

# Hyper-V and ESXi

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# Outline

Microsoft Hyper-V  
Migration  
VMWare ESX



# First, Remote Desktop

Use Remote Desktop Connection if on Windows

Try this if macOS:

<https://docs.microsoft.com/en-us/windows-server/remote/remote-desktop-services/clients/remote-desktop-mac>

Firewall settings → Inbound Rules → Add Rule  
→ Predefined → Remote Desktop

...should be all you need! If not, check to make sure Remote Desktop is activated!  
(Start menu → Allow Remote Access to your Computer)

# Hyper-V Scalability Improvements

System	Resource	Windows Server 2008 R2 Hyper-V	Windows Server 2012 Hyper-V	Improvement Factor
Host	Logical Processors	64	320	5×
	Physical Memory	1TB	4TB	4×
	Virtual CPUs per Host	512	2,048	4×
VM	Virtual CPUs per VM	4	64	16×
	Memory per VM	64GB	1TB	16×
	Active VMs per Host	384	1,024	2.7×
	Guest NUMA	No	Yes	-
Cluster	Maximum Nodes	16	64	4×
	Maximum VMs	1,000	8,000	8×

# Hyper-V Requirements (2012)

## CPU and BIOS

- 64-bit chip

- BIOS that supports

  - CPU-assisted virtualization

  - Data Execution Prevention (DEP)

    - (Safe use of system memory)

- Not often enabled on older chips!

Helpful if server is **certified for Windows Server 2012**

- Vendor tests that Hyper-V can run on machine

- <http://windowsservercatalog.com>



# Hyper-V Requirements (2012)

We need **memory**

**At minimum**

- 8GB of memory

- Single/dual-socket CPU motherboard

- Quad-core CPUs

We need **space**

- As many disk spindles as you can afford

- More medium-capacity disks will outperform less higher-capacity disks

- High-speed solid states would be best

# Hyper-V Requirements (2012)

We need **connectivity**

- At least 2 NICs

  - One for the host

  - One for VMs to access network

- 4 or more to take advantage of options like failover, converged networking, etc.

# Hyper-V Requirements (2012)

We also have **software** requirements

VOSE → virtual operating system environment (licensing for guest OS)

Windows 2012 Edition	CPU Sockets	Virtualization Rights
Windows Server 2012 R2 Datacenter	2	Unlimited free VOSEs
Windows Server 2012 R2 Standard	2	2 free VOSEs
Hyper-V Server 2012	N/A	No free VOSEs
Windows Server 2012 Essentials	N/A	Hyper-V not available
Windows Server 2012 Foundation	N/A	Hyper-V not available



