

IBM Storage Support for Microsoft Volume
Shadow Copy Service and Virtual Disk Service
4.17.0

User Guide



Note

Before using this document and the product it supports, read the information in [“Notices” on page 39](#).

Third Edition (July 2022)

This publication applies to IBM Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service 4.17.0 and to all subsequent releases and modifications until otherwise indicated in a newer publication.

© **Copyright International Business Machines Corporation 2013, 2022.**

US Government Users Restricted Rights – Use, duplication or disclosure restricted by GSA ADP Schedule Contract with IBM Corp.

Contents

Figures.....	v
Tables.....	vii
About this guide.....	ix
Who should use this guide.....	ix
Conventions used in this guide.....	ix
Related information and publications.....	ix
Getting information, help, and service.....	x
Ordering publications.....	x
Feedback.....	x
Chapter 1. Introduction.....	1
Integration with VMware environments.....	1
Compatibility and requirements.....	1
Chapter 2. Installation.....	3
Compatibility and requirements.....	3
Download site.....	3
Running installation wizard.....	3
Upgrading from VSS 4.16.0 or earlier.....	5
Chapter 3. Configuration.....	9
Configuring in a physical environment.....	9
Configuring VSS using Fibre Channel.....	9
Configuring VSS using iSCSI.....	9
Configuring in a VMware environment.....	10
User Privileges.....	10
vSphere web Services.....	11
Configuring the provider settings for VMware.....	11
Configuring advanced functions with VMware.....	15
Snapshots with different storage protocols.....	18
Configuring Hyper-V.....	20
Hyper-V basic configuration.....	20
Hyper-V requirements.....	21
Configuring the Host (Hyper-V) Server.....	21
Configuring IBM Storage Support for Microsoft VSS and VDS using Microsoft Hyper-V.....	21
Configuring source volumes using Microsoft Hyper-V.....	22
Taking snapshots using Microsoft Hyper-V.....	22
Microsoft Hyper-V advanced configuration.....	23
Creating a virtual port with Microsoft Windows 2012 Virtual HBA.....	23
Creating a zone with Microsoft Windows Server 2012 Virtual HBA.....	23
Configuring storage with Microsoft Windows Server 2012 Virtual HBA.....	23
Configuring NPIV with Hyper-V.....	24
Configuring Windows Failover Cluster.....	28
Configuring for dynamic target volume allocation.....	28
Configuring for dynamic target volume allocation for IBM Spectrum Virtualize family storage systems.....	28
Configuring for dynamic target volume allocation for IBM DS8000 storage systems.....	29

Chapter 4. Troubleshooting.....	31
Error codes.....	34
Notices.....	39
Trademarks.....	40
Index.....	41

Figures

1. The installation welcome page..... 4

2. Enter CIM Server Details..... 5

3. The installation welcome page..... 6

4. Enter CIM Server Details..... 7

5. vSphere client - user privileges.....11

6. Select Compatibility Mode..... 12

Tables

1. Role settings in the vCenter server..... 11

2. Server certificate file names and locations of the VMware ESX(i) and vCenter servers..... 14

3. Summary table of protocol selections.....19

About this guide

This user guide describes how to configure and use the IBM Storage Support for Microsoft Volume Shadow Copy Service (VSS) and Virtual Disk Service (VDS).

Who should use this guide

This guide is intended for system administrators or others who install and use IBM Storage Support for Microsoft VSS and VDS 4.17.0.

You should have an understanding of the Microsoft Windows Server environment, the VSS framework, the IBM Spectrum Virtualize family and DS8000® storage systems, the VMware environment, and Windows Hyper-V environment (if used).

Conventions used in this guide

These notices are used to highlight key information.

Note: These notices provide important tips, guidance, or advice.

Important: These notices provide information or advice that might help you avoid inconvenient or difficult situations.



Attention: These notices indicate possible damage to programs, devices, or data. An attention notice appears before the instruction or situation in which damage can occur.

Related information and publications

You can find more information and publications that are related to the IBM Storage Support for Microsoft VSS and VDS.

- [IBM Documentation](http://ibm.com/docs/en) (ibm.com/docs/en)
- [IBM DS8880 documentation](http://ibm.com/docs/en/ds8880) (ibm.com/docs/en/ds8880)
- [IBM Storwize® V3500 documentation](http://ibm.com/docs/en/v3500) (ibm.com/docs/en/v3500)
- [IBM Storwize V3700 documentation](http://ibm.com/docs/en/v3700) (ibm.com/docs/en/v3700)
- [IBM FlashSystem 5200, 5000, 5100, IBM Storwize V5100 and V5000E documentation](http://ibm.com/docs/en/flashsystem-5x00) (ibm.com/docs/en/flashsystem-5x00)
- [IBM FlashSystem 7300, 7200 and IBM Storwize V7000 documentation](http://ibm.com/docs/en/flashsystem-7x00) (ibm.com/docs/en/flashsystem-7x00)
- [IBM Storwize V7000 Unified documentation](http://ibm.com/docs/en/flashsystem-v7000u) (ibm.com/docs/en/flashsystem-v7000u)
- [IBM FlashSystem® V9000 documentation](http://ibm.com/docs/en/flashsystem-v9000) (ibm.com/docs/en/flashsystem-v9000)
- [IBM FlashSystem 9500, 9200 and V9100 documentation](http://ibm.com/docs/en/flashsystem-9x00) (ibm.com/docs/en/flashsystem-9x00)
- [IBM SAN Volume Controller \(2145 and 2147\) documentation](http://ibm.com/docs/en/sanvolumecontroller) (ibm.com/docs/en/sanvolumecontroller)
- [VMware Docs](http://docs.vmware.com) (docs.vmware.com)
- [VMware Support Offerings and Services](http://vmware.com/support/services.html) (vmware.com/support/services.html)
- [VMware Customer Connect knowledge base](http://kb.vmware.com) (kb.vmware.com)
- [Microsoft MSDN web page for Volume Shadow Copy Service](http://docs.microsoft.com/en-us/windows/win32/vss/volume-shadow-copy-service-portal) (docs.microsoft.com/en-us/windows/win32/vss/volume-shadow-copy-service-portal)
- [Microsoft Windows Server documentation](http://docs.microsoft.com/en-us/windows-server) (docs.microsoft.com/en-us/windows-server)

Getting information, help, and service

If you need help, service, technical assistance, or want more information about IBM products, you can find various sources to assist you. You can view the following websites to get information about IBM products and services and to find the latest technical information and support.

- [IBM \(ibm.com®\)](http://ibm.com)
- [IBM Publications Center \(www.ibm.com/shop/publications/order/\)](http://www.ibm.com/shop/publications/order/)
- [IBM Directory of Worldwide Contacts \(www.ibm.com/planetwide\)](http://www.ibm.com/planetwide)

Ordering publications

The IBM Publications Center is a worldwide central repository for IBM product publications and marketing material.

The [IBM Publications Center \(www.ibm.com/shop/publications/order/\)](http://www.ibm.com/shop/publications/order/) offers customized search functions to help you find the publications that you need. Some publications are available for you to view or download at no charge. You can also order publications. The publications center displays prices in your local currency.

Sending comments

Your feedback is important in helping to provide the most accurate and highest quality information.

To submit any comments about this publication or any other IBM storage product documentation:

- Send your comments by email to ibmdocs@us.ibm.com. Be sure to include the following information:
 - Exact publication title and version
 - Publication form number (for example, GA32-1234-00)
 - Page, table, or illustration numbers that you are commenting on
 - A detailed description of any information that should be changed

Chapter 1. Introduction

The IBM Storage Support for Microsoft Volume Shadow Copy Service (VSS) and Virtual Disk Service (VDS) is a software module that runs as a service on Microsoft Windows Server and automatically creates snapshots of Windows-based applications.

The module uses the Microsoft Windows Server VSS framework for its management interface, and the snapshot data is stored and maintained on integrated DS8000 and Spectrum Virtualize family storage systems. Part of the framework is the VSS provider, a component that creates and manages the shadow copies.

Integration with VMware environments

The IBM Storage Support for Microsoft VSS and VDS supports full integration with VMware ESX or vCenter server environments.

The IBM Storage Support for Microsoft VSS and VDS uses physical Raw Device Mapping (pRDM) to physically attach an entire volume to a virtual machine.

To manipulate pRDM disks during the snapshot operation, the IBM Storage Support for Microsoft VSS and VDS interacts with VMware ESX or vCenter servers through the vSphere API that runs on the server as a web service.

Compatibility and requirements

For the complete and up-to-date information about the compatibility and requirements of the IBM Storage Support for Microsoft VSS and VDS, refer to the latest release notes.

You can find the latest release notes in [IBM Documentation](http://www.ibm.com/docs/en) (www.ibm.com/docs/en) or on [IBM Fix Central](http://www.ibm.com/support/fixcentral) (www.ibm.com/support/fixcentral).

Note: Refer to the relevant VMware documentation for information about how to install the compatible versions of vSphere Web Client Server. You can also refer to the latest installation and configuration instructions for VMware ESXi and vCenter servers.

Chapter 2. Installation

Complete the following steps to install the IBM Storage Support for Microsoft VSS and VDS on a Windows Server:

Compatibility and requirements

For the complete and up-to-date information about the compatibility and requirements for using IBM Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service, refer to its latest release notes. The release notes detail supported operating system and container platform versions, and microcode versions of the supported storage systems.

Before installing the IBM Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service, be sure that the following packages are installed on your storage system:

- *Both* 64-bit and 32-bit versions of the Microsoft Visual C++ Redistributable package (version 2015 or later)
- *Both* 64-bit and 32-bit versions of the Microsoft System CLR Types for SQL Server package (version 2016 or later)

Downloading the software

IBM Storage Support for Microsoft VSS and VDS is available as a free software solution.

The IBM Storage Support for Microsoft VSS and VDS is available as a free software solution. The IBM Storage Support for Microsoft VSS and VDS is available for download at [IBM Support Fix Central](https://ibm.com/support/fixcentral/) (ibm.com/support/fixcentral/).

Running the installation wizard

Run the installation wizard to install IBM Storage Support for Microsoft VSS and VDS.

You must have administrator user privileges in order to install and run the IBM Storage Support for Microsoft VSS and VDS services.

1. Download the appropriate executable file to the server. The format of the file name depends upon the server that you use, and is of the form IBMVSSVDS_<version>_<timestamp>_B<buildnumber>.exe. For example, IBMVSSVDS_41300_160909_B8.exe
2. Run the installation package.
3. Click **Next** after the Welcome panel is brought up.

