Microsoft

Optimizing and Troubleshooting

Hyper-V Storage

Mitch Tulloch with
the Windows Server Team

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Introduction

Troubleshooting is a difficult art to learn because it requires deep knowledge of the subject of study, familiarity with a wide variety of tools, and thinking that can be both sequentially logical and inspirationally outside the box. Perhaps the best way of learning such arts is by watching experts demonstrate their skills as they are exhibited in different situations.

Optimizing how something performs can also be quite difficult to master. If you've ever used an old-fashioned radio where you had to find your station using a dial, you'll realize that a certain degree of fiddling is required to tune things just right. Now imagine a device that has dozens of dials, each tuning a different variable, with all the variables related to one another so that tuning one affects the settings of the others. Tuning an information technology system can often be just like that...or worse!

Optimizing and Troubleshooting Hyper-V Storage is all about watching the experts as they configure, maintain, and troubleshoot different aspects of storage for Hyper-V hosts and the virtual machines running on these hosts. And when I use the word "expert" here, I really mean it, because the contributors to this book all work at Microsoft and have first-hand knowledge and experience with the topics they cover. The different sections in this book range from how to automate configuration using Windows PowerShell to get it right the first time so you won't have to troubleshoot, to step-by-step examples of how different problems were identified, investigated, and resolved. Of course there's no way to exhaustively or even systematically cover the subject of optimizing and troubleshooting Hyper-V storage in a short book like this. But I hope that by reading this book (or by referring to certain topics when the need arises) your own troubleshooting skills will become more finely honed so you will be able to apply them more effectively even in scenarios that are not described in this text.

This book assumes that you are a moderately experienced administrator of the Windows Server virtualization platform. You should also have at least a basic understanding of Windows PowerShell and familiarity with tools and utilities for managing Windows servers, Hyper-V hosts, virtual machines, and the various components of an enterprise storage infrastructure. The main focus of this book is on the Windows Server 2012 version of Hyper-V and associated storage technologies, including version 3.0 of the Server Message Block file-sharing protocol (SMB 3.0). Some content in this book will also apply to earlier versions of Hyper-V and Windows Server, and we've tried to indicate this where applicable.

Good luck in mastering this arcane art!

—Mitch Tulloch, Series Editor

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About the companion content

The companion content for this book consists of a zip file containing the Windows PowerShell scripts found in certain sections of this text. This companion content can be downloaded from the following page:

http://aka.ms/TroubleshootHyper-VStorage/files

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Pass-through disks

Pass-through disks are a feature of Hyper-V that allow virtual machines to access storage that is directly mapped to the Hyper-V host without requiring that the volume be configured. This storage can be any of the following:

- Physical disk internal to the host
- Direct-Attached Storage (DAS) device attached to the host
- Storage Area Network (SAN) Logical Unit Number (LUN) that is mapped to the host

In this section Chuck Timon demonstrates how to troubleshoot some scenarios involving pass-through disks for highly available virtual machines running on Hyper-V hosts.

Storage options for Hyper-V

There are several options available to Hyper-V administrators for attaching storage to virtual machines. The most frequently used option is virtual hard disks (VHD\VHDX). Another is pass-through disks. When Hyper-V first showed up on the scene as an out-of-band release for Windows Server 2008, only the VHD format existed. There was a limit on the size a VHD could be (2 terabytes), and it did not perform as well as administrators would have hoped. As a result, pass-through disks were used to get the larger disk sizes and to get the storage performance needed for virtualized application workloads.