# Hyper-V Architecture

## Privilege levels (Rings)

Intel / AMD processor model

Ring 0

Windows kernel / device drivers

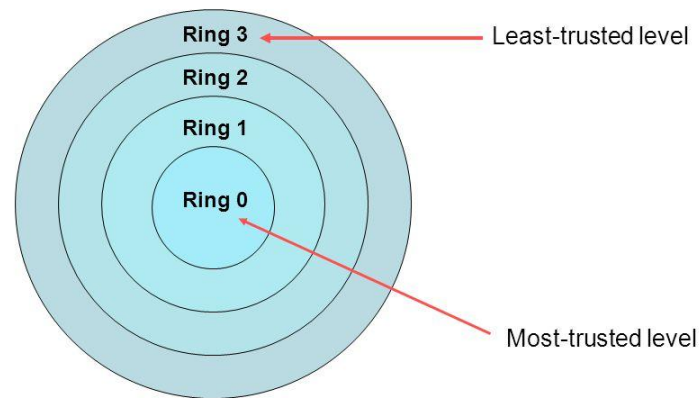
Ring 1,2

Not really used in current Windows

Ring 3

User programs

## Four Privilege Rings



# Hyper-V Architecture

Ring -1 not necessary

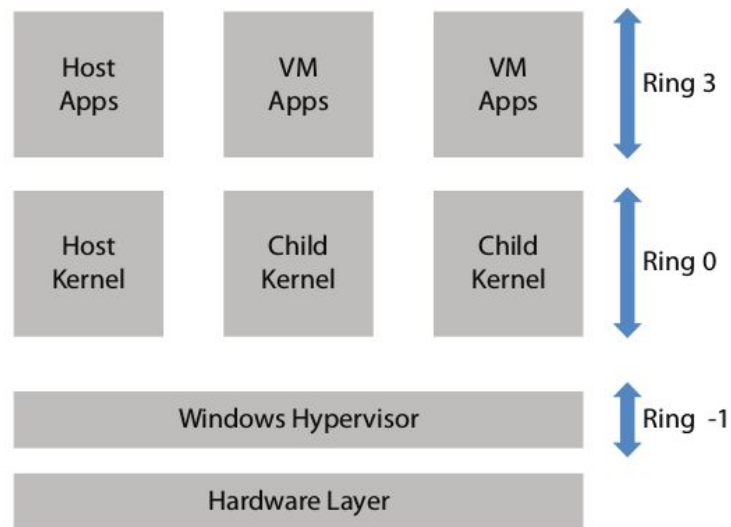
But mainly used because of  
Intel-VT/AMD-V chipset

Higher priority than ring 0

Host OS has direct access to  
hardware

**FIGURE 27.8**

With a hypervisor, the host operates on the same level as the VMs: atop a hypervisor layer.



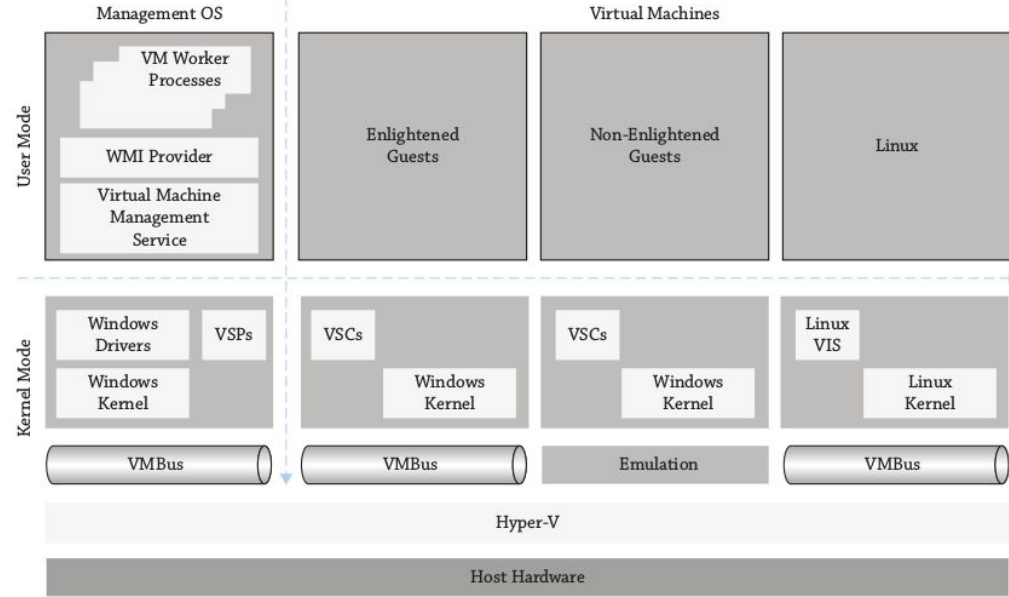
# Hyper-V Architecture

**FIGURE 27.9**  
Hyper-V architecture:  
the hypervisor, the  
virtual machines, and  
their relationship

Management OS partition  
Lower block is ring 0  
Upper block is ring 3

## VMBus

Virtual connection between partitions  
Data communication → Share data between VMs  
Shared memory / IPC  
Does not communicate with hypervisor directly  
Windows drivers **only** in Management OS  
Disk drivers, etc.