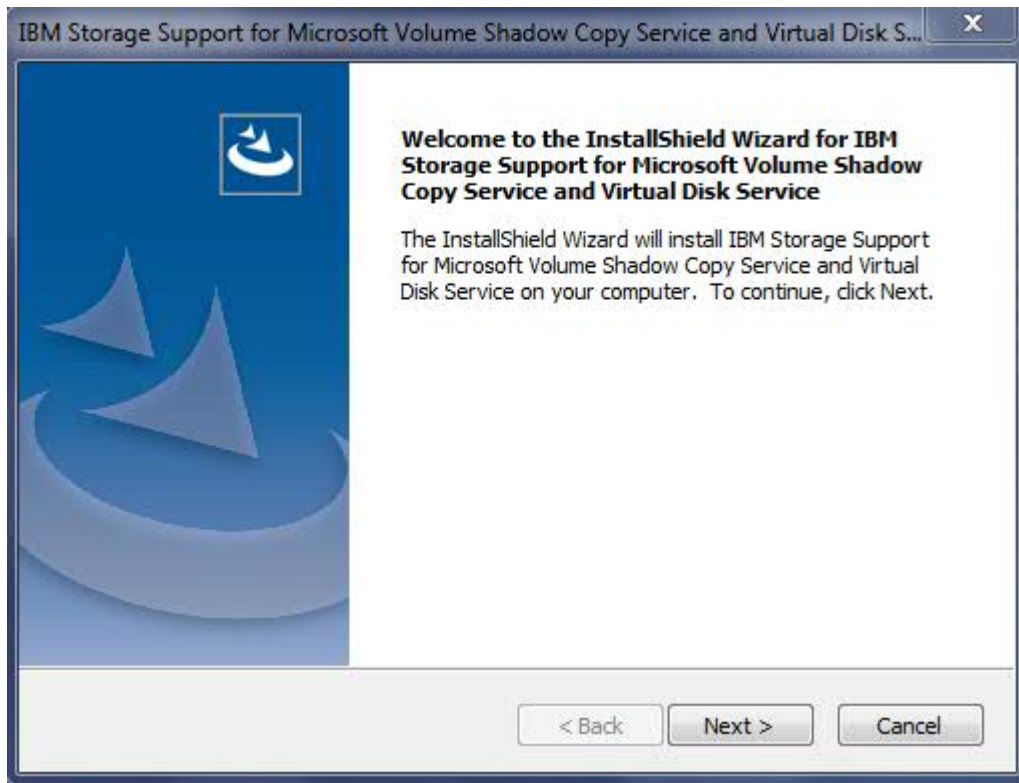


Figure 1. The installation welcome page

4. At the End User License Agreement panel, you must read and accept the end user license agreement and click **Next** to continue.
5. On the Location panel, select a location and click **Next**. The location is the local directory in which you want to install the program.
6. Click **Install** on the next panel to go to the **Enter CIM Server Details** panel.
7. Complete the following steps:
 - a) Specify the CIM Server address.

For the Spectrum Virtualize Family, the default port is 5989.
For the DS8000 family, the default port is 6989.
 - b) Specify the CIM username.
 - c) Specify the CIM password.

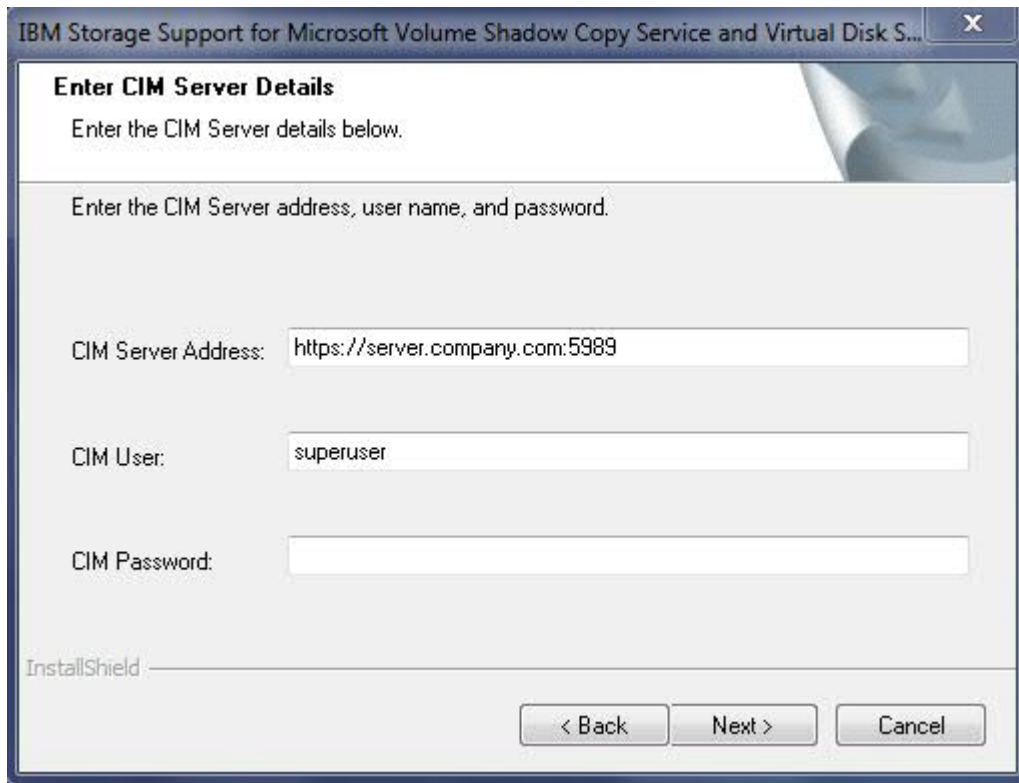


Figure 2. Enter CIM Server Details

a) Click **Next** and then click **Finish**.

Upgrading from VSS 4.16.0 or earlier

Use this information to upgrade IBM Storage Support for Microsoft VSS and VDS services.

Before the upgrade procedure, be sure to complete the following steps:

1. Be sure that a supported Windows Server version and all the required Microsoft hotfixes as specified in the Release notes.

Note: While any of the Windows Server versions that are mentioned in the Release notes are supported, it is recommended to use Windows Server 2016 or later.

2. Install *both* 64-bit and 32-bit versions of the Microsoft Visual C++ Redistributable package (version 2015 or later)
3. Install *both* 64-bit and 32-bit versions of the Microsoft System CLR Types for SQL Server package (version 2016 or later)

Note:

- Java installation is done through the IBM Storage Support for Microsoft VSS and VDS services installer. Local or manual installation of Java is not required.
 - You must have administrator user privileges in order to install and run the IBM Storage Support for Microsoft VSS and VDS services.
1. Download the appropriate executable file to the server. The format of the file name depends upon the server that you use, and is of the form IBMVSSVDS_<version>_<timestamp>_B<buildnumber>.exe. For example, IBMVSSVDS_41300_160909_B8.exe
 2. Run the installation package.
 3. Click **Next** after the Welcome panel is brought up.

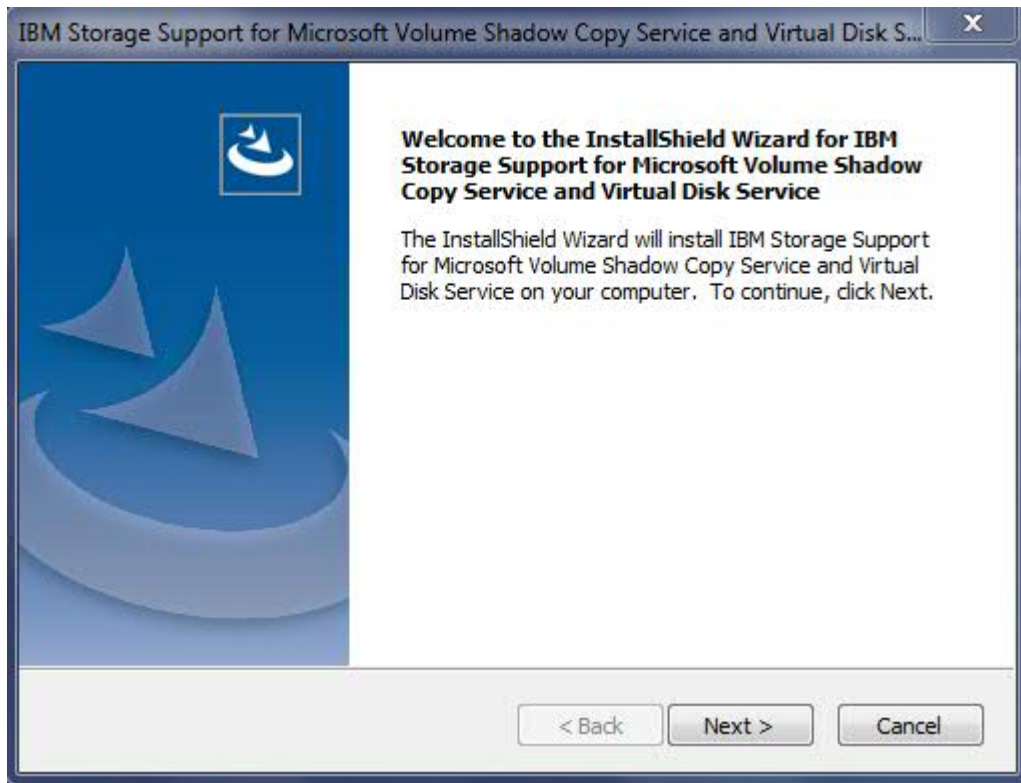


Figure 3. The installation welcome page

4. At the End User License Agreement panel, you must read and accept the end user license agreement and click **Next** to continue.
5. On the Location panel, select a location and click **Next**. The location is the local directory in which you want to install the program.
6. Click **Install** on the next panel to go to the **Enter CIM Server Details** panel.
7. Complete the following steps:
 - a) Specify the CIM Server address.

For the Spectrum Virtualize Family, the default port is 5989.
For the DS8000 family, the default port is 6989.
 - b) Specify the CIM username.
 - c) Specify the CIM password.

IBM Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk S...

Enter CIM Server Details

Enter the CIM Server details below.

Enter the CIM Server address, user name, and password.

CIM Server Address:

CIM User:

CIM Password:

InstallShield

< Back Next > Cancel

Figure 4. Enter CIM Server Details

- a) Click **Next** and then click **Finish**.

Chapter 3. Configuration

You can configure the IBM Storage Support for Microsoft VSS and VDS service in a physical environment or in a VMware environment. In addition, you can configure for Microsoft Hyper-V and dynamic target volume allocation.

Configuring in a physical environment

You can configure the IBM Storage Support for Microsoft VSS and VDS in a physical environment to use either Fibre Channel (FC) or iSCSI.

Configuring Volume Shadow Copy Service using Fibre Channel

You can use FC when you configure the VSS provider in a physical environment.

1. Connect to the storage system using the Common Information Model Object Manager (CIMOM).
2. Create the free storage pool and reserved storage pool for VSS. Define the virtual hosts VSS_FREE_POOL and VSS_RESERVED_POOL on the storage system with the following sample worldwide port names (WWPN): 5000000000000000 and 5000000000000001.

Note:

- In a multiple host environment where hosts are connecting to the same storage system, a common reserved storage pool and a common free storage pool must be created on the storage system. Every host uses the common free storage pool and the common reserved storage pool.
 - VSS_FREE_POOL and VSS_RESERVED_POOL must be FC Port type hosts. iSCSI and SAS type hosts are not supported.
3. Issue the following commands to set the sample WWPN of the free storage pool and the reserved storage pool:
 - **ibmvcfg set vssFreeInitiator**
 - **ibmvcfg set vssReservedInitiator**
 4. Map the source volumes to the physical host by FC.
 5. Map the target volumes to the free storage pool.

