

# Configure Virtual Networks

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# Topics in This Module



**Virtual switches**

**Virtual network interface cards**

**Performance tuning and monitoring**

**NIC teaming**

**Network security**

**Network isolation**



# Virtual Switches

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## Hyper-V virtual switches:

### Four types

- Private
- Internal
- Internal (NAT-enabled)
- External

### Multiple switches per host is fine

- # of external switches is limited

### Extensible architecture

### Can be shared with host system



# Tools for Creating Virtual Switches



## Hyper-V Manager

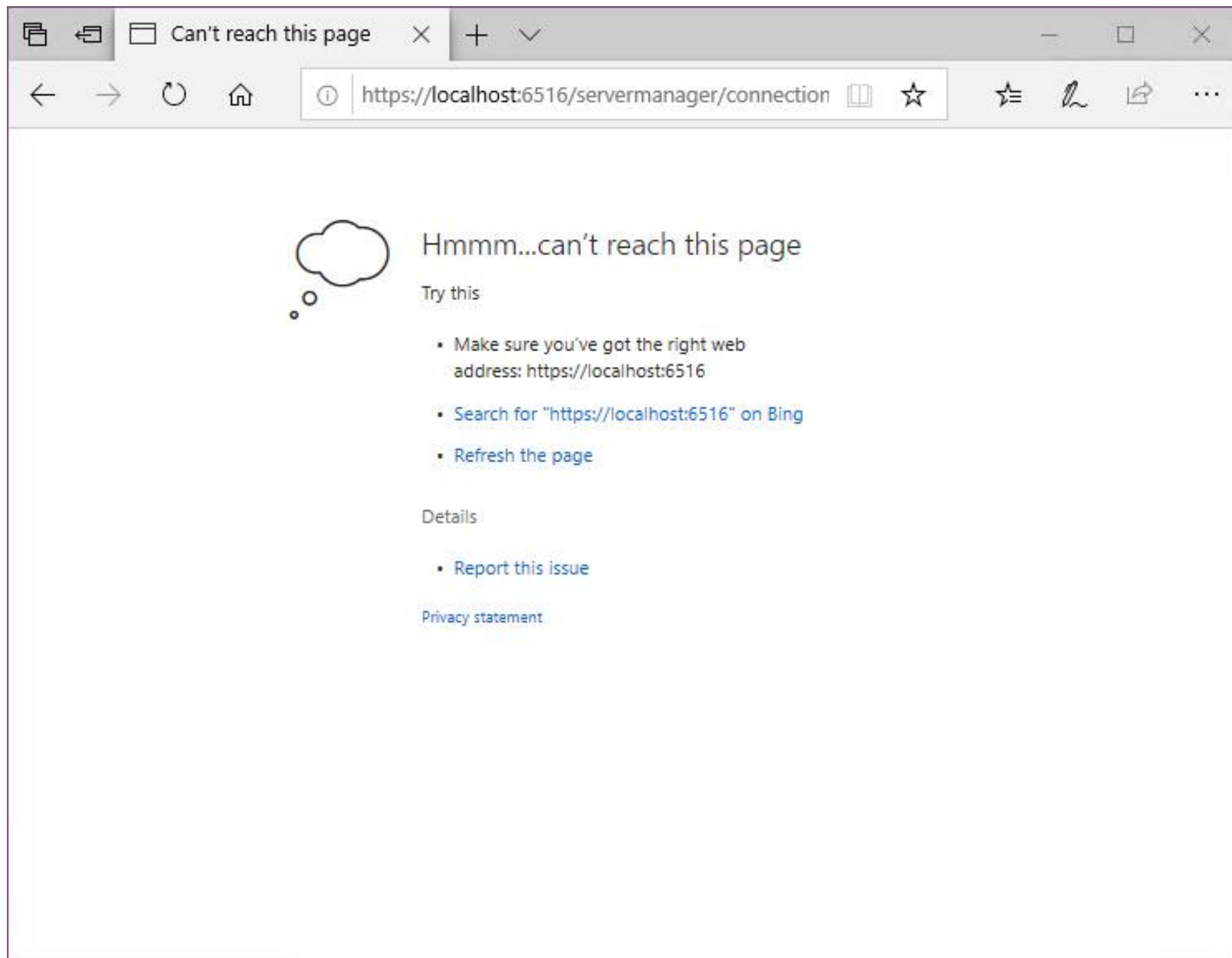
### PowerShell, for example:

- New-VMSwitch

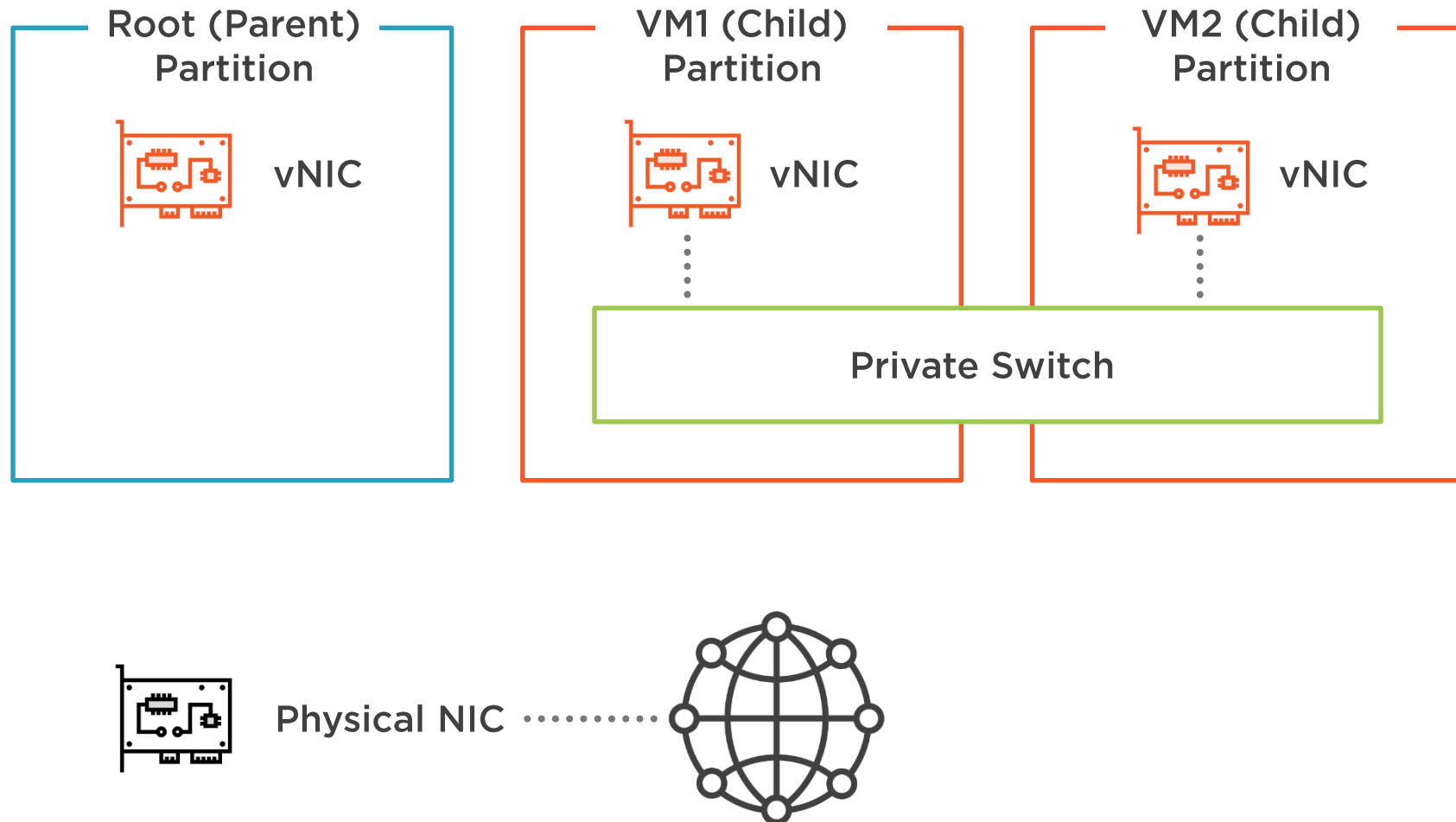
## System Center Virtual Machine Manager (SCVMM)

## Windows Admin Center

- Slow; buggy; “work in progress” but will probably improve...



# Private Virtual Switch



Virtual Switch Manager for ISI-S2019

**Virtual Switches**

- New virtual network switch
- Company External  
Intel(R) Ethernet Connection (9) I...
- Company Private**  
Private virtual switch

**Global Network Settings**

- MAC Address Range  
00-15-5D-01-03-00 to 00-15-5D-0...

**Virtual Switch Properties**

Name:  
Company Private

Notes:

Connection type  
What do you want to connect this virtual switch to?

☐ External network:  
ASIX AX88179 USB 3.0 to Gigabit Ethernet Adapter

☒ Allow management operating system to share this network adapter

☐ Enable single-root I/O virtualization (SR-IOV)

☐ Internal network

☒ Private network

VLAN ID

☐ Enable virtual LAN identification for management operating system

The VLAN identifier specifies the virtual LAN that the management operating system will use for all network communications through this network adapter. This setting does not affect virtual machine networking.

2

Remove

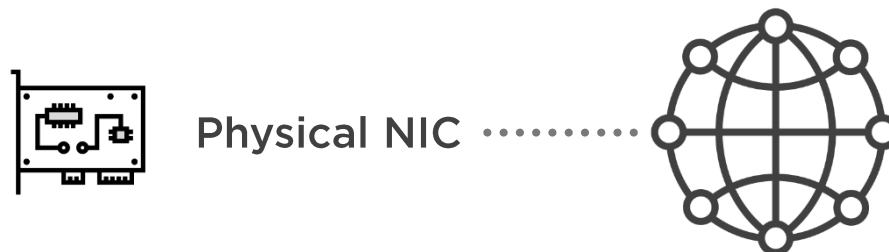
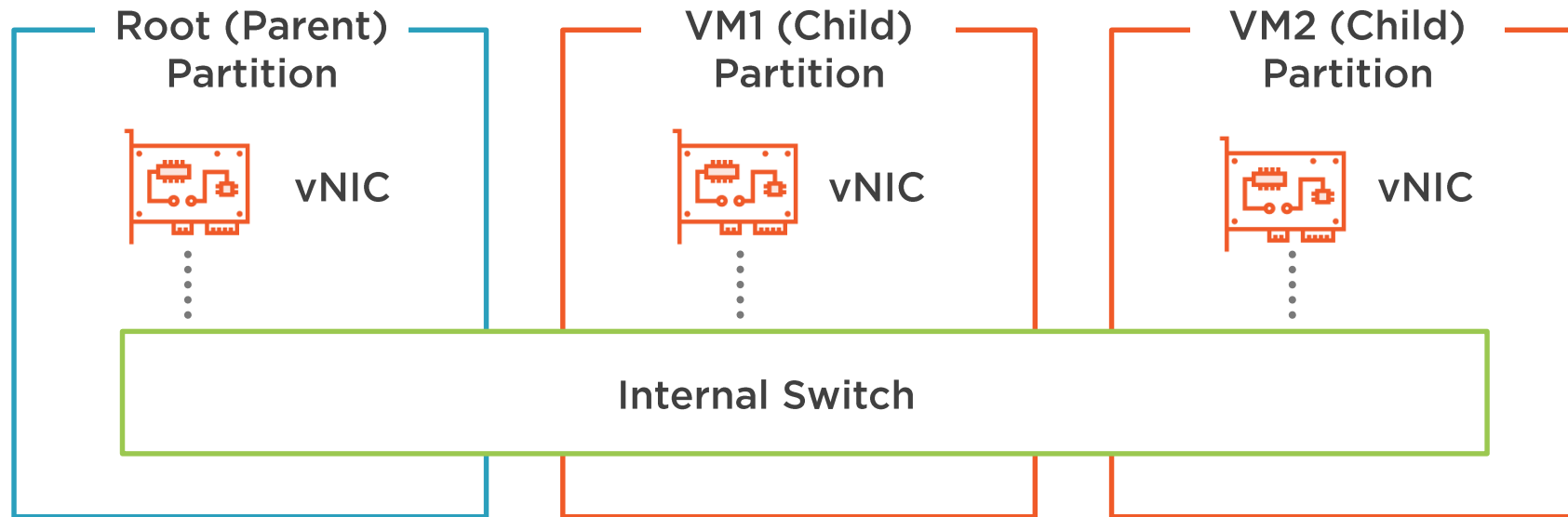
**i** SR-IOV can only be configured when the virtual switch is created. An external virtual switch with SR-IOV enabled cannot be converted to an internal or private switch.

