

Configure Virtual Machines



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Topics in This Module



Generations and versions

Memory settings

Processor settings

Host settings

Integration services

Security settings



Generations and Versions



```
Administrator: Windows PowerShell
PS C:\> Get-VM | fl name,version,generation

Name       : Globomantics DC2 2016
Version    : 8.0
Generation : 2

Name       : Globomantics Linux
Version    : 8.0
Generation : 2

Name       : Globomantics NETDNS S2012
Version    : 5.0
Generation : 2

Name       : Globomantics RAS1 2016
Version    : 8.0
Generation : 2

Name       : Globomantics S2019
Version    : 8.0
Generation : 2

Name       : Globomantics win7
Version    : 8.0
Generation : 1

Name       : Globomantics win81
Version    : 8.0
Generation : 2

Name       : Globomantics WS1 w10
Version    : 8.0
Generation : 2

Name       : Globomantics WS2 w10
Version    : 8.0
Generation : 2

Name       : Globomantics WS3 w10
Version    : 8.0
Generation : 2

PS C:\> _
```

VM generations:

Design choice at time of VM creation

Affect *devices* available to the VM

Also affect OS compatibility

- Gen2 VMs require a newer OS

VM versions:

Independent of generation

Associated with versions of Windows Server

Affect *features* available to the VM





Once you select the generation at the time you create a VM, you cannot change it later.



Generation 1 VMs

Gen1



BIOS boot

Devices emulated in software:

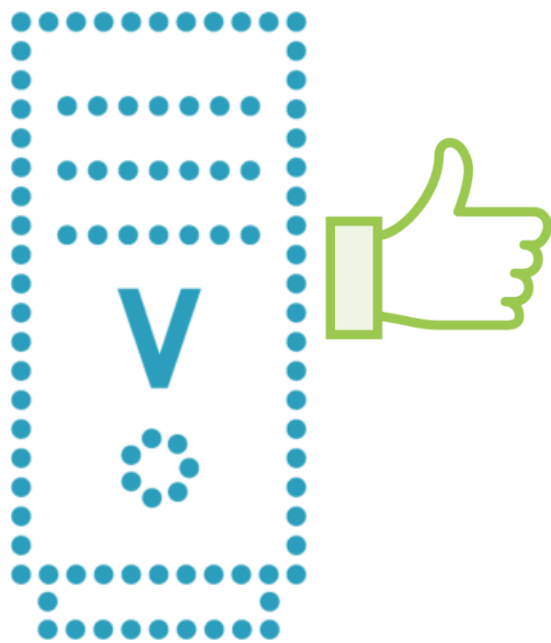
- IDE controllers
- SCSI controllers (non-booting)
- Network adapters
- COM ports
- Virtual floppies

Windows XP+



Generation 2 Advantages

Gen2



Supports “enlightened” operating systems

PXE boot using *standard* NIC

UEFI (and Secure Boot)

Virtual SCSI controller (up to 64 devices)

- Boot from SCSI (VHDX or ISO)

Max boot volume 64TB versus 2TB

Resize VHDX boot volume while running



Generation 2 Drawbacks

Gen2



No Windows 7, Server 2008R2, or earlier

- Windows 8+ (64-bit only)

Can no longer access physical DVD drive

No IDE controllers

Can no longer boot to a VFD

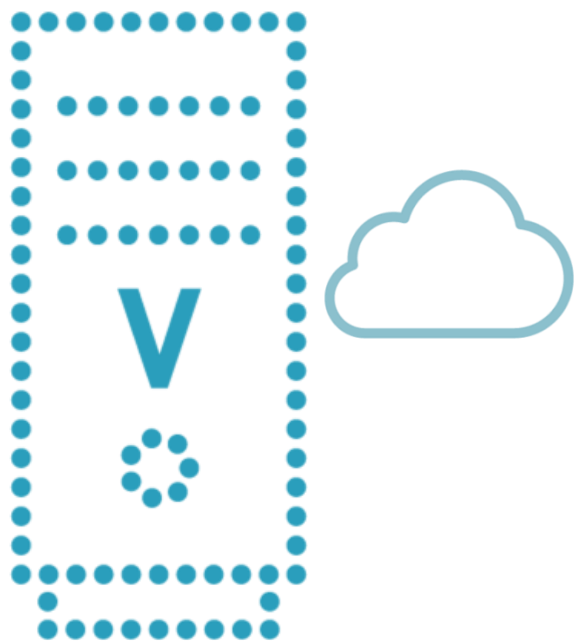
- Or use one at all

No COM ports initially

- Can be added via PowerShell

Generation 2 in Azure

Gen2



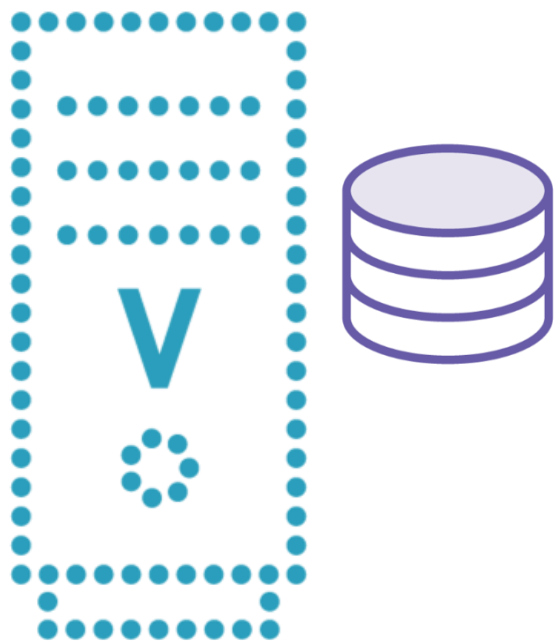
Now supported, *except* for:

- Secure boot
- Virtual TPM
- VHDX
- Shielded VMs
- Virtualization-Based Security



OS Support for Generation 2 VMs

Gen2



Server 2012+, Windows 8+ (x64)

RHEL/CentOS 6.x+ (6.x requires S2016+)

Debian 8.x+

FreeBSD 11.1+

Oracle Linux 7.x+

SUSE Linux Enterprise Server 12+

Ubuntu 14.04+



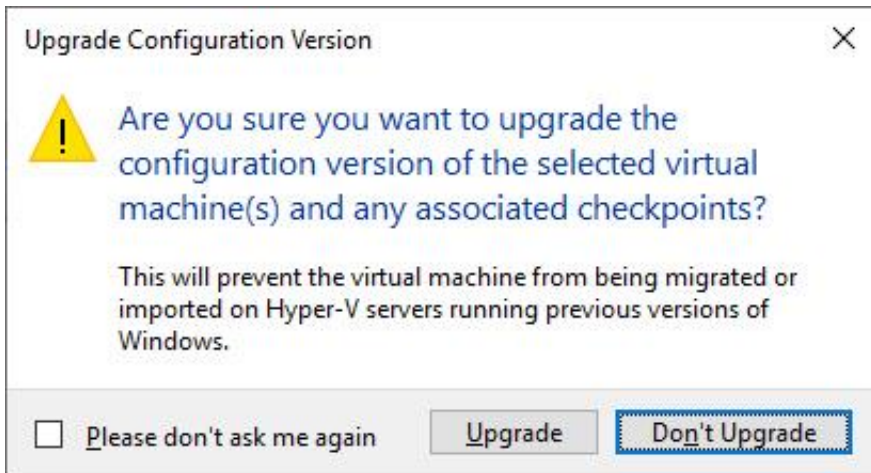
Demo



Exploring generational differences



Virtual Machine Versions



Check with Get-VM or Hyper-V Manager

Update with Update-VMVersion or Hyper-V Manager "Upgrade Configuration Version"

- VM must be off
- No downgrades

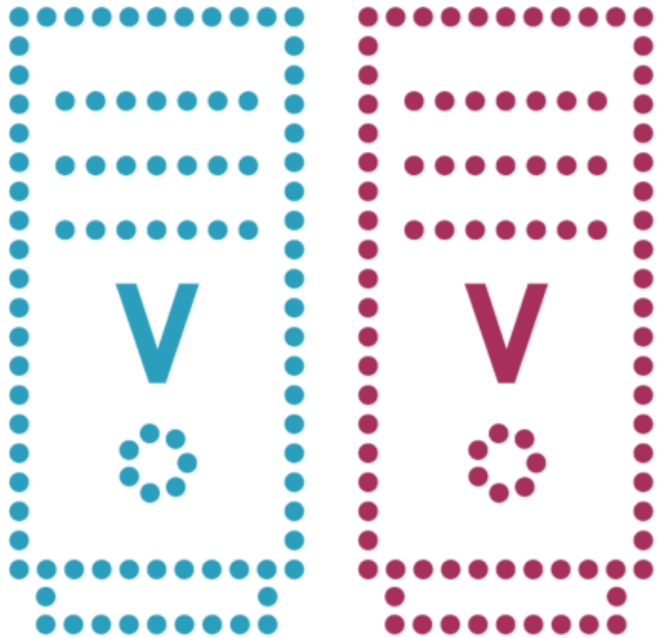
Associated with the server version where the VM was created

Host operating system defines maximum version possible for VM

- Get-VMHostSupportedVersion



Supported VM Versions by Host OS



Windows Server 2012 R2

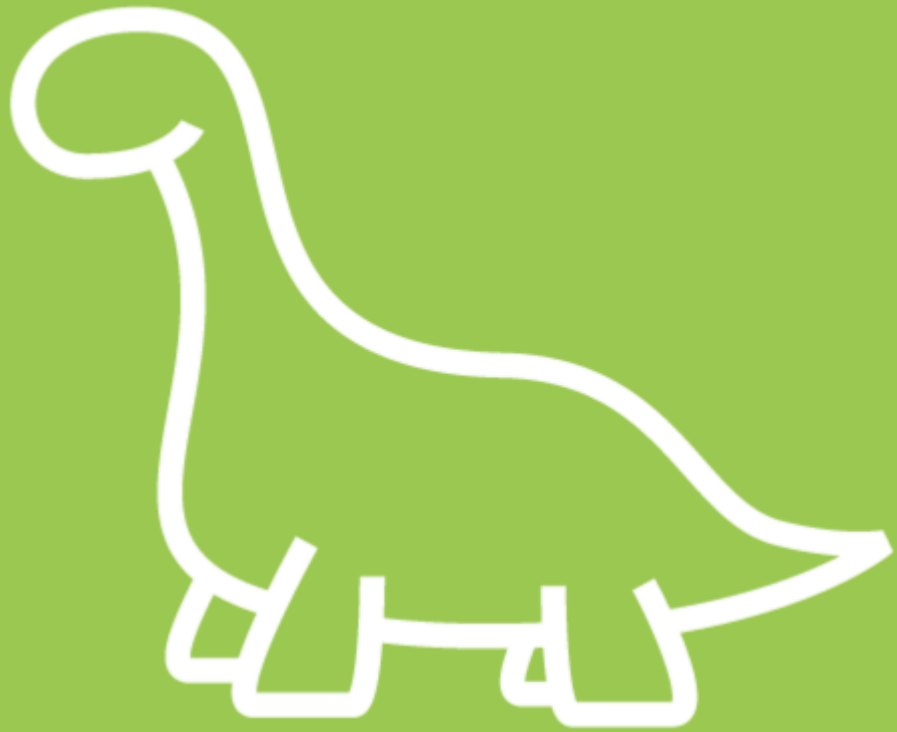
- 5.0

Windows Server 2016

- 5.0, 6.2, 7.0, 7.1, 8.0

Windows Server 2019

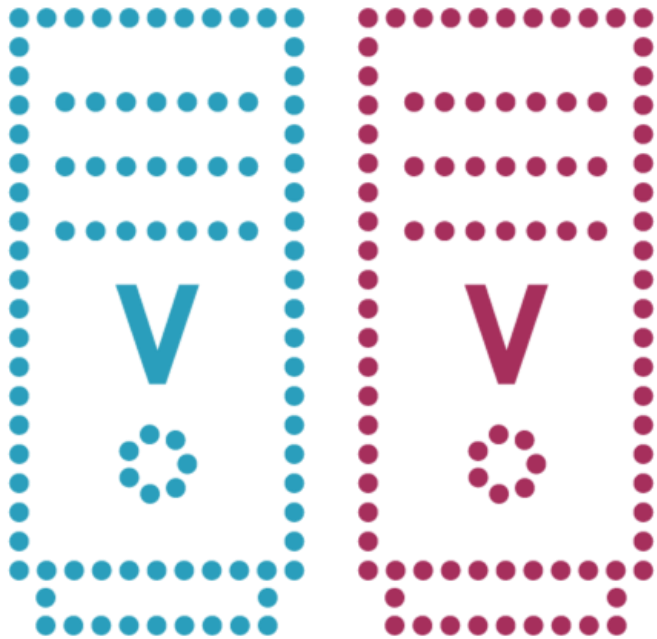
- 5.0, 6.2, 7.0, 7.1, 8.0, 8.1, 8.2, 8.3, 9.0



Need to build a VM for a legacy OS?

To create a VM with a version older than the default, use the parameter **-version** with the PowerShell cmdlet **New-VM**.

Features by VM Version: 6.2 (Server 2016 TP3)



Hot add/remove memory

Linux secure boot

Production checkpoints

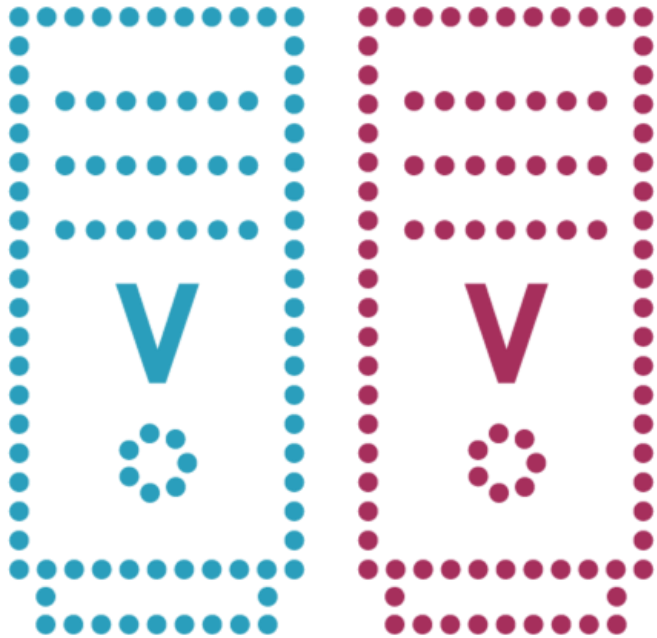
- More robust; backup inside the guest

PowerShell Direct

VM grouping

- For administrative activities

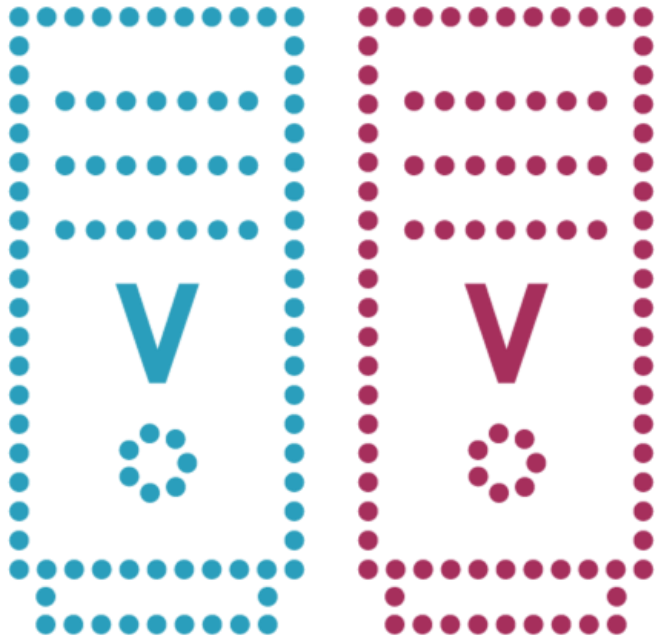
Features by VM Version: 7.0 (Server 2016 TP4)



Virtual TPM

- Enables BitLocker within a VM

Features by VM Version: 7.1 (Server 2016 TP5)

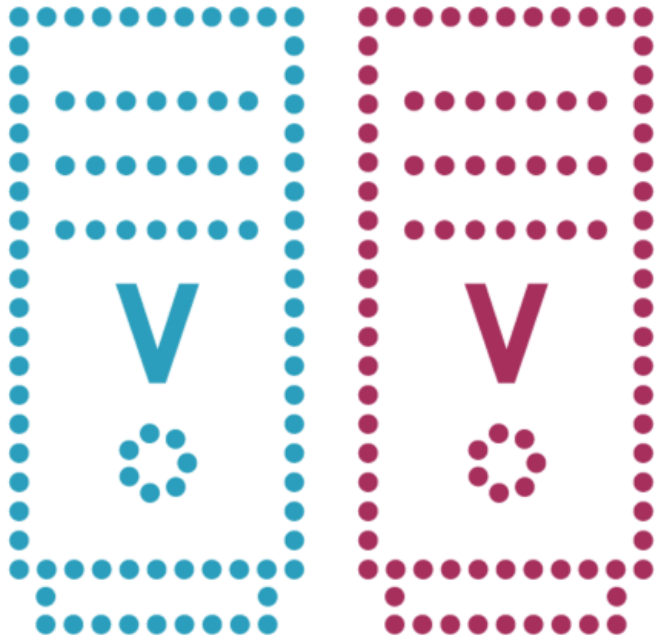


VM Multi-Queues (VMMQ)

- Multiple traffic queues per VM



Features by VM Version: 8.0 (Server 2016)



Key storage drive

- Encryption option for Gen1 VMs

Guest VBS support

- Device Guard, Credential Guard, etc.