Note:

- Each target volume must be exactly the same size as the corresponding source volume.
- Enable multi-path input/output (MPIO) with the appropriate vendor DSM if you configure multiple paths from the host to the storage array.
- After the configuration is set (see step 3), the service must be restarted using the following commands in order for the configuration to take effect:
 - net stop vss
 - net stop ibmvss

The above commands will stop both VSS VDS and the IBM VSS HW Provider. Both services will start automatically in later use.

Configuring Volume Shadow Copy Service using iSCSI

You can use iSCSI when you configure the VSS provider in a physical environment.

1. Connect to the storage using CIMOM.
2. Create the free storage pool and reserved storage pool for VSS. Define the virtual hosts VSS_FREE_POOL and VSS_RESERVED_POOL on the storage system with the following sample WWPN: 5000000000000000 and 5000000000000001.

Note: VSS_FREE_POOL and VSS_RESERVED_POOL must be FC Port type hosts. iSCSI and SAS type hosts are not supported.

3. Issue the following commands to set the sample WWPN of the free storage pool and the reserved storage pool:

- **ibmvcfg set vssFreeInitiator**
- **ibmvcfg set vssReservedInitiator**

4. Map the source volumes to the physical host by iSCSI.

5. Map the target volumes to the free storage pool.

Note:

- Each target volume must be exactly the same size as the corresponding source volume.
- After the configuration is set (see step 3), the service must be restarted using the following commands in order for the configuration to take effect:

- net stop vss
- net stop ibmvss

The above commands will stop both VSS VDS and the IBM VSS HW Provider. Both services will start automatically in later use.

Configuring in a VMware environment

You can configure the IBM Storage Support for Microsoft VSS and VDS in a VMware environment, as described in the following topics.

- [“Checking the vSphere user privileges” on page 10](#)
- [“Configuring the provider settings for VMware” on page 11](#)
- [“Configuring advanced functions with VMware” on page 15](#)
- [“Snapshot principles through different storage protocols” on page 18](#)

Note: If the VMware virtual machine (VM) is not recognized as a VM, ensure that the result of the **systeminfo** command in the VM is correct. For more information, see [“VMware virtual machine not recognized as a virtual machine” on page 31](#).

Checking the vSphere user privileges

The following user privileges are required for the IBM Storage Support for Microsoft VSS and VDS in a VMware environment:

- **Host > Configuration > Storage partition configuration**
- **Virtual machine > Configuration > Raw device**
- **Virtual machine > Configuration > Change resource**
- **Virtual machine > Configuration > Add or remove device**

If the IBM Storage Support for Microsoft VSS and VDS communicate with the vCenter server, you must assign the Read-Only role to the data center to which the VMware ESX(i) server belongs.

You can view the user privileges by accessing the vSphere client and selecting the Permissions tab. Role settings in the vCenter server list the roles and permissions for the vCenter server.

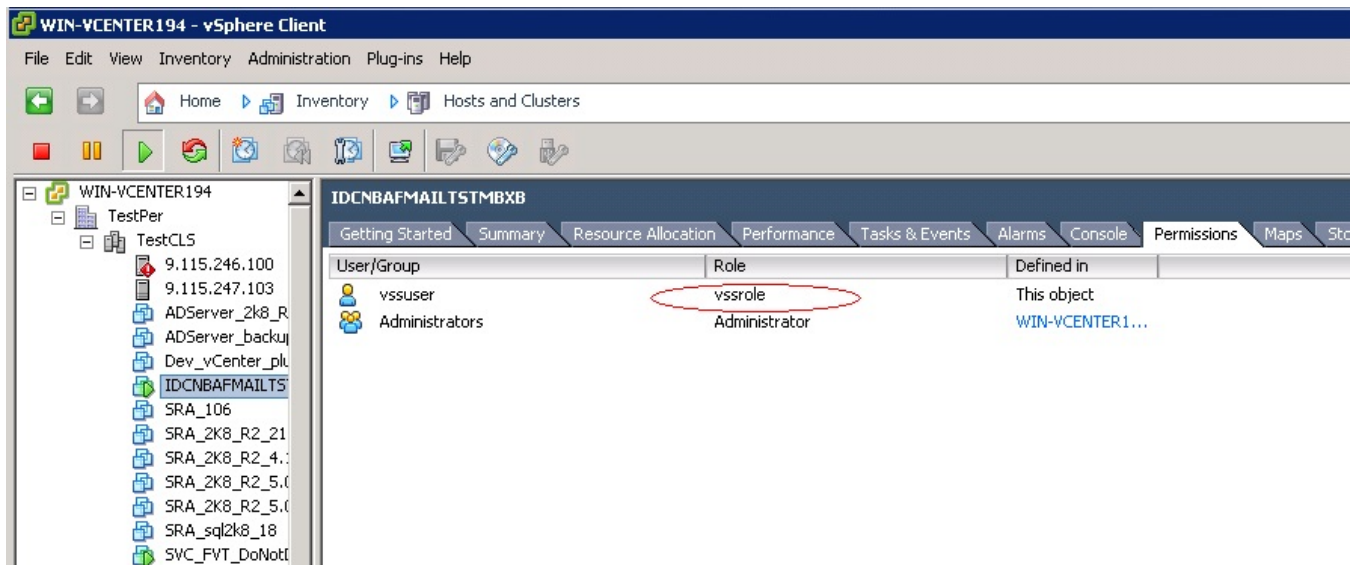


Figure 5. vSphere client - user privileges

In Table 1 on page 11, the vCenter client is **ARCX3455GBXV3**.

Table 1. Role settings in the vCenter server			
Directory	Role Description	User Group	Role Value
ARCX3455GBXV3	Role for vCenter server	vssuser	No access
ARCX3455GBXV3/test	Role for data center	vssuser	Read-only
ARCX3455GBXV3/ test/<IP address>	Role for VMware ESX(i) Server	vssuser	vssrole
ARCX3455GBXV3/ test/<IP address>/ NewVirtual Machine	Role for virtual machine	vssuser	vssrole
Note: In Role for data center, ensure the check-box Propagate is selected.			

Checking the vSphere web services

The vSphere web services must be operational so the IBM Storage Support for Microsoft VSS and VDS can work properly in the guest Windows Server. By default, the vSphere web services are on when you load the VMware ESX(i) operating system.

To check whether the vSphere web services are online, use a web browser to access a VMware ESX(i) server or a vCenter Server IP address. For example:

```
https://189.0.0.222/mob
```

When prompted, enter the user credentials to log in to the hosted web services.

Configuring the provider settings for VMware

Provider settings include IBM Storage Support for Microsoft VSS and VDS parameters and a generated Java credentials keystore.

- “Installing VMware tools” on page 12
- “Setting the provider parameters for VMware” on page 12
- “Generating the Java credential keystore” on page 13

If you use pRDM, you must select **Physical** from the **Select Compatibility Mode** (see [Figure 6](#) on page 12).

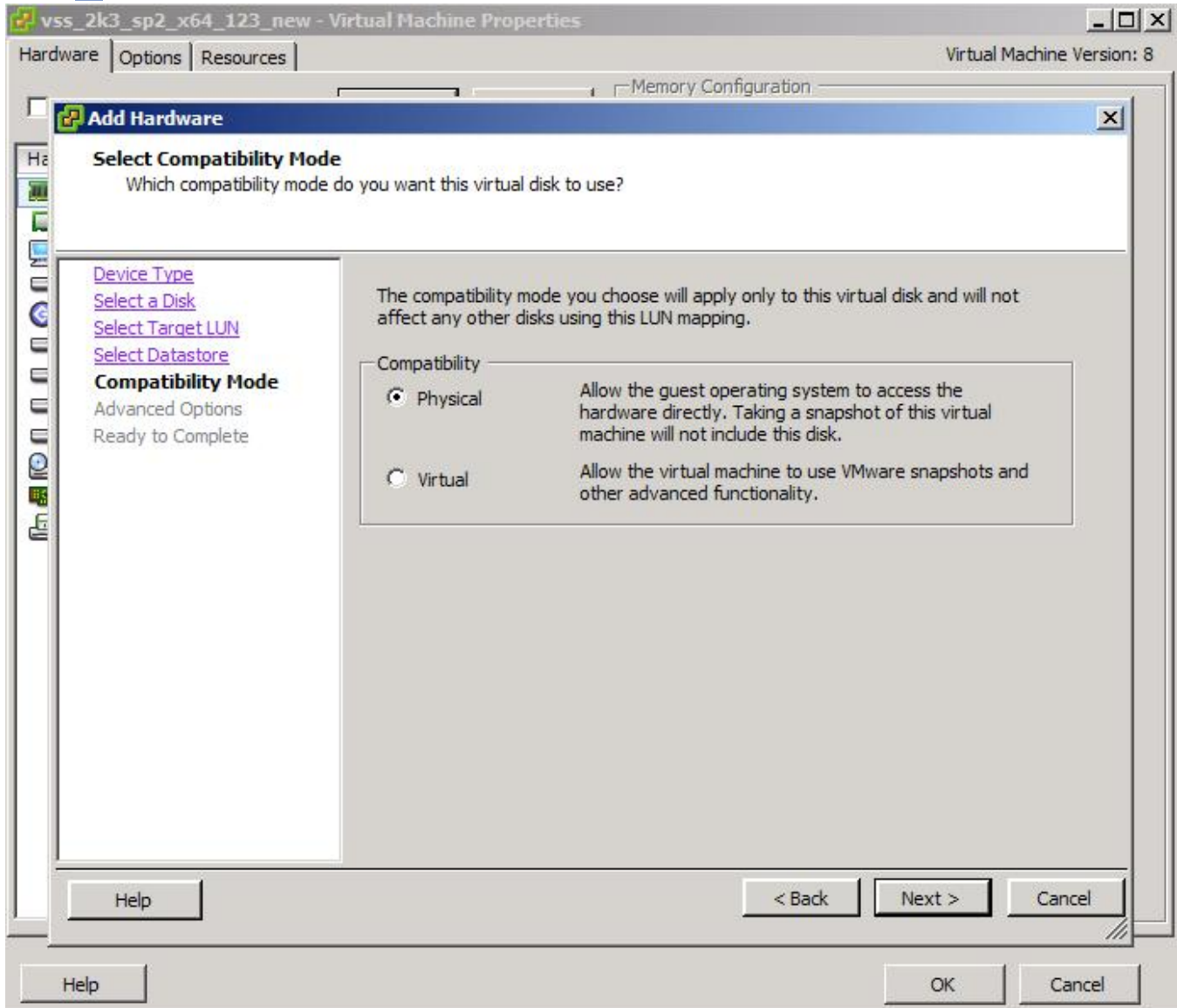


Figure 6. Select Compatibility Mode

Installing VMware tools

You must install VMware tools to facilitate communication between the VMware ESX(i) server web services and VM. VMware tools collect guest-related information such as the IP address and the host name.