OK Cancel Apply

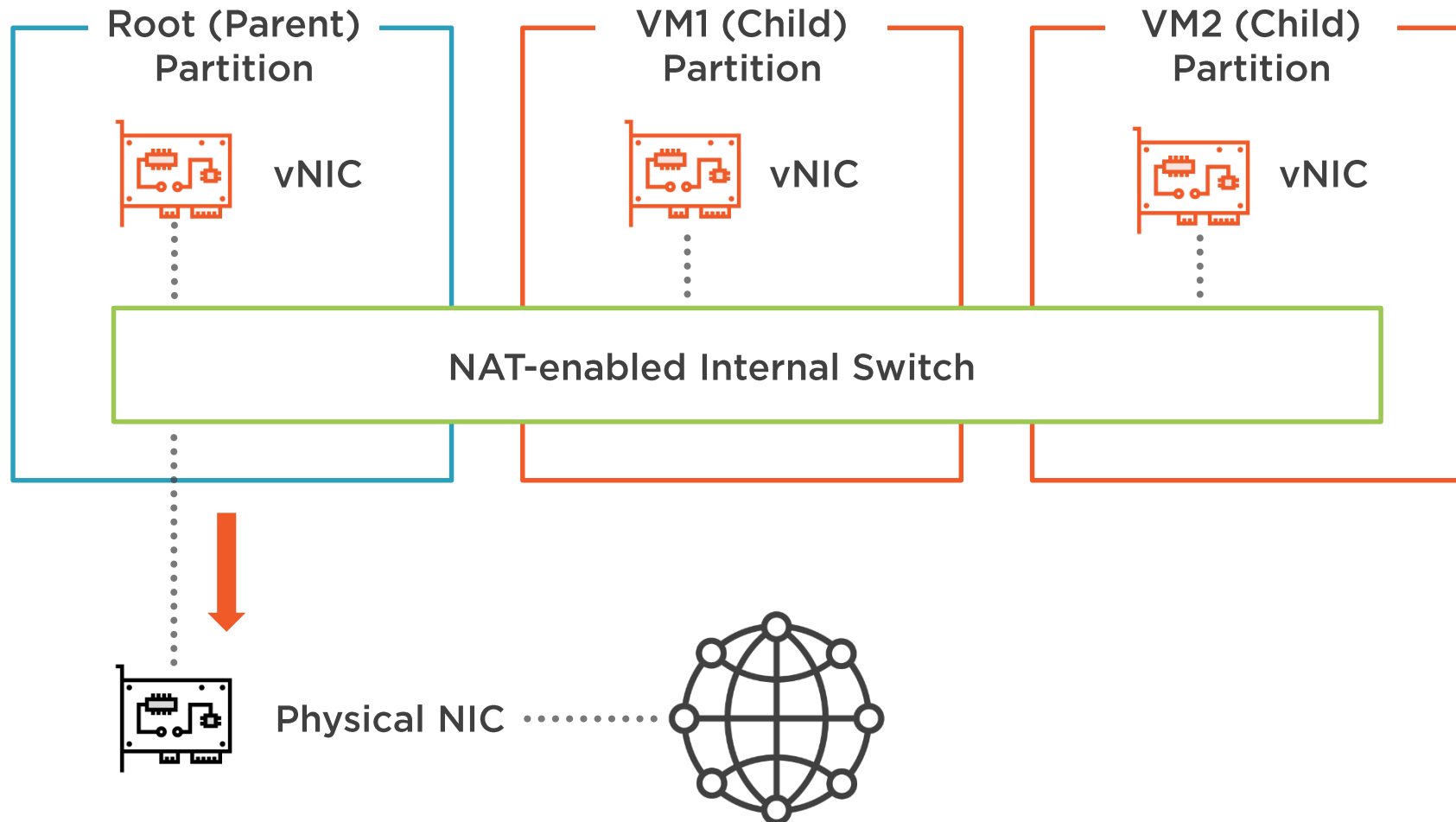




# Internal Virtual Switch



# NAT-enabled Internal Virtual Switch

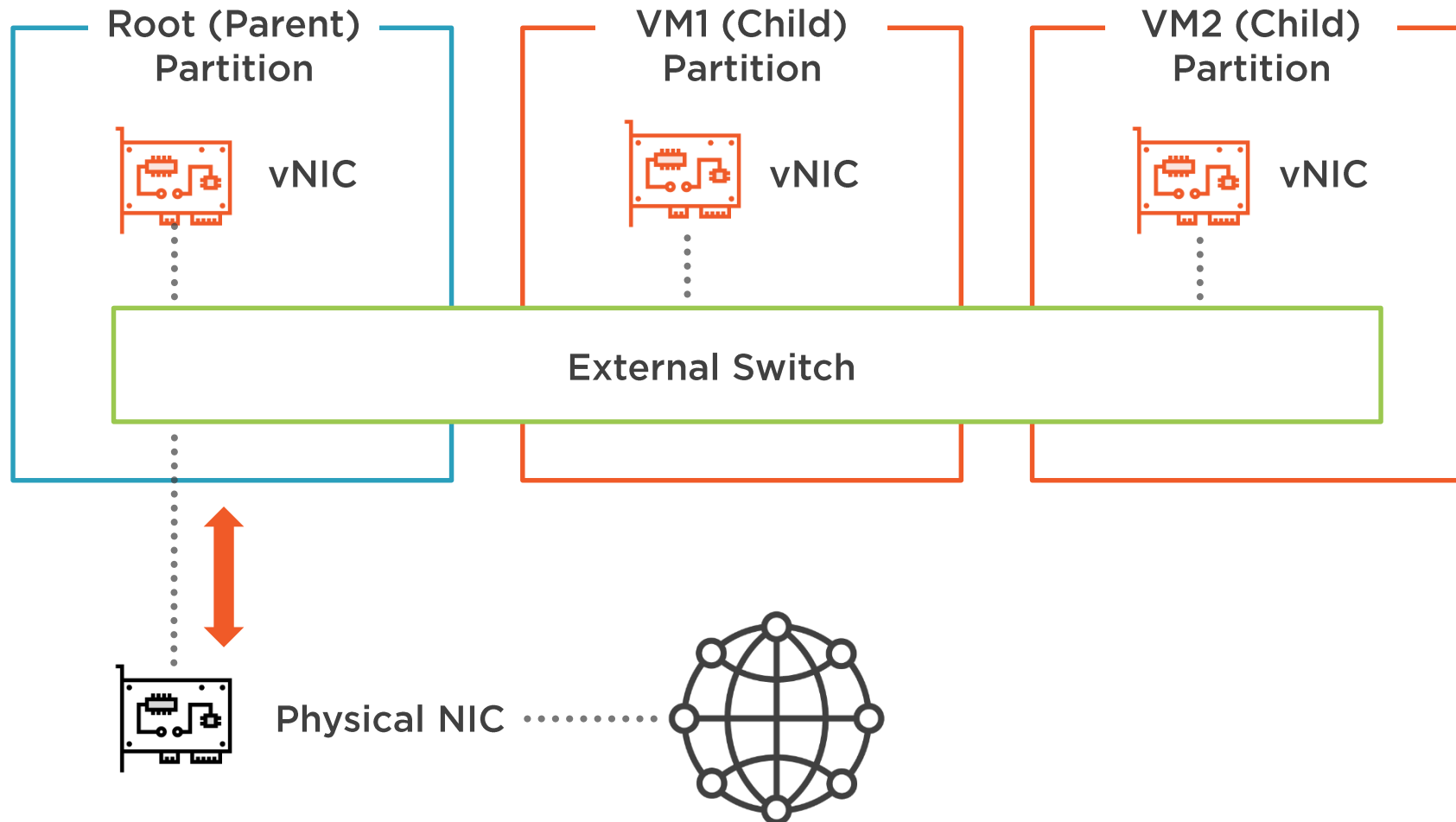




Setting up a NAT-enabled internal virtual switch is a whole lot easier than building a separate VM to act as a NAT router!



# External Virtual Switch



Virtual Switch Manager for ISI-S2019

**Virtual Switches**

- New virtual network switch
- Company External**  
Intel(R) Ethernet Connection (9) I...
- Company Private  
Private virtual switch

**Global Network Settings**

- MAC Address Range  
00-15-5D-01-03-00 to 00-15-5D-0...

**Virtual Switch Properties**

Name:  
Company External

Notes:

Connection type  
What do you want to connect this virtual switch to?

☒ External network:  
Intel(R) Ethernet Connection (9) I219-LM

☒ Allow management operating system to share this network adapter

☐ Enable single-root I/O virtualization (SR-IOV)

☐ Internal network

☐ Private network

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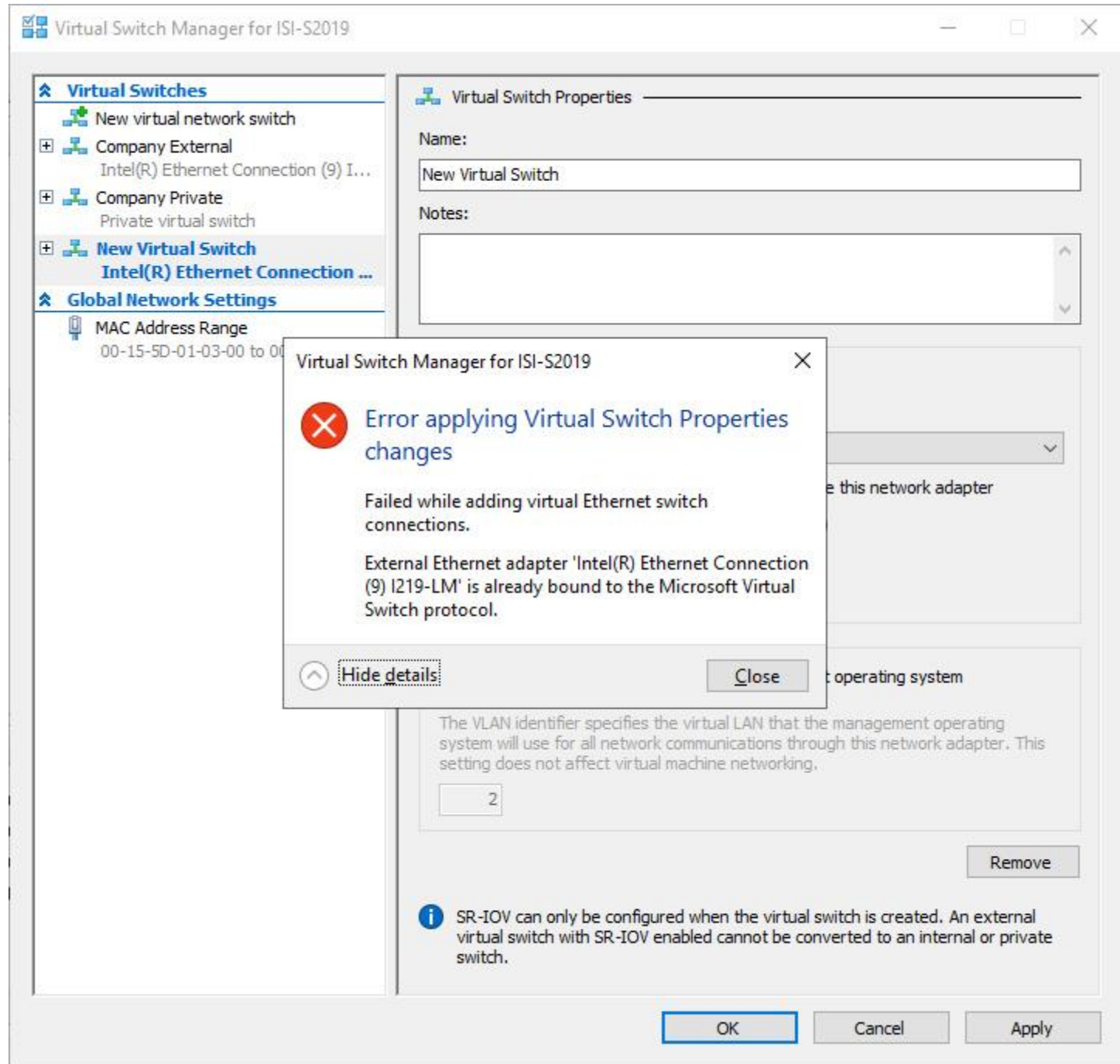
2

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OK Cancel Apply





## hyperv1.company.pri

## Tools

Search Tools 🔍

- Performance Monitor
- PowerShell
- Processes
- Registry
- Remote Desktop
- Roles & features
- Scheduled tasks
- Services
- Storage
- Storage Migration Service
- Storage Replica
- System Insights
- Updates
- Virtual machines
- Virtual switches**
- Settings

## Virtual switches

[+ New](#) [Rename](#) [Delete](#) [Settings](#)

Name ↑	Network adapter
Company Private	

## New virtual switch

Enter the name and switch type for this virtual switch below. For an external virtual switch, an eligible network adapter must be chosen from the list of available adapters.