Nested virtualization

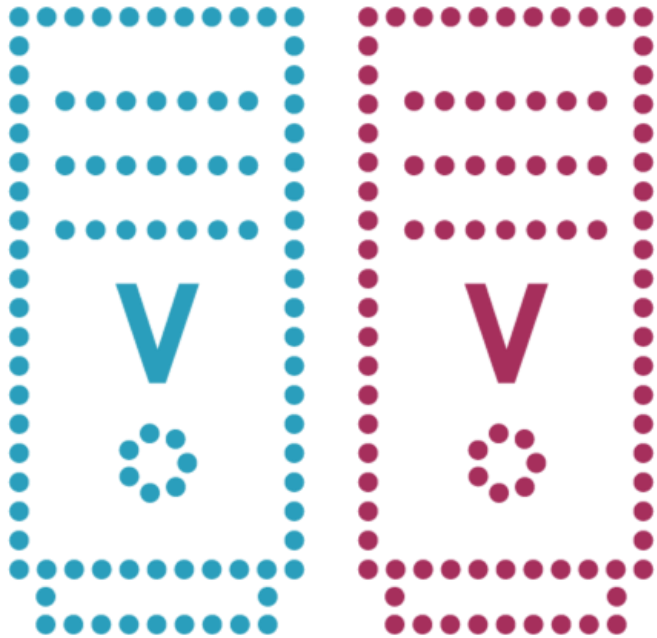
More virtual processors

- 240 vs. 64

Large memory VMs

- 12TB vs. 1TB

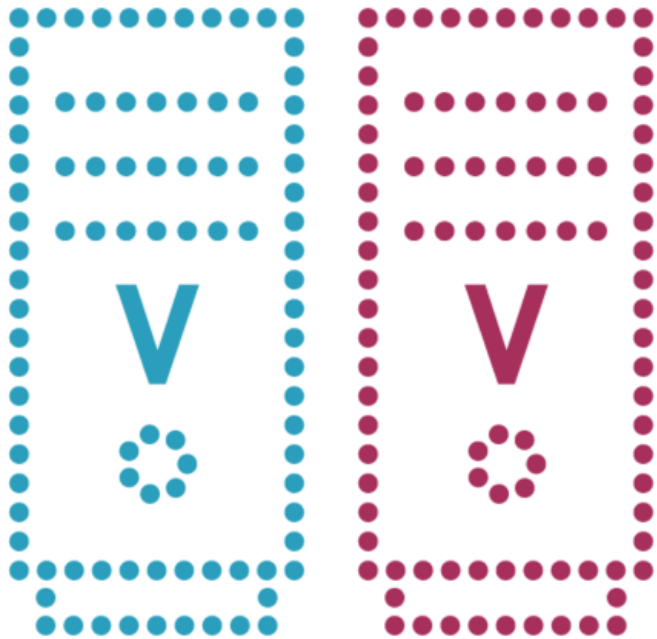
Features by VM Version: 8.3 (Server 1803)



Increase default maximum of virtual devices to 64



Features by VM Version: 9.0 (Server 2019)



Additional processor features for Performance Monitor

Provide SMT (Simultaneous MultiThreading) for VMs

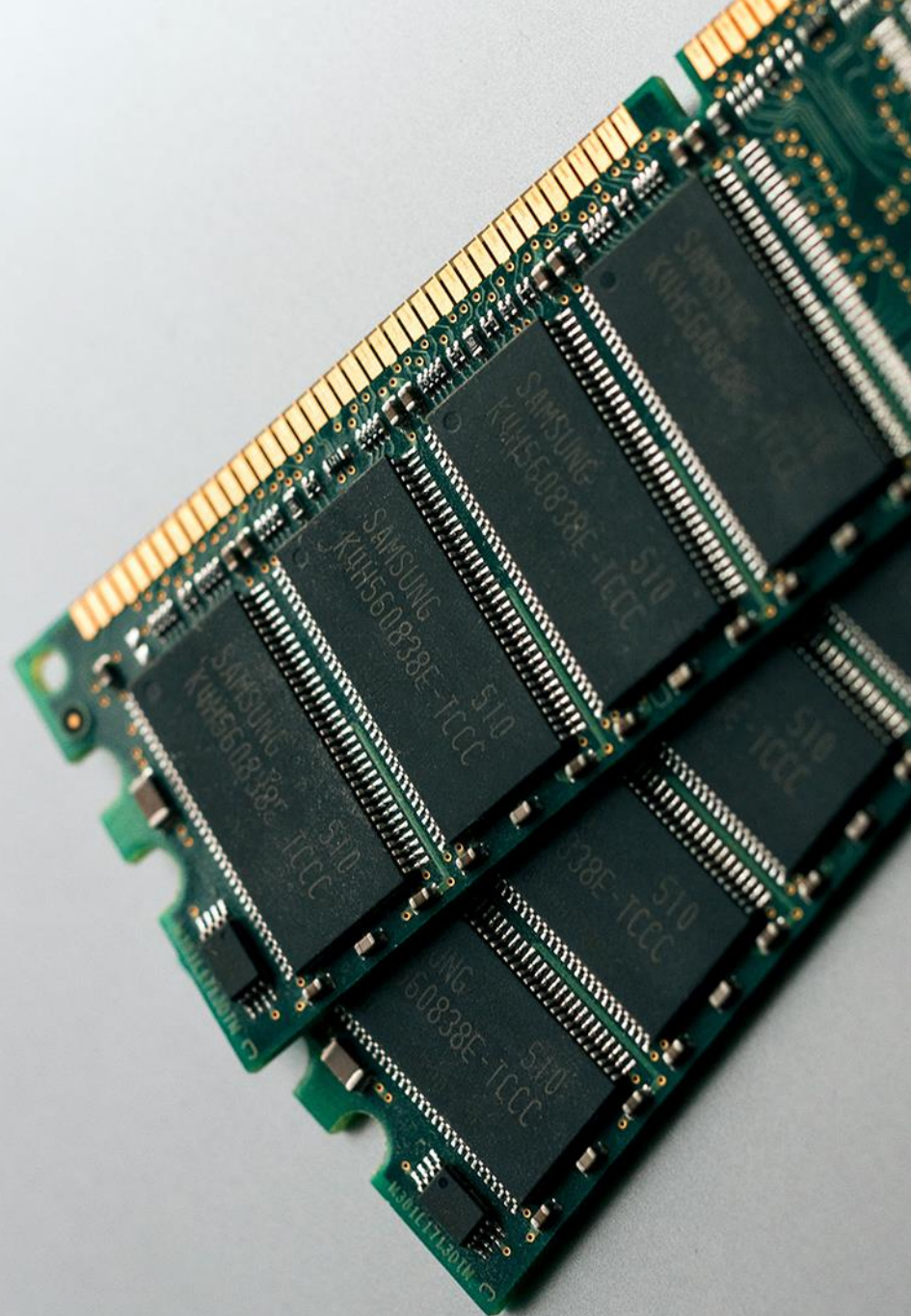
Hibernation support

Support for Linux in shielded VMs

Shielded VM enhancements for branch offices with intermittent connectivity

Memory Settings





Configuring VM memory:

Static (fixed) value

Dynamic memory

Persistent memory

Smart paging



The Importance of Memory



Memory is a major determinant of VM performance and stability

Static vs. dynamic

- Static: predictability
- Dynamic: efficiency

Persistent memory = fast RAM as storage

- Even faster than virtual disks on SSD

Smart paging = insurance policy



Static Memory Settings



RAM

- Fixed amount the VM will always see
- If physical memory available is less than this amount, VM will not start
- Property of the VM in Hyper-V Manager and Windows Admin Center
- Set-VMMemory in PowerShell

Weight

- Slider to prioritize one VM versus others in case of contention
- (Also available with dynamic memory)



Dynamic Memory Settings



Startup

- What the VM sees at boot time

Minimum

- The least amount the VM will receive
- Could be lower than the startup value

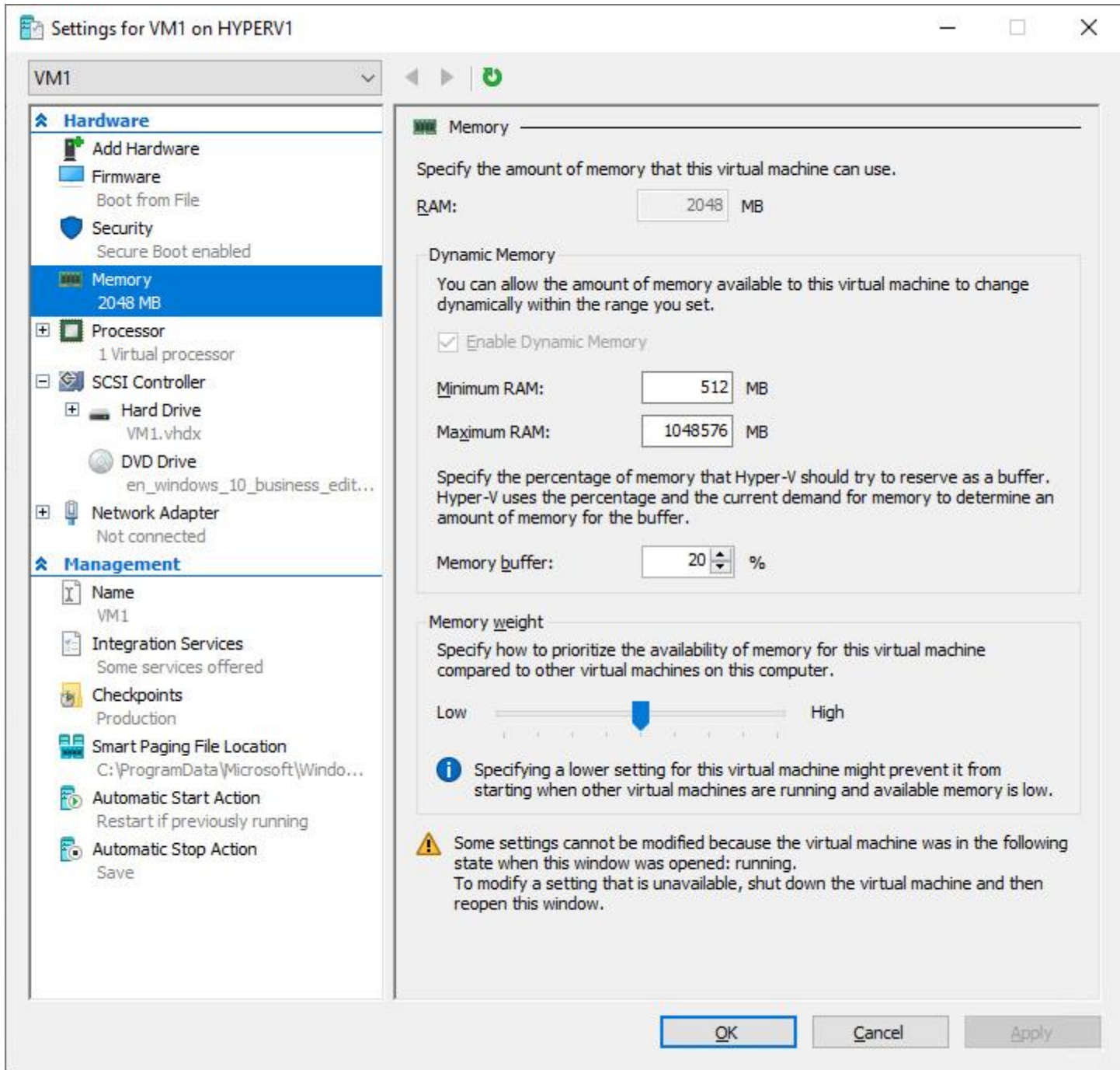
Maximum

- The greatest amount the VM will receive

Buffer

- Useful as the VM readjusts to demand





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Tools

- Virtual machine tools
- Roles & features
- Scheduled tasks
- Services
- Storage
- Storage Migration Service
- Storage Replica
- System Insights
- Updates
- Virtual machines**
- Virtual switches
- Settings

Settings for VM1

⚙️ General

📦 Memory

🖨️ Processors

📄 Disks

✈️ Networks

💻 Boot order

🕒 Checkpoints

🔍 Security

Memory

Startup memory (GB) *

Enable dynamic memory



Minimum memory (GB) *

Maximum memory (GB) *

Memory buffer (%) *

Memory weight



Save memory settings

Discard changes

Close



Administrator: Windows PowerShell

```
PS C:\Windows\system32> get-vmmemory -computername hyperv1 -vmname vm1
```

VMName	DynamicMemoryEnabled	Minimum(M)	Startup(M)	Maximum(M)
VM1	True	512	2048	1048576

```
PS C:\Windows\system32> set-vm -computername hyperv1 -vmname vm1 -memorystartupbytes 1536mb
```

```
PS C:\Windows\system32> set-vm -computername hyperv1 -vmname vm1 -dynamicmemory -memoryminimumbytes 640mb
```

```
PS C:\Windows\system32> set-vm -computername hyperv1 -vmname vm1 -dynamicmemory -memorymaximumbytes 4gb
```

```
PS C:\Windows\system32> get-vmmemory -computername hyperv1 -vmname vm1
```

VMName	DynamicMemoryEnabled	Minimum(M)	Startup(M)	Maximum(M)
VM1	True	640	1536	4096

```
PS C:\Windows\system32> █
```



Dynamic Memory

RAM used by VM1

At startup

RAM used by VM2

At startup



Dynamic Memory

RAM used by VM1

Under heavy load

RAM used by VM2

At idle



Dynamic Memory

RAM used by VM1

Under moderate load

RAM used by VM2

Under moderate load



Demo



The effect of dynamic memory



Persistent Memory: Concept



Similar to “RAM disk” of yesteryear

- Persistent storage at fast RAM speeds
- DIMM slot = closer to processor
- Battery backup = nonvolatile