Complete the following steps to install the VMware tools:

1. Turn on the guest operating system. From the VI Client menu for the specific guest, select **Install/Upgrade VMware Tools**.
2. Log in to the Windows Server (guest) and install the package.

Setting the provider parameters for VMware

Several IBM Storage Support for Microsoft VSS and VDS parameters are specific to the VMware guest support feature. The parameters allow the IBM Storage Support for Microsoft VSS and VDS to

communicate with the VMware ESX(i) server web services to manipulate the pRDM disks during a snapshot.

You must set up the parameters for VMWare in the following two cases:

1. The snapshot disk is discovered by the VMware ESX(i) Server through FC and mapped to the virtual machine as the pRDM disk.
2. The snapshot disk is discovered by the VMware ESX(i) Server through software iSCSI and mapped to the virtual machine as the pRDM disk.

The following IBM Storage Support for Microsoft VSS and VDS parameters are available only in the VMware virtual platform:

vmhost

The VMware web service that is on the VMware ESX(i) Server or vCenter Server.

vmuser

The user who has access to the VMware ESX(i) Server or vCenter Server with the authority to run pRDM disk operations.

vmpassword

The password for the vmuser to log on.

vmtimeout

The amount of time that the connection is out to the VMware ESX(i) Server or vCenter Server.

vmcredential

The session credential store path for the VMware ESX(i) Server or vCenter Server that is used by Java.

Note: The `vmcredential` path is the full path name of the Java key file.

You can use the IBM VSS configuration tool **ibmvcfg** to set the parameters. For example, type **ibmvcfg set vmhost https://9.11.110.115/sdk**

```
C:\Program Files\IBM\Hardware Provider for VSS-VSD>ibmvcfg set vmhost
https://9.11.110.115/sdk
```

Note: After the configuration is set, the service must be restarted using the following commands in order for the configuration to take effect:

- net stop vss
- net stop ibmvss

Generating the Java credential keystore

To generate the Java credential keystore, obtain the VMware ESX(i) Server certificates and then set the credential as the keystore path.

Complete the following steps to generate the Java credential keystore:

1. Obtain the VMware ESX(i) Server or vCenter Server certificate by using the vSphere client, the Secure Shell client application, or a web browser.

To obtain VMware ESX(i) Server or vCenter Server certificates by using the vSphere client, create a root-level directory for the certificates.

For example, C:\VMware-Certs

- a) Install the vSphere client if not already installed.
- b) Start the vSphere client and click to the VMware ESX, ESXi, or vCenter Server web server.
A message about certifying authority for the certificate is displayed.
- c) Click **View Certificate** to show the certificate properties page. See [Table 2 on page 14](#) for an example of the certificate properties page.
- d) Click the **Details** tab.
- e) Click **Copy to File** to start the **Certificate Export wizard**.

- f) Select **DER encoded binary X.509** (the default) and click **Next**.
 - g) Click **Browse** and find the C:\VMware-Certs subdirectory.
 - h) Enter a certificate name that identifies the server to which the certificate belongs.
For example, C:\VMware-Certs\<server name>.cer
2. To obtain server certificates by using the Secure Shell client application, connect to the VMware ESX system with a Secure Sockets Layer (SSL) client.

Note: Remote connections to the VMware ESX service console as root are effectively disabled. To obtain the certificate, you must connect as another user with privileges on the server.

Table 2. Server certificate file names and locations of the VMware ESX(i) and vCenter servers		
Server	Directory location for certificate	Certificate
VMware ESXi 5.0, 5.1, 5.5, 6.0, 6.5, 6.7, 7.0	/etc/vmware/ssl/	rui.crt
vCenter Server 5.0, 5.1, 5.5, 6.0, 6.5, 6.7, 7.0	C:\Documents and Settings\All Users\Applications	rui.crt

- a) Copy the certificates from the server to the certificate subdirectory. Use a unique file name for the certificate (assuming that you are copying multiple default certificates from multiple VMware ESX systems).
3. To obtain server certificates by using a web browser, enter the following URL in a web browser to access the web service of the VMware ESX(i) Server or vCenter Server: <https://9.11.110.240/>
 - a) If you receive a message about the security certificate, select **Continue to this website (not recommended)**.
 - b) On the toolbar, click **Certificate Error** and, in the **Certificate Invalid** window, click **View certificates**.
 - c) In the **Certificate** window, select the **Details** tab.
 - d) Click **Copy to File** and follow the **Certificate Export Wizard** with the default option to save the certificate.
 - e) Create a directory for the Java keystore.
For example, C:\VMware
 - f) Use the Java keytool utility to import a certificate.
The syntax is

```
keytool.exe -import -file <certificate-filename>
-alias <server-name> -keystore vmware.keystore
```

For example:

```
C:\Program Files\IBM\Hardware Provider for VSS-VDS\jre\bin\keytool.exe -import -file
C:\tools\rui.crt -keystore C:\VMware\vmware.keystore
```

- g) When prompted for a keystore password, enter a password. The keystore utility shows the certificate information at the console.
The following example shows the certificate information:

```
Owner: OID.1.2.840.113549.1.9.2="1301079258,564d7761726520496e632e",
CN=cimxa.ibm.com, EMAILADDRESS=ss1-certificates@vmware.com, OU=VMware
ESX Server Default Certificate, O="VMware, Inc", L=Palo Alto,
ST=California, C=US
Issuer: O=VMware Installer
Serial number: 7730362f66385863
Valid from: 3/25/13 7:45 PM until 9/23/24 8:54 PM
Certificate fingerprints:
MD5: 58:A3:A3:D4:D8:E0:CE:63:6B:B7:7F:4E:3E:6B:71:9D
```



```
SHA1: 8B:60:B9:08:32:33:06:11:47:7D:6D:B6:B4:D1:D5:F9:78:D2:15:5F
SHA256: 59:1B:A2:BE:D0:BC:04:1B:CE:62:B8:95:07:52:3E:54:69:76:10:A1:
      85:A6:A8:5A:C0:DB:45:79:46:FB:72:82
Signature algorithm name: SHA1withRSA
Version 3
```

At the end of the certificate information, a prompt shows a request for confirmation that the certificate is trusted.

```
Trust this certificate? [No]
```

- h) Type **yes** and press **<Enter>** to respond to the prompt and import the certificate into the `vmware.keystore` keystore. The console shows the following message:

```
Certificate was added to keystore
```

4. To set the `vmcredential` as the `vmware.keystore` path, issue the following command

```
ibmvcfg set vmcredential "C:\VMware\vmware.keystore"
```

5. Issue the **`ibmvcfg showcfg`** command to verify that the configuration is correctly saved. The following example output is from the **`ibmvcfg showcfg`** command:

```
cimomHost:          9.115.246.54
cimomPort:          5989
username <cimom>:    superuser
usingSSL:            true
vssFreeInitiator:   5000000000000000c0
vssReservedInitiator: 5000000000000000c1
backgroundCopy:     50
targetSVC:
incrementalFC:      false
cimomTimeout:       0
rescanOnceArr:      0
rescanOnceRem:      0
rescanRemMin:       0
rescanRemMax:       45
storageProtocol:    auto
storagePool:        test_pool_1
allocateOption:     standard
ioGroup:            io_grp0
vmhost:             https://9.115.247.103/sdk
vmusername:         root
vmcredential:       C:\vmware103.keystore
vmtimeout:          600000
```

Note: After the configuration is set, the service must be restarted using the following commands in order for the configuration to take effect:

- `net stop vss`
- `net stop ibmvss`

The above commands will stop both VSS VDS and the IBM VSS HW Provider. Both services will start automatically in later use.

Configuring advanced functions with VMware

N_Port ID Virtualization (NPIV) is an extension to the FC industry standard. In a server virtualization environment, NPIV allows each VM to have a unique FC World Wide Name (WWN).

When each VM has a unique FC WWN, multiple VMs can then share a single physical host bus adapter (HBA) and switch port.

To configure NPIV, refer to the following topics:

- [“NPIV implementation requirements” on page 16](#)
- [“Server administrator tasks” on page 16](#)

- b) Create another host for VM with virtual HBA WWPNs. The result is that you now have two hosts, one for the physical HBA port WWPNs and one for the virtual port WWPNs. The following example shows what the output might look like:

3. Map the LUN to both hosts so that the LUN can work through NPIV.

```
node2:~ # svcinfo lsvdiskhostmap 22
id      name          SCSI_id  host_id    host_name    vdisk_UID          IO_group_id
IO_group_name
22      vm110npiv         0        3          ESX100       6005076802908168E00001D3C  0
io_grp0
22      vm110npiv         0        32         Win35npiv    6005076802908168E00001D3C  0
io_grp0
```

The LUN 22 is mapped to physical HBA ports.

When you configure NPIV and turn on the VM, the NPIV is functioning. To verify that I/O traffic is going through the virtual port (depending on the host HBA), you must create a Secure Shell connection to the physical VMware ESX(i) Server.

- For a Brocade HBA, type **cat /proc/bfa/1**
- For a QLogic HBA, type **cat /proc/scsi/qla2300/1**
- For an Emulex HBA, **cat /proc/scsi/lpfc/1**

Note: Replace the number 1 at the end of the command with the HBA number.

Note: You can enable NPIV only after at least one pRDM disk is attached to the VM.

The IBM Storage Support for Microsoft VSS and VDS automatically detects whether the NPIV is enabled. If the NPIV is enabled and functioning correctly, the IBM Storage Support for Microsoft VSS and VDS takes the appropriate actions during the various snapshot stages as described below.

During the snapshot-creation process, the IBM Storage Support for Microsoft VSS and VDS maps the snapshot target LUN to both the physical HBA WWPNs and virtual WWPNs. The LUN is then assigned to the virtual machine from the VMware ESX(i) Server as the pRDM disk.

During the deletion, the IBM Storage Support for Microsoft VSS and VDS first unassign the pRDM disk from the virtual machine. The LUN is then masked from both physical HBA WWPNs and virtual WWPNs.

Snapshot import

The import operation also uses NPIV if it is enabled and functioning. The process is similar to the snapshot creation process.

The IBM Storage Support for Microsoft VSS and VDS first maps the snapshot target LUN to both the physical HBA WWPNS and virtual WWPNS of the destination server. The LUN is assigned to the VM from the VMware ESX(i) Server as the pRDM disk.

Snapshot mask operation

Similar to the deletion of the snapshot, the mask operation causes the pRDM disk to be removed from the VM. The LUN is then masked from both the physical HBA WWPNS and the virtual WWPNS.

Snapshot principles through different storage protocols

The CLI configuration tool provides an option for choosing the protocol to use if more than one protocol is available. You can choose auto, FC, or iSCSI.

You can select the type of protocol when the Snapshot is created. The following example shows what the output might look like:

```
cimomHost:          9.115.246.54
cimomPort:          5989
username (cimom):   superuser
usingSSL:            true
vssFreeInitiator:   5000000000000000c0
vssReservedInitiator: 5000000000000000c1
backgroundCopy:      50
targetSVC:
incrementalFC:       false
cimomTimeout:        0
rescanOnceArr:       0
rescanOnceRem:       0
rescanRemMin:        0
rescanRemMax:        45
storageProtocol:     fc
storagePool:         test_pool_1
allocateOption:      standard
ioGroup:             io_grp0
vmhost:              https://9.115.247.103/sdk
vmusername:          root
vmcredential:        C:\vmware103.keystore
vmtimeout:           600000
```

Note: If you choose auto, the IBM Storage Support for Microsoft VSS and VDS select the protocol to use.