Switch name: \*

Company External

Switch type: \*

External ▼

**i** This server supports Switch Embedded Teaming (SET) virtual switches. To create a SET switch select between 2 and 8 adapters from the network adapters list. Choosing a single adapter will not create a SET switch.

Network adapters:

\* Required

<input type="checkbox"/>	Name ↑	Description	IP Addresses	Connection state	Link Speed	MAC Address
<input type="checkbox"/>	Ethernet	Microsoft Hyper-V N...	192.168.3.200/24	Connected	10 Gbps	00-15-5D-01-03-00

**⚠️** The server may lose its network connection while the changes are applied. This may affect any network operations in progress, including this management session. These changes also may overwrite some static changes. If that happens, you must reapply the static changes to restore network connectivity.

Save

Cancel




## New virtual switch

Enter the name and switch type for this virtual switch below. For an external virtual switch, an eligible network adapter must be chosen from the list of available adapters.

Switch name: \*


Switch type: \*

 This server supports Switch Embedded Teaming (SET) virtual switches. To create a SET switch select between 2 and 8 adapters from the network adapters list. Choosing a single adapter will not create a SET switch.

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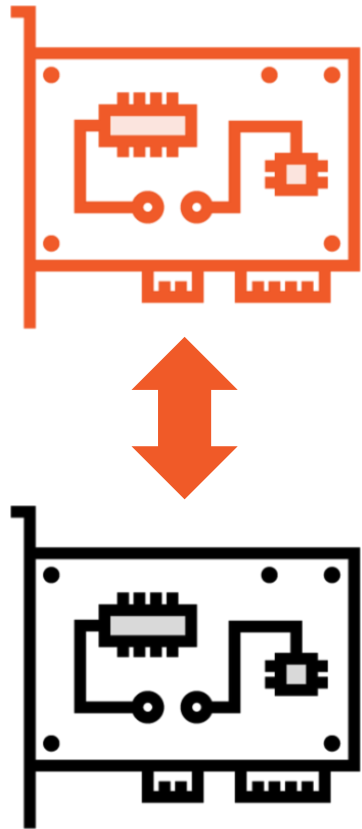
Save

Cancel





# Single-Root I/O Virtualization (SR-IOV)



**VM uses Direct Memory Access (DMA) to bypass the vSwitch**

**SR-IOV is a PCI Express pass-through technology**

- Many services break

**Requires support in motherboard and physical NIC**

**Must check box when creating switch**

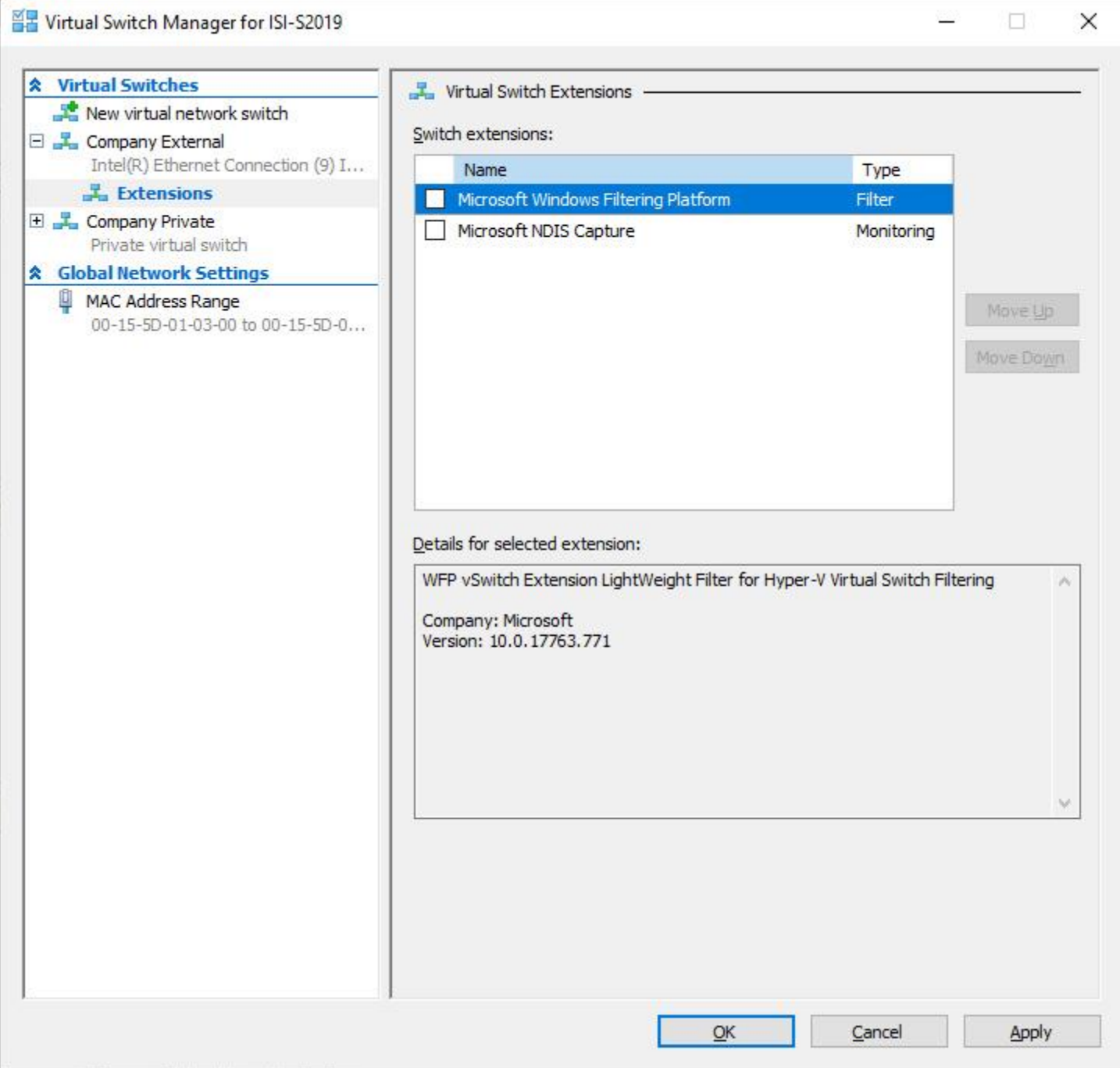
**Only consider when speed is paramount**

# Switch Extensibility



## Third parties can add functionality

- Network packet inspection
- Network packet filter
- Network forwarding
- Firewall/intrusion detection



# Notes on Virtual Switches



Consider multiple switches to separate *management* traffic from *guest* traffic

Switch type can be changed later

- Unless it uses SR-IOV

Switch naming must be consistent if VMs are moved across hosts

VM-to-VM communication on an external network does not touch physical NIC

# Virtual Network Interface Cards

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## Types

- Legacy
- Synthetic (“standard”)

## Basic configuration

- IP addressing
- MAC addressing

## Hot add/remove

# Tools for Working with Virtual NICs



## Hyper-V Manager

- Settings for VM > “Add hardware” > “Add” > select switch

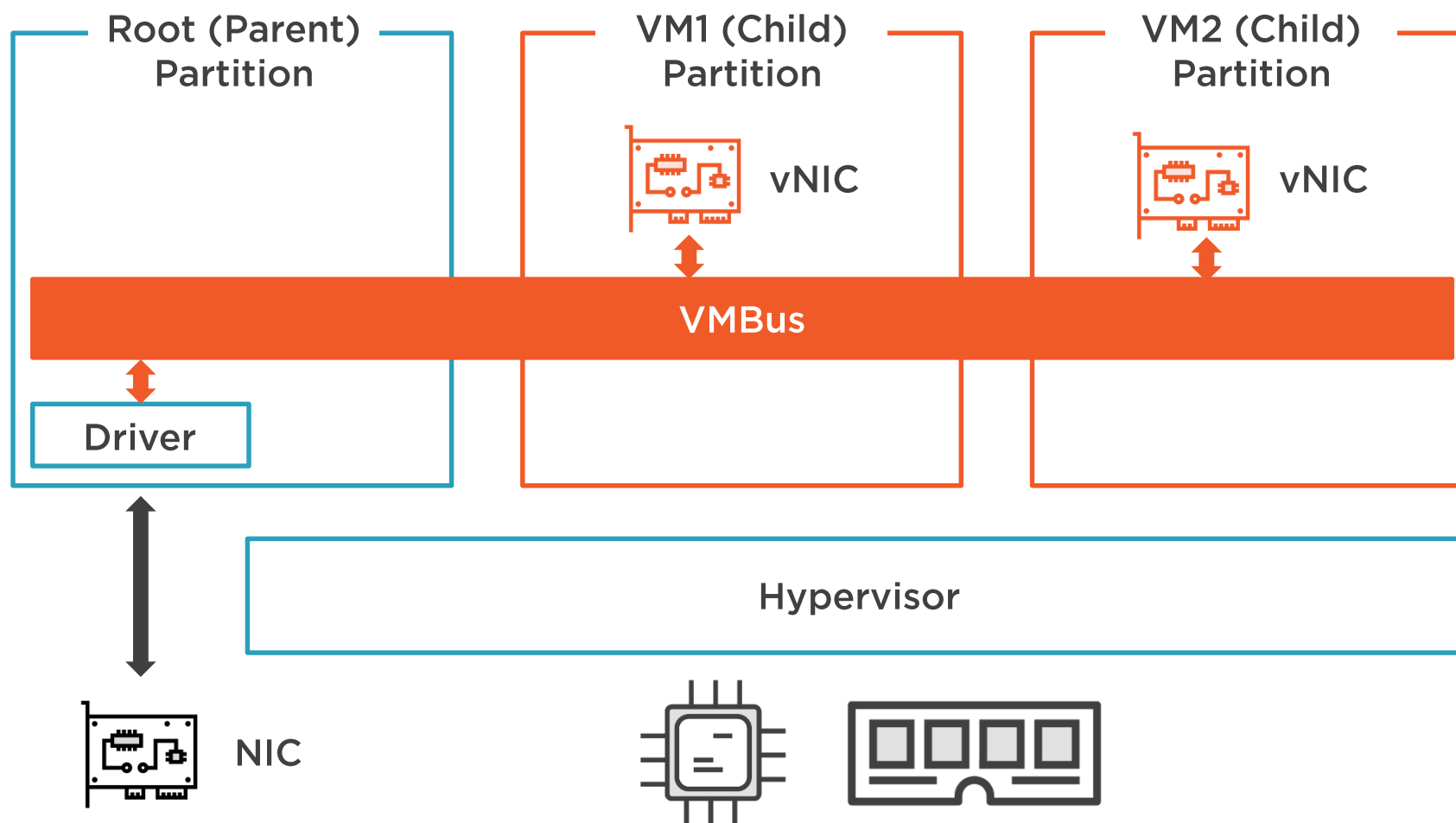
## PowerShell, for example:

- Add-VMNetworkAdapter
- Get-VMNetworkAdapter
- Remove-VMNetworkAdapter

## Windows Admin Center

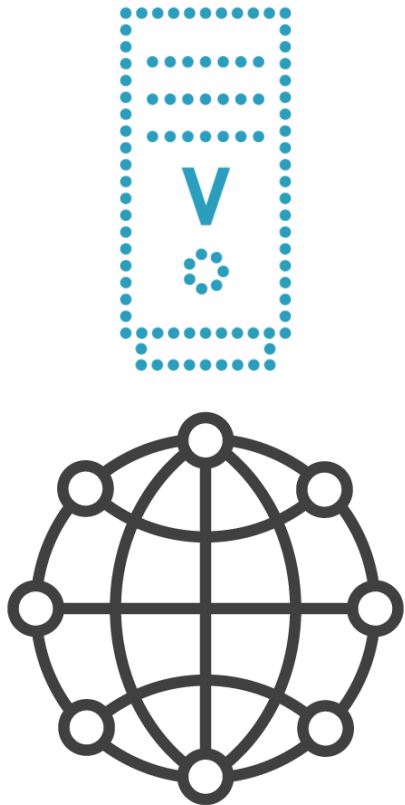
- Missing certain features at this writing