Newly supported for VMs in Server 2019

NVDIMM, NVM, SCM

Implement via BIOS/UEFI, PowerShell

Persistent Memory: Implementation



Relevant PowerShell (full syntax omitted):

```
Get-PmemUnusedRegion | New-PmemDisk
```

```
Initialize-Disk
```

```
New-Partition
```

```
Format-Volume -FileSystem NTFS  
-IsDAX $True
```

```
Add-VMPmemController -VMName <name>
```

```
New-VHD -Path <path>.vhdpmem  
-SizeBytes <size> -Fixed
```



Persistent Memory: Implementation



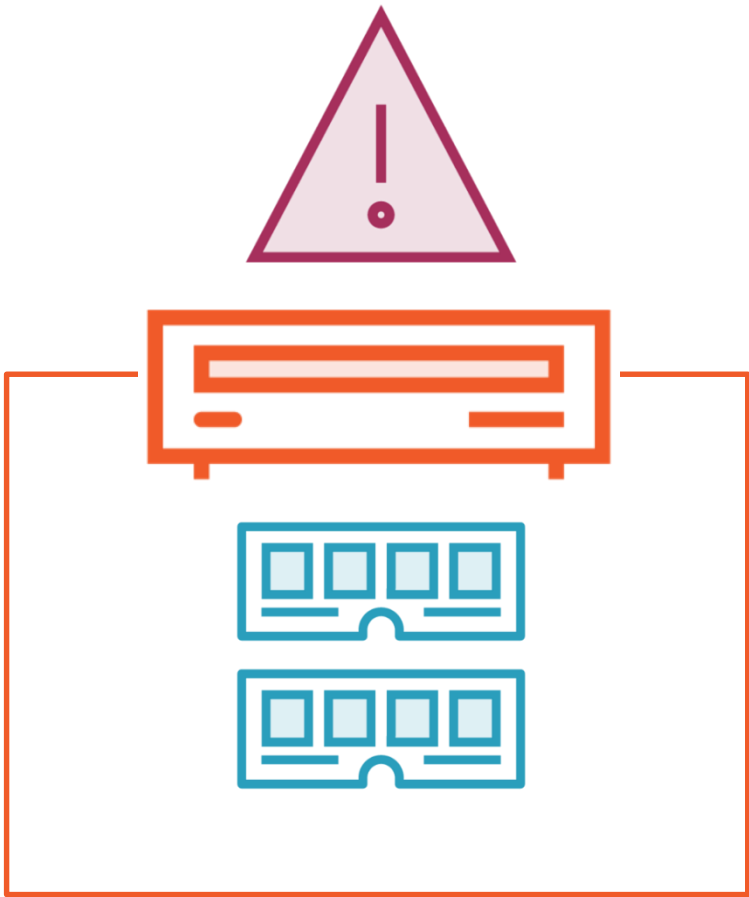
```
Add-VMHardDiskDrive -VMName <name>  
-ControllerType PMEM -Path <path>
```

Within the VM:

- Initialize disk
- Create and format volume using IsDAX parameter



Persistent Memory: Limitations



Generation 2 VMs only

No live migrations

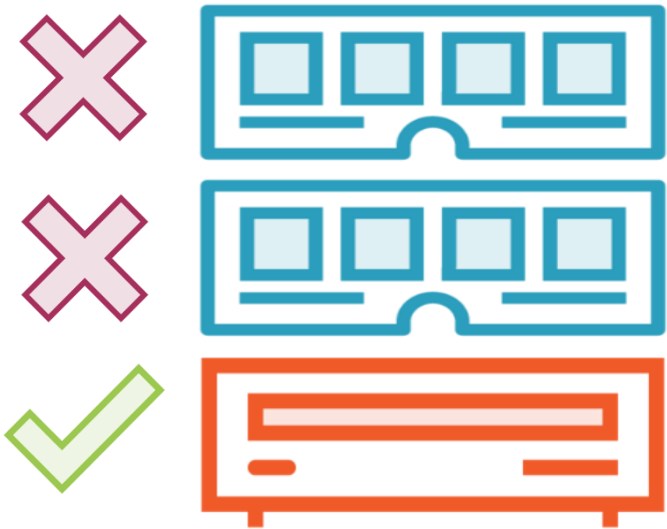
No storage migrations

No dynamic resizing

No production checkpoints



Smart Paging



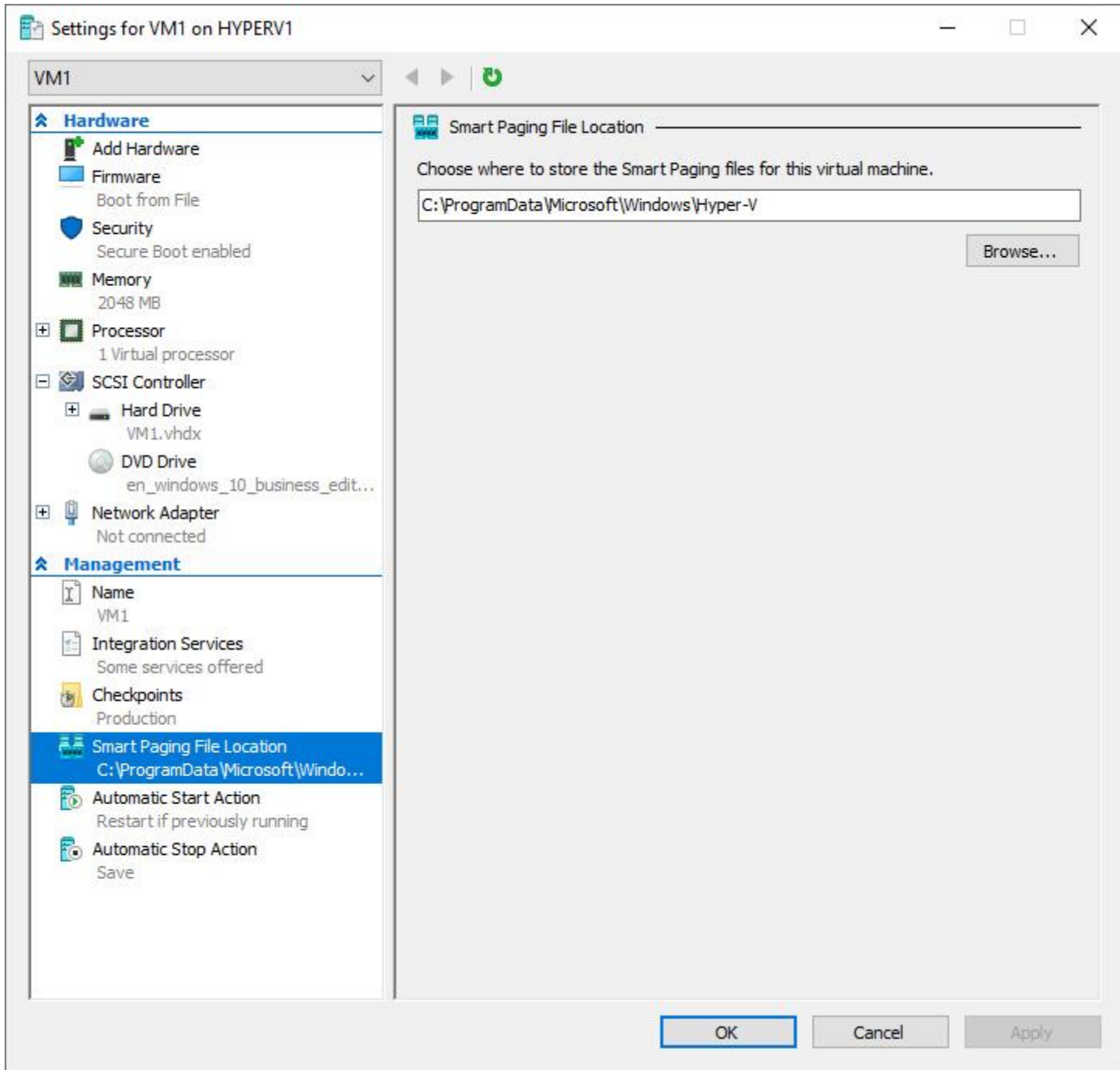
Uses disk space as an emergency reserve

Only used for extra memory needed during startup

Deals with scenario where multiple VMs reboot at the same time and RAM is low

Only configurable parameter is pagefile location

- Hyper-V Manager
- Set-VM ... -SmartPagingFilePath



Processor Settings





Processor settings to consider:

Number of processors to emulate

Resource control

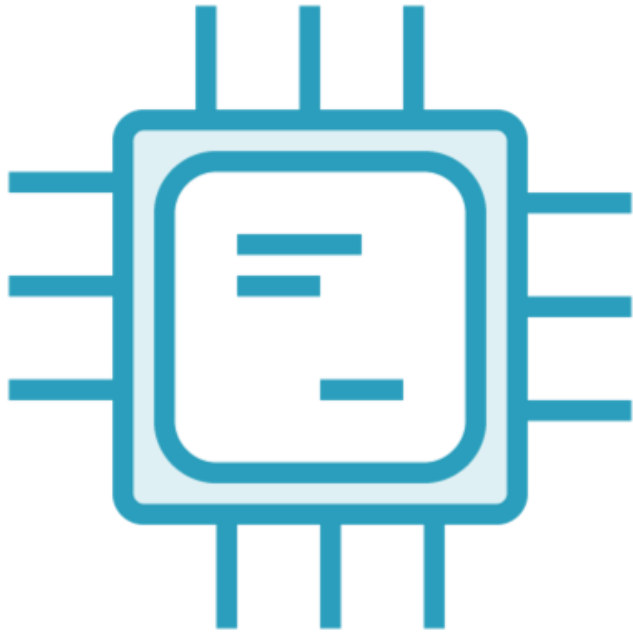
Scheduler type

Compatibility mode

Non-Uniform Memory Access (NUMA)



Number of Virtual Processors



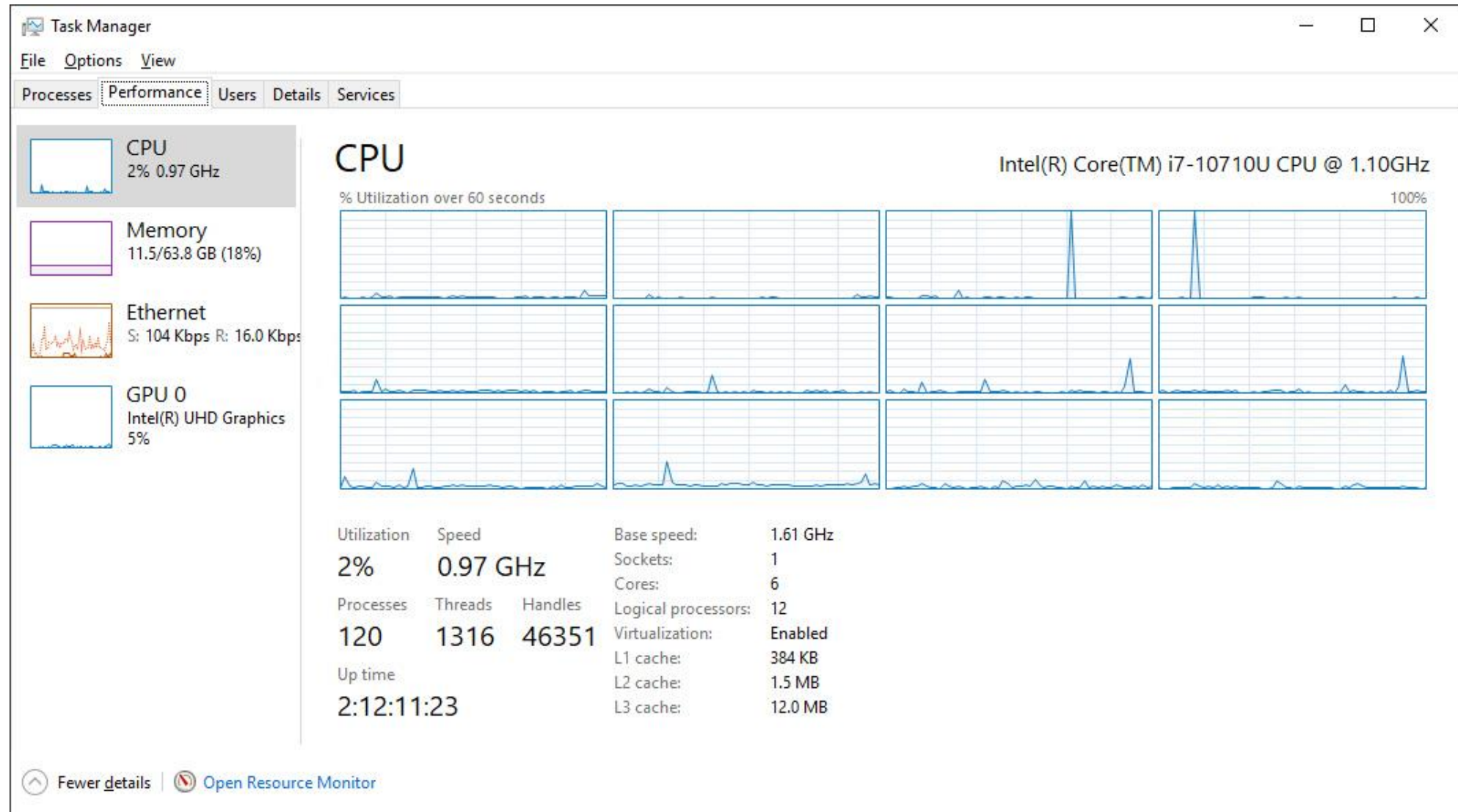
Maximum vCPUs per host = 2048

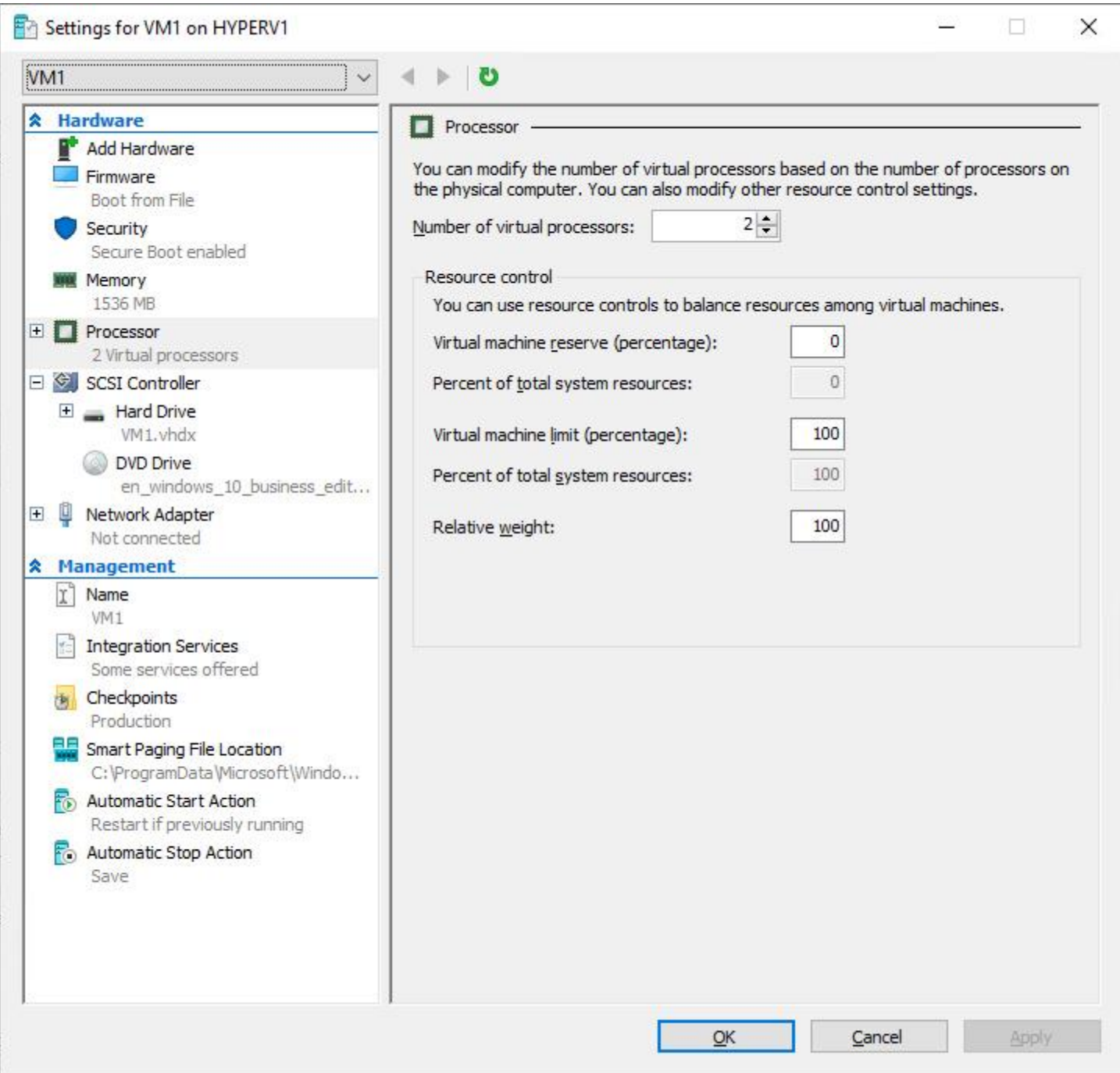
Maximum vCPUs per VM = 240 (!)