Setting the storage protocol

The storage protocol setting is determined by the protocol that attached the target LUNs to the host.

The following options are available for this setting:

Auto

IBM Storage Support for Microsoft VSS and VDS automatically selects the appropriate protocol. If no protocol is available on the host, the snapshot fails.

FC

IBM Storage Support for Microsoft VSS and VDS selects the FC protocol. If the FC protocol is not available, the snapshot fails.

iSCSI

IBM Storage Support for Microsoft VSS and VDS selects the iSCSI protocol. If the iSCSI protocol is not available, the snapshot fails.

Issue the following command to set the storage protocol:

```
ibmvcfg set storageprotocol <auto, fc, iSCSI>
```

If more than one storage protocol is installed on the host and guest OS, IBM Storage Support for Microsoft VSS and VDS follows an algorithm to select the correct protocol. The protocol is as follows:

1. Protocol setting is auto
 - If FC and iSCSI coexist, selects FC before iSCSI.
 - If iSCSI is installed on both guest and host, selects iSCSI on guest before on host.
2. Protocol setting is FC
 - If FC protocol is available, selects FC protocol on host.
3. Protocol setting is iSCSI
 - Ignore FC configuration with this setting.
 - If iSCSI is installed on both guest and host, selects iSCSI on guest before on host.

See [Table 3 on page 19](#) for the protocol settings and their priorities.

<i>Table 3. Summary table of protocol selections</i>			
Protocol Setting	Guest OS	Host	Using
Auto	None	FC, iSCSI	FC on Host
		FC	FC on Host
		iSCSI	iSCSI on host
		None	ERROR
	iSCSI (software initiator)	FC, iSCSI	FC on Host
		FC	FC on Host
		iSCSI	iSCSI on Guest
		None	iSCSI on Guest
FC	None	FC, iSCSI	FC on Host
		FC	FC on Host
		iSCSI	ERROR
		None	ERROR
	iSCSI (software initiator)	FC, iSCSI	FC on Host
		FC	FC on Host
		iSCSI	ERROR
		None	ERROR
iSCSI	None	FC, iSCSI	iSCSI on host
		FC	ERROR
		iSCSI	iSCSI on host
		None	ERROR
	iSCSI (software initiator)	FC, iSCSI	iSCSI on Guest
		FC	ERROR
		iSCSI	iSCSI on Guest
		None	ERROR

Storage protocol priority

If several protocols coexist, define a priority that determines which protocol is used during the snapshot.

The following cases require a decision on which protocol to use:

- VMware ESX(i) Server has FC HBA and also with the iSCSI software enabled.
- VMware ESX(i) Server software has iSCSI enabled, and virtual machine software iSCSI installed.
- VMware ESX(i) Server has FC HBA with software iSCSI enabled, along with virtual machine software iSCSI installed.

The protocol choice depends on the **storageProtocol** parameter of the IBM Storage Support for Microsoft VSS and VDS configuration and which protocols are available. The priority among the various protocols is as follows:

- VMware ESX(i) Server FC has the highest priority. If the **storageProtocol** parameter is set to auto, the IBM Storage Support for Microsoft VSS and VDS first checks whether VMware ESX(i) Server FC is available. The IBM Storage Support for Microsoft VSS and VDS try other protocols only when the FC protocol is not available.
- VM software iSCSI has a higher priority than software iSCSI. If the **storageProtocol** parameter is set to auto or iSCSI and the FC protocol is not available (no HBA or WWPNs not defined on storage), the IBM Storage Support for Microsoft VSS and VDS first checks to determine whether iSCSI is enabled on the VM. The IBM Storage Support for Microsoft VSS and VDS tries VMware ESX(i) Server software iSCSI, only when the virtual machine software iSCSI is not available.

Configuring for Microsoft Hyper-V

With IBM Storage Support for Microsoft VSS and VDS, you can take shadow copies in a Microsoft Hyper-V guest OS.

If you installed the software iSCSI initiator on the guest OS and you do not plan to use FC protocol or iSCSI protocol on the host, the configuration is the same as the physical host.

Because the guest OS does not support an FC HBA, IBM Storage Support for Microsoft VSS and VDS serves as a bridge to associate the FC HBA on the host to the guest OS when creating and deleting a shadow copy. IBM Storage Support for Microsoft VSS and VDS provider also supports the host iSCSI, depending on host and provider settings. Privileges to access the host Windows Management Instrumentation (WMI) are required to support this feature.

IBM Storage Support for Microsoft VSS and VDS cannot support the hardware information of a virtual hard disk (VHD). Therefore, IBM Storage Support for Microsoft VSS and VDS supports shadow copies only on pass-through disks on the guest OS. IBM Storage Support for Microsoft VSS and VDS automatically attaches the target LUN of the volume shadow copy to the guest OS as a pass-through disk.

Microsoft Hyper-V basic configuration

You can create shadow copies in the Microsoft Hyper-V guest OS by following the basic configuration procedures.

Basic configuration includes:

- [“Microsoft Hyper-V requirements” on page 21](#)
- [“Configuring the Host \(Microsoft Hyper-V\) Server” on page 21](#)
- [“Configuring Storage Support for Microsoft VSS and VDS using Microsoft Hyper-V” on page 21](#)
- [“Configuring source volumes using Microsoft Hyper-V” on page 22](#)
- [“Taking snapshots using Microsoft Hyper-V” on page 22](#)

Microsoft Hyper-V requirements

To configure the Microsoft Hyper-V guest OS, you must ensure that certain requirements are met.

Obtain the following applications to configure the Microsoft Hyper-V guest OS:

- IBM Storage Support for Microsoft VSS and VDS 4.17.0.
- Server Hardware: Microsoft recommended server configuration for Microsoft Windows Server 2008 Hyper-V.
- Microsoft Windows Server 2008 Hyper-V.
- MPIO software (Hyper-V Host only). Available from your storage array vendor.

Configuring the Host (Microsoft Hyper-V) Server

Configure the host server to create shadow copies in the Microsoft Hyper-V guest OS.

1. Install one of the following servers:
 - Microsoft Windows Server 2008 x64
 - Windows Server 2008 R2
 - Microsoft Windows Server 2012
 - Microsoft Windows Server 2012 R2
 - Microsoft Windows Server 2016
2. Install the Microsoft Hyper-V role on the Windows server using the Server Manager.
3. Reboot the server.
4. Disable automount for the disks on the host. Issue the following commands:

```
C:\>diskpart  
DISKPART>automount disable
```

5. To enable the Windows firewall to allow for remote administration on the physical host, issue the following command:

```
netsh firewall set service RemoteAdmin enable
```

6. Install the MPIO driver that ships with Windows Server 2008.
7. Install the MPIO driver that your storage vendor supplied.
8. Install and configure the Microsoft Hyper-V guest OS using the Microsoft Hyper-V Manager. The guest OS can be Windows Server 2008 or later.
9. Download and install Microsoft Visual C++ 2008 SP1 Redistributable Package on the physical host. The package can be downloaded from the Microsoft website:
 - [Microsoft Visual C++ 2008 SP1 Redistributable Package \(x64\)](#)
 - [Microsoft Visual C++ 2008 SP1 Redistributable Package \(x86\)](#)

Note: Both the x86 and x64 versions must be installed.

Configuring Storage Support for Microsoft VSS and VDS using Microsoft Hyper-V

Configure the IBM Storage Support for Microsoft VSS and VDS using the Microsoft Hyper-V guest OS.

1. Log on to the Microsoft Hyper-V guest OS.
2. Install the IBM Storage Support for Microsoft VSS and VDS.
3. Add the host IP address to the VM host file.

4. Set the parameters to access the host server. For this step, you need the host server domain, user name, and password. The following list provides information about the settings and the relevant commands:
 - To set the Microsoft Hyper-V host user name that can manage Microsoft Hyper-V, issue the **ibmvcfg set vmusername** command.
 - To set the Microsoft Hyper-V host user password, issue the **ibmvcfg set vmpassword** command.
 - To set the Microsoft Hyper-V host user domain, issue the **ibmvcfg set vmdomain** command.
 - To view the configuration settings, issue the **ibmvcfg showcfg** command.
5. Provide the following privileges for the user:
 - Access WMI on the host Server
 - Query WMI objects in the following name spaces: root/cimv2, root/wmi, root/default, and root/virtualization.
 - Create a process with class Win32_Process in root/cimv2.
 - Manage the resources in the root/virtualization name space.

Set the domain as the host name if the user does not belong to a Windows domain.

Note: After the configuration is set, the service must be restarted using the following commands in order for the configuration to take effect:

- net stop vss
- net stop ibmvss

The above commands will stop both VSS VDS and the IBM VSS HW Provider. Both services will start automatically in later use.

Configuring source volumes using Microsoft Hyper-V

Disks must be assigned to the guest OS by pass-through mode. This is because the IBM Storage Support for Microsoft VSS and VDS supports taking shadow copies only for volumes that are based on disks from the SAN Volume Controller or DS8000.

1. Shut down the guest OS and add the iSCSI Controller to the guest OS.
2. Add the pass-through disk drive to the guest OS.

Note: The guest OS can be in the running state, but the disks should be in the offline state on the host so that they can appear in the physical hard box combo box.

3. Log on to the guest OS.
4. Create a volume on the newly added hard disk and assign a drive letter or mount point to the volume.

Taking snapshots using Microsoft Hyper-V

You must configure LUNs, with the same size as the source LUNs, as snapshot targets in the free storage pool on the storage system.

Before you take a snapshot of the volume on the guest OS, issue the following command to see whether the configuration is correct:

```
ibmvcfg testsnapshot X:
```

Tip: The command can support one or more drive letters or mount points. In the example command, X: is the drive letter or mount point to take the snapshot.

The procedures to take, delete, mask, resynchronize, and import snapshots are the same as the procedures for the physical host. The provider attaches the target LUNs to the physical host and then assigns it to the guest OS as a pass-through disk when taking or importing a snapshot. When you delete or mask a snapshot, the IBM VSS hardware provider removes the target LUN from the guest OS before detaching it from the physical host.

See [“Snapshot principles when NPIV is used” on page 17](#) for information on these tasks.

Microsoft Hyper-V advanced configuration

Advanced configuration includes NPIV configuration and storage protocol priority support in the IBM Storage Support for Microsoft VSS and VDS.

- [“Creating a virtual port with Microsoft Windows Server 2012 Virtual HBA” on page 23](#)
- [“Configuring NPIV with Microsoft Hyper-V” on page 24](#)
- [“Setting the storage protocol” on page 18](#)
- [“Configuring Windows Failover Cluster” on page 28](#)

Creating a virtual port with Microsoft Windows Server 2012 Virtual HBA

Before you configure the Microsoft Hyper-V guest OS, you must configure the Microsoft Windows Server 2012 virtual HBA.