# Hyper-V Architecture

**FIGURE 27.9**  
Hyper-V architecture:  
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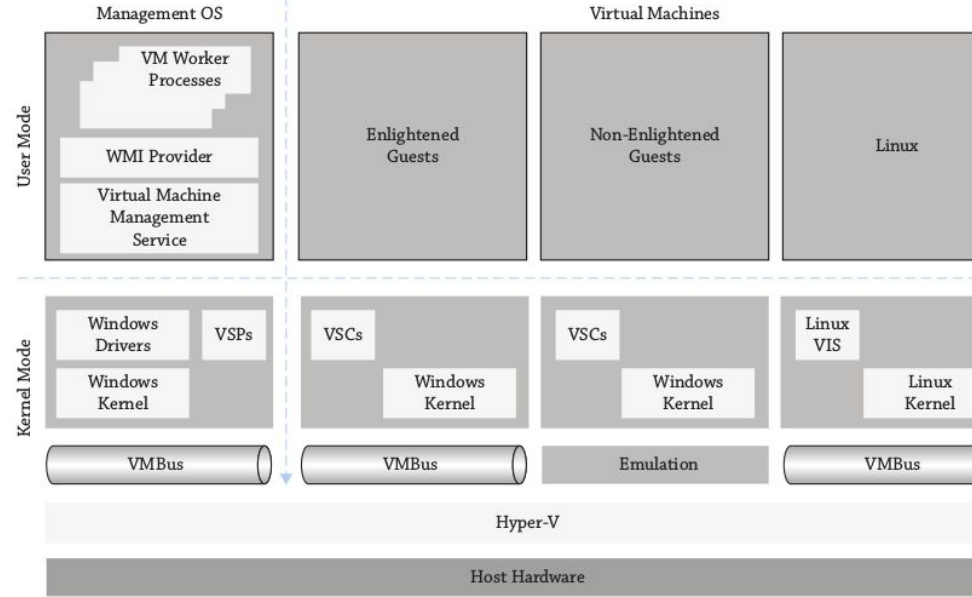
Performance:

VSPs in Management OS

Virtualization service provider

VSCs in Client OS

Virtualization service client



VSP translates data from VMBus and Windows drivers

VSP → made up of modules (storage, networking, etc.)

Communicates with appropriate VSC module

# Hyper-V Architecture

VMM (virtual machine management) manages all virtual partitions

- Only monitors, starts up, shuts down, etc.

WMI (windows management instrumentation) manages system resources

- Not just Hyper-V...all Microsoft products

- Mouse/keyboard status

- VM BIOS

- Managing networking, guest configuration, devices, etc.