- BUT you cannot have more vCPUs than you have logical processors in the host



1 CPU, 6 Cores, 12 Logical Processors





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Tools

- Virtual machine tools
- Roles & features
- Scheduled tasks
- Services
- Storage
- Storage Migration Service
- Storage Replica
- System Insights
- Updates
- Virtual machines**
- Virtual switches
- Settings

Settings for VM1

⚙️ General

💾 Memory

🖨️ **Processors**

💾 Disks

🌐 Networks

💻 Boot order

🕒 Checkpoints

🔍 Security

Processors

Number of virtual processors *

Enable nested virtualization

☐

Enable Simultaneous Multithreading (SMT)

☒

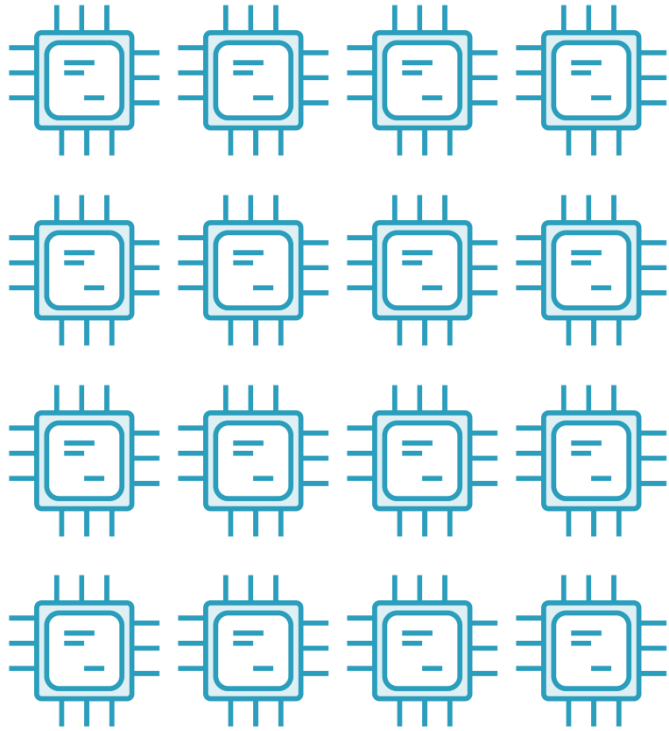
Save processor settings

Discard changes

Close



More is not Always Better



Guest CPU synchronization can add overhead

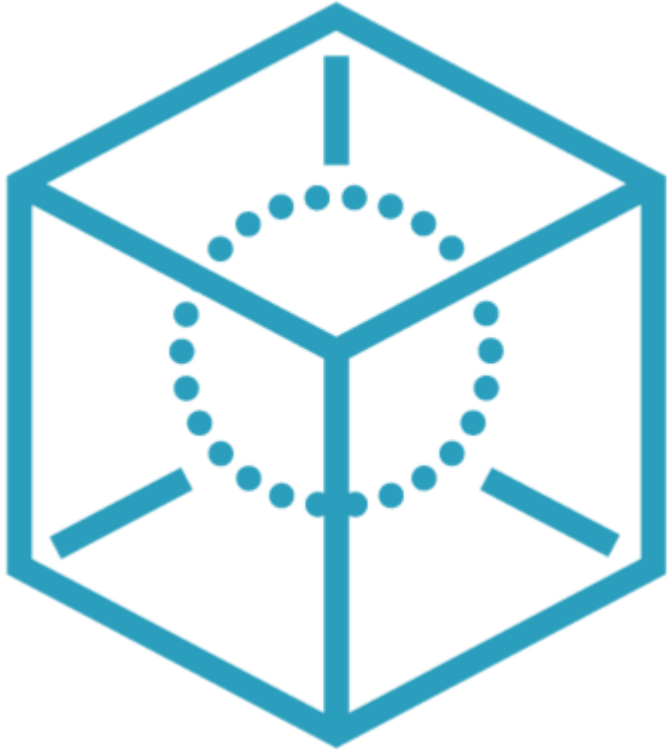
Point of diminishing returns

Testing (as usual) is recommended

CPU-intensive applications can benefit from multiple virtual CPUs



Resource Control: Lower Limit



Virtual machine reserve

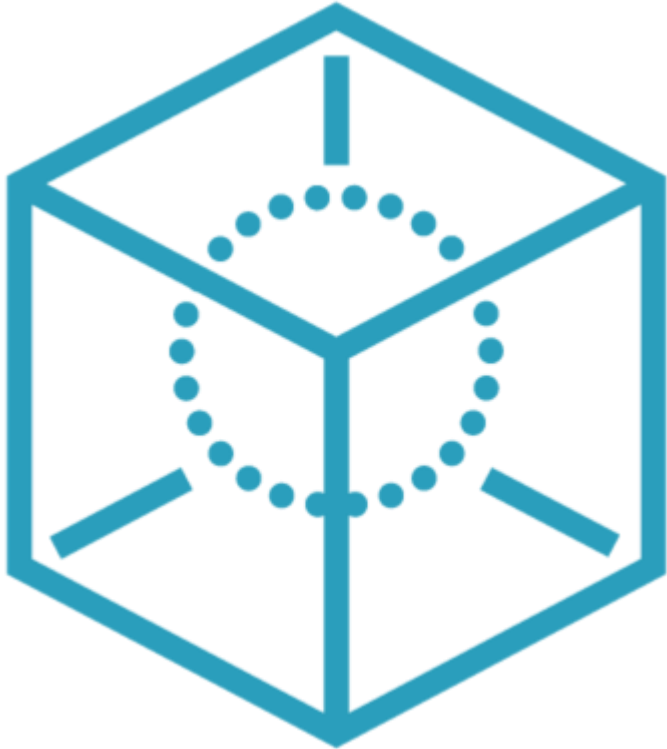
- % of allocated vCPUs to set aside

Percent of total system resources

- $(\text{VM reserve}) \times (\text{allocated vCPUs}) \div (\text{host logical processors})$



Resource Control: Upper Limit



Virtual machine limit (%)

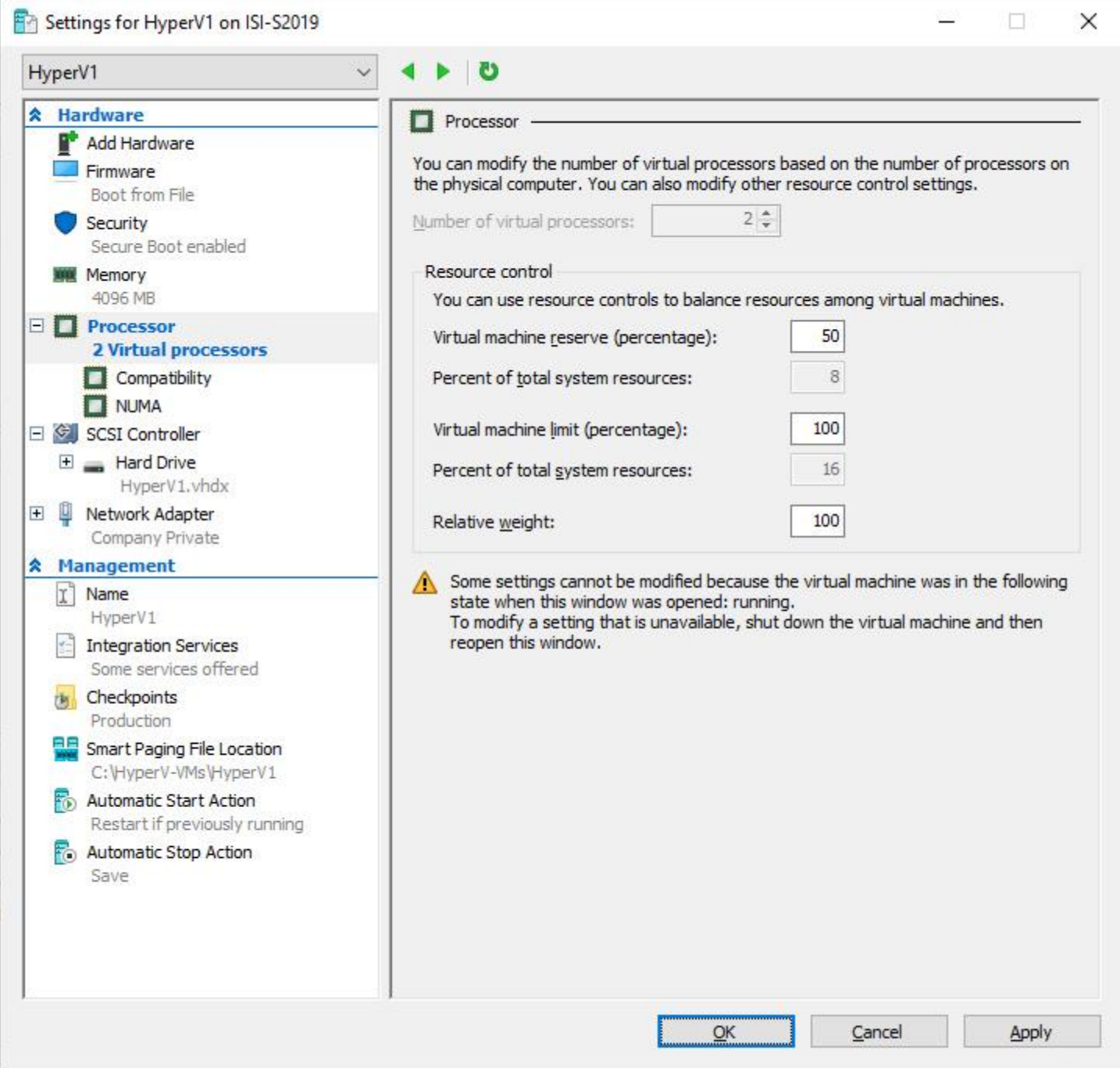
- Maximum % of allocated vCPUs

Percent of total system resources

- $(\text{VM limit}) \times (\text{allocated vCPUs}) \div (\text{host logical processors})$

Relative weight

- How to allocate CPU time when multiple VMs are contending for resources



Hypervisor Scheduler Type



How the hypervisor allocates CPU time

Core scheduler

- Introduced in Server 2016
- Default in Server 2019
- Reduces vulnerability to certain security threats (“side-channel snooping”)
- VMs can use multithreading (SMT) if supported on host

Classic scheduler

- Fine for most environments

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Tools

- Overview
- Azure hybrid services
- Azure Backup
- Azure File Sync
- Azure Monitor
- Azure Security Center
- Certificates
- Devices
- Events
- Files
- Settings

Settings

General

- Environment variables
- Azure Arc for Servers
- Power configuration
- Remote Desktop
- Role-based Access Control

Hyper-V Host Settings

- General
- Enhanced Session Mode
- NUMA Spanning
- Live Migration
- Storage Migration

General

Virtual Hard Disks Path * ⓘ

C:\Users\Public\Documents\Hyper-V\Virtual H

Browse

Virtual Machines Path * ⓘ

C:\ProgramData\Microsoft\Windows\Hyper-V

Browse

Hypervisor Scheduler Type ⓘ

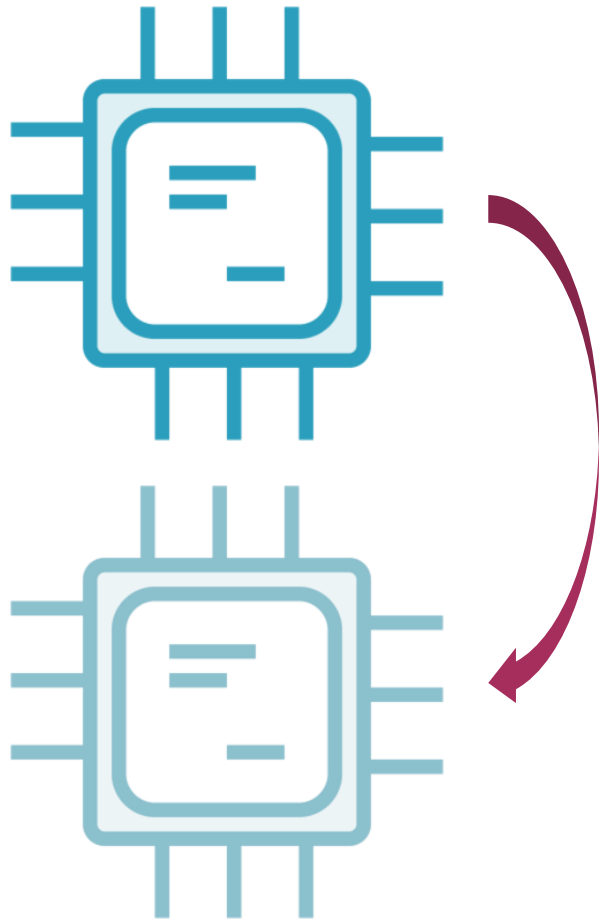
- ☒ Core Scheduler (Recommended)
- ☐ Classic Scheduler