The following requirements are necessary to configure Microsoft Windows Server 2012 Virtual HBA with Microsoft Hyper-V:

- NPIV-enabled FC adapter
 - NPIV-enabled FC Switch
 - Microsoft Windows Server 2012
 - NPIV WMI provider that is installed on the host. (Most of the FC drivers implement this provider.)
1. Click **Virtual SAN Manager** in the right panel of the Microsoft Windows Server 2012 Hyper-V Manager.
 2. Create a virtual SAN and select the HBA to be virtualized.
 3. In the Microsoft Hyper-V guest OS settings, add an FC adapter. Specify the virtual SAN created in step [“2” on page 23](#).
 4. In the **Open Switch Administration** panel, double-check the WWPN of the virtual HBA from the name server. Typically, it shares a port with the physical HBA.
 5. Modify the zone configuration to make the virtual HBA visible to the storage port.

Creating a zone with Microsoft Windows Server 2012 Virtual HBA

You can create a zone with Microsoft Windows Server 2012 Virtual HBA.

1. Click **Virtual SAN Manager** in the right panel of the Windows Server 2012 Hyper-V Manager.
2. Create a zone by using NPIV.
3. Create an alias and zone with the virtual port that you created in [“Creating a virtual port with Microsoft Windows Server 2012 Virtual HBA” on page 23](#). However, do not add the host WWN to the zone.

Note: The zone contains the new virtual port that you created and the storage system. It is not necessary to restart the host to make the NPIV port available.

Configuring storage with Microsoft Windows Server 2012 Virtual HBA

You can configure the storage system with Microsoft Windows Server 2012 Virtual HBA.

1. Click **Virtual SAN Manager** in the right panel of the Windows Server 2012 Hyper-V Manager.
2. Add the virtual port to the LUN that will contain the guest.

Note: It is not necessary to add the physical port to the LUN.

Configuring NPIV with Microsoft Hyper-V

Advanced configuration includes NPIV configuration and storage protocol priority support in IBM Storage Support for Microsoft VSS and VDS.

Note: The following topics do not apply to the iSCSI protocol.

- [“Requirements for configuring NPIV with Microsoft Hyper-V” on page 24](#)
- [“Creating a virtual port” on page 24](#)
- [“Creating a zone” on page 24](#)
- [“Configuring storage” on page 24](#)
- [“Configuring the host disk” on page 25](#)
- [“Deploying guests” on page 25](#)
- [“Configuring source volumes” on page 27](#)
- [“Verifying NPIV configuration” on page 27](#)
- [“Preparing to take a snapshot” on page 27](#)

Taking a snapshot with Microsoft Windows Server 2012 Virtual HBA

The provider automatically attaches the LUN to the guest OS through a virtual port.

During the snapshot-creation process, the IBM Storage Support for Microsoft VSS and VDS maps the snapshot target LUN to both the physical HBA WWPNs and virtual WWPNs. The LUN is then assigned to the VM from the VMware ESX(i) Server as the pRDM disk.

Requirements for configuring NPIV with Microsoft Hyper-V

The requirements for configuring NPIV with Microsoft Hyper-V are listed.

- NPIV-enabled FC Adapter.
- NPIV-enabled FC Switch.
- FC HBA Manager and Agent with V-Port creation feature.
- NPIV WMI provider that is installed on the host (most of the FC drivers implement this provider).

Creating a virtual port

Create a virtual port using the FC HBA Manager GUI.

1. Open FC HBA Manager GUI.
2. Select a physical port and create a virtual port on it.

Creating a zone

On the HBA manager, create a zone using NPIV.

Create an alias and zone with the virtual port that you created in [“Creating a virtual port” on page 24](#) but do not add the host WWN to the zone.

Note: The zone contains only the new NPIV port that you created and the storage. You do not need to restart the host to make the NPIV port available.

Configuring storage

To configure storage, add the virtual port to the LUN that will contain the guest.

Note: You do not need to add the physical port to the LUN.

Configuring the host disk

For virtual disks, bring the new LUN online and initialize it. Assign drive letters to the volume to contain the guest OS configuration files and VHDs. A volume with a mount point is not supported by IBM Storage Support for Microsoft VSS and VDS NPIV.

For pass-through disks, two LUNs per guest are required. One LUN is required for the configuration files and the other LUN is required to install the OS. The volume that contains configuration files must be assigned a drive letter. Make sure that the disk is offline when you install the OS.

Deploying guests

You can use Microsoft Hyper-V Manager or Microsoft System Center Virtual Machine Manager (SCVMM) to deploy guests.

Deploying with Hyper-V Manager

If the host is managed by Hyper-V Manager, complete the following steps to create a VM:

1. Open Microsoft Hyper-V Manager.
2. Click **New** > **Virtual Machine** in the **Actions** panel.
3. When you are prompted for a location for the VM, choose the volume that is on the LUN that you created in [“Configuring storage” on page 24](#).

After memory and networking configurations, specify the name and location of the hard disk where you want to install the guest OS.

If you are using a VHD

Locate the hard disk on a volume that is on the LUN through the virtual port.

If you are using a pass-through disk

It is better that the disk be from a virtual port, be offline, and be configured as MBR disk type.

A pass-through disk does not support GPT and dynamic disk types. If the disk is previously configured as GPT or dynamic, you must bring the disk online and convert it, in which case you need to shut down the guest.

Deploying with SCVMM

If the host is managed by the SCVMM, complete the following steps to create a VM:

1. Select the host that has the virtual port active when you are prompted for the host on which to place the guest.
2. Click **Browse** and select the LUN that you created when you are prompted for a location for the files.

Note: Refresh the disks or check the host to make sure that the disk is online and formatted if you do not see the LUN.

To configure the disk to install the guest OS, complete the following tasks:

Configuring the Host (Microsoft Hyper-V) Server

To configure the host (Microsoft Hyper-V) server, complete the following steps:

1. Install one of the following operating systems:
 - Microsoft Windows Server 2008 x64
 - Windows Server 2008 R2
 - Microsoft Windows Server 2012
 - Microsoft Windows Server 2012 R2
2. Install the Microsoft Hyper-V role on the Windows server using the Server Manager, and then restart the server.

3. Disable automount for the disks on the host. Issue the following commands:

```
C:\>diskpart  
DISKPART>automount disable
```

4. To allow for remote administration on the physical host, enable the Windows firewall.
5. Install the MPIO driver that ships with Windows Server 2008.
6. Install the MPIO driver that your storage vendor supplied.
7. Install and configure the Microsoft Hyper-V guest OS using the Microsoft Hyper-V Manager. The guest OS can be Windows Server 2008 or later.
8. Download and install Microsoft Visual C++ 2008 SP1 Redistributable Package on physical host. The package can be downloaded from the Microsoft website:
 - [Microsoft Visual C++ 2008 SP1 Redistributable Package \(x64\)](#)
 - [Microsoft Visual C++ 2008 SP1 Redistributable Package \(x86\)](#)

Note: The x86 and x64 versions must both be installed.

Configuring IBM Storage Support for Microsoft VSS and VDS using Hyper-V

To configure IBM Storage Support for Microsoft VSS and VDS using Hyper-V, complete the following steps:

1. Log on to the Microsoft Hyper-V guest OS.
2. Install the IBM Storage Support for Microsoft VSS and VDS.
3. Add the host IP address to the VM host file.
4. Set the parameters to access the host server. For this step, you need the host server domain, user name, and password. The following list provides information about the settings and the relevant commands.
 - To set the user name, issue the **ibmvcfg set vmusername** command (hyper-V host user name, which can manage hyper-V)
 - To set the password, issue the **ibmvcfg set vmpassword** command (hyper-V host user password)
 - To set the domain, issue the **ibmvcfg set vmdomain** command (hyper-V host user domain)
 - To view the configuration settings, issue the **ibmvcfg showcfig** command
5. Provide the following privileges for the user:
 - Access WMI on the host Server
 - Query WMI objects in the following name spaces: root/cimv2, root/wmi, root/default, and root/virtualization.
 - Create a process with class Win32_Process in root/cimv2.
 - Manage the resources in the root/virtualization name space.

Set the domain as the host name if the user does not belong to a Windows domain.

Note: After the configuration is set, the service must be restarted using the following commands in order for the configuration to take effect:

- net stop vss
- net stop ibmvss

The above commands will stop both VSS VDS and the IBM VSS HW Provider. Both services will start automatically in later use.

Configuring source volumes using Microsoft Hyper-V

To configure source volumes using Microsoft Hyper-V, complete the following steps:

1. Shut down the guest OS and add the iSCSI Controller to the guest OS.

2. Add the pass-through disk drive to the guest OS.

Note: The guest OS can be in the running state. But it is suggested that the disks be in the offline state on the host so that they can appear in the physical hard box combo box.

3. Log on to the guest OS.
4. Create a volume on the newly added hard disk and assign a drive letter or mount point to the volume.

Taking snapshots using Microsoft Hyper-V

Before you take a snapshot of the volume on the guest OS, issue the following command to check to see whether the configuration is correct:

```
ibmvcfg testsnapshot X:
```

Note: The `ibmvcfg testsnapshot X:` command supports one or more drive letters or mount points. In the example command, X: is the driver letter or mount point to take the snapshot.

The procedures to take, delete, mask, resynchronize, and import snapshots are the same as the procedures for the physical host. The provider attaches the target LUNs to the physical host and then assigns it to the guest OS as a pass-through disk when taking or importing a snapshot. When deleting or masking a snapshot, the IBM VSS Hardware Provider removes the target LUN from the guest OS before detaching it from the physical host.

Configuring source volumes

Because the VSS and VDS support taking shadow copies only for volumes that are based on disks from SAN Volume Controller or DS8000, the disks must be assigned to the guest OS by the pass-through mode.

To configure source volumes, complete the following steps:

1. Shut down the guest OS and add the iSCSI Controller to the guest OS.
2. Create LUNs and map them to the host in the storage unit that is connected to the host.
3. Add the pass-through disk drive to the guest OS.

Note: The guest OS can be in the running state, but the disks should be in the offline state on the host so that they can appear in the physical hard box combo box.

4. Log on to the guest OS.
5. Create a volume on the newly added hard disk and assign a drive letter or mount point to the volume.

Verifying NPIV configuration

You can verify the NPIV configuration by using the FC HBA Manager.

To ensure that a LUN is from a virtual port, open the FC HBA Manager and verify that the LUN is under the virtual port.

Preparing to take a snapshot

Before you take a snapshot of the volume on the guest OS, you must check the configuration.

Issue the following command to see whether the configuration is correct:

```
ibmvcfg testsnapshot X:
```

Note: The command can support one or more drive letters or mount points. In the example command, X: is the driver letter or mount point to take the snapshot.

The procedure for taking a snapshot is similar to when you take a snapshot by using Hyper-V. However, when you take a snapshot after you configure NPIV with Hyper-V, the following events happen:

- The provider automatically attaches the target LUNs to the host via a virtual port

- The provider assigns the LUN to the guest OS as a pass-through disk when taking or importing a snapshot

When deleting or masking a snapshot, the IBM VSS hardware provider removes the target LUN from the guest OS before detaching it from the physical host.