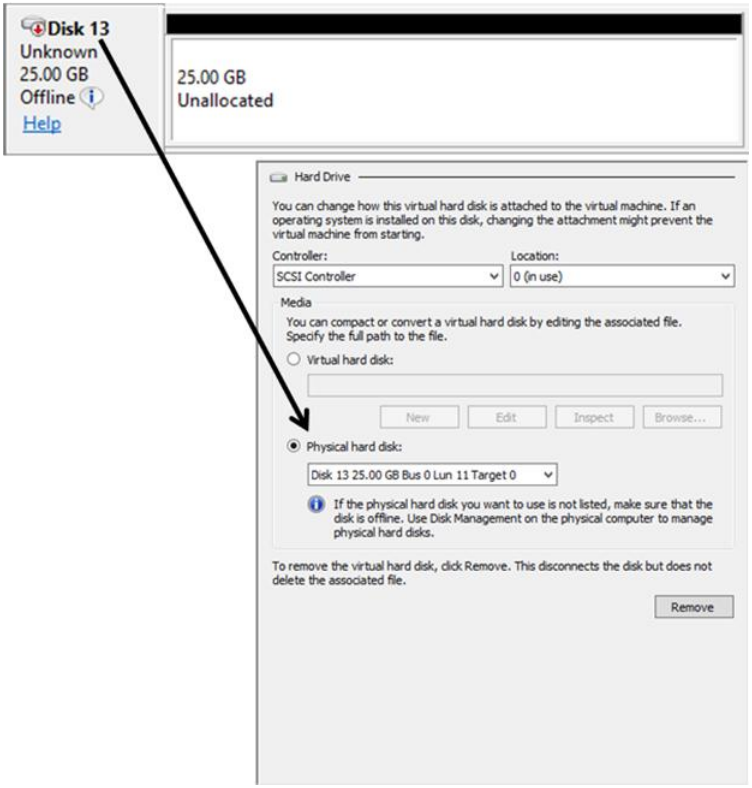
With the introduction of a new virtual hard disk format (VHDX) in Windows Server 2012 and the capability to access SAN storage directly inside of a virtual machine by way of a synthetic fibre-channel adapter, pass-through disks are no longer needed to achieve high storage performance or to gain access to the larger disk sizes needed in the enterprise. A brief overview of some of the new features in the VHDX format can be found on TechNet (http://technet.microsoft.com/en-us/library/hh831446.aspx). The full VHDX specification is also available for download (http://www.microsoft.com/en-us/download/details.aspx?id=34750).

Pass-through disk quick review

Virtual machines can be connected to storage attached directly to the Hyper-V server. The storage can be disks internal to the Hyper-V server itself or attached externally to the server. An example of externally attached storage would be a fibre channel connection to a storage area network (SAN) using a host bus adapter (HBA). There are only two basic requirements for this configuration to work:

1. The disk is registered in the host (for example, the disk is visible in the Disk Management interface).
2. The disk is offline. The disk must be offline before it is attached to a virtual machine. Once attached, the disk is never brought online again in the host operating system. Bringing a pass-through disk online outside of the operating system in the guest could result in data corruption. In Windows Server 2012, attempting to bring a pass-through disk online is blocked.

A pass-through disk is attached using either an IDE or SCSI controller in a virtual machine. There are a limited number of IDE attachment points (four). Using SCSI, 256 disks (distributed among four virtualized SCSI controllers) can be attached to a virtual machine. If an administrator wants to hot-add storage to a virtual machine (i.e., add storage while the virtual machine is up and running), the SCSI controller is the only option. A pass-through disk is configured in a virtual machine by choosing the Physical Hard Disk option when configuring a hard drive:



Once the settings are applied, the disk appears in Disk Management in the virtual machine and can be configured for use there. If the disk was not brought online and initialized in the Hyper-V host, when it is brought online for the first time in the virtual machine, it will need to be initialized before it can be configured further:

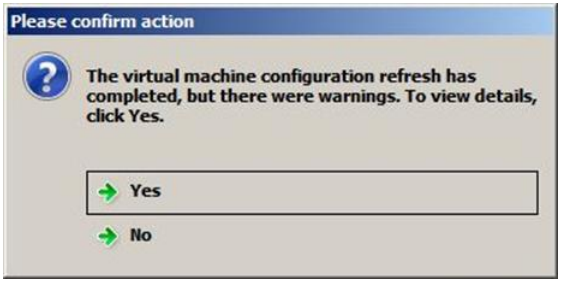
The standard limitations apply when using pass-through disks in a virtual machine, that is no snapshots and no backups at the host level (outside of the guest operating system). One additional limitation has been added in Windows Server 2012—Hyper-V Replica does not support replicating pass-through disks attached to a virtual machine. Hyper-V Replica supports only file replication (VHD, VHDX, AVHD, AVHDX) between primary and replica sites.

