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# Introduction to Windows Server 2016 Nested Virtualization

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**Introduces this new feature of Microsoft Windows Server 2016**

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**Describes the steps how to implement nested virtualization**

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**Demonstrates how to create VMs nested three levels**

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**Helps IT Specialists understand the new features of Windows Server 2016**

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# Abstract

Windows Server 2016 includes a number new features that will be useful to IT managers and nested virtualization is one of them. This new feature makes it possible to create virtual machines inside virtual machines running on one physical server. This feature is particularly useful in cloud environments.

In this paper we describe how to enable and use this feature on Lenovo servers using Windows Server 2016 Technical Preview 4 (TP4). We provide the step-by-step instructions on how to create a virtual machine inside a Hyper-V virtual machine.

This paper is aimed at IT specialists and IT managers wanting to understand more about the new features of Windows Server 2016.

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# Introduction

Nested virtualization is a new feature of Windows Server 2016 that enables users to run virtualization inside a virtualized environment. It is similar in concept to the VMware ESXi feature with the same name. With this new feature, you can create and run a Hyper-V virtual machine (VM) inside a Hyper-V guest environment.

In our lab we used Windows Server 2016 Technical Preview 4 (TP4) and we evaluated the new feature on these Lenovo® servers:

- ▶ ThinkServer® TD340
- ▶ ThinkServer RD650
- ▶ System x3650 M5

The configuration of the TD340 was as follows:

- ▶ CPU: Intel Xeon E5-2470 v2 processor
- ▶ Memory: 32 GB DDR3 memory
- ▶ Storage: 500 GB SATA HDD
- ▶ NIC: Intel I350-T4 Ethernet adapter

The objective of our testing was to create a a guest operating system three-levels deep using Hyper-V; that is, a guest VM within a guest VM within a guest VM.

## Hyper-V virtualization

Server virtualization enables users to run multiple operating systems on a single physical machine as virtual machines. This function can consolidate workloads of underutilized server machines into a smaller number of fully utilized machines.

Hyper-V requires hardware virtualization support (such as Intel VT-x and AMD-V) to run virtual machines. However, the hypervisor has previously hidden this capability from guest VMs which prevents guest VM from running Hyper-V server role among other hypervisors. For example, in Windows Server 2012 R2, the Hyper-V role cannot be installed in a Hyper-V guest OS.

In Windows Server 2016 TP4 however, Microsoft provides PowerShell scripts to enable virtualization within hosted Windows Server 2016 VMs.

The following two diagrams illustrate the architectural differences between Hyper-V VMs and Hyper-V Nested VMs. Figure 1 on page 4 represents Hyper-V *without* nesting. The Hyper-V hypervisor takes full control of the hardware virtualization extensions, and does not expose them to the guest operating systems.

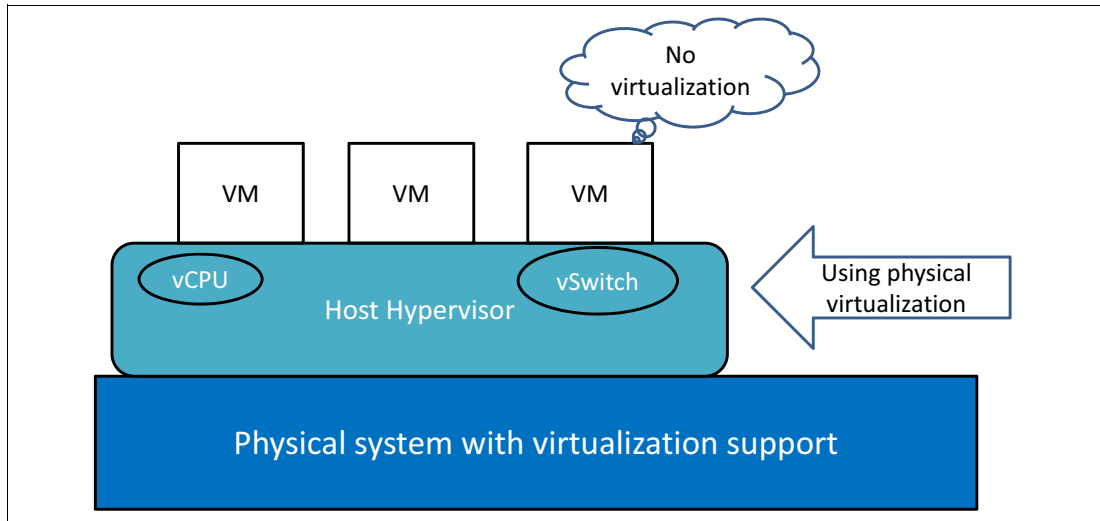


Figure 1 Hyper-V without nested VMs

In contrast, Figure 2 represents Hyper-V *with* nesting. In this case, Hyper-V exposes the hardware virtualization extensions to its virtual machines. With nesting enabled, a guest virtual machine can install its own hypervisor and run its own guest VMs.