Configuring Windows Failover Cluster

You can configure ibmvss with Windows Failover Cluster on Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2.

Before you configure ibmvss with Windows Failover Cluster, you must create the cluster with the hosts. Complete the following requirements to configure ibmvss with Windows Failover Cluster:

- The DNS server must already be configured or all node IP addresses must be added to the VM hosts file
- All hosts should have the same external virtual network in Microsoft Hyper-V Virtual Switch Manager
- The cluster node IP address should be in one subnet and have only one cluster IP
- Create a VM base on CSV (cluster shared volumes)

Complete the following steps to configure Windows Failover Cluster:

1. Add all cluster hosts to the storage system through iSCSI or FC, and add a volume to all the nodes as the source volume.
2. Create a free storage pool and a resolve storage pool, and map some volumes (the same size as the source volume) to the free storage pool.
3. In **Failover Cluster Manager**, click **Storage**, right-click **Add a storage** and add the source volume as available storage in the cluster.
4. In **Failover Cluster Manager**, right-click **VM** and select **Add storage**. This process adds the source volume as a disk drive of the VM.
5. Set the source volume as a VM pass-through disk and change its status to online.
6. To check the ibmvss configuration, install the ibmvss in the VM and open the command prompt. Change directory to the ibmvss installed path and issue the **ibmvcfg.exe showcfg** command.
7. Issue the **ibmvcfg.exe set vmusername administrator** command to set the host user name.
8. Issue the **ibmvcfg.exe set vmpassword** command to set the host password.
9. Issue the **ibmvcfg.exe set vmdomain** command to set the domain.

Configuring for dynamic target volume allocation

You can configure IBM Storage Support for Microsoft product to dynamically create target volumes for backup use for IBM Spectrum Virtualize family and DS8000 storage systems.

There is no need to create the target volumes and map them to the free storage pool in advance. However, the free pool and reserved pool need to be created manually.

Configuring for dynamic target volume allocation for IBM Spectrum Virtualize family storage systems

Complete the following procedure to configure IBM Storage Support for Microsoft VSS and VDS to dynamically create target volumes for backup use for IBM Spectrum Virtualize family storage systems.

There are three options which need to be set in order to configure IBM Storage Support for Microsoft for Microsoft VSS and VDS to dynamically create target volumes for IBM Spectrum Virtualize family storage systems. These options are:

- The name of the storage pool from which you would like IBM Storage Support for Microsoft VSS and VDS to dynamically create target volumes.
- The name of the IO group with which to associate the created volumes.

- The allocate option, used to specify the creation of either standard volumes or space-efficient volumes.

To configure for dynamic target volume allocation for IBM Spectrum Virtualize family storage systems, complete the following steps:

1. Issue the **ibmvcfg.exe set storagePool** command to set the name of the storage pool.

Example: ibmvcfg.exe set storagePool test_pool_1

2. Issue the **ibmvcfg.exe set ioGroup** command to set the name of the IO group.

Example: ibmvcfg.exe set ioGroup io_grp0

3. Issue the **ibmvcfg.exe set allocateOption** command to set the allocate option.

Example: ibmvcfg.exe set allocateOption se

Configuring for dynamic target volume allocation for IBM DS8000 storage systems

Complete the following procedure to configure IBM Storage Support for Microsoft VSS and VDS to dynamically create target volumes for backup use for IBM DS8000 storage systems.

There are two options which need to be set in order to configure IBM Storage Support for Microsoft for Microsoft VSS and VDS to dynamically create target volumes for IBM DS8000 storage systems. These options are:

- The name of the storage pool from which you would like IBM Storage Support for Microsoft VSS and VDS to dynamically create target volumes.
- The allocate option, used to specify the creation of either standard volumes or space-efficient volumes.

To configure for dynamic target volume allocation for IBM DS8000 storage systems, complete the following steps:

1. Issue the **ibmvcfg.exe set storagePool** command to set the name of the storage pool.

Example: ibmvcfg.exe set storagePool "Extent Pool 10"

2. Issue the **ibmvcfg.exe set allocateOption** command to set the allocate option.

Example: ibmvcfg.exe set allocateOption se

Chapter 4. Troubleshooting

The topics in this section provide troubleshooting information that is related to IBM Storage Support for Microsoft VSS and VDS support for Hyper-V.

Provider cannot find FC or iSCSI initiator

If Provider cannot find FC or iSCSI initiator, complete the following steps:

1. Verify the FC and iSCSI configurations on the host, SAN, and storage system. Make sure that at least one initiator is installed on the host or the guest OS.
2. Verify the settings for Hyper-V. Ensure that the following situations are true:
 - The IP address, user name, password, and domain are set correctly
 - The user is authorized to access WMI on the host
 - The domain is set as the host's computer name if it is not the domain user
3. Ensure that the storage protocol setting and the existing initiator configuration are not in conflict.

Unsupported volumes

Verify that the volume on the disk is supported by the IBM Storage Support for Microsoft VSS and VDS. The disk must be from SAN Volume Controller or DS8000 and must be added to the guest OS as a pass-through disk. Virtual hard disks are not supported by the IBM Storage Support for Microsoft VSS and VDS, although they might be supported on the LUN from SAN Volume Controller or DS8000.

Restriction: Any LUNs that are mapped to a VMware virtual machine by using virtual raw device mapping (vRDM) are recognized as a VMware virtual disk, and are not supported.

Importing a shadow copy failed or locating a LUN failed while taking the shadow copy

Either the guest OS has no iSCSI controller or the address on the iSCSI controller or the guest OS is insufficient. Shut down the guest OS and add the iSCSI controller to the guest OS.

Target LUNs are not attached to the host through the virtual port

If target LUNs are not attached to the host through the virtual port, complete the following steps:

1. Verify the virtual port configuration on the host, SAN, and storage system.
2. Verify that the guest OS configuration files are on the LUN through the virtual port. The volume on the LUN must be assigned a drive letter. A mount point is not supported.
3. Ensure that the storage protocol is not set to iSCSI.

VMware virtual machine not recognized as a virtual machine

The VMware VM is not recognized as a VM because the result of the **systeminfo** command in the VM is incorrect.

The result of the **systeminfo** command appears like the following example:

- System Manufacturer: VMware, Inc
- System Model: VMware Virtual Platform

If the option `SMBIOS.reflectHost = "TRUE"` in the VM's configuration file (vmx) is added, the result of the **systeminfo** command changes.

For example:

- System Manufacturer: IBM
- System Model: Custom_

Note: If the VM is converted by the VMware vCenter Converter, the option is added automatically.

To correct this problem, complete the following steps:

1. Shut down the VM.
2. From the VMware ESXi/vCenter datastore, delete the SMBIOS option from the configuration file whose suffix is .vmx.
3. Turn on the VM.

Ensuring that no shadow copy exists before you change settings that are related to FC/ISCSI initiators

If you configured IBM Storage Support for Microsoft VSS and VDS to attach the target LUN to the guest OS through the host FC/ISCSI when creating or importing a shadow copy, delete or mask the shadow copy with the same configuration.

Ensure that no shadow copy exists before you change settings that are related to FC/ISCSI initiators.

The **ibmvss** settings are as follows:

- **storageProtocol**
- **VMHost**
- **Vmusername**
- **vmpassword**
- **vmdomain**

The hardware or OS settings are as follows:

- enable/disable host FC/ISCSI HBA
- enable/disable host software ISCSI
- enable/disable guest OS software ISCSI

Incremental FlashCopy mapping persists

Incremental FlashCopy® makes a copy of only the changes to either the source or target data since the last FlashCopy operation. It is designed to enable completion of point-in-time online backups much more quickly than using traditional FlashCopy.

To enable incremental FlashCopy mapping, in the IBM VSS hardware provider, issue the following command:

```
ibmvcfg.exe set incrementalFC Yes
```

After setting to incremental, all FlashCopy created is incremental until you return to regular FlashCopy by issuing the following command:

```
ibmvcfg.exe set incrementalFC No
```

Assume that an Incremental FlashCopy mapping called "fcmapi" was created, where F1 is the source volume that is mapped to the host and F2 is the target volume. Then, F1 can be used as a source volume in only one FlashCopy mapping. If the FlashCopy mapping is deleted from IBM VSS hardware provider, the target volume F2 returns to the free storage pool, but the FlashCopy mapping still exists in storage. When a new incremental FlashCopy using F1 as the source volume is later created, F2 and fcmapi are reused.

Deleting and restoring cascaded FlashCopy mappings

SAN Volume Controller and the IBM Spectrum Virtualize Family can minimize the overhead that is required to maintain multiple snapshots of the same source volume. To minimize the overhead, put the target volumes into a cascade where each target depends on changes that are recorded in target volumes of subsequent snapshots.

For example, assume that four VSS snapshots are created of a source volume, where S is the source volume and T1 through T4 are the targets, T1 being first chronologically and T4 the last. The following cascade occurs: **S > T4 > T3 > T2 > T1**

With this type of cascade relationship, a copy-on-write process is needed only between the source volume and the latest FlashCopy target. Any block that remains unchanged on the source volume are not copied at all.

In IBM VSS Hardware Provider, to enable cascading FlashCopy mapping, issue the **ibmvcfg.exe set backgroundCopy 0** command.

To disable cascading FlashCopy mapping, issue the **ibmvcfg.exe set backgroundCopy <n>** command, where <n> is a number in the range 1–100.

When you enable cascading, sequentially create the FlashCopy mappings: **S > T1**, **S > T2**, **S > T3**, and **S > T4**.

If you delete mapping **S > T2**, then **S > T1** is also deleted, and only **S > T3** and **S > T4** exist.

If you restore mapping **S > T2**, then **S > T2**, **S > T3**, and **S > T4** are deleted, and only **S > T1** exists.

To use space efficient volume, set the backgroundCopy to zero. Mixed volume types (fully allocated and space-efficient) of VDisks in VSS_FREE storage pool and mixed copy rates in cascading/multi-target volumes are not recommended.

Volume Shadow Copy Service supports Windows Failover Cluster

When you attach the source volume to the VM, first add an available storage to the VM from the cluster and add pass-through disks to the VM.

Prerequisites:

The following prerequisites must be satisfied.

- The cluster node IP addresses must be in one subnet
- Add the cluster node IP addresses and the host names to the VM hosts file
- The DNS server must already be configured

Storage protocol special cases and exceptions

The IBM Storage Support for Microsoft VSS and VDS offer the option to choose the storage protocol.

You are responsible for ensuring that changing the storage protocol and IBM Storage Support for Microsoft VSS and VDS settings for VMware does not affect the previously created snapshots.

The following example illustrates a special case that can cause some problems. The procedure in this example is as follows:

1. Create a snapshot with the FC protocol.
2. Change the protocol setting to virtual machine iSCSI.
3. Incorrectly modify or clear the VMware settings.
4. Delete the previously created snapshot.