- Read CPU properties

- Power state

- Manageable through PowerShell

# Hyper-V Parent Partition -- Services

Data exchange service

Data between VM and Management OS

Guest service interface

Host interaction with guest OS services

Guest shutdown interface

Interface to shutdown guest OS from “real” machine

Heartbeat service

Monitor alive state of VMs

# Hyper-V Parent Partition -- Services

Remote desktop virtualization service

Communication between VM and physical computer

Time synchronization service

Synchronize times between VM and physical computer

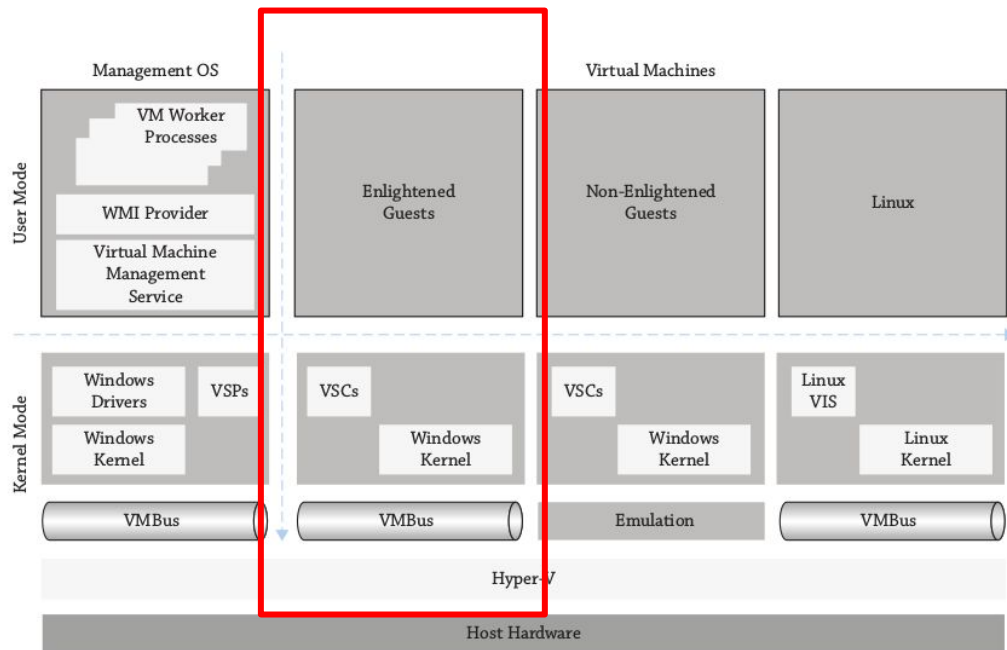
Virtual machine management

Manage multiple VMs at a high level

Only service started **automatically**

# Now...the guests

ecture:  
the  
es, and  
hip



# Welcome Guests



# Enlightened Guests

Two types in Hyper-V

- General

  - Works with VMBus

- Specific

  - Kernel-based

    - If kernel knows about hypervisor → *enlightened* kernel

      - Server guest OS: ≥ Windows 2008

      - Client guest OS: ≥ Vista SP1



Why?

- Optimize VMBus access

- Bypass internal layers (networking, disk access, etc.)

# Non-Enlightened

Don't know about virtualization

E.g., Windows XP, 2003...need VSC to be installed manually

Again, 2008 and higher have VSC built in

Meaning...

Microsoft hasn't written any modules for the system

VSCs:

Cannot be configured from guest partition

Only through Management OS

# Where are VSCs?

- Display Adapter
  - a. C:\Windows\System32\VMBusVideoD.dll
  - b. C:\Windows\System32\Drivers\VMBusVideoM.Sys
- Human Interface Devices
  - a. C:\Windows\System32\Drivers\hidusb.sys
  - b. C:\Windows\System32\Drivers\VMBusHID.SYS
- For Network Adapters
  - a. C:\Windows\System32\Drivers\NetVSC60.sys
- For Storage Controllers
  - a. C:\Windows\System32\Drivers\StorVSC.sys

# Other

## Non-Microsoft guest partitions

Linux → Linux Virtual Integration Services (VIS)

Kernel-level drivers that give access to VMBus



# Installing Hyper-V

...yea...

Installation?

- Fairly straightforward

- Let's focus on the best practices

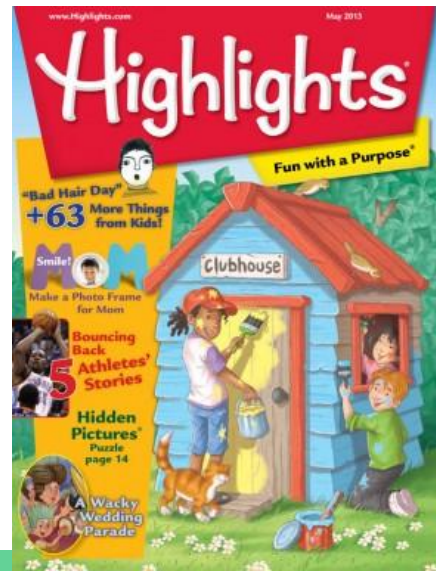
- I'll do a quick demo after our 'best practices'

# Best Practices

<https://blogs.technet.microsoft.com/askpfplat/2013/03/10/windows-server-2012-hyper-v-best-practices-in-easy-checklist-form/>

Some industry insights into the best practices when installing Hyper-V  
Use at your own risk...