Save

Discard changes

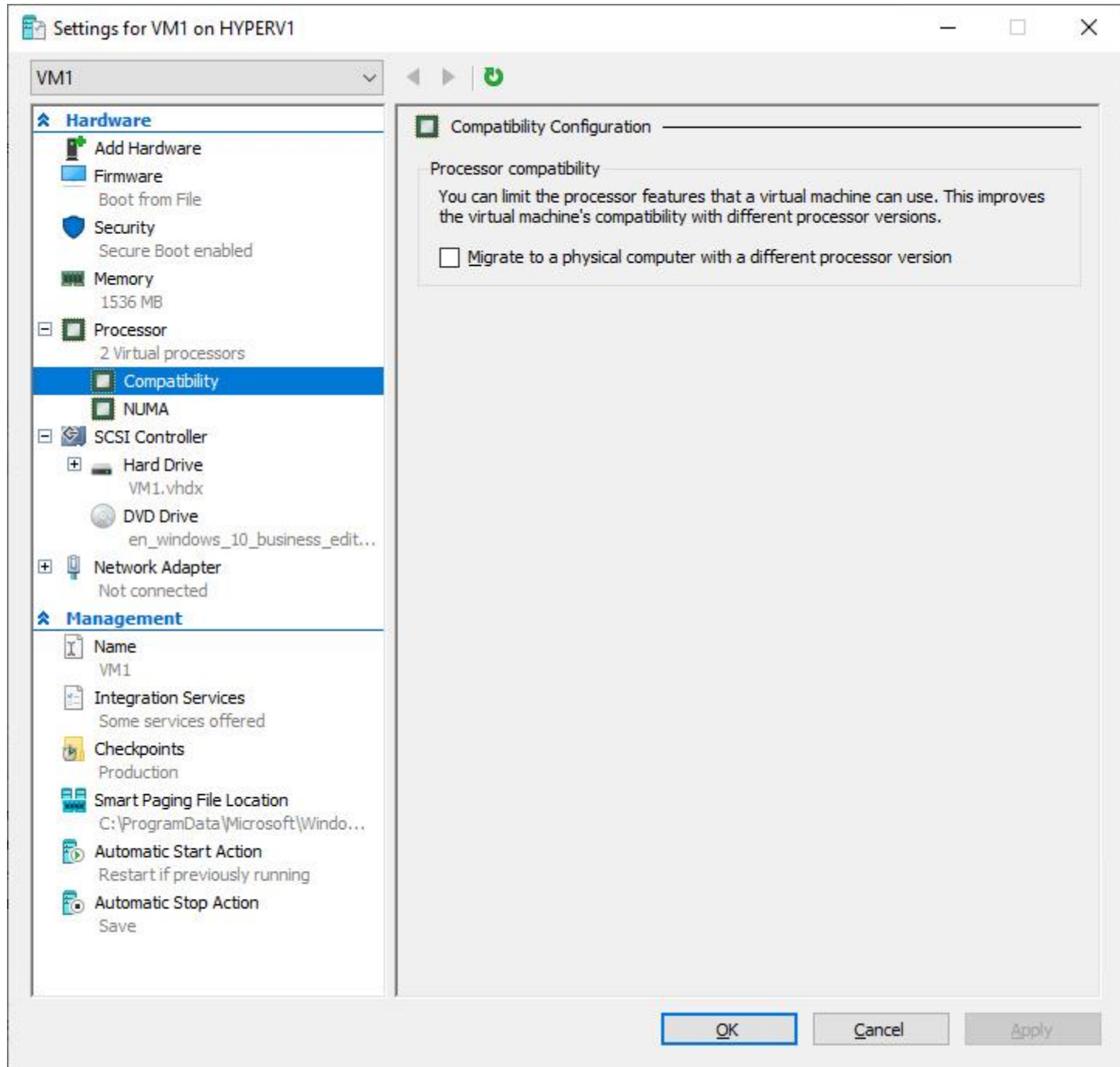


Processor Compatibility Mode

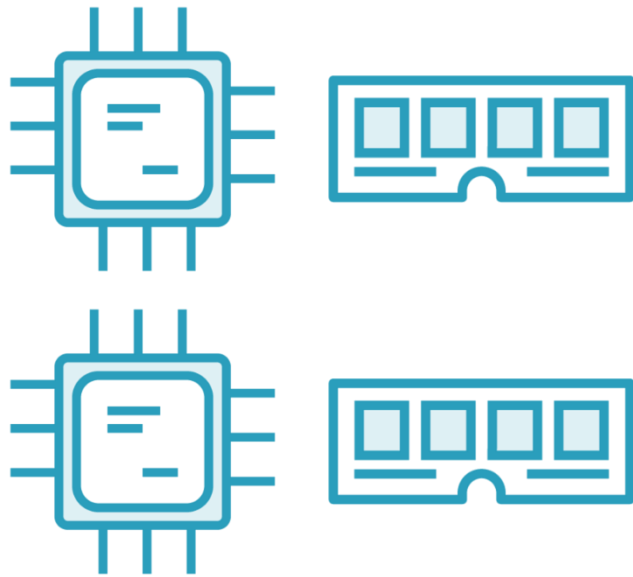


Lets us “live migrate” a running VM to a host with a different CPU version

- Must stay within same manufacturer (Intel, AMD)
- Disables some advanced features
- May not need if CPUs are same generation
- Not meant to be on permanently



NUMA Spanning



Host setting + VM setting

Enabled by default

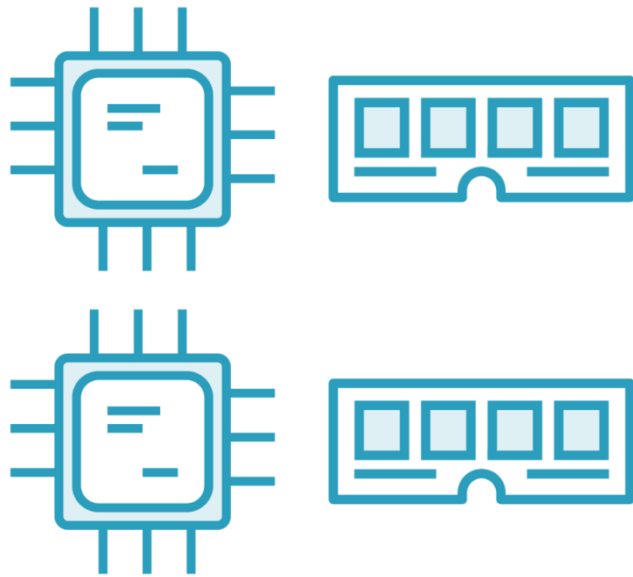
Node = processor + nearby memory

NUMA spanning: VM can use memory outside its node

NUMA-aware applications can perform NUMA speed optimizations

- Fastest if virtual NUMA topology mirrors physical (host) NUMA topology

NUMA Spanning Pros and Cons

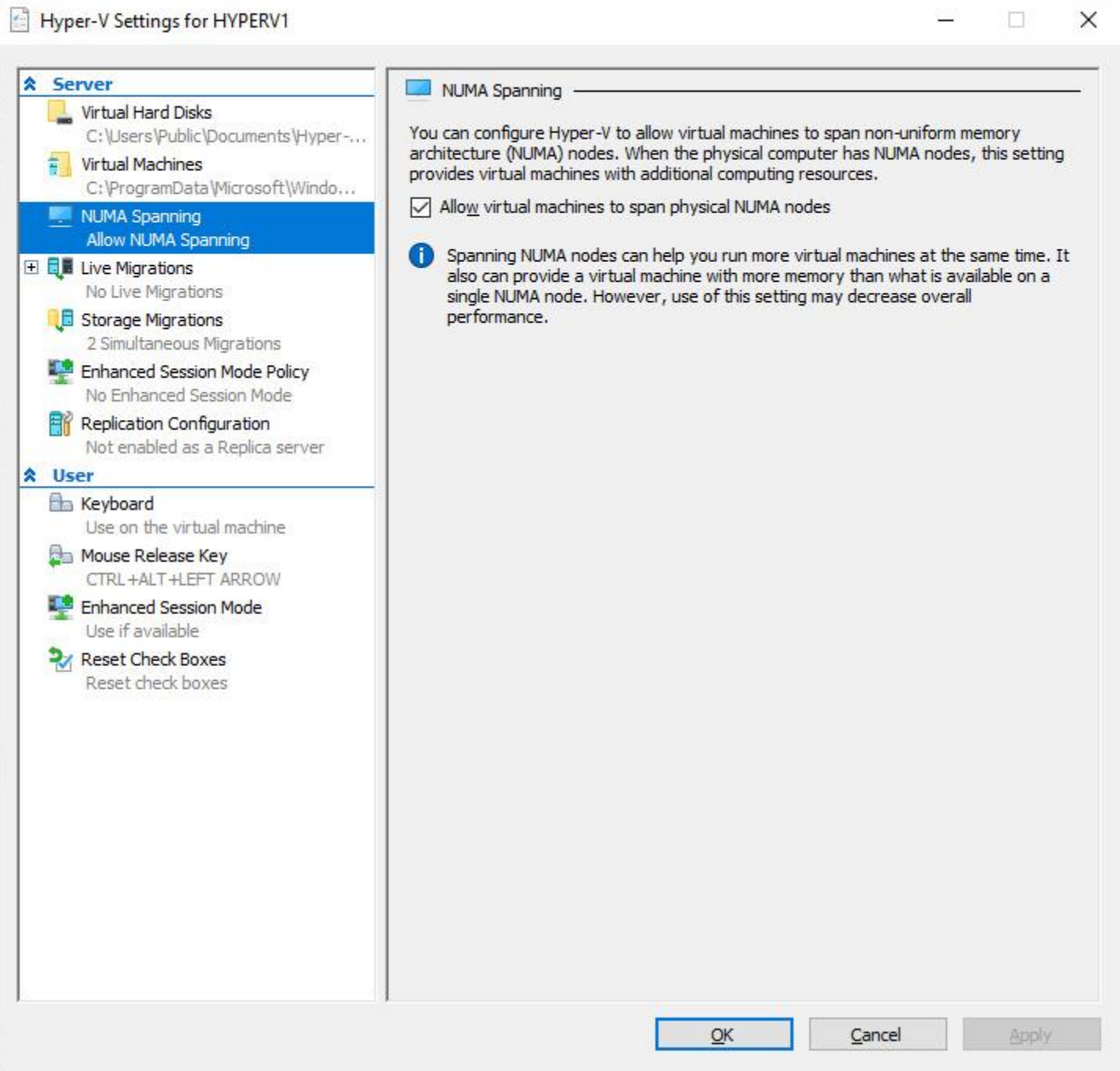


NUMA spanning ON:

- Very large VMs can access all available memory
- NUMA-aware apps may run slower if virtual topology does not mirror physical

NUMA spanning OFF:

- Very large VMs might not start if they need more RAM than in one node
- NUMA-aware apps will perform fastest



Windows Admin Center

Server Manager

Microsoft

>

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Tools

Search Tools

Overview

Azure hybrid services

Azure Backup

Azure File Sync

Azure Monitor

Azure Security Center

Certificates

Devices

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Files

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Hyper-V Host Settings

General

Enhanced Session Mode

NUMA Spanning

Live Migration

Storage Migration

NUMA Spanning

NUMA Spanning

You can configure Hyper-V to allow virtual machines to span non-uniform memory architecture (NUMA) nodes. When the physical computer has NUMA nodes, this setting provides virtual machines with additional computing resources.

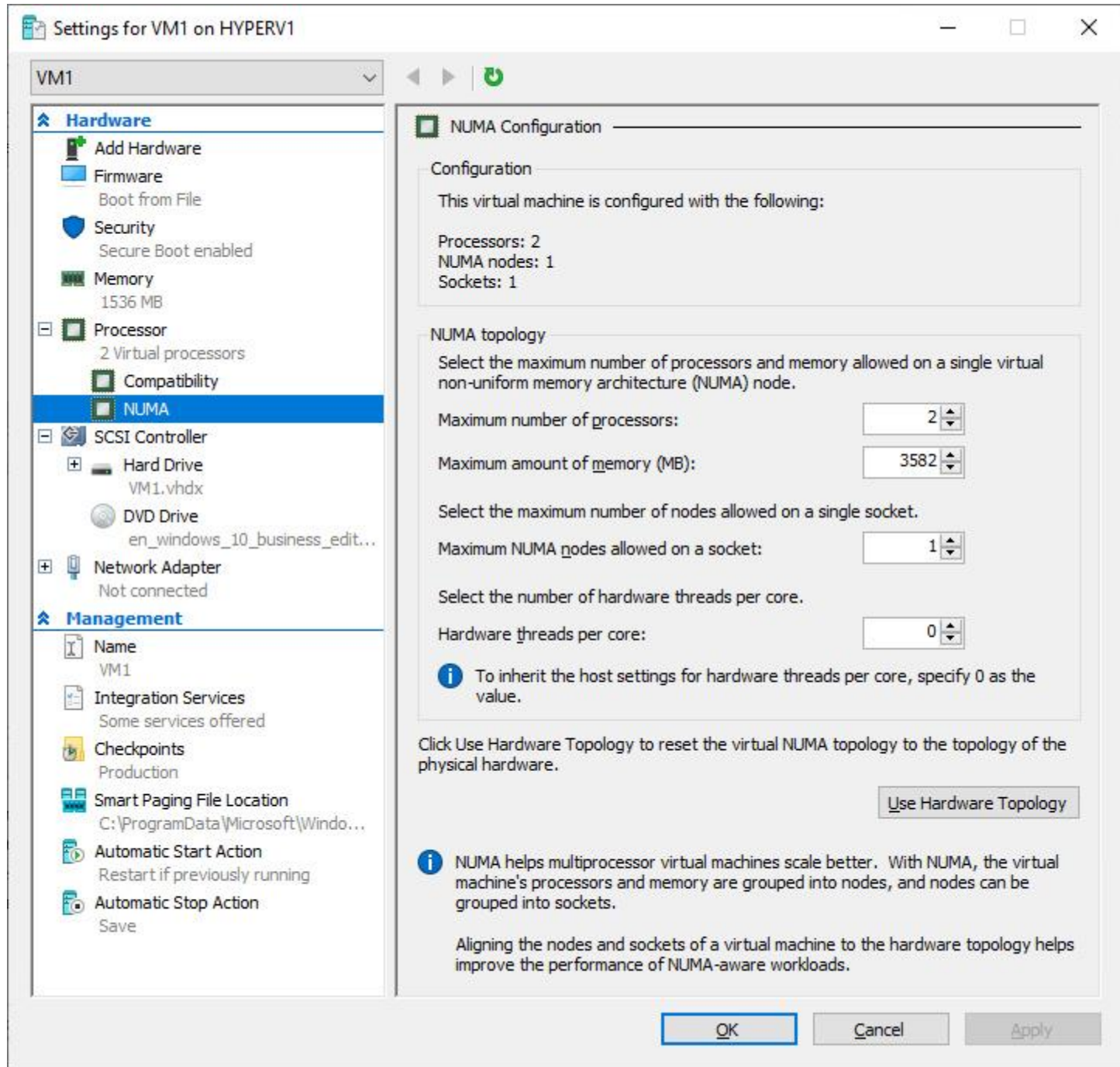
Allow virtual machines to span physical NUMA nodes ☒

NUMA Spanning

Spanning NUMA nodes can help you run more virtual machines at the same time. It also can provide a virtual machine with more memory than what is available on a single NUMA node. However, use of this setting may decrease overall performance.

Save

Discard changes





At this writing, you cannot set the NUMA spanning settings on the guest VM using Windows Admin Center.



Host Settings





Hyper-V host settings:

Enhanced session mode

Resource metering

Live migration

Export/import



Enhanced Session Mode



Permits guests to see host resources:

- USB devices (not by default)
- Drives (not by default)
- Printers
- Clipboard
- Drag-and-drop file copy
- Audio devices

Enable via GUI tools

- Two locations in Hyper-V Manager

Server

- Virtual Hard Disks
C:\Users\Public\Documents\Hyper-...
- Virtual Machines
C:\ProgramData\Microsoft\Windo...
- NUMA Spanning
Allow NUMA Spanning
- Live Migrations
No Live Migrations
- Storage Migrations
2 Simultaneous Migrations
- Enhanced Session Mode Policy**
No Enhanced Session Mode
- Replication Configuration
Not enabled as a Replica server

User

- Keyboard
Use on the virtual machine
- Mouse Release Key
CTRL+ALT+LEFT ARROW
- Enhanced Session Mode
Use if available
- Reset Check Boxes
Reset check boxes

Enhanced Session Mode Policy

You can configure Hyper-V to allow enhanced session mode connections to virtual machines running on this server.