Pass-through disks can be used in virtual machines running in standalone Hyper-V servers or in highly available virtual machines running in Hyper-V failover clusters. Pass-through disk behavior as it applies to a standalone Hyper-V host has not changed in Windows Server 2012. The same cannot be said for pass-through disks attached to virtual machines in a Hyper-V failover cluster. There are several pass-through disk behaviors that have changed with respect

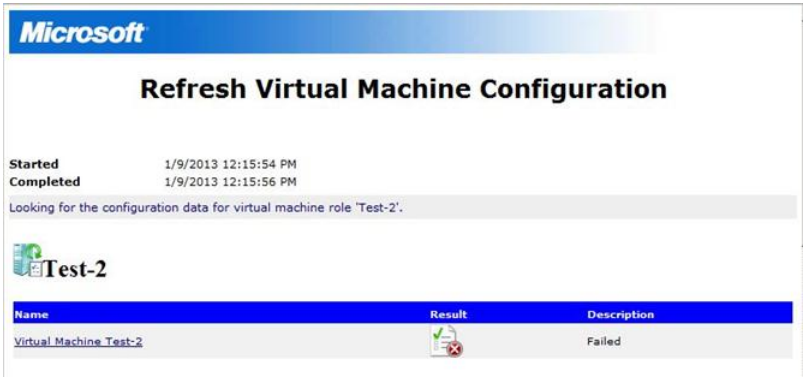
to highly available virtual machines in Windows Server 2012. To put it in perspective, let's flash back in time a little for a quick refresher on how things were, and still are, in Windows Server 2008 R2 Failover Clusters.

For those of us who are veterans when it comes to working with failover clusters, we know that, in a cluster, it is all about resources and the cluster having control of those resources. It does not matter what the resource is, the cluster needs to be in control of it in a high availability scenario. Working with pass-through disks in virtual machines translates into working with physical disk resources in a cluster. What this means is that before you configure a pass-through disk in a virtual machine that is either already highly available or is in the process of being made highly available, the disk, mapped to the host, which will be configured as the pass-through disk in the virtual machine, must first be added to the cluster as a physical disk resource. If not, all kinds of alarms start going off when making a virtual machine highly available. Let's take a look....

The first indication that something is wrong is when the process for making the virtual machine highly available completes. A pop-up indicates the refresh virtual machine configuration process completed with warnings, and the administrator is provided an opportunity to view a report:

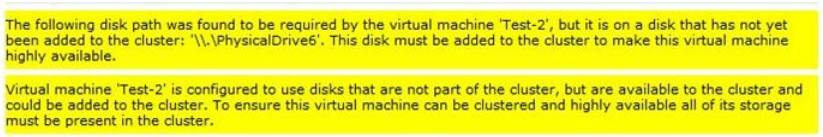


The available report indicates a failure has occurred:



The actual details of the failure message are not clear as to why the failure occurred (i.e., "Element not found"):

A review of the additional information contained in the report clarifies the failure. The information also provides help with respect to the corrective action that can be implemented to fix the issue (i.e., add the disk to the cluster):



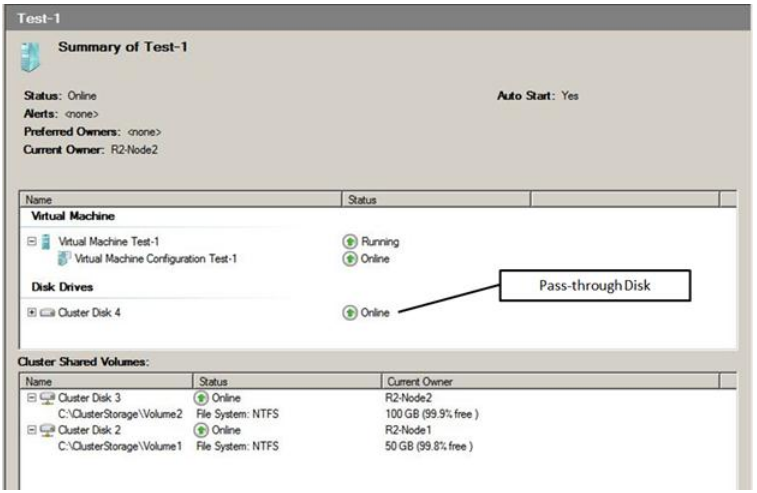
The reported failure does not prevent the pass-through disk from being added to the virtual machine configuration. However, this issue must be addressed or live migrations of the virtual machine may fail.