# Standard Virtual NICs Use VMBus





# Legacy vs. Synthetic NICs



## Legacy network adapter

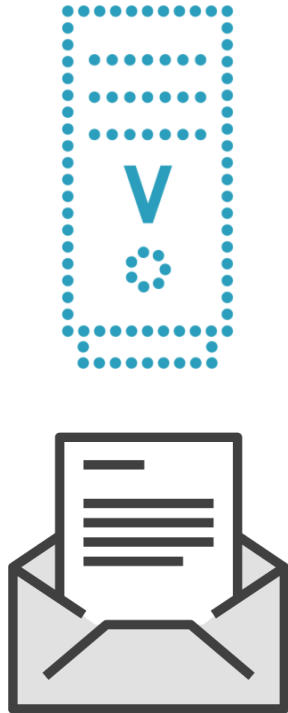
- Generation 1 VMs only
- Can perform PXE boot, e.g. to install an OS over the network
- Does not use VMBus

## Synthetic (“standard”) network adapter

- Faster
- Supports acceleration technologies

**If you need PXE boot, switch to synthetic adapter after installing the OS**

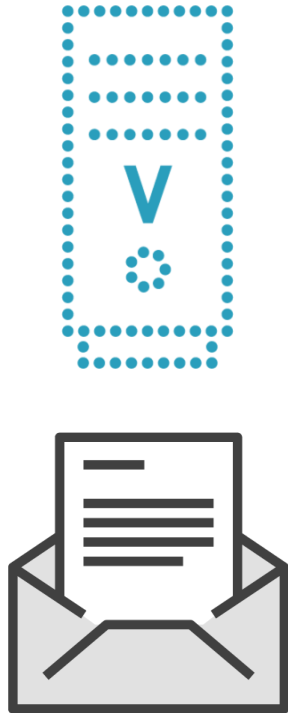
# IP Addressing



Set up TCP/IP properties inside the VM as you would normally within the OS

If using VLANs, ensure IP matches up with VLAN ID (more on that coming up)

# MAC Addressing



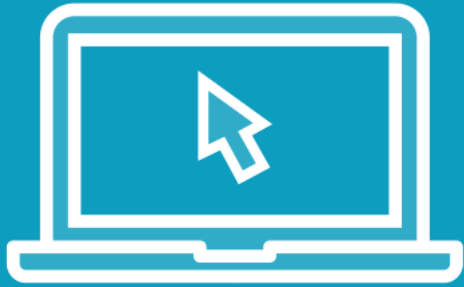
**Hyper-V uses dynamic MAC address by default**

**You can set a static MAC address if desired**

**MAC address spoofing is also possible**

- VM can change MAC address on outbound packets
- May be necessary in load balancing scenarios

# Demo



Create a vSwitch and vNIC  
with Hyper-V Manager



# Performance Tuning and Monitoring

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### Performance *tuning*:

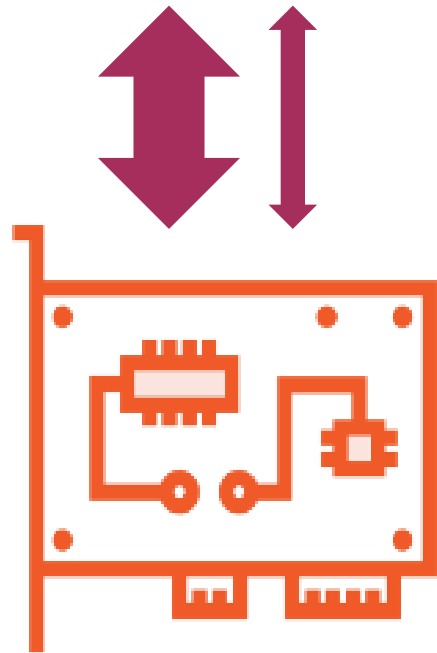
- Bandwidth management
- VMQ and VMMQ
- vRSS
- RDMA

### Performance *monitoring*:

- Port mirroring
- PerfMon
- Resource Metering



# Bandwidth Management



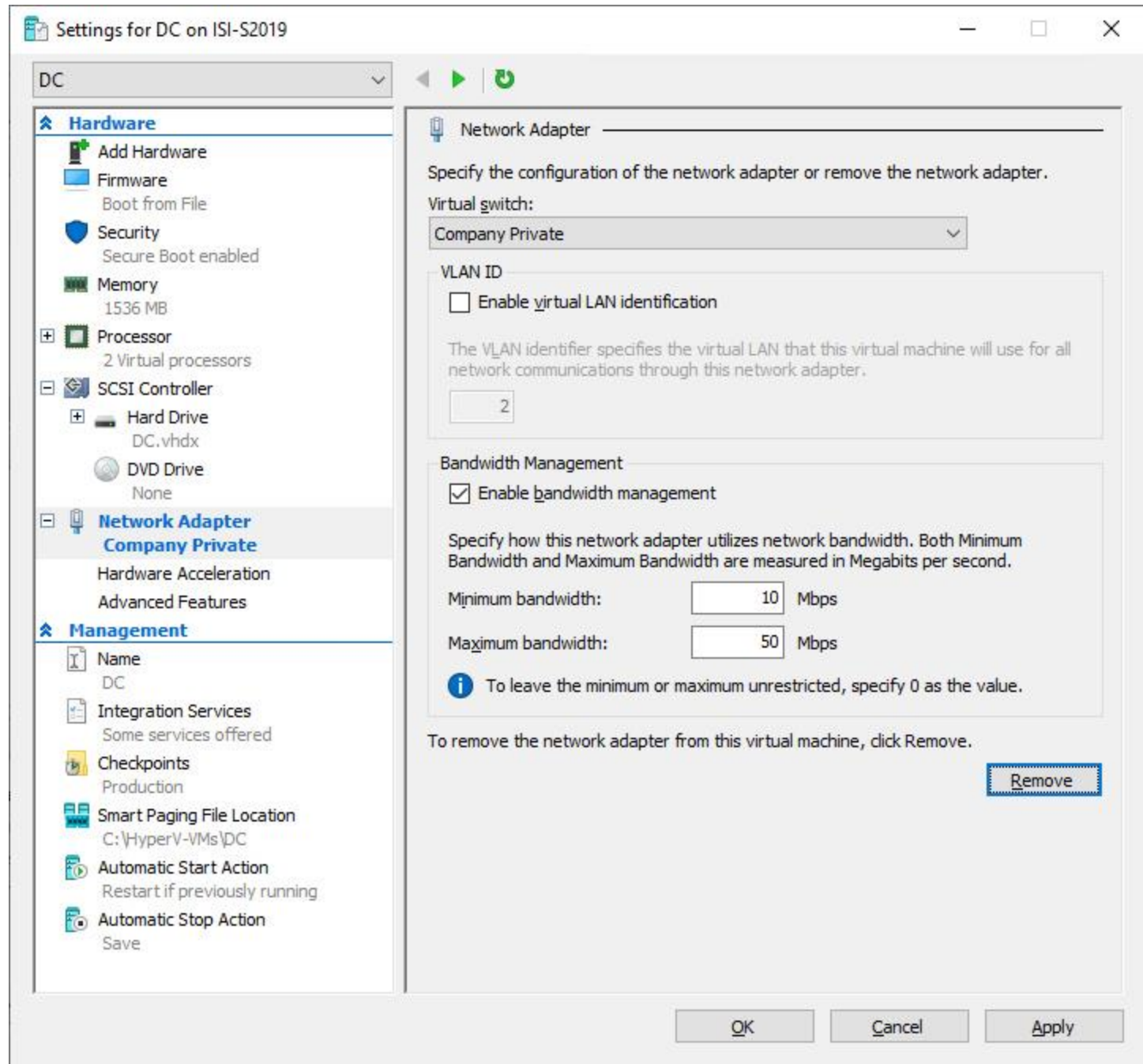
**Hyper-V Manager: properties of VM, network adapter**

**Set-VMNetworkAdapter**

- Lets you set minimum bandwidth as absolute or relative (“weight”)

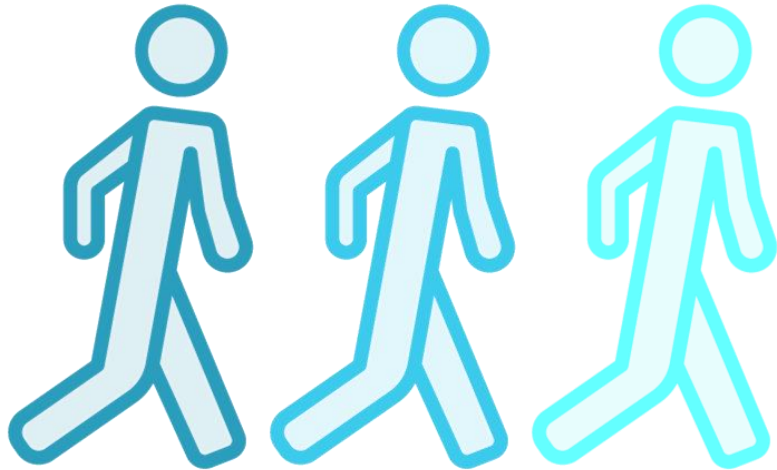
**Options (Mbps):**

- Minimum bandwidth: guarantee that if NIC is in use, it will have this value
- Maximum bandwidth: guarantee that NIC will never exceed this value