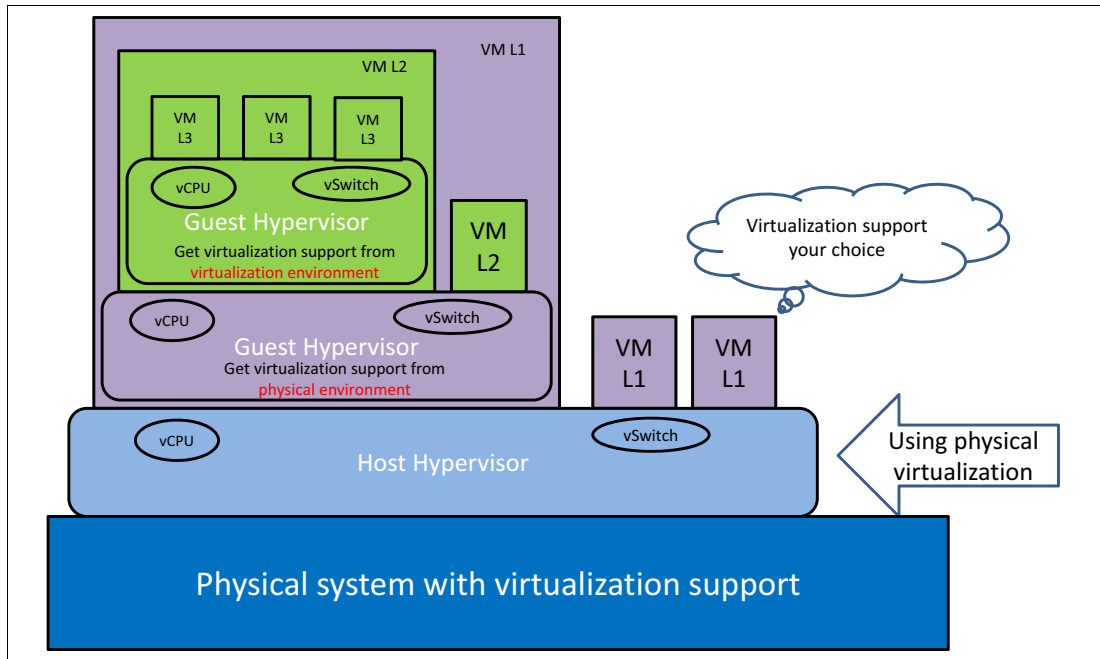


Figure 2 Hyper-V with nested virtual machines

## Creating a nested virtual machine

The steps to configure Hyper-V and create nested virtual machines are as follows:

1. Install Windows Server 2016 TP4 on the host, as well as the Hyper-V feature role.
2. Create a first layer of VM named VM1. Be sure to provision enough resources for VM1 as subsequent layers of virtualization will require some of these resources as well. In our tests we kept the default selections of 24 GB of memory and 320 GB of storage. As

Windows Server 2016 TP4 is installed in each layer of VM, keep 8 GB of memory and 60 GB of disk for each layer of VM.

- a. In the New Virtual Machine Wizard, choose **Generation 2** in the “Specify Generation” setting, as shown in Figure 3

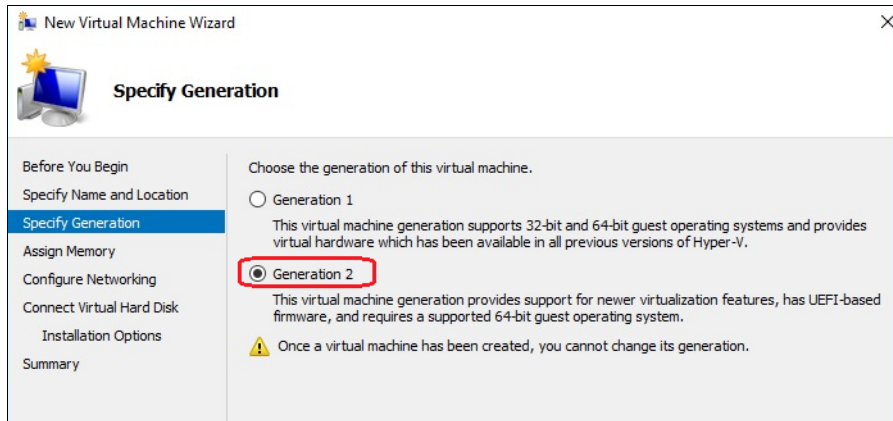


Figure 3 Specify generation

- b. Assign 24 GB of memory to first layer of VM. Ensure that **Use Dynamic Memory for this virtual machine** is *not* selected. See Figure 4.