Slides won't be comprehensive as blog is *long*  
But, we'll highlight the...highlights



# Best Practices - General (Host)

- Use Server Core (or Windows Minimal Interface)
  - Reduce overhead
- Keep Host up to date
  - Patches
  - Hotfixes
  - Windows Updates
  - BIOS / Hardware device drivers
- Domain-joined
  - Centralize policy management
  - Auditing
  - Required for High Availability Cluster

# Best Practices -- General (Host)

- RDP printer mapping disabled
  - Avoid printer driver inconsistencies
  - Instead use a Group Policy to define printing
- Ensure Hyper-V is the **only** role installed on the Host
  - Limit performance concerns
  - Excluding Failover Cluster Manager, for instance
- Exclude antivirus software from scanning Hyper-V folders
  - Snapshots, configuration directories, Hyper-V executables, etc.
  -
- Periodically check performance
  - Run performance counters (will chat about performance in a future module)
  - Look for issues like disk latency, low memory, networking problems, etc.
    - Resolve!



# Best Practices -- General (Host)

- NICs (when to use emulated NIC adapters → legacy network adapters vs. Synthetic NIC drivers (Hyper-V default))
  - Synthetic NIC
    - Highly-efficient and tuned for VMBus
    - Reduced CPU cycles required
    - Lower amount of information transferred between hypervisor and guest
  - Legacy → only use for PXE booting
    - Or installing non-Hyper-V-aware guest OS
    - PXE booting?
      - Network boot

# Best Practices -- Guests (VMs)

- Run only supported guest OSs
  - Including Windows Server and client OS environments
- Be cautious when snapshotting VMs
  - Very quickly run out of space
  - Make sure snapshot location is not on the host
- Use VHDX format
  - Older formats were VHD → should convert to VHDX as necessary

# Best Practices (Memory and Bandwidth)

- A guest's memory (RAM) should be configured, at minimum, with:
  - Windows Server 2008 / 2012 → 2048MB
  - Windows 7 / Vista → 1024MB
  - Windows Server 2003 R2,SP2 → 512MB
  - Windows XP → 512MB
- If performing live migration or replications:
  - Use compression if NICs are 10GB or less
  - Otherwise, use RDMA (remote direct memory access)
    - Low latency network transfer / CPU utilization
    - Not affected by VM workload!

# Best Practices -- Integration Services

- Ensure Integration Services (IS) is installed on **all** VMs
  - Improves VM/host communication/interaction
  - Similar to VMWare Tools
  - Services available:
    - VM Connection Enhancements → helps with mouse focus
    - Virtual drivers / Hypervisor-Aware Kernel → easy parent<->guest communication via VMBus
    - Time Synchronization service
    - Heartbeat service → detect hangups
    - Shutdown service → clean shutdown (avoid logging in manually)
    - Key/Value pair exchange → exchange configuration information via registry

# Best Practices -- Conversion

- Converting VMs from VMWare to Hyper-V
  - Consider using Microsoft's Migration Automation Toolkit
    - <https://gallery.technet.microsoft.com/Automation-Toolkit-for-d0822a53>
    - Essentially a bunch of PowerShell scripts
      - Doesn't work on Windows Server 2012 R2 though!

# Migration

Planning on moving from physical → virtual

Or virtual → physical

Or virtual → virtual!