# Virtual Machine Queuing (VMQ)



**Requires explicit support in the NIC**

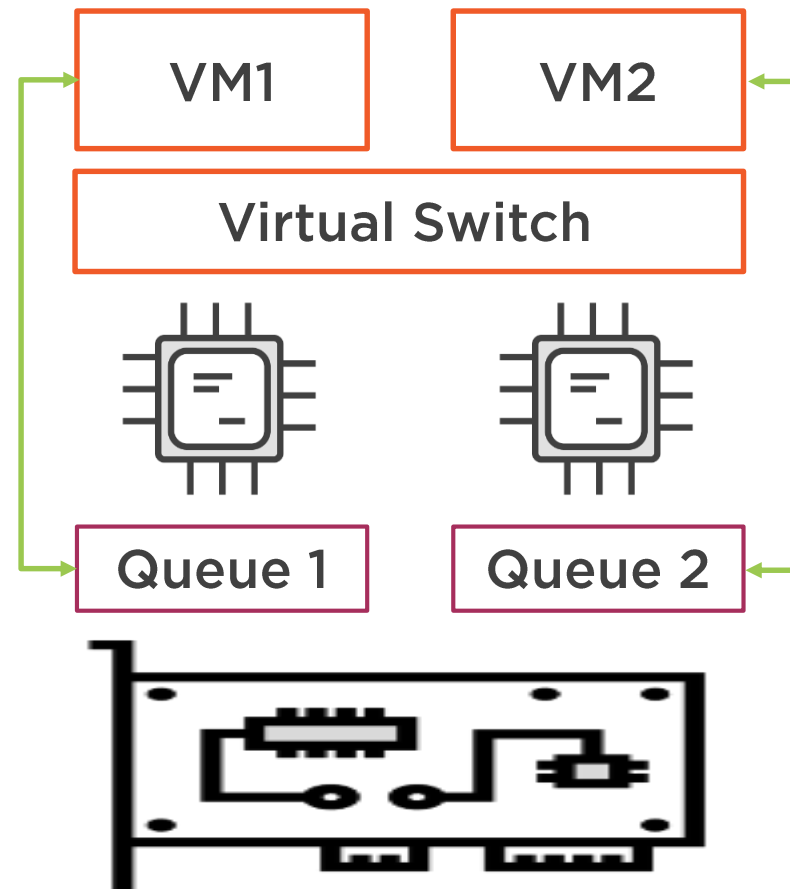
## **Benefits**

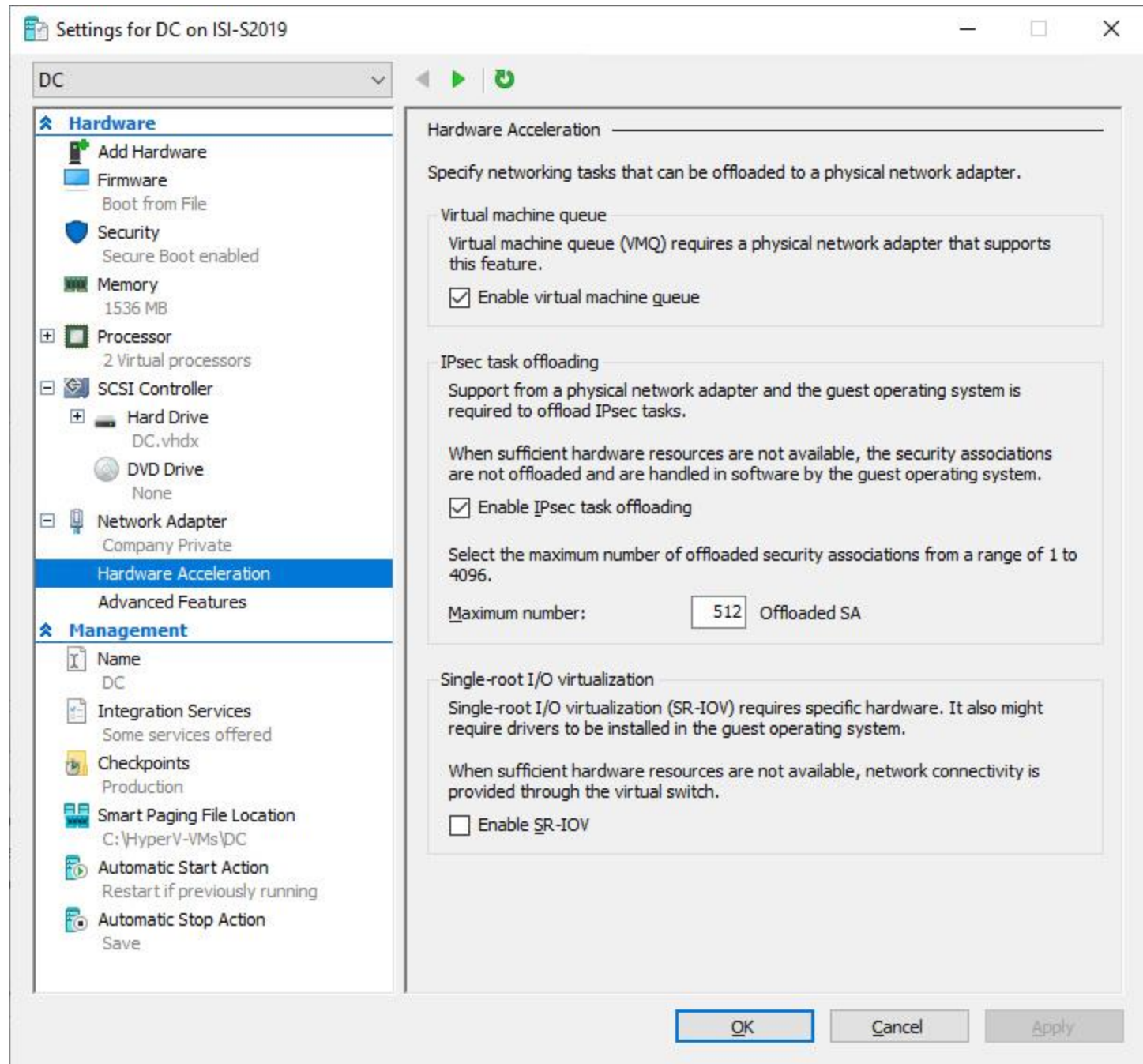
- Spreads out host CPU workload across multiple cores
- Eases load on virtual switch

**Hyper-V Manager: VM settings > Network Adapter > Hardware Acceleration**

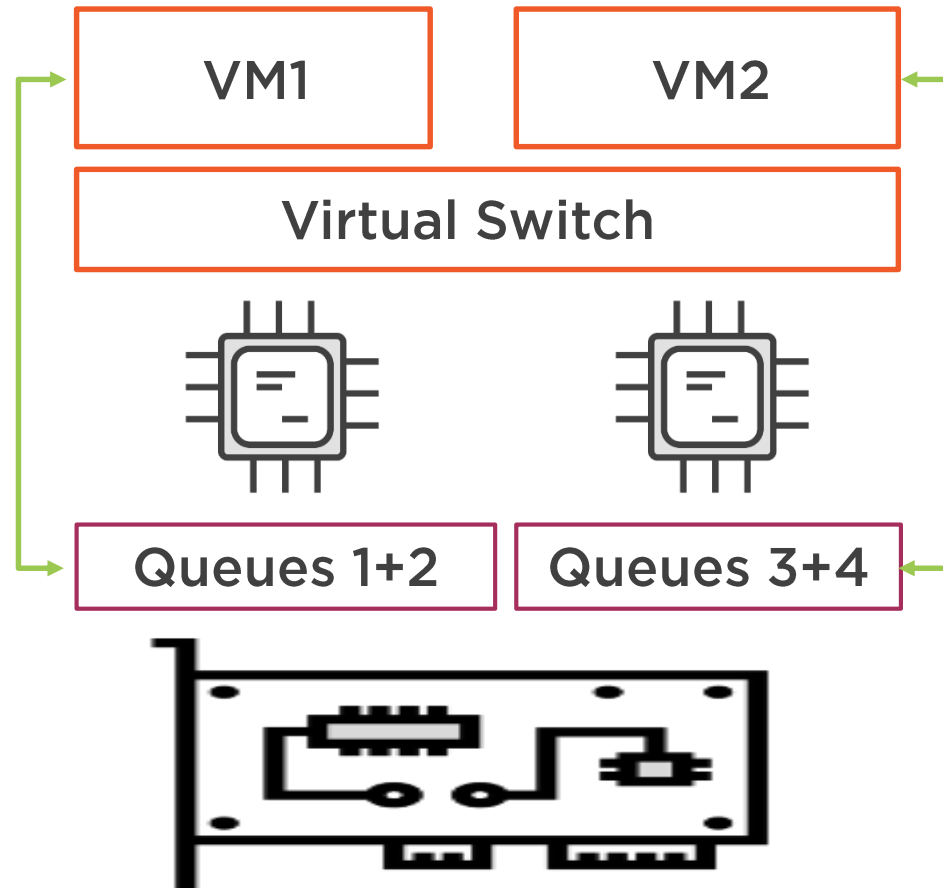
**Set-NetAdapterVmq**

# Virtual Machine Queuing (VMQ)





# Virtual Machine Multi-Queueing (2016+)





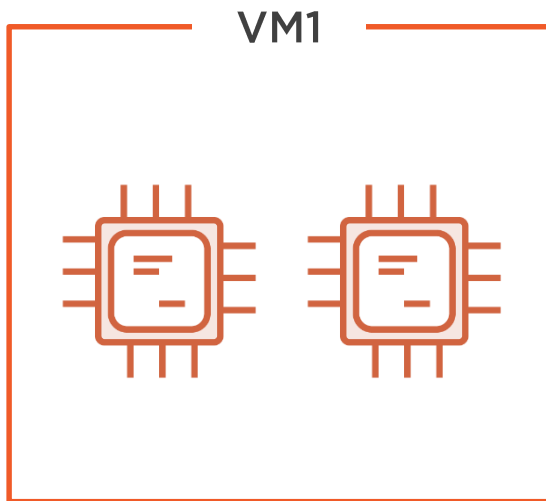
PowerShell is not always consistent:

```
Set-NetAdapterVmq -Name "Adapter"  
-Enabled $True
```

```
Set-VMNetworkAdapter "VMName"  
-VmmqEnabled $True
```



# Virtual Receive Side Scaling (vRSS)



**Requires VMQ support in NIC**

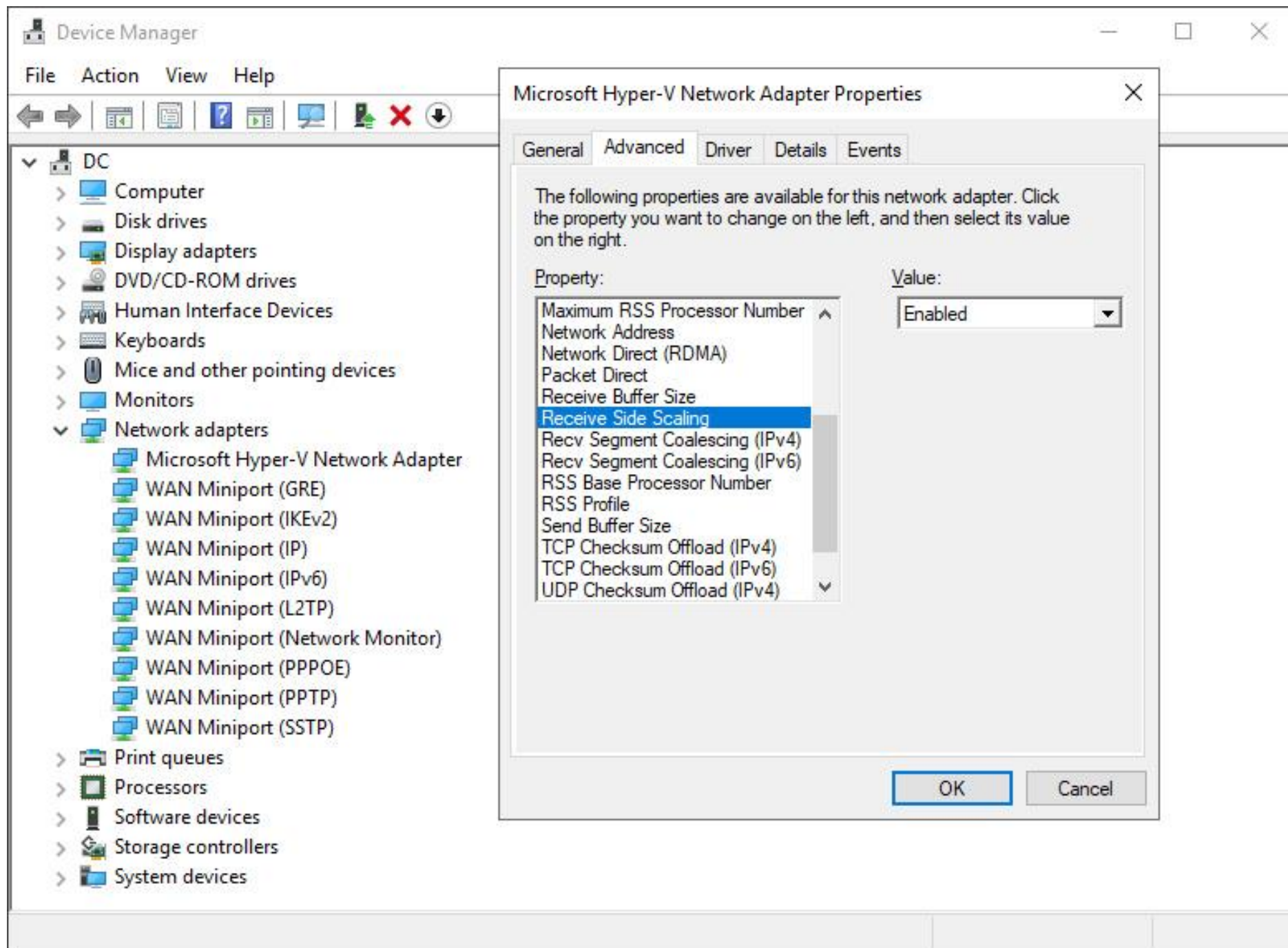
**Disabled by default**

**Takes things one step further by spreading packet traffic across multiple *virtual* CPUs**

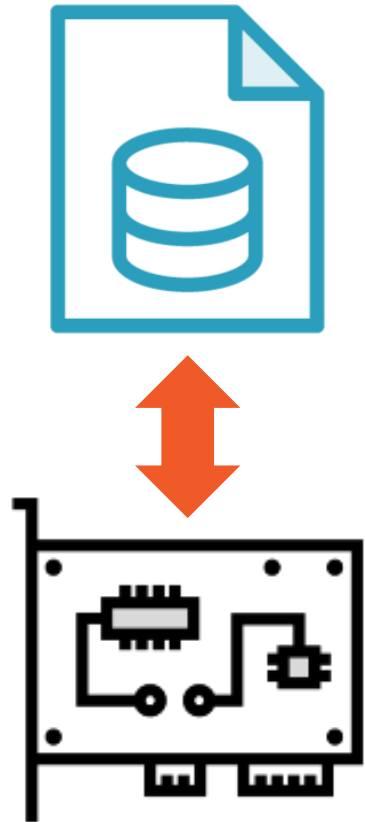
**Increases workload on virtual switch**