☐ Allow enhanced session mode

i Enhanced session mode allows redirection of local devices and resources from computers running Virtual Machine Connection.

Enhanced session mode requires a supported guest operating system, and may require additional configuration inside the virtual machine. Redirection capabilities may differ according to guest operating system version.

Existing Virtual Machine Connection sessions may need to be restarted if this setting is changed.

OK

Cancel

Apply



Windows Admin Center

Server Manager

Microsoft

>

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Tools

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Scheduled tasks

Services

Storage

Storage Migration Service

Storage Replica

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Enhanced Session Mode

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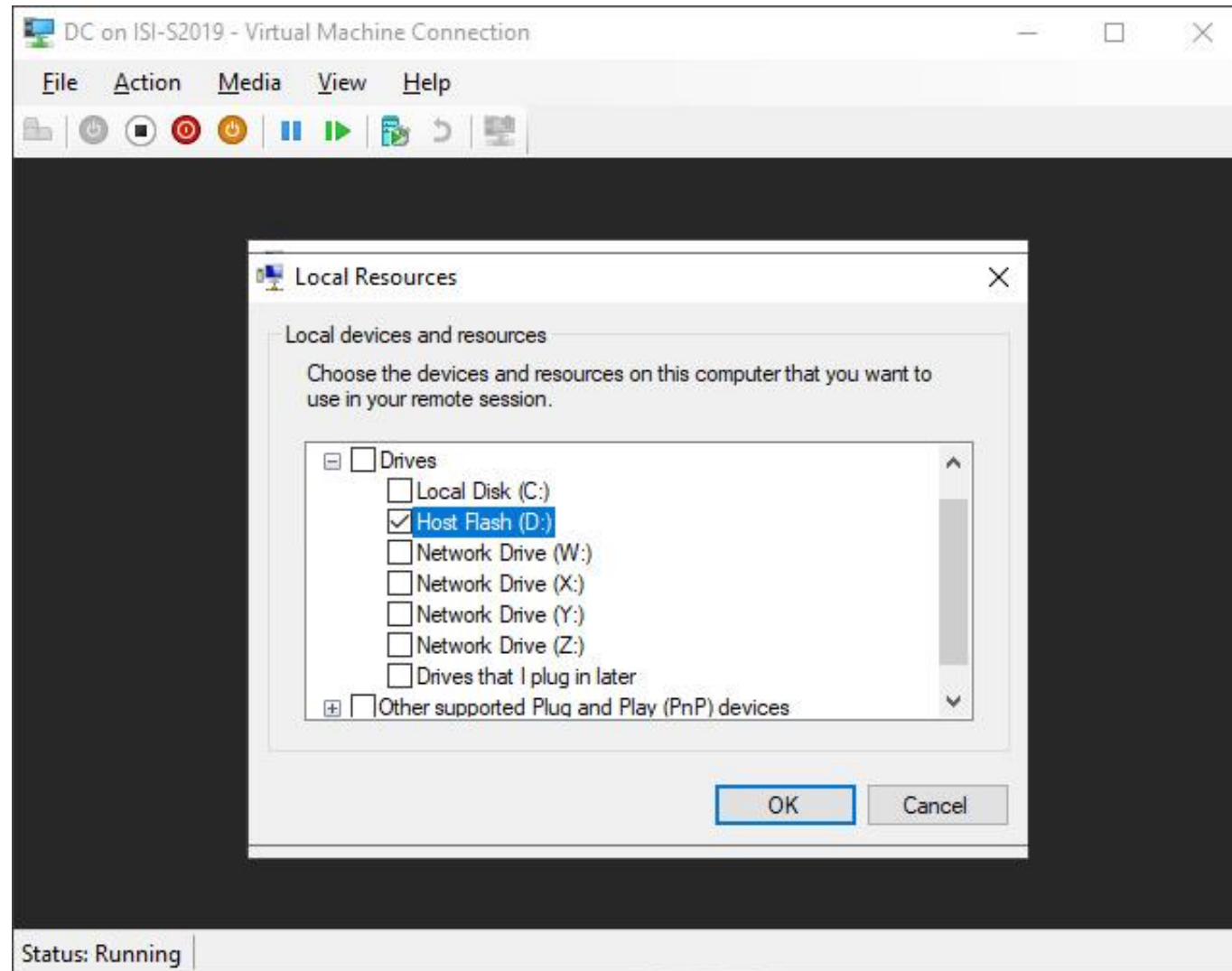
Existing Virtual Machine Connection sessions may need to be restarted if this setting is changed.

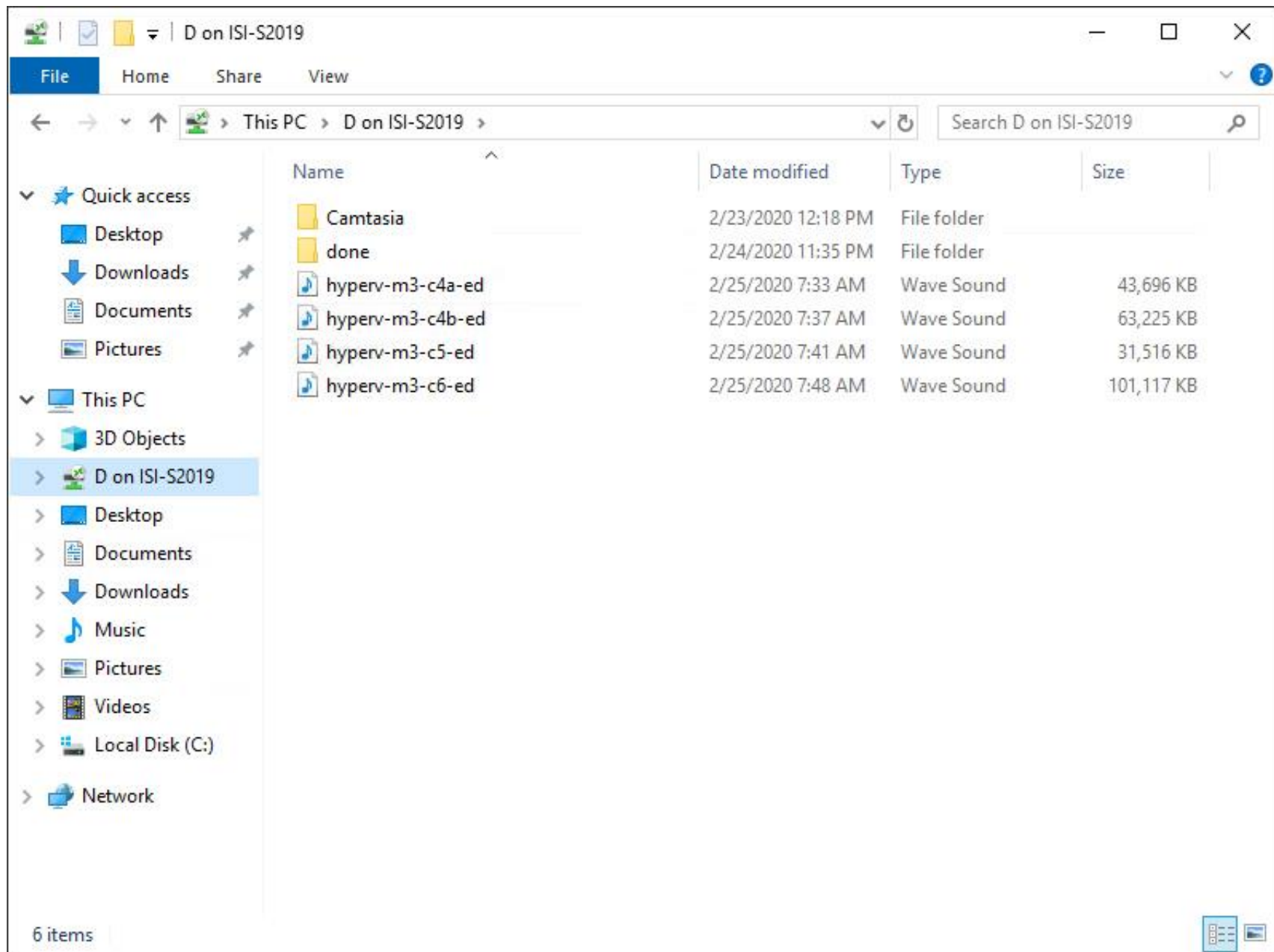
Save

Discard changes



Using Enhanced Mode





Resource Metering



Limited VM resource monitoring from host

- CPU, memory, disk, network
- Primarily for billing and chargeback

Implement via PowerShell

- `Enable-VMResourceMetering`
 - `ComputerName <hostname>`
 - `VMName <guestname>`
- Time passes...
- `Measure-VM` (same parameters)

Text-based, not especially friendly

Resource Metering



Frequency of data save operations

- Default = 1 hour
- Maximum = 24 hours
- Minimum = 1 hour

Use Set-VMHost to change

- `-ResourceMeteringSaveInterval`





If you just need a quick view of a VM's resource usage, consider the Windows Admin Center.

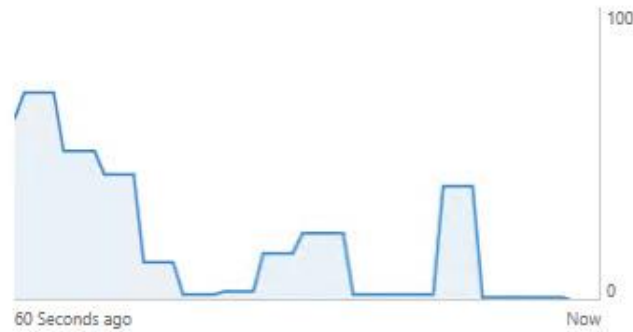


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CPU

0 %



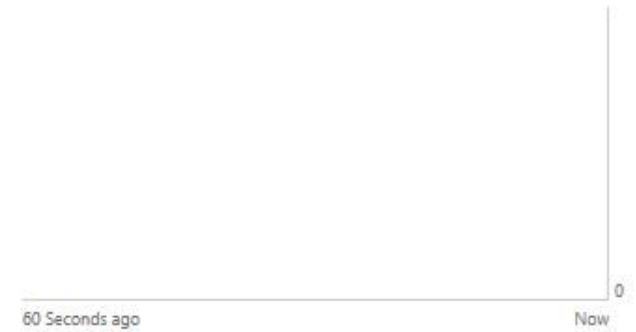
Memory

1.05 GB



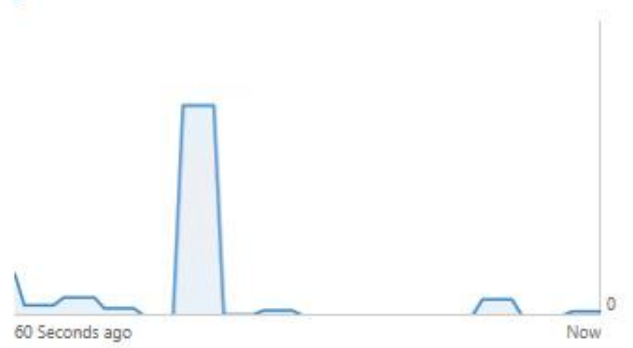
Network

0 B/s



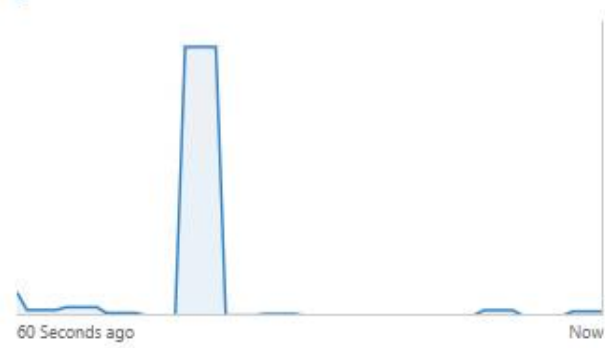
IOPS

68 IO/s

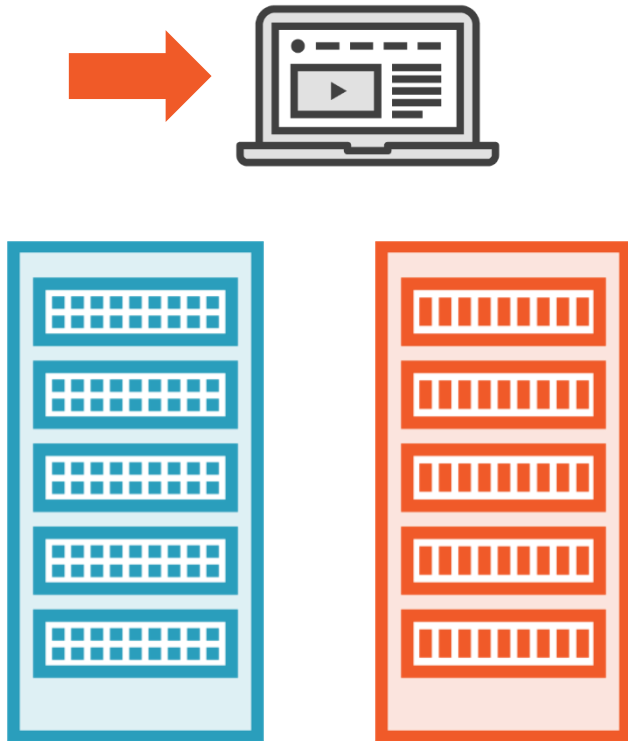


Throughput

2.66 MB/s



Live Migration



Move a running VM's memory and configuration between hosts

In Server 2019, live migration is available without failover clustering:

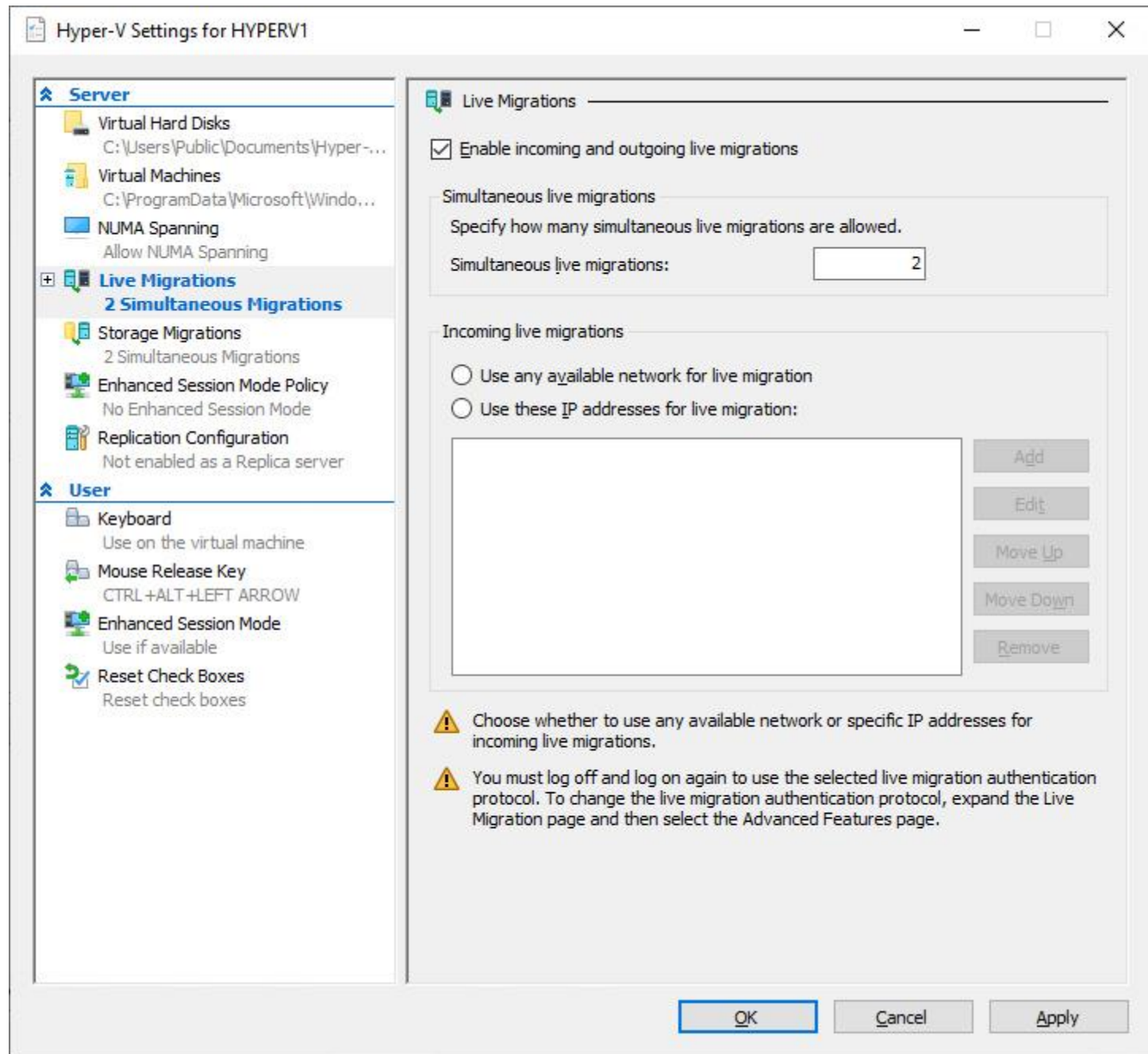
- Both hosts should have processors from same company (Intel or AMD)
- Both hosts should be in same domain or domains with a trust relationship
- Virtual switches have same name, setup

Use Hyper-V Manager ("Move") or PowerShell ("Move-VM")



If the source and destination hosts are running different versions of Windows Server, doublecheck your VM **configuration versions** to ensure compatibility.