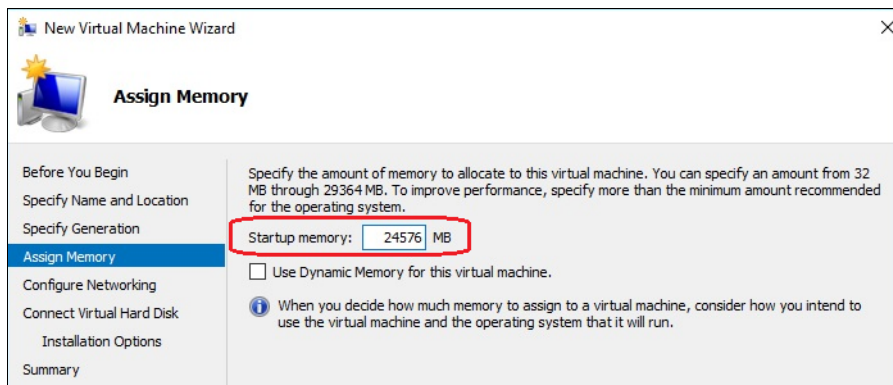


Figure 4 Assign memory

- c. Assign 320 GB of HDD to the first layer of VM, as shown in Figure 5.

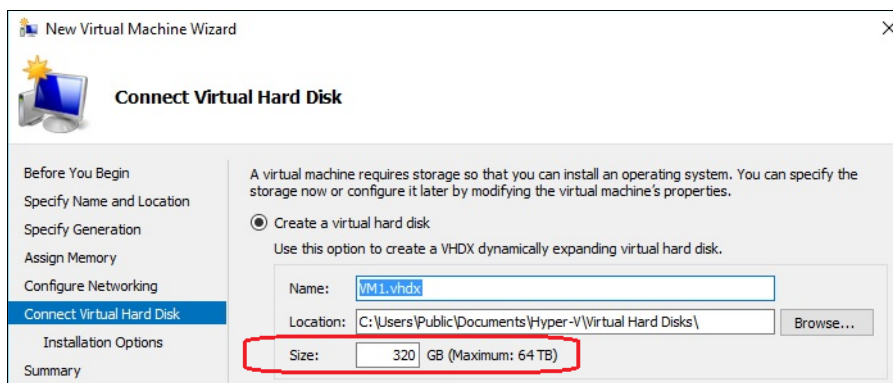


Figure 5 Create a virtual hard disk

- d. Assign physical server's Ethernet controller (I350 NIC in our example) to the vSwitch between host and VM, Figure 6.

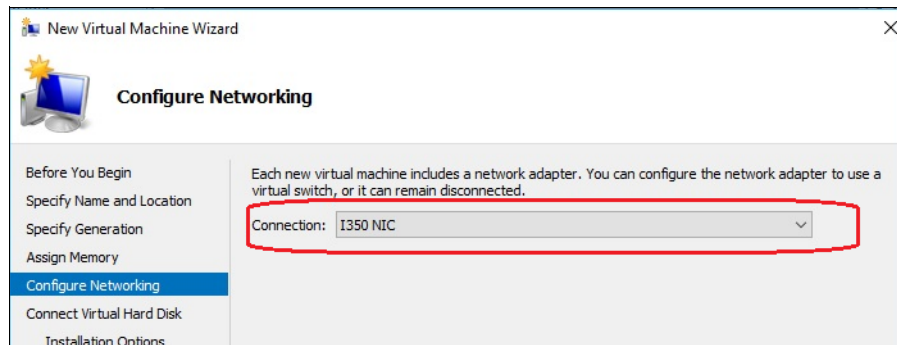


Figure 6 Configure networking

3. Install Windows Server 2016 TP4 on the VM you just created, VM1. If you attempt to directly install the Hyper-V role in VM1, you may meet with the following error, Figure 7.

Hyper-V cannot be installed: the processor does not have required virtualization capabilities

You will see this message because, by default, the hypervisor hides hardware virtualization support capability from guest VMs. The next steps are to use the PowerShell scripts to enable virtualization support capability for guest VMs.