**Enable via Device Manager inside guest VM**

**Enable-NetAdapterRSS**



# Remote Direct Memory Access (RDMA)



**Permits very fast access to SMB3 data storage**

**Requires explicit support in the physical NIC**

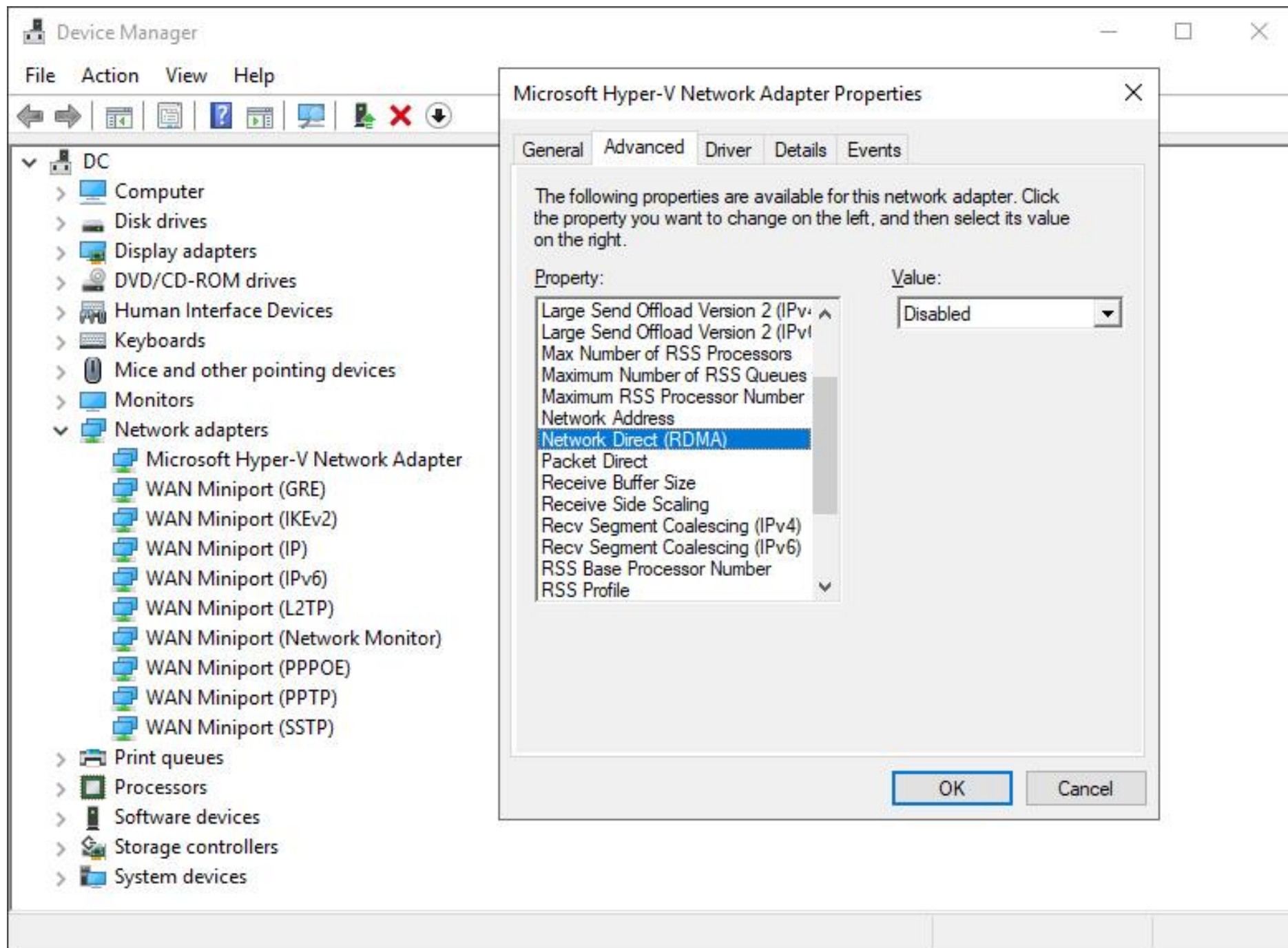
**RDMA in a Hyper-V guest leverages SR-IOV**

- Device Manager in the VM
- `Enable-NetAdapterRdma`

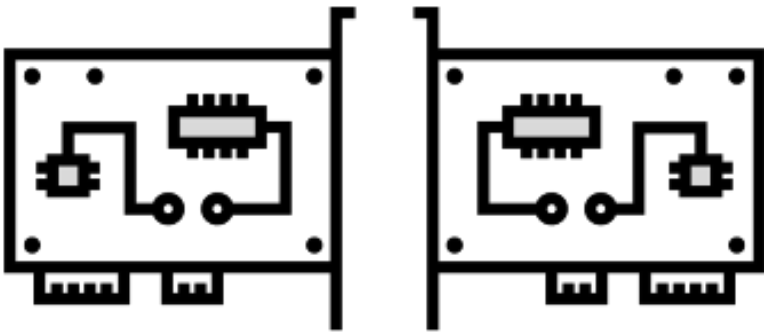
**You can use RDMA with NIC teaming using Switch-Embedded Teaming**

- Discussion coming up shortly!





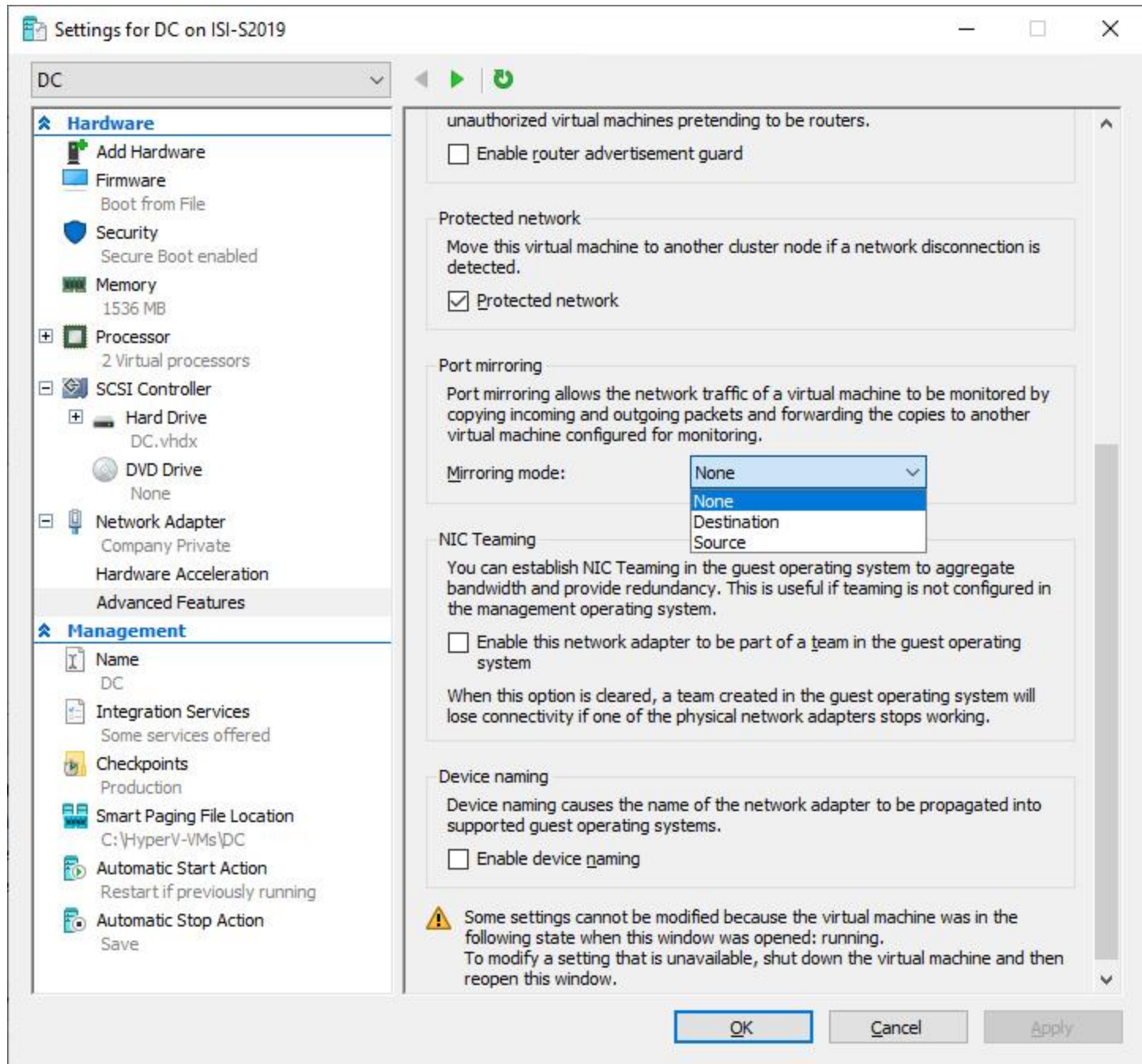
# Port Mirroring for Performance Monitoring



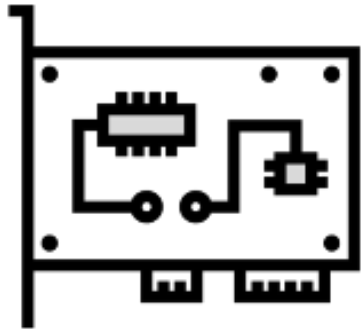
“Source” vNIC sends all data to  
“Destination” vNICs

Destination VMs perform traffic capture  
and analysis e.g. via sniffer





# PerfMon Objects



## Hyper-V Hypervisor Logical Processor

- Host plus guests

## Hyper-V Hypervisor Root Logical Processor

- Host

## Hyper-V Hypervisor Virtual Processor

- Guests (per vCPU per VM)

## Hyper-V Virtual Network Adapter

## Hyper-V Dynamic Memory



If you don't need as much detail,  
**Resource Metering** (PowerShell)  
may be all you need  
(totals and averages).



# NIC Teaming

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## Types of NIC teams:

Host teaming

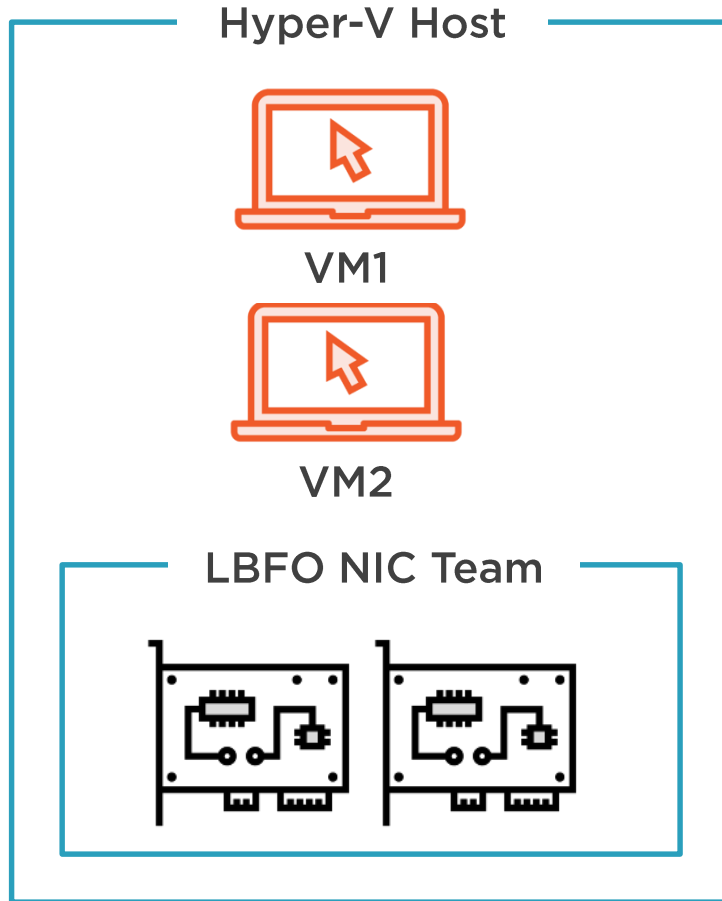
Guest teaming

Switch-Embedded Teaming





# Host Teaming (LBFO)



## More common type

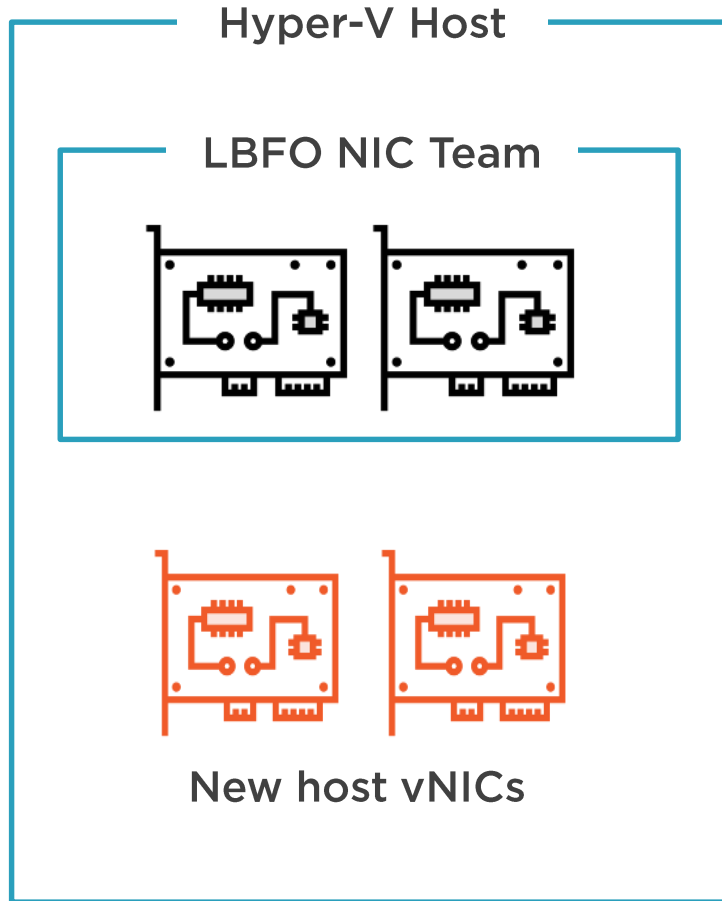
- LBFO = Load Balancing Fail Over
- Formerly only available from OEMs
- Support is native in Windows 2012+ via Server Manager, PowerShell