There are relevant events registered in both the FailoverClustering-Manager and Hyper-V-High-Availability logs:

```
Event ID: 4649

Source: FailoverClustering -Manager
Level: Warning
"Failover Cluster Manager detected that virtual machine <VM_Name> is configured to
use one or more disk that are not yet added to the cluster. Please add all
required disks to the cluster before making this virtual machine highly
available".

The Hyper-V-High-Availability log registers an event as well -

Event ID: 21105

Source: Hyper-V-High-Availability
Level: Error
"'Virtual machine Configuration <VM_Name>' failed to update the configuration data
of the virtual machine: Element not found. (0x80070490)."
```

Even with all the pop-ups and events registered in the logs, the pass-through disk is still visible in Disk Manager in the virtual machine and can be manipulated as if it had been properly configured. It is up to the administrator to heed the pop-ups and implement corrective action before actually placing the virtual machine in production.

In the end, when the virtual machine is configured properly, the pass-through disk appears as a normal disk (physical disk resource) in Failover Cluster Manager. The disk is placed in the resource group with the virtual machine it is associated with. Pass-through disks also co-exist alongside cluster shared volumes (CSV). The major difference being the physical disk resource representing a pass-through disk must be taken offline as part of a virtual machine migration process. CSV volumes, on the other hand, do not have to move with the virtual machine(s) they support:



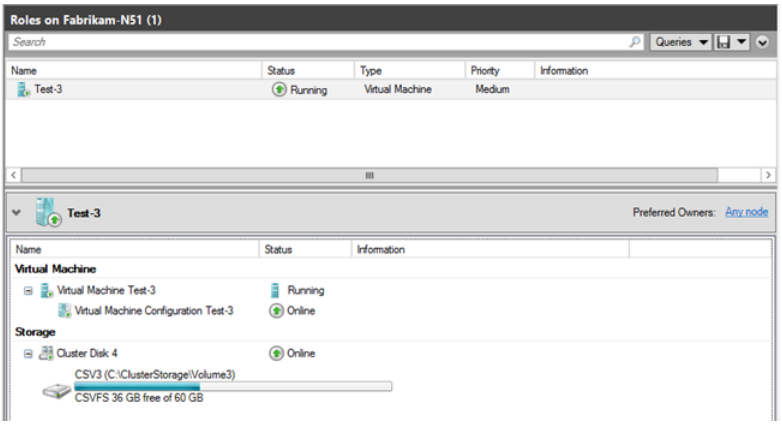
Let's switch gears and examine this same behavior in a Windows Server 2012 failover cluster.

In Windows Server 2012 Hyper-V failover clusters, pass-through disk configurations are still supported, however the check-and-balance mechanism that was in place in Windows Server 2008 R2 is no longer available.

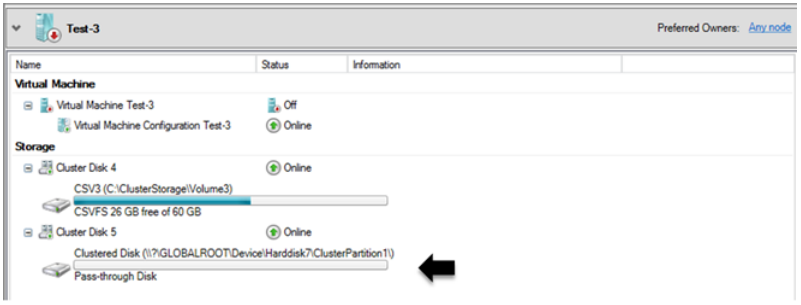
Scenario 1: Adding a pass-through disk to an already highly available virtual machine

When configuring a pass-through disk in an already highly available virtual machine using the Failover Cluster Manager interface in Windows Server 2012 when the disk is not a cluster resource, there is no report generated as part of a Refresh Virtual Machine process. Therefore,

information that could make an administrator aware of a misconfiguration is not immediately available. The event documented above for the Hyper-V-High Availability Log (Event ID: 21105) is still registered (the FailoverClustering-Manager Event ID: 4649 is not). Even with the misconfiguration, the disk(s) can still be manipulated in the virtual machine and the virtual machine role moves freely (migrates) between nodes in the cluster without error. A vigilant administrator may eventually notice that the improperly configured pass-through disk is not listed in the Resources tab for the virtual machine and could then correct the misconfiguration.