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Tools

- Local users & groups
- Networks
- Performance Monitor
- PowerShell
- Processes
- Registry
- Remote Desktop
- Roles & features
- Scheduled tasks
- Services
- Storage
- Storage Migration Service
- Storage Replica
- System Insights
- Updates

⚙️ Settings

Settings

General

- Environment variables
- Azure Arc for Servers
- Power configuration
- Remote Desktop
- Role-based Access Control

Hyper-V Host Settings

- General
- Enhanced Session Mode
- NUMA Spanning
- Live Migration
- Storage Migration

Live Migration

Live Migrations

Enable incoming and outgoing live migrations



You can specify how many live migrations * can be performed at the same time on this computer.

Authentication Protocol *

Credential Security Support Provider (CredSSP) ▾

⚠️ You must log on to the server to perform a live migration.

Performance Options *

Compression ▾

⚠️ The memory of the virtual machine being migrated is compressed and then copied over the network to the destination server over a TCP/IP connection.

Use any network



Save

Discard changes

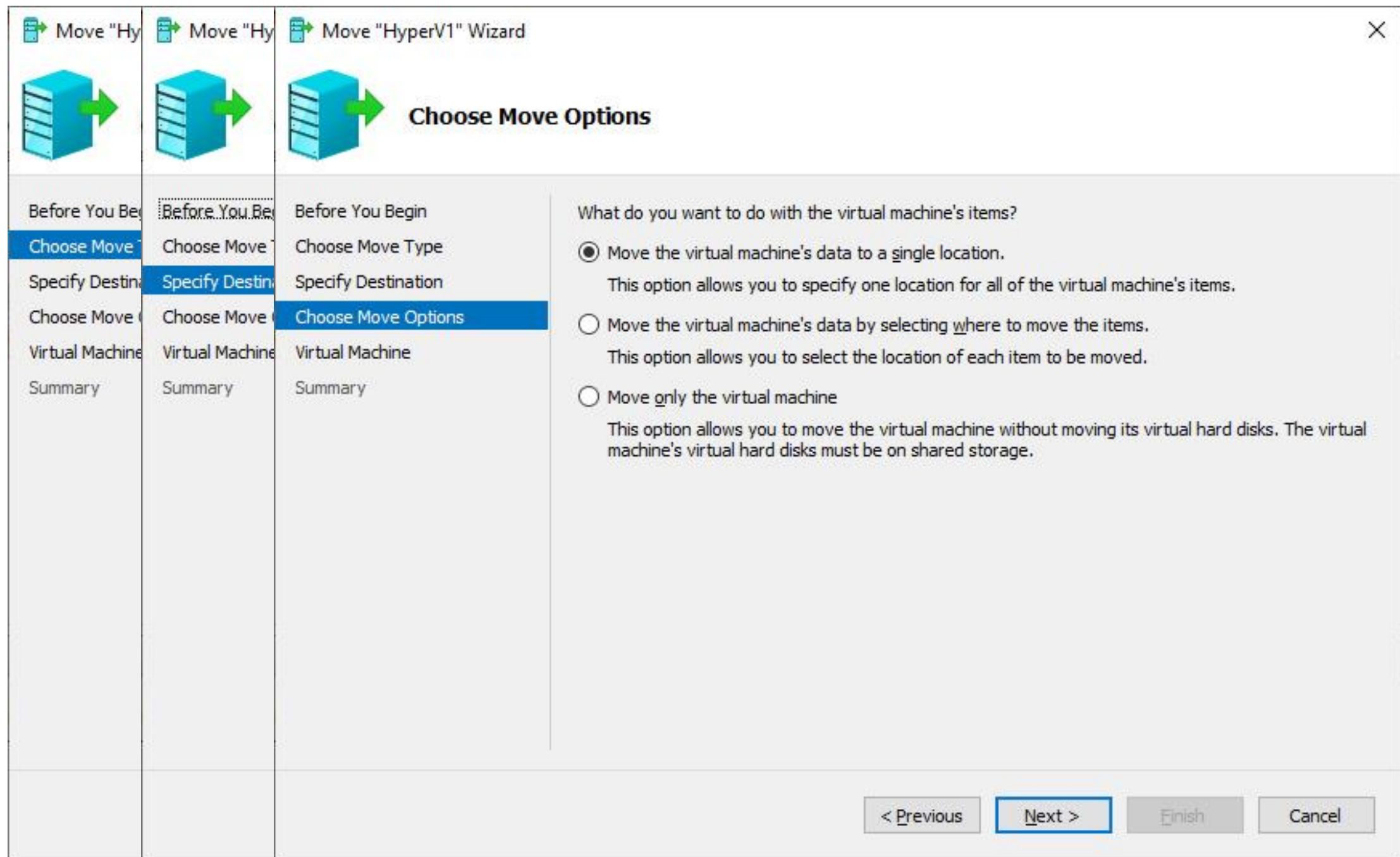




A **storage migration** is similar to a live migration but just moves the VM's storage, not its settings.

Supported for directly-attached storage, SANs, and SMB3 file shares.





Export/Import



Useful when live migration or storage migration is not feasible

- You can't just do a file copy, alas!

Moves a VM and related files to new host

- VM configuration file (*.VMCX)
- Virtual hard disk(s)
- Checkpoints

Hyper-V Manager, Windows Admin Center, PowerShell

- Import-VM, Export-VM

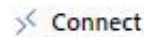
hyperv1.company.pri



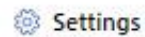
Virtual machines

Help protect your VMs from disasters by using Azure Site Recovery. [Update now](#)[Learn more](#)[Summary](#) [Inventory](#)

+ New



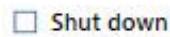
> Connect



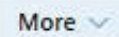
Settings



Start



Shut down



More

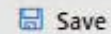
1 item



Search



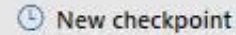
✓	Name ↑	State	CPU usage	Memory pressure	Uptime	Heartbeat	Disaster Recovery status	Tags
✓	VM1	Runni...	0 %	78 %	0:00:07:09	OK	Not signed in	



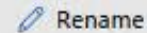
Save



Move



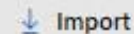
New checkpoint



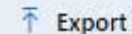
Rename



Delete



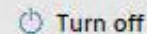
Import



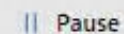
Export



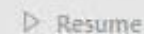
Delete saved state



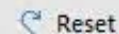
Turn off



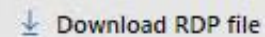
Pause



Resume



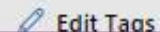
Reset



Download RDP file



Set up VM Protection



Edit Tags



Import Choices



Register in-place

- Leave the files where they are
- VM ID remains the same

Restore

- Copy the files to destination you choose
- VM ID remains the same

Copy

- Like “restore” but VM gets new ID
- Useful if you want to import repeatedly



Import Virtual Machine

Connect Network

Before You Begin

Locate Folder

Select Virtual Machine

Choose Import Type

Choose Destination

Choose Storage Folders

Connect Network

Summary

This page allows you to connect to virtual switches that are available on the destination computer.

The following configuration errors were found for virtual machine 'Globomantics Win7'.
✖ Could not find Ethernet switch 'Globomantics External Switch'.

Specify the virtual switch you want to use on computer "ISI-S2019".

Connection:

Not Connected

< Previous

Next >

Finish

Cancel



Integration Services





Integration services can include:

Operating system shutdown

Time synchronization

Data exchange

- Key/value pairs that both systems see

Heartbeat

- Informs host that guest has booted

Backup (volume shadow copy)

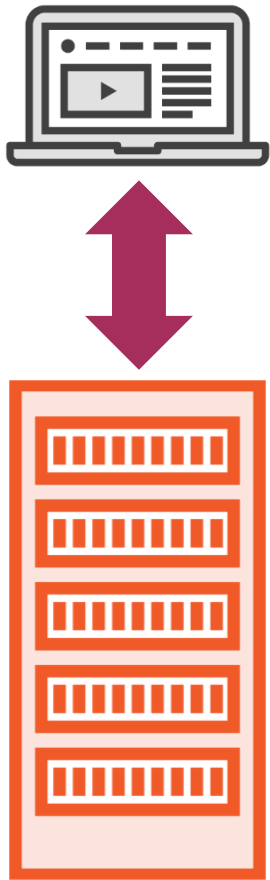
- Host backup notifies VSS in guest

Guest services

- Permits file copies to and from VM



Integration Services (Windows)

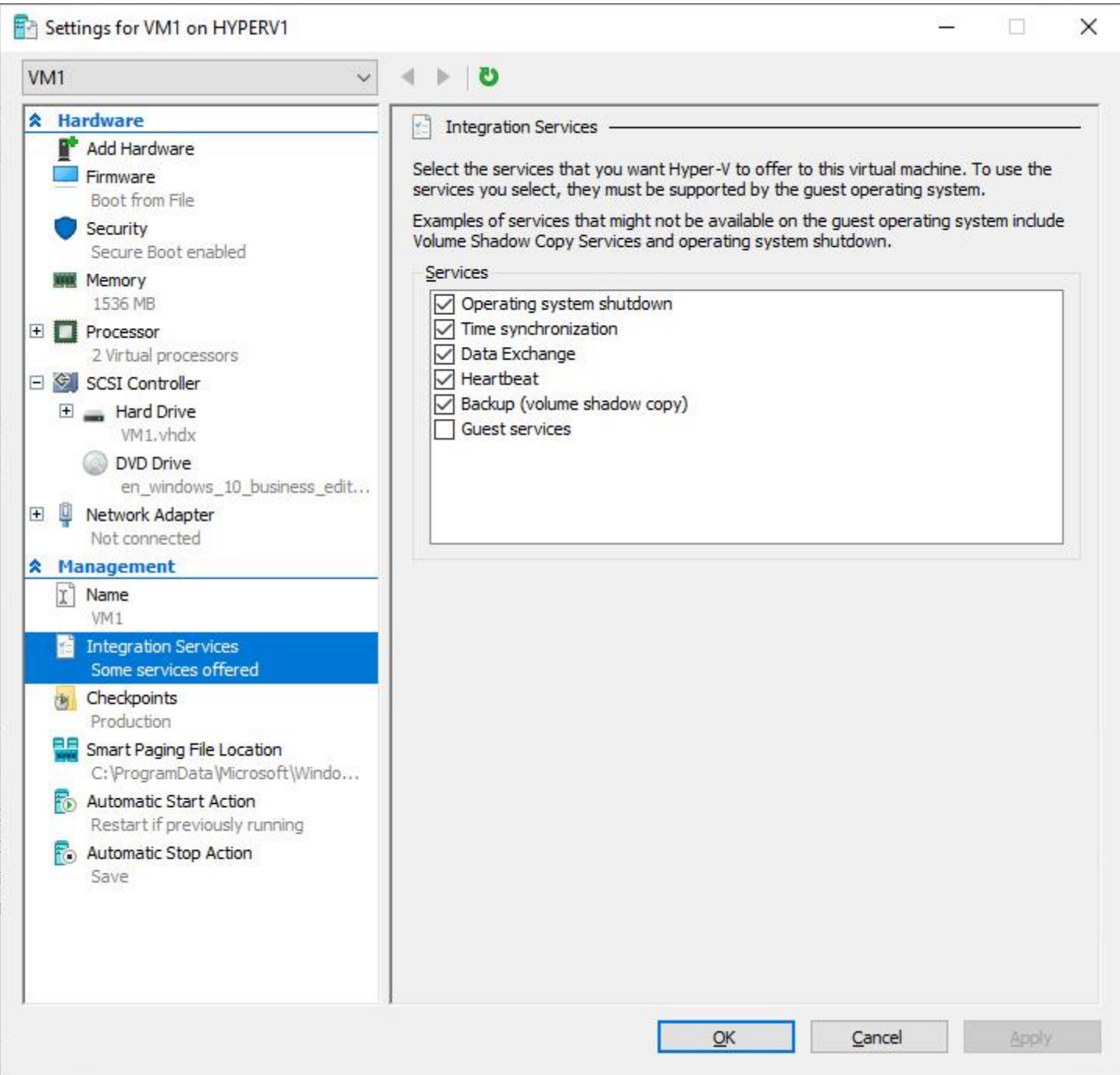


Included with all recent versions of Windows, no need for separate install

- Service updates come via Windows Update

Toggle individual services at the host

- The corresponding service in the Windows guest will follow
- Hyper-V Manager, PowerShell
- `Enable-VMIntegrationService`
 -VMName <name> -Name <service>



Administrator: C:\Windows\system32\cmd.exe - powershell

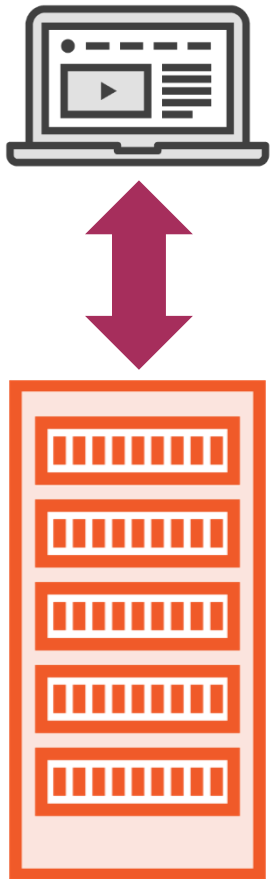
PS C:\Users\Administrator> get-vmintegrationervice -vmname vm1

VMName	Name	Enabled	PrimaryStatusDescription	SecondaryStatusDescription
VM1	Guest Service Interface	False		
VM1	Heartbeat	True		
VM1	Key-Value Pair Exchange	True		
VM1	Shutdown	True		
VM1	Time Synchronization	True		
VM1	VSS	True		