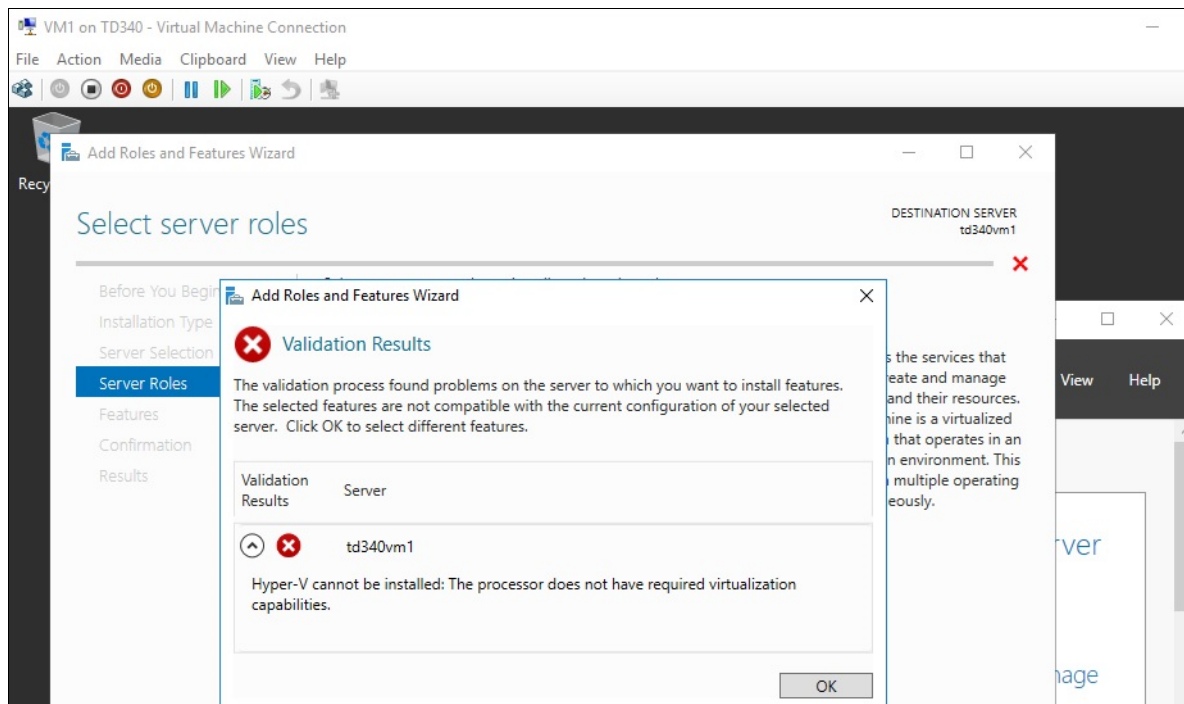


Figure 7 Error installing the Hyper-V server role

4. Shut down VM1.
5. Download the two PowerShell scripts as follows:
  - Enable-NestedVM.ps1This script is used to enable virtualization support within a VM.

<https://raw.githubusercontent.com/Microsoft/Virtualization-Documentation/master/hyperv-tools/Nested/Enable-NestedVm.ps1>

– Get-NestedVirtStatus.ps1

This script is used to get status of nested virtualization and to verify that nested virtualization is supported.

<https://raw.githubusercontent.com/Microsoft/Virtualization-Documentation/master/hyperv-tools/Nested/Get-NestedVirtStatus.ps1>

Use the following command syntax to download them:

```
Invoke-WebRequest link_address -OutFile ~/filename.ps1
```

For example for the first script:

```
Invoke-WebRequest https://raw.githubusercontent.com/Microsoft/Virtualization-Documentation/master/hyperv-tools/Nested/Enable-NestedVm.ps1 -OutFile ~/Enable-NestedVm.ps1"
```

**Tip:** We recommend you use the Invoke-WebRequest command to download the scripts rather than using your browser's Save As functionality. Using the command will ensure the script is downloaded without any character conversions.

6. Use the PowerShell scripts to verify support and to enable support of nested virtualization.

To know whether the physical system supports nested virtualization or not, Microsoft provides Get-NestedVirtStatus.ps1 to check support status. This is an easier way to validate support rather than reviewing the processor specifications.

- a. Open PowerShell as Administrator
- b. Change to the folder where you downloaded the scripts
- c. Issue the following command to check the status:

```
.\Get-NestedVirtStatus.ps1
```

Figure 8 on page 8 shows that our lab system, the ThinkServer TD340, supports nested virtualization, but VM1 currently does not support it.

```

C:\users\snytst\Get-NestedVirtStatus.ps1(Elevated)

The virtualization host TD340 supports nested virtualization: YES

Computer                : TD340
Manufacturer            : LENOVO
Model                   : ThinkServer TD340
ProcessorManufacturer   : GenuineIntel
Product Name           : Windows Server 2016 Technical Preview 4
Installation Type       : Server
Edition ID              : ServerDatacenter
Build Lab               : 10586.17.amd64fre.th2_release.151121-2308
HypervisorRunning      : True
FullHyperVRole         : True
HostNestedSupport       : True
HypervisorLoadOptionsPresent : False
HypervisorLoadOptionsValue  :
IumInstalled           : False
VbsRunning             : False
VbsRegEnabled          : False
BuildSupported         : True
VbsPresent             : False

Looking for VMs...found 1 VMs.
Validating virtual machines...done.

The virtual machine VM1 supports nested virtualization: NO
The following VM configuration errors have been detected:
This VM is not configured to expose virtualization extensions.

Name                    : VM1
SupportsNesting         : False
ExposeVirtualizationExtensions : False
DynamicMemoryEnabled   : False
SnapshotEnabled        : False
State                   : Off

```

Figure 8 Output of the Get-NestedVirtStatus command

- d. Issue the following command to enable virtualization of VM1:

```
.\Enable-NestedVm.ps1 -Vmname "VM1"
```

The output of this command is shown in Figure 9.

```

C:\users\snytst\Enable-NestedVm.ps1(Elevated)

This script will set the following for vm1 in order to enable nesting:
  Virtualization extensions will be enabled
  Optionally enable mac address spoofing
Input Y to accept or N to cancel:y
WARNING: Nested virtualization is an unsupported preview feature. Hypervisors other than the Hyper-V hypervisor running
in a guest virtual machine are likely to fail. Furthermore, some Hyper-V features are incompatible with nested
virtualization, such as dynamic memory, checkpoints, and save/restore.
Mac Address Spoofing isn't enabled, nested guests won't have network!
Would you like to enable? (Y/N)y
PS C:\users\snytst>