## Pros and cons:

- Redundancy for fault tolerance
- Additional throughput
- All NICs must be same speed but not necessarily identical models
- No SR-IOV or RDMA NICs



# Host Teaming and Traffic Management



**Hyper-V hosts may need to manage multiple types of traffic separately:**

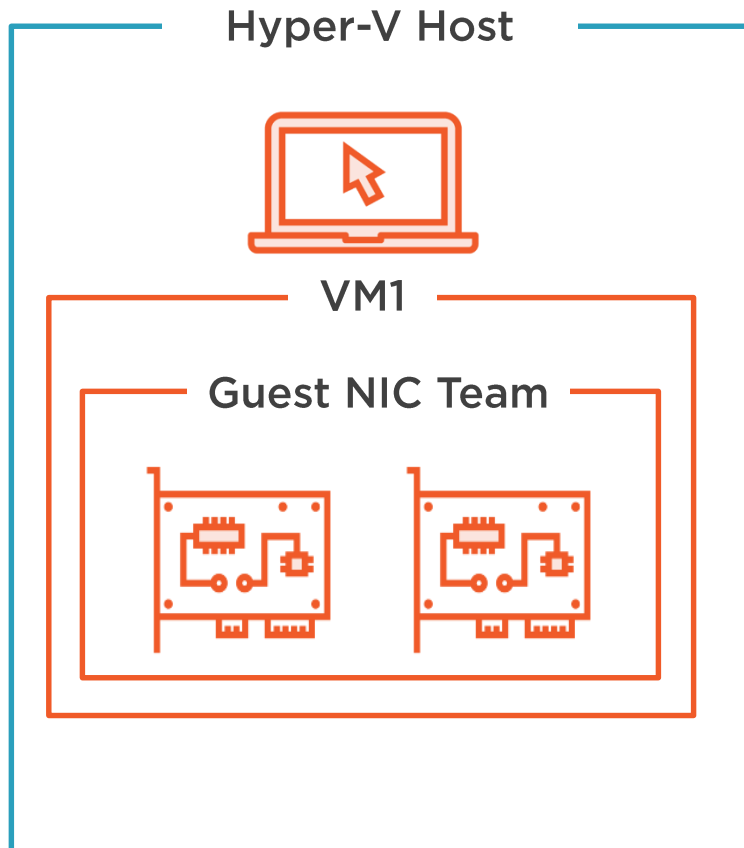
- Storage
- Management
- VM traffic

**Separate NICs on the host are inefficient**

**We can create a team and then create vNICs on the host with PowerShell**

- QoS can then be applied to the vNICs
- This is “converged networking”

# Guest Teaming



## Less common type

### Create the team in the VM

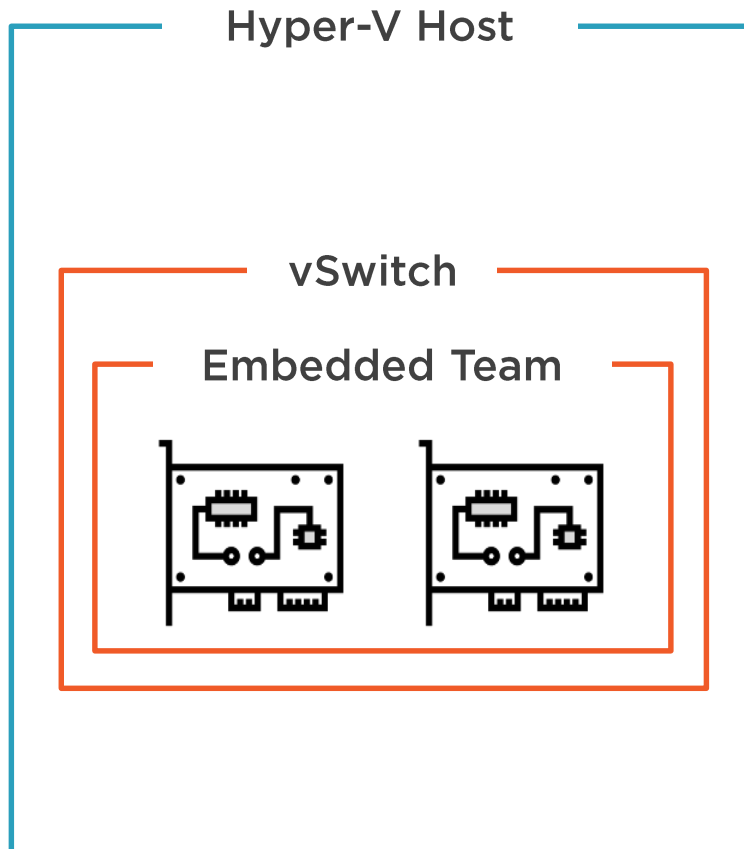
- Hyper-V Manager: VM properties > Advanced Features > checkbox
- `Set-VMNetworkAdapter -VMName <name> -AllowTeaming On`

### Compatible with SR-IOV NICs

Microsoft only supports 2 vNICs per team



# Switch-Embedded Teaming (SET)



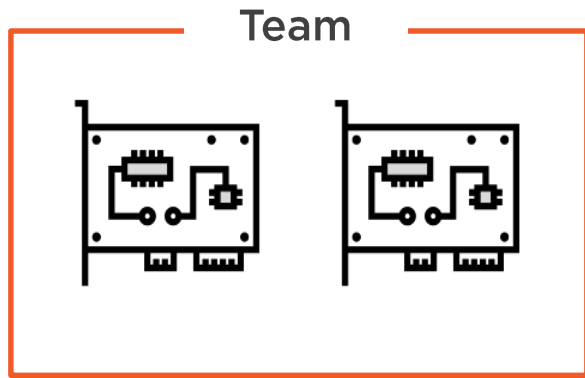
## Newest type

Supports RDMA for high-speed access to SMB3 storage

## Create the team in the switch

- Up to 8 adapters, must be identical
- Use PowerShell, SCVMM, or Windows Admin Center
- `New-VMSwitch`
  - `EnableEmbeddedTeaming $True`

# NIC Teaming Modes



## Teaming mode:

- Switch-Independent (switch is unaware of team)
- Switch-Dependent (switch determines how to distribute traffic, e.g. LACP)

## Load balancing mode:

- Dynamic (recommended)
- Address Hash (less common)
- Hyper-V Port (OK for even workloads)



## SERVERS

All Servers | 1 total

Name	Status
ISI-S2019	Online

## TEAMS

All Teams | 0 total

Team	Status	Teaming Mode
------	--------	--------------

## New team

Team name:

DemoTeam

Member adapters:

In Team	Adapter	Speed	State	Reason
<input checked="" type="checkbox"/>	Ethernet	1 Gbps		
<input checked="" type="checkbox"/>	Ethernet-USB	1 Gbps		

Additional properties

**Teaming mode:** Switch Independent

**Load balancing mode:** Dynamic

**Standby adapter:** None (all adapters Active)

**Primary team interface:** DemoTeam: Default VLAN

OK

Cancel



# Network Security

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## Hyper-V network security:

Antimalware

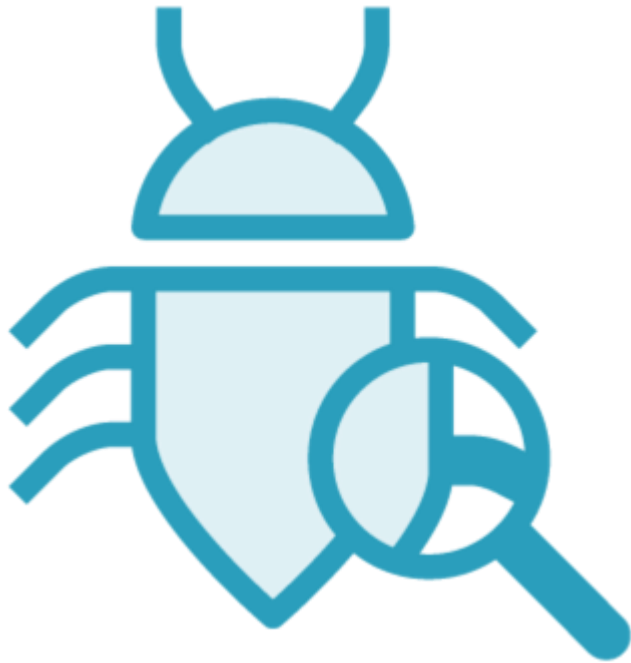
Firewall protection

DHCP Guard

Router Guard

Shielded VMs

# Antimalware



## Exclusions to confirm on host:

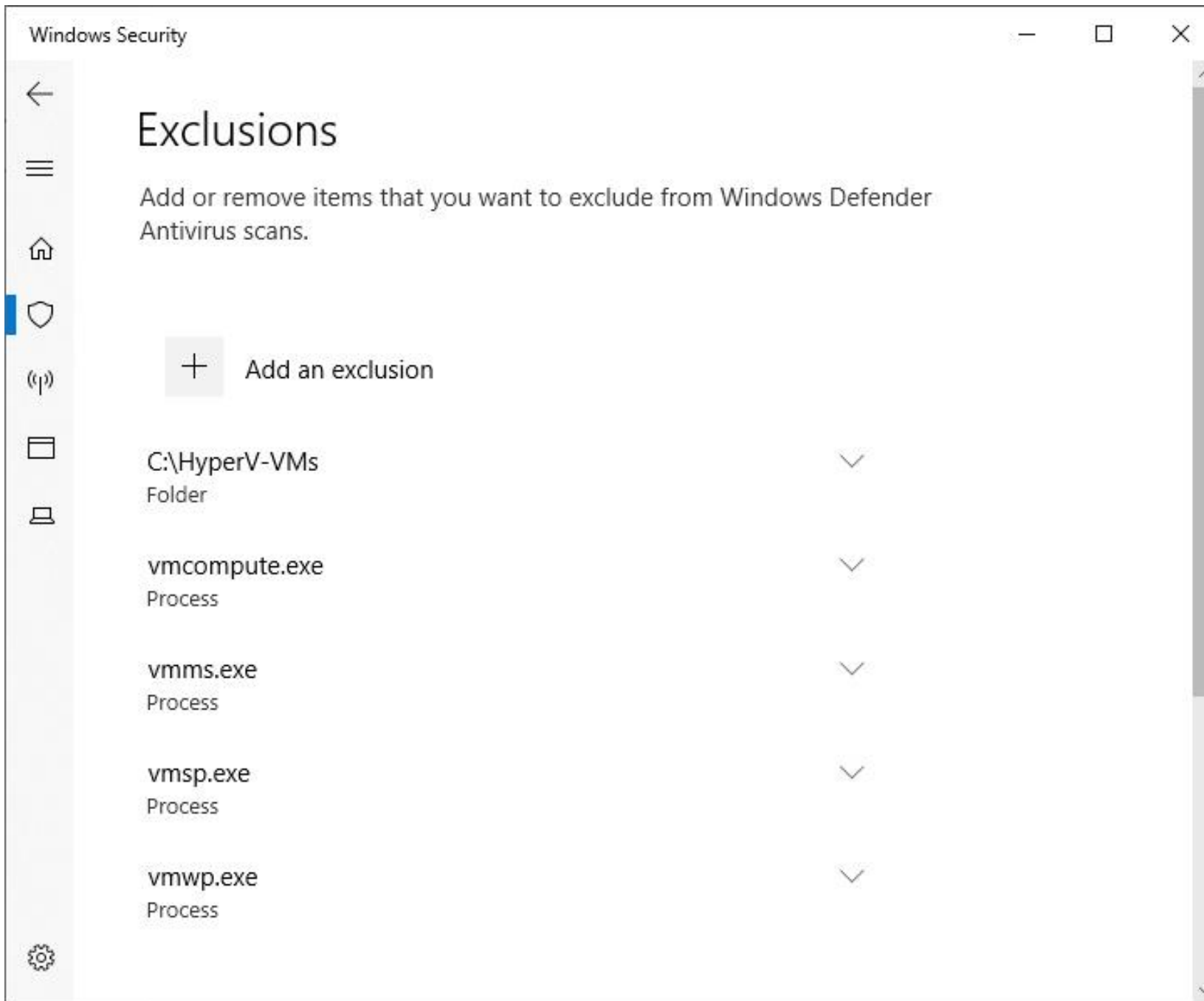
- VHD, checkpoint, and VM configuration file directories
- Hyper-V processes (vmms.exe, vmwp.exe, vmosp.exe, vmcompute.exe)

## UEFI Secure Boot for Generation 2 VMs

- Only boot to known OS
- Discourage rootkits
- Fairly good Linux support now

**Antimalware on guests is recommended**





# Firewall Protection



## Firewall on host does not affect guests

- ...and vice versa!