# Migration Steps

(May have more for your particular organization)

## P2V

- Remove unique hardware drivers and security identifiers

- Convert drive to virtual hard disk (VHD)

- Load VHD into virtual machine environment

- Boot and load appropriate virtualization drivers (e.g., Hyper-V drivers)

## V2P

- Remove unique hardware drivers and security identifiers

- Convert VHD to drive image

- Load image onto physical hard drive

- Boot physical machine and load appropriate drivers

# Migration Steps

Or...

Have Microsoft do it for you...

Microsoft Assessment and Planning Toolkit

<https://technet.microsoft.com/en-us/library/bb977556.aspx>

“The Microsoft Assessment and Planning Toolkit (MAP) is an agentless, automated, multi-product planning and assessment tool for quicker and easier desktop, server and cloud migrations. MAP provides detailed readiness assessment reports with extensive hardware and software information, and actionable recommendations to help organizations accelerate their IT infrastructure planning process, and gather more detail on assets that reside within their current environment. MAP also provides server utilization data for Hyper-V server virtualization planning; identifying server placements, and performing virtualization candidate assessments.”



# VMWare ESXi

ESXi → new iteration of ESX

Type 1 hypervisor

We'll mainly focus on the differences to Hyper-V

Difference:

- Hyper-V requires Windows and hooks directly into the Windows kernel

- ESXi runs as a standalone ISO file

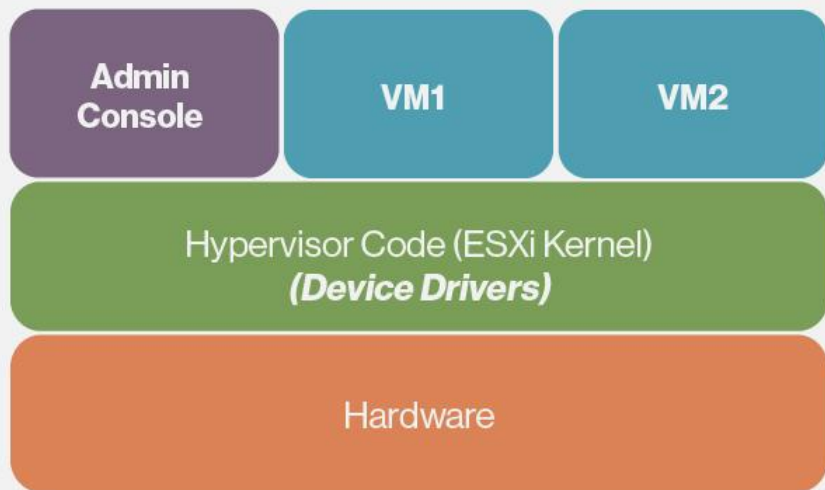
  - ESX used to ship with a modified Linux kernel

  - ESXi built on proprietary VMWare kernel

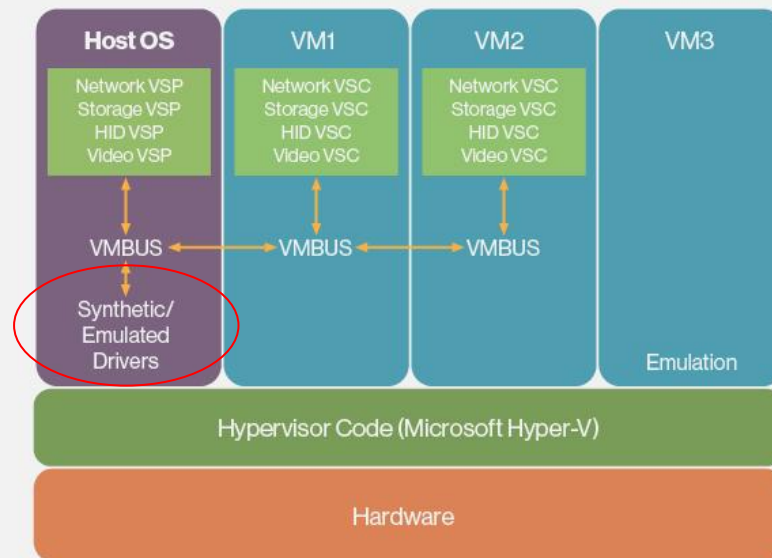
    - Cannot load Linux drivers directly either → require modification