```

Figure 9 Output of the Enable-NestedVm command

- e. To check status again, issue the following command:

```
.\Get-NestedVirtStatus.ps1
```

The status changes to YES as shown in Figure 10 on page 9. This will enable you to install the Hyper-V feature role in VM1.

```

C:\users\snyts1\Get-NestedVirtStatus.ps1(Elevated)

The virtualization host TD340 supports nested virtualization: YES

Computer                : TD340
Manufacturer            : LENOVO
Model                   : ThinkServer TD340
ProcessorManufacturer   : GenuineIntel
Product Name            : Windows Server 2016 Technical Preview 4
Installation Type       : Server
Edition ID              : ServerDatacenter
Build Lab               : 10586.17.amd64fre.th2_release.151121-2308
HypervisorRunning      : True
FullHyperVRole         : True
HostNestedSupport       : True
HypervisorLoadOptionsPresent : False
HypervisorLoadOptionsValue  :
IumInstalled           : False
VbsRunning             : False
VbsRegEnabled          : False
BuildSupported         : True
VbsPresent             : False

Looking for VMs...found 1 VMs.
Validating virtual machines...done.

The virtual machine VM1 supports nested virtualization: YES
Name                    : VM1
SupportsNesting         : True
ExposeVirtualizationExtensions : True
DynamicMemoryEnabled    : False
SnapshotEnabled        : False
State                   : Off

```

Figure 10 Checking the status after enabling nested virtualization

7. In the settings for VM1, change the setting Automatic Stop Action to **Turn off the virtual machine**. We are doing this to avoid problems associated with nesting as indicated in the warning message displayed in Figure 9 on page 8.
8. Boot VM1 again and enable the Hyper-V server role into the virtual machine. This time, you should not see the same error you did in step 3 on page 6.
9. From within VM1, create a virtual machine named VM2. Provision 16 GB of memory to VM2, Figure 11.