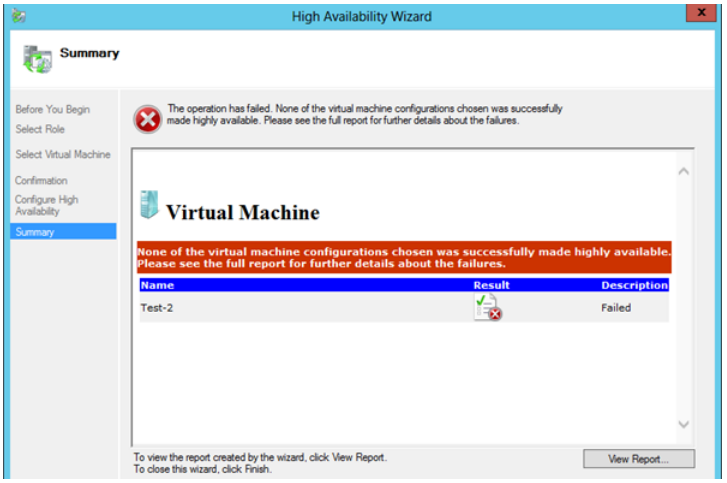
To correct the misconfiguration, the virtual machine must be shut down, the pass-through disk must be added to the cluster as a physical disk resource, and then the virtual machine must be restarted. Once that is accomplished, the pass-through disk appears in the Resources tab for the virtual machine and is properly identified as a pass-through disk in Failover Cluster Manager:



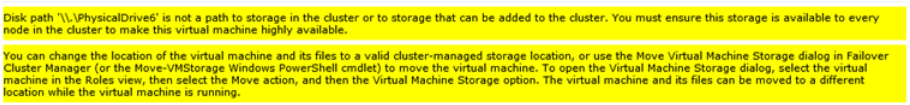
Migration of the virtual machine role continues to function properly.

Scenario 2: Adding a pass-through disk to a virtual machine before making it highly available

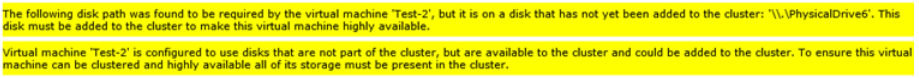
If a virtual machine is configured with a pass-through disk before it is made highly available (i.e., it is configured in Hyper-V Manager outside of the cluster), and the disk(s) has not been added as a cluster resource, the Configure Role process in Failover Cluster Manager detects the misconfiguration, and the process fails:



The information contained in the generated report provides actionable information to the administrator to help resolve the issue. If the disk had *not* been initialized in the host, the information detail would state that a disk is "not a path to storage in the cluster or to storage that can be added to the cluster." In other words, the cluster is not aware of the disk at all:



If the disk had been initialized in the host, but not yet added to the cluster as a resource, the information provided in the report is different and states that the disk has not yet been added to the cluster:



Both of these examples provide actionable information to the administrator so he or she can remedy the situation. In Windows Server 2012, the virtual machine is not made highly available until the problem is corrected. Once the discrepancy is fixed, the High Availability

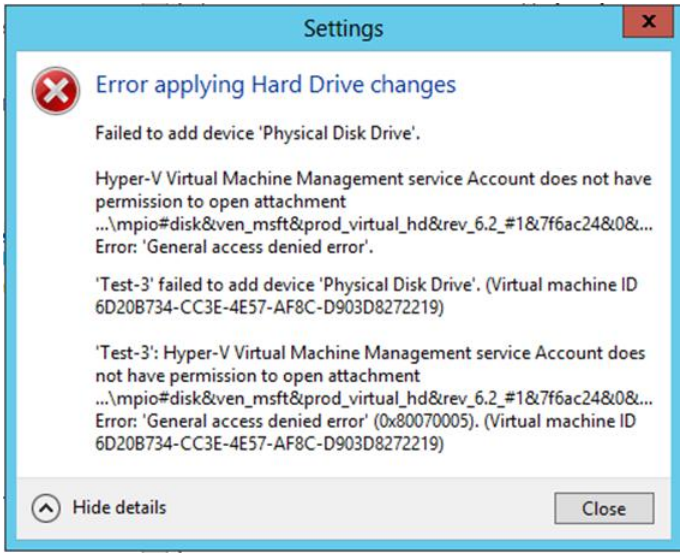
Wizard completes successfully, and the virtual machine role is properly configured. As in Windows Server 2008 R2, the application log entries both for Failover Cluster Manager and Hyper-V Manager provide information the administrator can use to resolve this problem.

