SP1

Render Capture Compress (RCC) Component

The RCC component performs three core functions:

- **Render**
  Graphics processing requests are received from the virtual machine through the virtual GPU driver and are rendered into content using the physical GPU on the server running Hyper-V.
- **Capture**
  RemoteFX reviews the rendered content and captures any frame changes required for transport to the virtual machine. RemoteFX capture works with RDP to ensure that the client receives only the information (frames) it can process.
- **Compress**
  After frame information is finalized, the content is compressed and encoded using either software or a dedicated hardware chip.

Virtual Machines - Windows 7 with SP1

Applications

Remote Desktop Protocol (RDP)

RDP 7.1

RemoteFX integrates with RDP, which enables shared encryption, authentication, management, and device support.

Virtual GPU Driver

Applications in a running virtual machine behave as if they have a dedicated GPU. The virtual GPU driver takes advantage of the physical GPU capabilities on the server running Hyper-V and provides hardware acceleration to the guest operating system in the virtual machine.

Application requests for graphics processing are intercepted by the virtual GPU driver and sent to the RCC component across the Hyper-V virtual machine bus (VMBus).

Virtual GPU

VMBus

Hypervisor / Windows Certified Hardware

Server Requirements

- At least one GPU with at least 1 GB of video memory.
- Second-Level Address Translation (SLAT)–capable processor.
- Compliance with the Hyper-V hardware requirements.
- Remote Desktop Virtualization Host role service with RemoteFX enabled, Hyper-V role enabled.

Server Running Hyper-V

Graphics Processing Unit (GPU)

The physical GPU in the server is virtualized and shared among participating virtual machines. It works directly with the RCC component.

RemoteFX Application-specific Integrated Circuit (optional)

Compression and encoding can be transferred (from the CPU and GPU) onto a dedicated hardware chip that encodes display data from the RCC component.

End