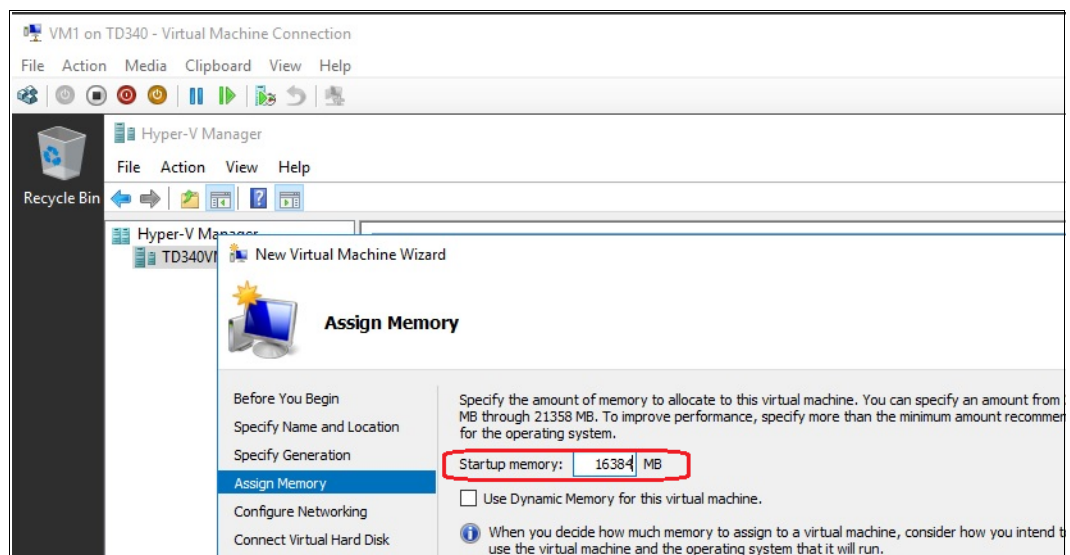


Figure 11 Assigning memory to VM2

10. Provision 120 GB of disk to VM2, Figure 12 on page 10.

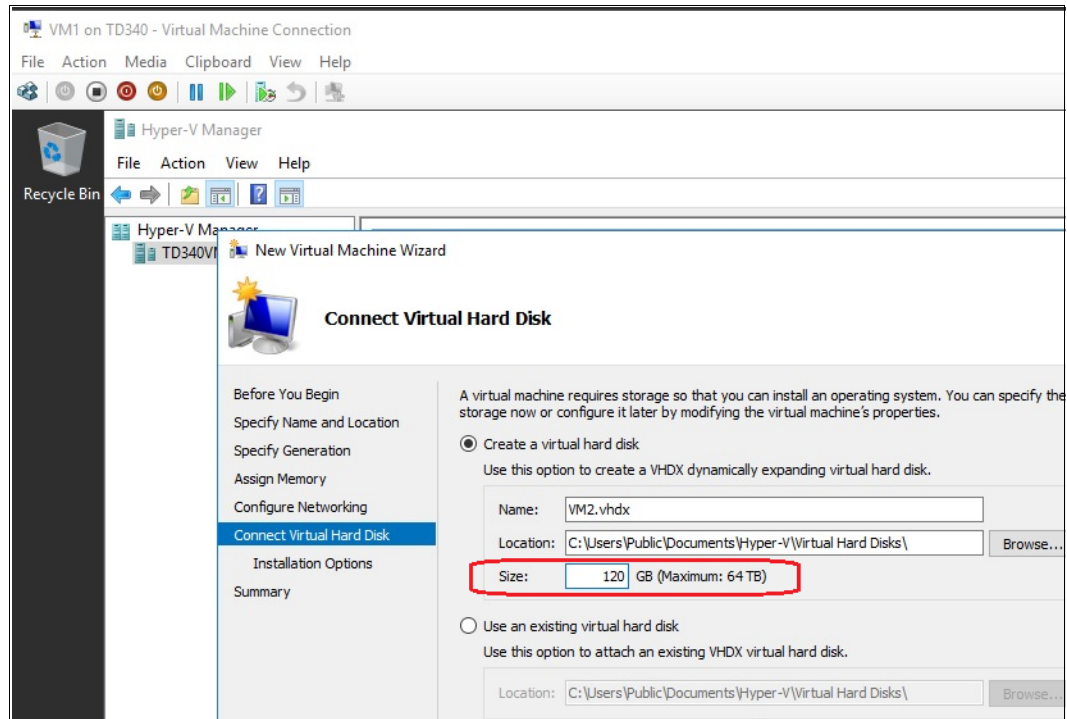


Figure 12 Configuring a disk to VM2

11. Select **Microsoft Hyper-V network adapter - virtual switch** to VM2 as VM2 vSwitch as shown in Figure 13.

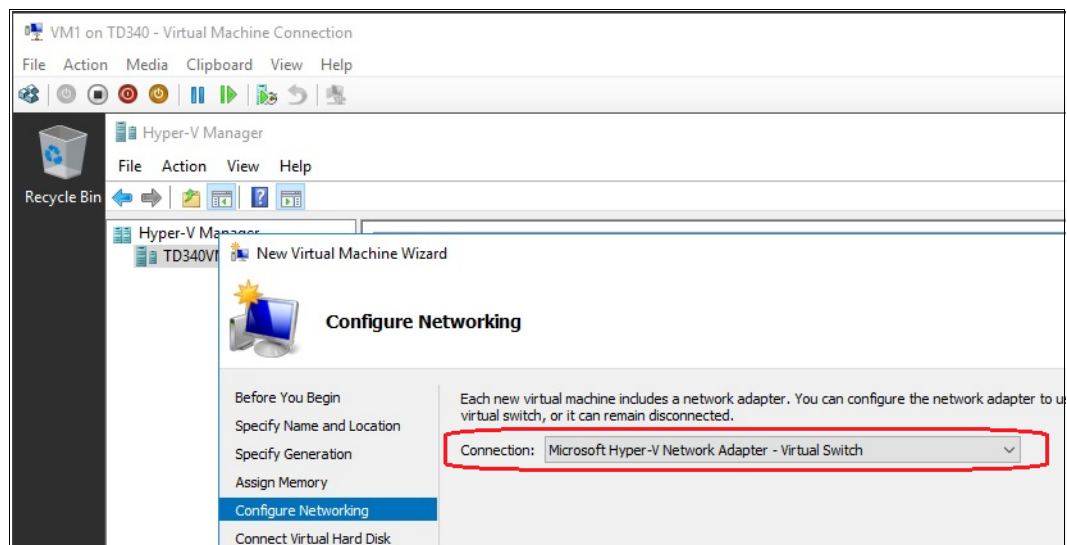


Figure 13 Configuring networking in VM2

12. Copy Windows Server 2016 TP4 ISO image and the two PowerShell scripts to VM1, and install Windows Server 2016 TP4 into VM2. We used the ISO image as the source files to install the operating system.
13. In Figure 14 on page 11, you can see that VM2 is a guest of VM1 and VM1 is a guest on the physical server.