## Consider virtual switch extensions

## Options depend on environment

- In Active Directory environments, use Group Policy to configure
- In Azure, use Network Security Groups
- In SDNv2 deployments, use Distributed Firewall Manager in Network Controller

# DHCP Guard and Router Guard



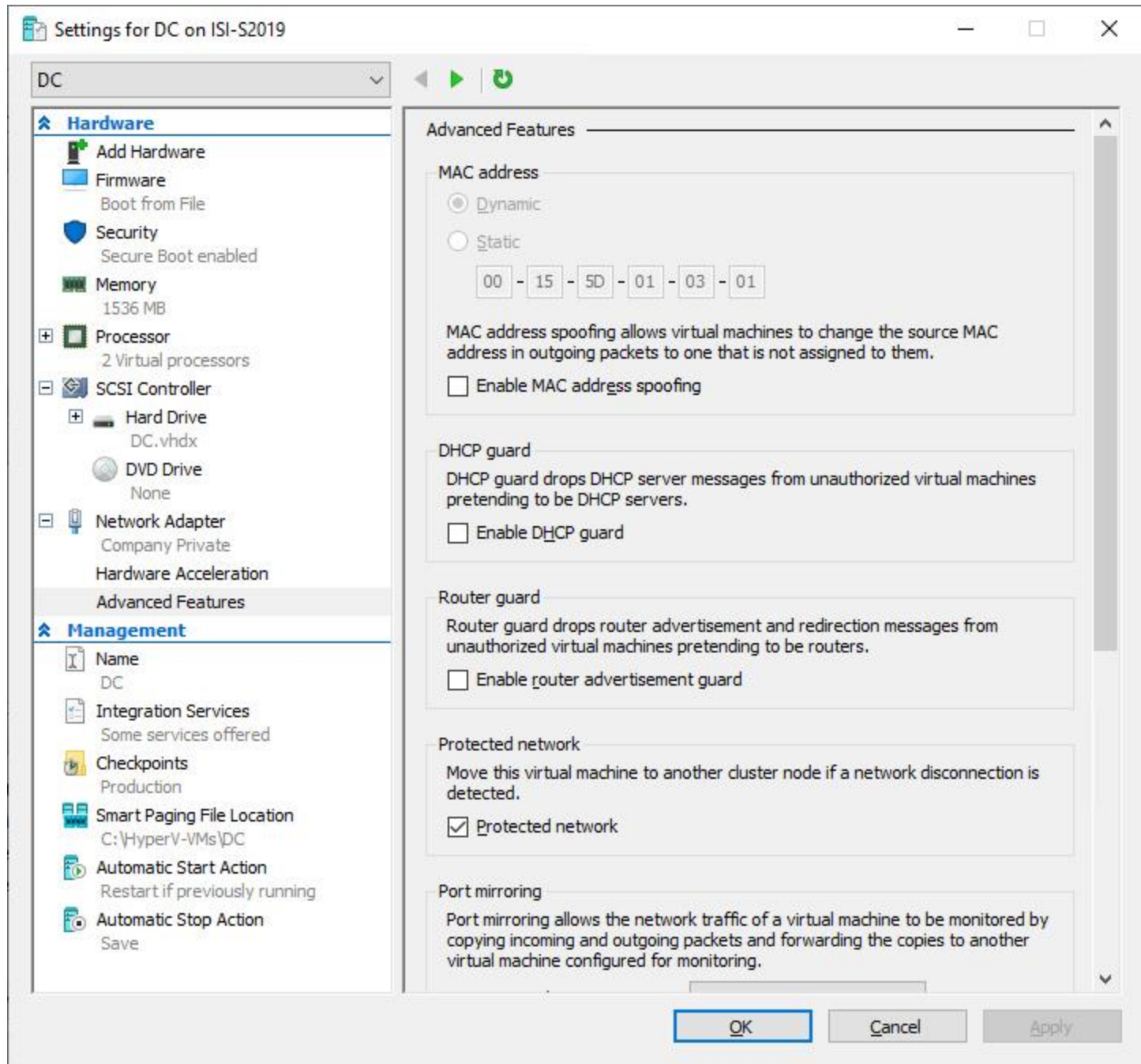
**Mainly for multitenant environments**

**“Rogue DHCP servers” in VMs**

- If enabled, Hyper-V switch will drop DHCP packets
- Per-NIC setting

**Router Guard behaves similarly**

- Drops router advertisement messages



# Shielded VMs (“Shielded Fabric”)



## Goal: Separate host administration from VM administration

- Host admins will have no access to guests (console, file copy, PowerShell Direct, etc.)
- VHDs encrypted with BitLocker

## Provide decryption keys only to trusted (healthy) hosts via Host Guardian Service

- TPM verifies secure boot
- Keys stored in VBS “vault”
- HGS runs in its own forest



Shielded VMs may be more important  
in cloud scenarios where the hoster  
and the tenant are different  
organizations.





The HGS is super important and is therefore typically run on a cluster.

Server 2019 provides HGS **caching** in case the HGS is temporarily unavailable.





# Shielded VMs for Linux!

Server 2019 introduces limited support for shielded VMs running Ubuntu, Red Hat Enterprise Linux, and SUSE Linux Enterprise Server.





# Network Isolation

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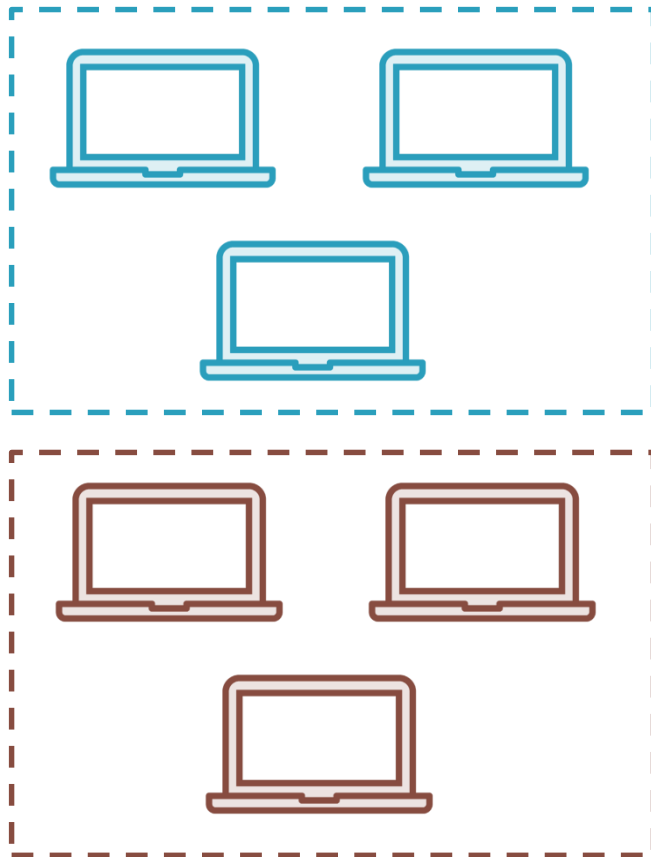
# VLAN

Partitioning a single physical network segment into separate logical networks for controlling broadcast and other traffic without routers.

A VLAN may contain one or multiple subnets.



# Setting up VLAN Support for VMs



**Set up physical network switch to provide a port in “trunk mode” to Hyper-V host**

- Multiple VLAN IDs exposed on this port

**Configure Hyper-V host pNIC with no VLAN ID**

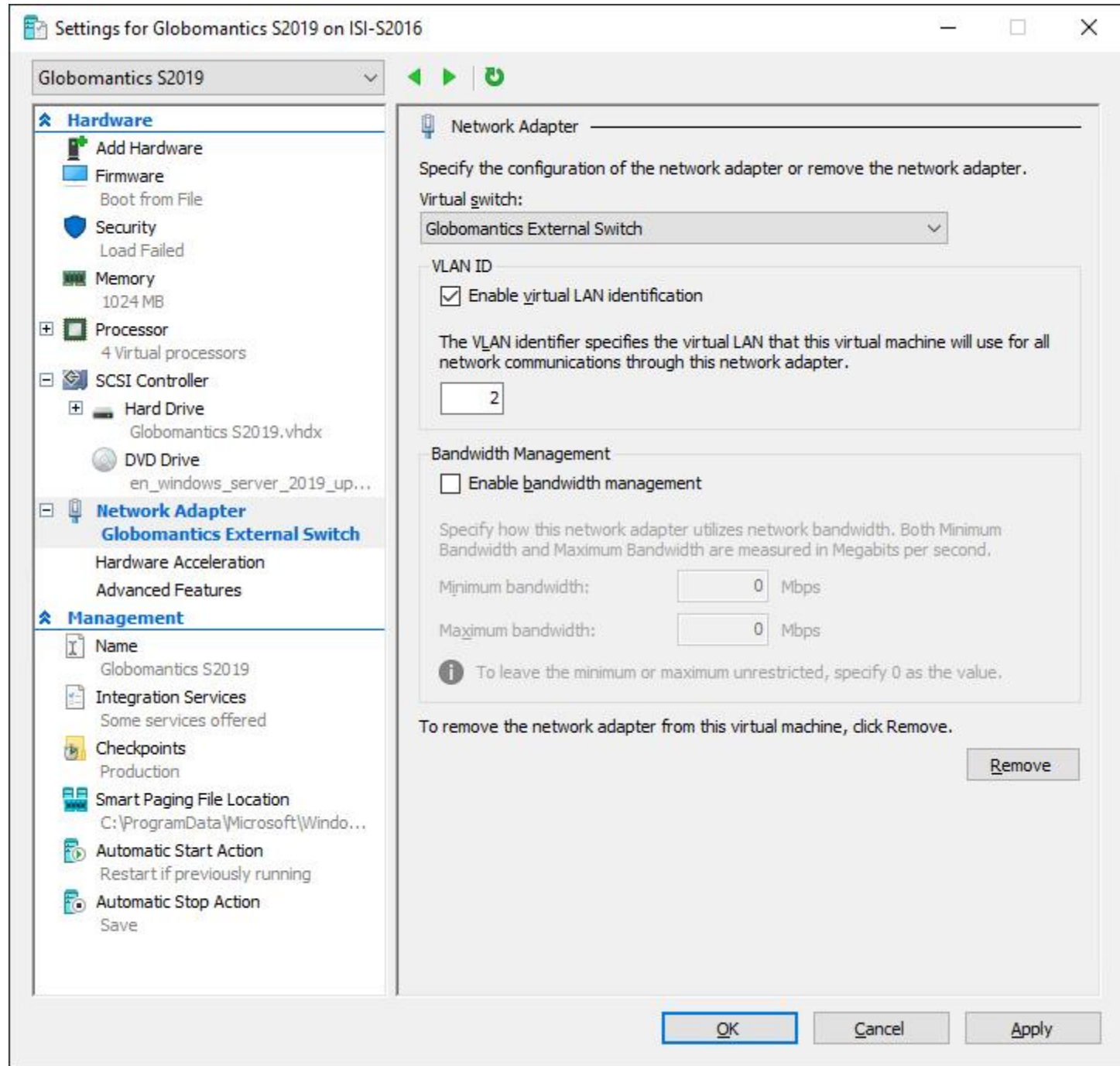
**Set the VLAN ID on each VM’s NIC**

- Hyper-V Manager, Windows Admin Center, or PowerShell
- `Set-VMNetworkAdapterIsolation -IsolationMode Vlan`



When you change the VLAN for a vNIC, be sure that the VM has an IP address compatible with that VLAN.









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## Tools

Search Tools

- PowerShell
- Processes
- Registry
- Remote Desktop
- Roles & features
- Scheduled tasks
- Services
- Storage
- Storage Replica
- Updates
- Virtual machines
- Virtual switches
- Settings

## Settings for Globomantics Linux


 General Memory Processors Disks Networks \* Boot order Checkpoints Security

## Networks

 Add network adapter Remove

Network Adapter

Virtual switch

Globomantics External Enable virtual LAN identification ☒

VLAN identifier: \*

2

Advanced

Save network settings

Discard changes

Close



Nice work! You've finished this module - and this course on implementing Windows Server 2019 Hyper-V!

I hope you will explore other courses in this learning path. Meanwhile, thank you for watching Pluralsight!

*Glenn Weaver*