PS C:\Users\Administrator> _



Integration Services (Linux)



Often included in the Linux distribution

You can download updated files from Microsoft

- Some distro providers recommend against it
- The download is an ISO that you can mount in Hyper-V Manager

Security Settings





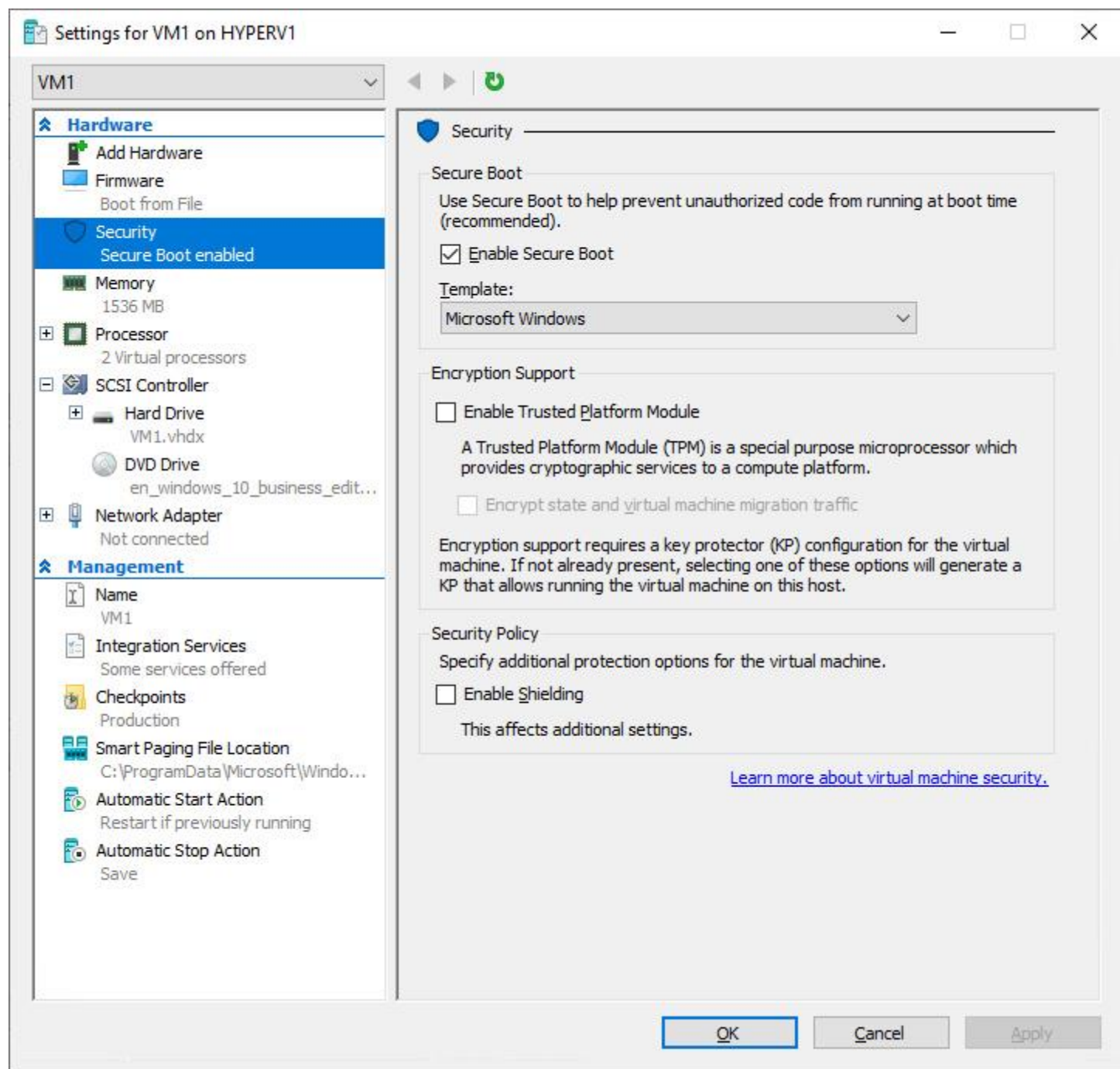
Security settings:

Secure boot

Virtual TPM

Host resource protection







Another important security feature is
shielded VMs
which we will discuss
in our networking module.



Secure Boot



Ensures boot components are digitally signed

- Helps prevent early-launch malware
- Generation 2 only
- UEFI only

Hyper-V Manager

- Security node for the VM

PowerShell

- `Set-VMFirmware -VMName <name>`
- `EnableSecureBoot On`

Secure Boot and Linux



Several Linux distros support Secure Boot:

- Debian 10
- Oracle 7.4+
- RHEL/CentOS 7.x+
- Suse (SLES) 12+
- Ubuntu 14.04+





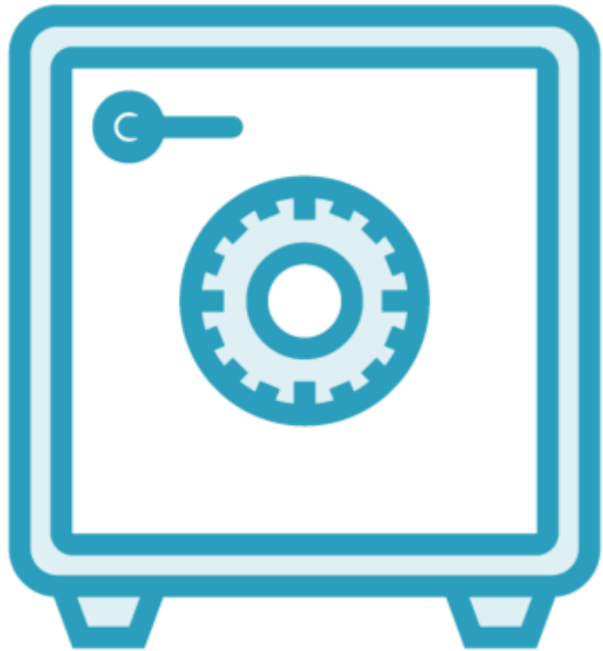
If a Linux guest won't boot,
try disabling Secure Boot via
Hyper-V Manager or PowerShell.

Also try signing the bootloader with the
Microsoft certificate; for example:

```
Set-VMFirmware <VMName> -SecureBootTemplate  
MicrosoftUEFICertificateAuthority
```



Virtual TPM (or “Encryption Support”)



Virtual hard disk encryption uses BitLocker

- Startup key unlocks disk so VM can boot
- On physical systems, startup key is stored in TPM chip or flash drive

vTPM for VMs available on Server 2016+

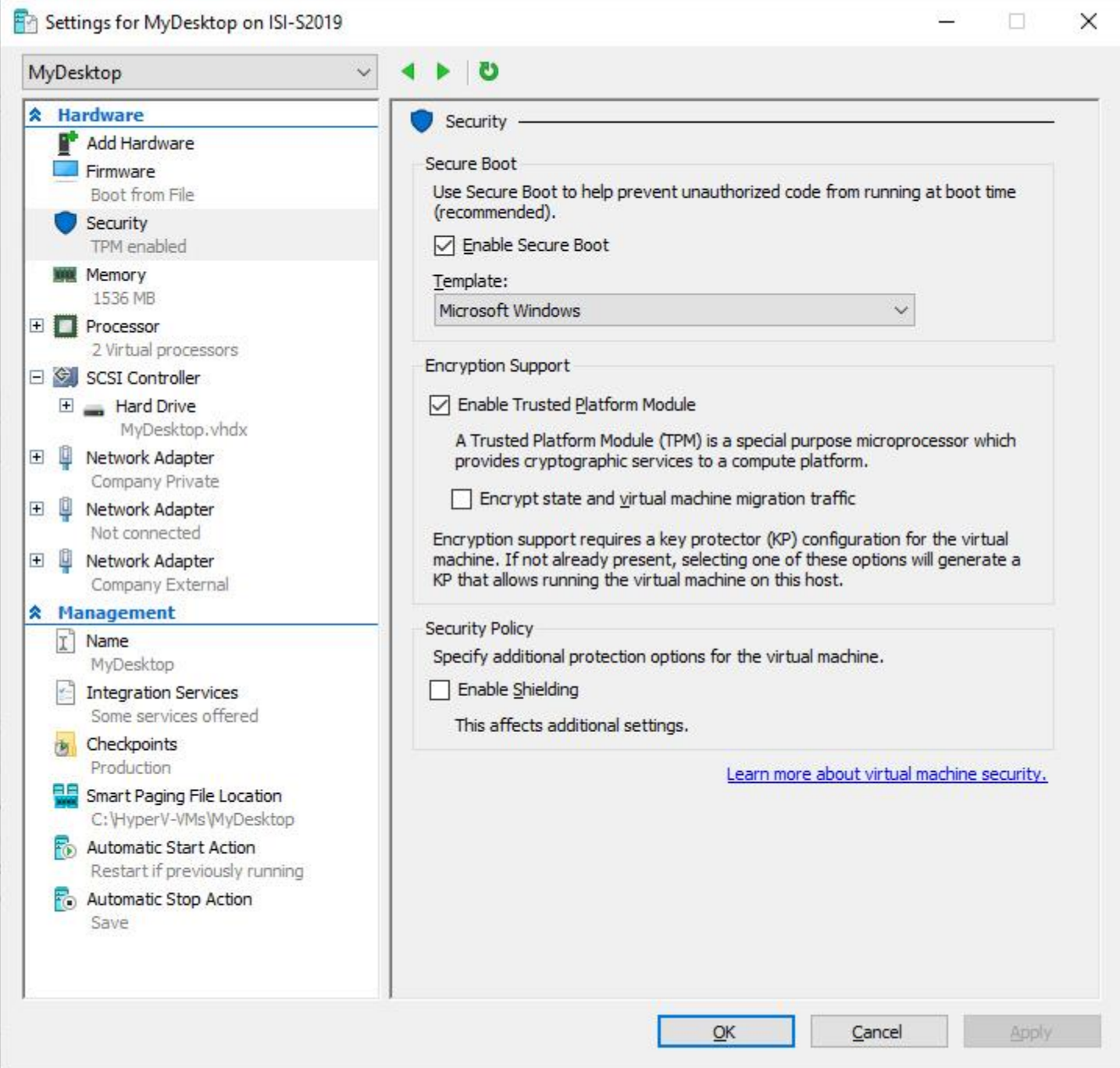
- Generation 2 VMs only
- Does not require physical TPM on host

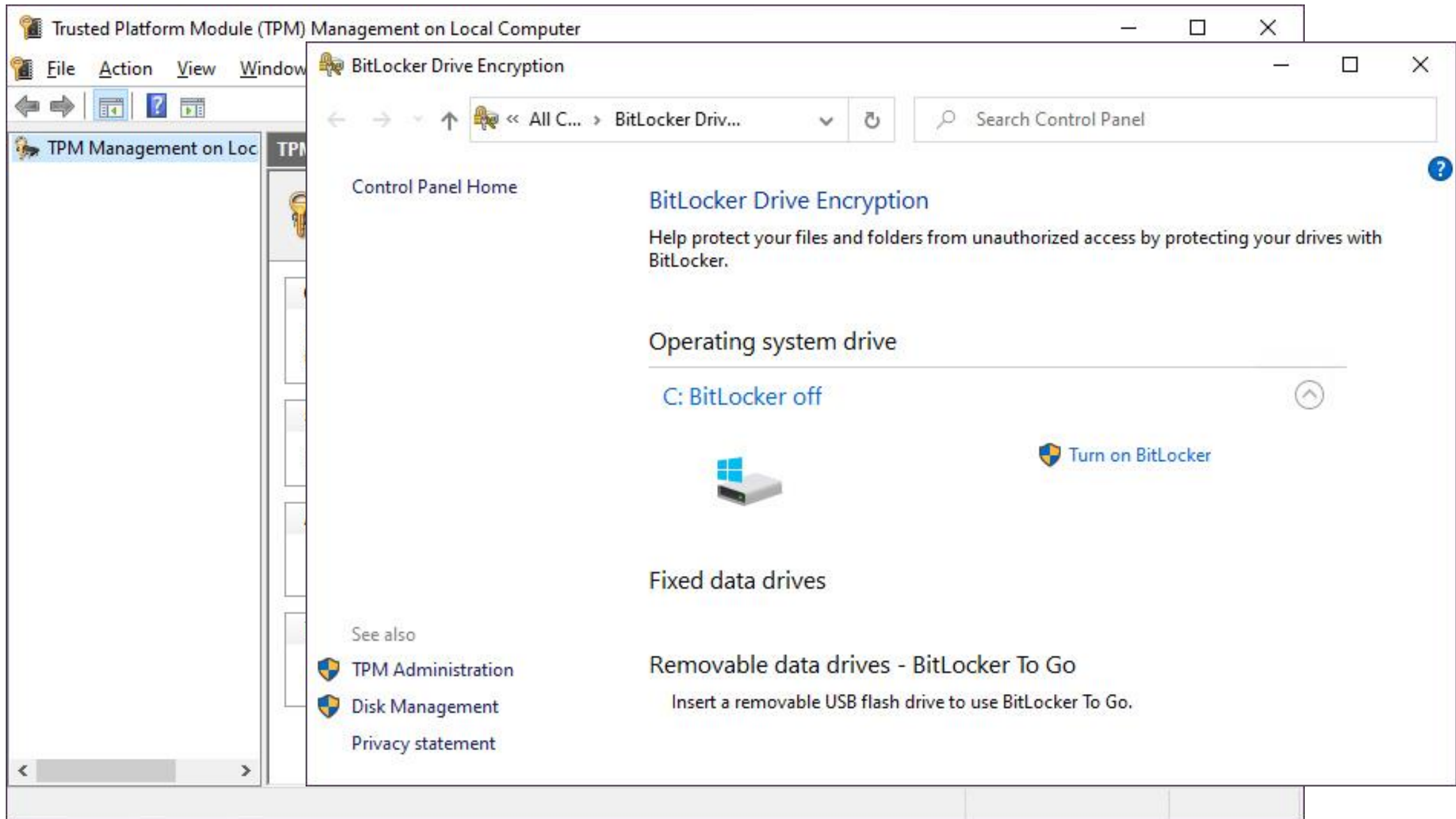
Required for “shielded VMs”

The vTPM travels with the VM

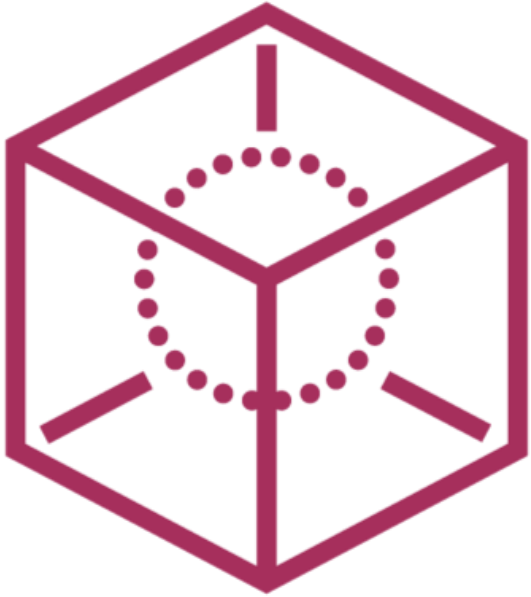
Enable-VMTPM in PowerShell







Host Resource Protection



Prevents overactive VM from overwhelming host, other guests

- Reduces video, keyboard, mouse, and memory resources given to rogue VM
- Introduced in Server 2016
- Off by default

`Set-VMProcessor <VMName>`

`-EnableHostResourceProtection $true`



Good work! Up Next:
Configure VM Storage