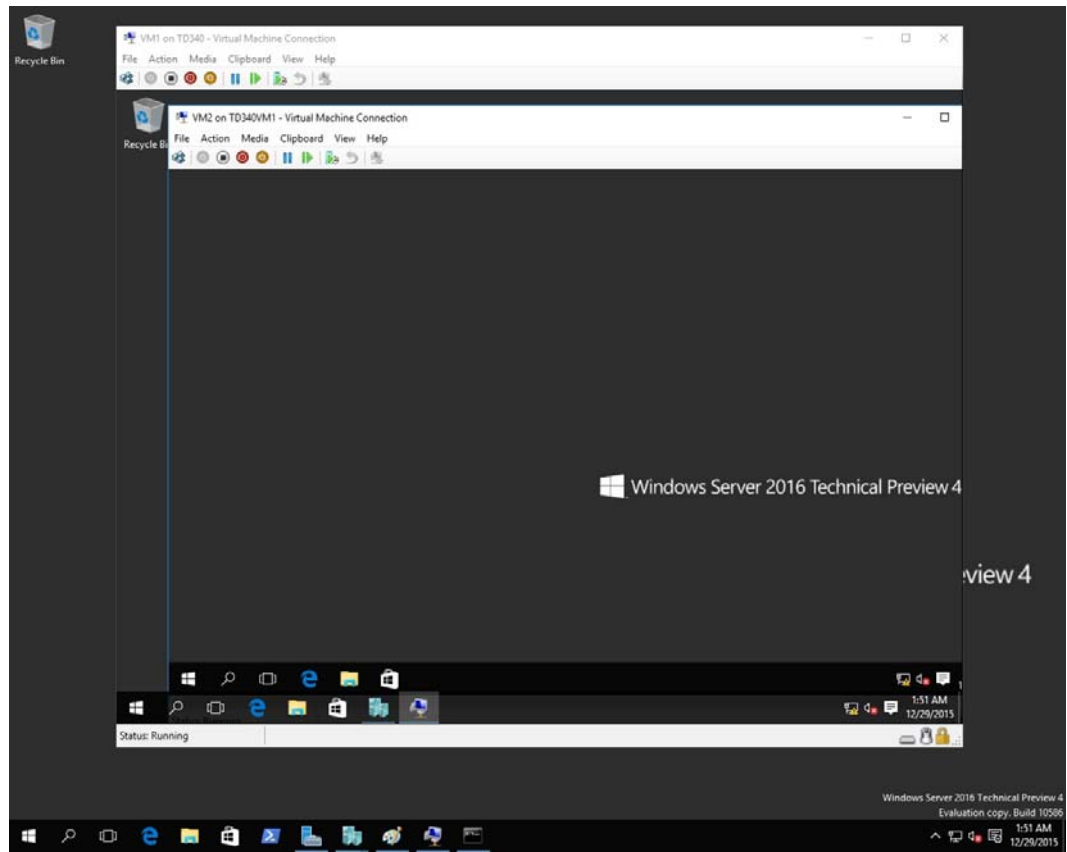


Figure 14 Two levels of nesting Windows Server 2016

14. To enable nesting inside VM2, shut down VM2 and run the PowerShell scripts. We ran Enable-NestedVm.ps1 in VM1 to enable virtualization support of VM2. The command is:

```
.\Enable-NestedVm.ps1 -Vmname "VM2"
```

The output of the command is shown in Figure 15.

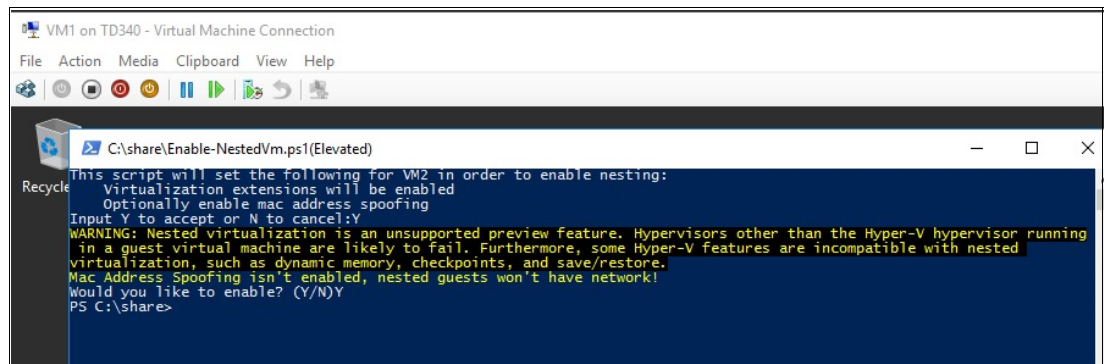


Figure 15 Running Enable-NestedVm in VM1 to enable nesting support in VM2

15. Verify that nesting has been enabled using the Get-NestedVirtStatus command in VM1 as shown in Figure 16 on page 12. The command is:

```
.\Get-NestedVirtStatus.ps1
```

```

RecycleThe virtualization host TD340VM1 supports nested virtualization: Yes

Computer                : TD340VM1
Manufacturer            : Microsoft Corporation
Model                   : Virtual Machine
ProcessorManufacturer   : GenuineIntel
Product Name            : Windows Server 2016 Technical Preview 4
Installation Type       : Server
Edition ID              : ServerDatacenter
Build Lab               : 10586.0.amd64fre.th2_release.151029-1700
HypervisorRunning      : True
FullHyperVRole         : True
HostNestedSupport       : True
HypervisorLoadOptionsPresent : False
HypervisorLoadOptionsValue : False
IumInstalled           : False
VbsRunning              : False
VbsRegEnabled          : False
BuildSupported          : True
VbsPresent              : False

Looking for VMs...found 1 VMs.
Validating virtual machines...done.

The virtual machine VM2 supports nested virtualization: Yes

Name                    : VM2
SupportsNesting         : True
ExposeVirtualizationExtensions : True
DynamicMemoryEnabled    : False
SnapshotEnabled         : False
State                   : Off

Press any key to continue...