Scenario 3: Adding a pass-through disk to a virtual machine that is already running

The final scenario in Windows Server 2012 failover clusters involves adding pass-through disks (hot-add storage) to a virtual machine that is already running (online and providing services to end users). Ever since Windows Server 2008 R2, administrators have been able to, on demand, add storage to a virtual machine while it is running (a.k.a. hot-adding storage) provided the storage was connected to a virtual SCSI controller. The storage could be file based (a VHD\VHDX) or a pass-through disk.

> ***TIP*** **Always ensure the integration services in the virtual machine are updated and match those in the Hyper-V host. The Get-VMIntegrationService Windows PowerShell cmdlet can be used. Here is an example:**
>
> ```
> Get-VmIntegrationService -VMName Fabrikam-FS10 | Where-Object
> {$_.SecondaryOperationalStatus -eq 'ProtocolMismatch'}
> ```

In Windows Server 2012 standalone Hyper-V servers, the above statement still holds true. In Windows Server 2012 failover clusters, an administrator can hot-add storage to a running virtual machine provided that storage is file-based (a VHD\VHDX) and connected to a SCSI controller. A pass-through disk cannot be added to a running virtual machine. The pop-up error is Access Denied for the virtual machine management service account:

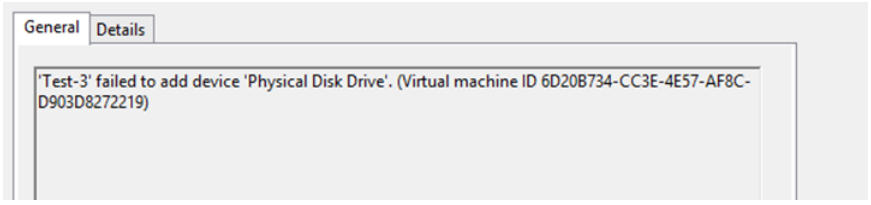


An event (Event ID: 12290) is registered in the Hyper-V-SynthStor\Admin log:

```
Event ID:  12290
Source: Hyper-V-SynthStor
Level:  Error
User: NT VIRTUAL MACHINE\<VMID>
<VM_Name>:8007005 Account does not have permission to open attachment <path to disk>.
Error: 'General access denied error' (7864368). (Virtual Machine ID <VM_guid>
```

An event (Event ID: 14140) is registered in the Hyper-VVMMs\Admin log:

```
Event ID: 14140
Source: Hyper-V-VMMS
Level: Error
User: System
'VM_Name> failed to add device 'Physical disk Drive'. (Virtual Machine ID <guid>)
```



To be able to successfully add the pass-through disk to the virtual machine in this scenario requires the virtual machine first be shut down and then the disk can be configured.

That concludes my discussion on Hyper-V storage with respect to the functionality changes in Windows Server 2012 pertaining to pass-through disks. Please keep in mind what I stated earlier: there should be no reason to continue using pass-through disks in Windows Server 2012 considering the new functionality available in the new VHDX virtual hard disk format.

—Chuck Timon, Senior Support Escalation Engineer

Additional resources

Here are a few additional resources concerning this topic:

- Adding a Pass-through Disk to a Highly Available Virtual Machine at: http://blogs.technet.com/b/askcore/archive/2009/02/20/adding-a-pass-through-disk-to-a-highly-available-virtual-machine.aspx
- Configuring Pass-through Disks in Hyper-V at: http://blogs.technet.com/b/askcore/archive/2008/10/24/configuring-pass-through-disks-in-hyper-v.aspx