# ESXi

## Monolithic Design



## Microkernelized Design



# Which is Better?

## ESXi

- Drivers part of kernel

- Therefore, can only be installed on supported hardware

- Direct access to hardware

- Can't install any additional roles

## Hyper-V

- Can really run on any hardware

- Reduces overhead for maintained drivers

- Don't need individual drivers on each VM

- Hyper-V servers can also support other roles

# But..

ESXi is just the free hypervisor

You really need vCenter to do all the fun stuff

- Live migrations

- Failover

- Etc.

However, these days many of the “improvements” one features over the other are also available in the other

# For Instance

vSphere introduces Virtual Volumes

Interact with hard drives at the storage level (hardware level)

However

Microsoft provides a similar technology in Windows Storage Spaces

Both bypass the layer of emulation to provide performance boosts

# As Well As...

## Network I/O control

Introduced by vSphere to limit VM bandwidth usage

Also provided by Hyper-V

# Hyper-V Installation Demo

- 1) Try to install Hyper-V role in Server Manager

# Hyper-V Installation Demo

- 1) Make sure we are able to run via the ExecutionPolicy

```
PS> Get-ExecutionPolicy
```

→ RemoteSigned is sufficient here

- 2) Let's enable the OptionalFeature

```
PS> Enable-WindowsOptionalFeature -Online -FeatureName  
Microsoft-Hyper-V -All -NoRestart
```



# Hyper-V Installation Demo

Does not install management tools → hypervisor only

```
PS> Install-WindowsFeature RSAT-Hyper-V-Tools  
-IncludeAllSubFeature
```

Any chance we want to do a cluster? If so, we need things for that too...

```
PS> Install-WindowsFeature RSAT-Clustering -IncludeAllSubFeature
```

Perhaps we want to allow multiple paths to file storage

```
PS> Install-WindowsFeature Multipath-IO
```

# Hyper-V Installation Demo

Now let's let this all take effect...

```
PS> Restart-Computer
```

# Hyper-V Installation Demo

Let's lookup what we can do now...

```
PS> Get-Help Export-VM
```

# Hyper-V Installation Demo

So we have a useless hypervisor...let's get rid of it  
Simply unroll commands (run the opposite in reverse order)

```
PS> Remove-WindowsFeature Multipath-IO
```

```
PS> Remove-WindowsFeature RSAT-Clustering
```

```
PS> Remove-WindowsFeature RSAT-Hyper-V-Tools
```

```
PS> Disable-WindowsOptionalFeature -Online -FeatureName  
Microsoft-Hyper-V
```

# Groupwork

One aspect of the project will be group administration

We will create an Active Directory setup for the **class** and each **team**

- I will be able to administrate each of your servers

- You will be able to administrate each of your teammate's servers

# Groupwork

Basic requirements for the project:

- 1) Your service must be ... accessible
  - a) Within VPN network
    - i) And administrated via each other's server
  - b) May require additional AD administration
    - i) You'll be hooked into my AD DS
  - c) Single sign-on
- 2) Your service must be ... fault-tolerant
  - a) Look into failover, clustering, backups, etc.
- 3) Your server must have a web portal
  - a) Like last semester ... your forward facing portal to the outside world
  - b) May provide turnkey access to your service, depending on the service
  - c) More than "just a landing page"
- 4) Your server must be able to deploy new services/applications
  - a) To all managed servers

## **Your task today:**

Figure out

- (a) Who's server will host what processes
- (b) How your particular domain will look (sketch it out -- with descriptive hostnames)
- (c) Additional details for how your service will participate in this schema
  - (i) Ubuntu or Windows?
  - (ii) Whose server will be main Domain Controller