```

Figure 16 Verifying the status of nested virtualization in VM2

Now that nested virtualization has been enabled in VM2, we can enable the Hyper-V role and install Windows in a new virtual machine.

16. As we did in step 7 on page 9, In the settings for VM2, change the setting Automatic Stop Action to **Turn off the virtual machine**.
17. Boot to VM2 and enable the Hyper-V feature role in VM2.
18. Create the third-level VM named VM3. Provision 8 GB of memory and 60 GB of disk.
19. Copy Windows Server 2016 TP4 ISO image to VM2 and install Windows Server 2016 TP4 into VM3.

As we show in Figure 17 on page 13, we now have 3 levels of embedded virtual machines, confirming that the nested virtualization feature is functioning correctly.

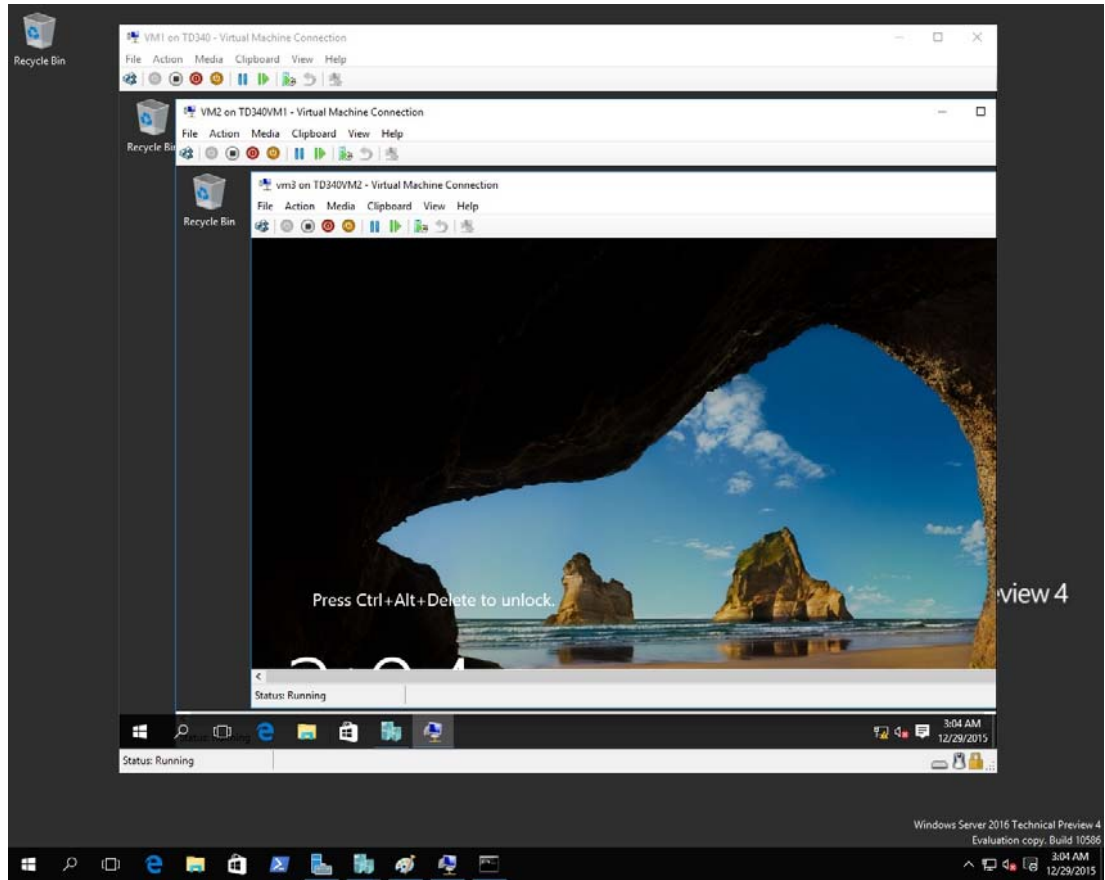


Figure 17 Nested virtualization to three levels

## Summary

Nested virtualization in Windows Server 2016 brings a new usage scenario for virtualization with Hyper-V that will be particularly useful in cloud installations. This paper describes how to enable the feature on Lenovo servers.

For more information on nested virtualization, see the following articles:

- ▶ Nested Virtualization

[https://msdn.microsoft.com/en-us/virtualization/hyperv\\_on\\_windows/user\\_guide/nesting](https://msdn.microsoft.com/en-us/virtualization/hyperv_on_windows/user_guide/nesting)

- ▶ Windows Insider Preview: Nested Virtualization

<http://blogs.technet.com/b/virtualization/archive/2015/10/13/windows-insider-preview-nested-virtualization.aspx>

- ▶ Welcome To Hyper-V Nested Virtualization

<http://blogs.msdn.com/b/msgulfcommunity/archive/2015/10/14/welcome-to-hyper-v-nested-virtualization.aspx>

## Authors

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