In this case, the FlashCopy map is removed from storage and the target LUN is unmapped from the hosts. However, the pRDM file remains on the VMware ESX(i) Server because the VMware settings (vmhost, vmuser, vmpassword, or vmcredential) were incorrectly set. The Volume Shadow Copy Service and Virtual Disk Service is therefore unable to communicate with the VMware ESX(i) Server.

If the settings are correct, the deletion process can still be successful with the pRDM file removal.

If this example case occurs, a warning message is issued if the VMware settings are changed using **ibmvcfg**.

It is not necessary to configure the IBM Storage Support for Microsoft VSS and VDS parameters (such as vmhost and vmuser) for VMware. If you decide to use the VM software iSCSI protocol, all processes are run using Ethernet protocol.

Error codes

This section details error messages for the IBM Storage Support for Microsoft VSS and VDS software.

Note: For more information see **Messages and codes** within your Spectrum Virtualize family documentation or **Reference** within your IBM DS8000 family documentation.

Error Code	Description
-1	Other errors for restore.
5	The CIMOM password or user name is incorrect.
100	VerifyMTFC: All the FCMAPs?copy rate is 0 in the dependency list of Target Volume
102	findTarget: An exception occurred while getting VSS_FREE volumes.
103	findTarget: The number of source and target volumes are not equal.
200	assignVol: Invalid controller WWPN.
201	assignVol: Invalid volume serial number; or Internal Error. Unable to determine target storage.
202	assignVol: Invalid assignment/unassignment operation, needs to be 1 or 2; or Internal Error: Unable to obtain Storage Configuration Service.
205	ERROR: The local host has defined WWPN/IQN that the configuration does not support.
300	The operation was successfully completed. And Newer plus current cascading snapshots are deleted.
308	Please specify to list 'all free reserved assigned unassigned infc'.
400	executeFlashCopy: Input Vector was null.
401	executeFlashCopy: AttachReplicas returned null.
402	AttachReplicas returned error.
500	withdrawFlashCopy: Input volume was null.

Error Code	Description
501	withdrawFlashCopy: Volumes are not in a storage synchronized relationship; or Invalid parameters.
502	withdrawFlashCopy: ModifySynchronization returned null
503	withdrawFlashCopy: Input volume was invalid.
504	withdrawFlashCopy: Storage Configuration Service was null!
512	Error: Volume is offline.
600	cleanup: Source volumes were null.
700	ERROR: Null value found either WWPN, boolean variable, or targetSVC.
701	ERROR: The length of WWPN does not match with boolean variable.
702	ERROR: The targetSVC's ID does not match.
711	No matching synchronization was found.
712	Internal Error: Unable to obtain Storage Configuration Service.
713	The SAN Volume Controller does NOT support restoring FlashCopy.
714	The SAN Volume Controller does not support restoring FlashCopy with SEV.
715	Cannot restore the FlashCopy because target volume is already a copying state FCMAP's target.
716	Reuse existing FCMAP to perform restore failed.
718	Provider does not support restoring FlashCopy for SAN Volume Controller 5.1 or higher.
719	Provider does not support restoring FlashCopy with cascading on SAN Volume Controller 5.1 or higher.
720	Prepare FlashCopy to restore failed.
730	Execute restore FlashCopy failed.
740	Wait related FCMAP to finish failed.
800	There is FCMAP with copy rate 0 and others copy rate greater than 0 in the dependency list of Target Volume.

Error Code	Description
911	Internal Error: The CIMOM may not be functioning correctly.
1000	JVM Creation failed. ERR_JVM
1001	Class not found: %1. ERR_CLASS_NOT_FOUND
1002	Some required parameters are missing. ERR_MISSING_PARAMS
1003	Method not found: %1. ERR_METHOD_NOT_FOUND
1004	A missing parameter is required. Use the configuration utility to set this parameter: %1. ERR_REQUIRED_PARAM
1006	The following method failed: %1. ERR_METHOD
1007	Provider initialization failed. Refer to the logs for the error messages. ERR_GLOBALINIT
1600	The recovery file could not be created. ERR_RECOVERY_FILE_CREATION_FAILED
1700	ibmGetLunInfo failed in AreLunsSupported. ERR_ARELUNSSUPPORTED_IBMGETLUNINFO
1800	ibmGetLunInfo failed in FillLunInfo. ERR_FILLLUNINFO_IBMGETLUNINFO
1900	Failed to delete the following temp files: %1 ERR_GET_TGT_CLEANUP
2500	Error initializing log. ERR_LOG_SETUP
2501	Unable to search for incomplete Shadow Copies. Windows Error: %1. ERR_CLEANUP_LOCATE
2502	Unable to read incomplete Shadow Copy Set information from file: %1. ERR_CLEANUP_READ
2503	Unable to clean up snapshot stored in file: %1. ERR_CLEANUP_SNAPSHOT
2504	Cleanup call failed with error: %1. ERR_CLEANUP_FAILED
2505	Unable to open file: %1. ERR_CLEANUP_OPEN
2506	Unable to create file: %1. ERR_CLEANUP_CREATE
2507	HBA: Error loading hba library: %1. ERR_HBAAPI_LOAD

Error Code	Description
3000	An exception occurred. Check the ESSService log. ERR_ESSSERVICE_EXCEPTION
3001	Unable to initialize logging. ERR_ESSSERVICE_LOGGING
3002	Unable to connect to the CIM agent. Check your configuration. ERR_ESSSERVICE_CONNECT
3003	Unable to get the Storage Configuration Service. Check your configuration. ERR_ESSSERVICE_SCS
3004	An internal error occurred with the following information: %1. ERR_ESSSERVICE_INTERNAL
3005	Unable to find the VSS_FREE controller. ERR_ESSSERVICE_FREE_CONTROLLER
3006	Unable to find the VSS_RESERVED controller. Check your configuration. ERR_ESSSERVICE_RESERVED_CONTROLLER
3007	Unable to find suitable targets for all volumes. ERR_ESSSERVICE_INSUFFICIENT_TARGETS
3008	The assign operation failed. Check the CIM agent log for details. ERR_ESSSERVICE_ASSIGN_FAILED
3009	The withdraw FlashCopy operation failed. Check the CIM agent log for details. ERR_ESSSERVICE_WITHDRAW_FAILED
4000	Failed to initialize the %1. ERR_INIT
4001	Internal Error: %1. ERR_INTERNAL
4002	%1. INFO_GENERAL
4096	executeFlashCopy() - Job started
32816	Volume(s) are already in a FlashCopy relationship. ERR_FLASHCOPY_ALREADY_IN_PROGRESS
37883	Volume already assigned.
38163	Volume already unassigned.

Notices

These legal notices pertain to IBM Storage Host Software Solutions product documentation.

This information was developed for products and services offered in the U.S.A.

IBM may not offer the products, services, or features discussed in this document in other countries. Consult your local IBM representative for information on the products and services currently available in your area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service.

IBM may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not grant you any license to these patents. You can send license inquiries, in writing, to:

*IBM Director of Licensing
IBM Corporation
North Castle Drive
Armonk, NY 10504-1785
U.S.A.*

For license inquiries regarding double-byte character set (DBCS) information, contact the IBM Intellectual Property Department in your country or send inquiries, in writing, to:

*Intellectual Property Licensing
Legal and Intellectual Property Law
IBM Japan Ltd.
19-21, Nihonbashi-Hakozakicho, Chuo-ku
Tokyo 103-8510, Japan*

The following paragraph does not apply to the United Kingdom or any other country where such provisions are inconsistent with local law: INTERNATIONAL BUSINESS MACHINES CORPORATION PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some states do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. IBM may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

Any references in this information to non-IBM Web sites are provided for convenience only and do not in any manner serve as an endorsement of those Web sites. The materials at those Web sites are not part of the materials for this IBM product and use of those Web sites is at your own risk.

IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you.

Licensees of this program who wish to have information about it for the purpose of enabling: (i) the exchange of information between independently created programs and other programs (including this one) and (ii) the mutual use of the information which has been exchanged, should contact:

*IBM Corporation
Attn: Office of Legal Counsel
650 Harry Road
San Jose, CA 95120-6099
U.S.A.*

Such information may be available, subject to appropriate terms and conditions, including in some cases, payment of a fee.

The licensed program described in this document and all licensed material available for it are provided by IBM under terms of the IBM Customer Agreement, IBM International Program License Agreement or any equivalent agreement between us.

Any performance data contained herein was determined in a controlled environment. Therefore, the results obtained in other operating environments may vary significantly. Some measurements may have been made on development-level systems and there is no guarantee that these measurements will be the same on generally available systems. Furthermore, some measurements may have been estimated through extrapolation. Actual results may vary. Users of this document should verify the applicable data for their specific environment.

Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.

All statements regarding IBM's future direction or intent are subject to change or withdrawal without notice, and represent goals and objectives only.

This information contains examples of data and reports used in daily business operations. To illustrate them as completely as possible, the examples include the names of individuals, companies, brands, and products. All of these names are fictitious and any similarity to the names and addresses used by an actual business enterprise is entirely coincidental.

Trademarks

This section describes trademark information.

IBM, the IBM logo, and ibm.com are trademarks or registered trademarks of the International Business Machines Corp., registered in many jurisdictions worldwide. Other product and service names might be trademarks of IBM or other companies. A current list of IBM trademarks is available on the Copyright and trademark information website at:

<http://www.ibm.com/legal/us/en/copytrade.shtml>

VMware, the VMware logo, ESX, ESXi, vSphere, vCenter, and vCenter Site Recovery Manager are trademarks or registered trademarks of VMware Corporation in the United States, other countries, or both.

Microsoft, Windows Server, Windows, and the Windows logo are trademarks or registered trademarks of Microsoft Corporation in the United States, other countries, or both.

Other product and service names might be trademarks of IBM or other companies.

Index

C

- comments, sending [x](#)
- compatibility [1](#)
- Compatibility and requirements [3](#)
- configuration
 - Failover
 - ibmvss [28](#)
 - Hyper-V
 - configuring source volumes [22](#)
 - Microsoft Windows Server 2012 virtual HBA [23](#)
 - NPIV [24](#)
 - requirements [21](#), [24](#)
 - Microsoft Hyper-V
 - configuring source volumes [27](#)
 - NPIV
 - server administration tasks [16](#)
 - storage administration tasks [16](#)
 - verify [17](#)
 - physical environment [9](#)
 - VMware environment [10](#)
 - VSS Hardware Provider [21](#)
- configuring Microsoft Windows Server 2012 virtual HBA [23](#)

D

- deploying guests [25](#)
- downloads [3](#)
- dynamic target volume allocation
 - configuration [28](#)
 - configuration for IBM DS8000 storage systems [29](#)
 - configuration for IBM Spectrum Virtualize family storage systems [28](#)

E

- ESX servers [1](#)

F

- feedback, sending [x](#)

G

- generating JAVA credential keystore [13](#)

H

- host
 - configuration
 - Hyper-V [21](#)
- host disk
 - configuration [25](#)
- Hyper-V
 - advanced configuration [23](#)
 - basic configuration [20](#)

- Hyper-V (*continued*)
 - configuration
 - configuring source volumes [22](#)
 - VSS Hardware Provider [21](#)
 - configuring Microsoft Windows Server 2012 virtual HBA [23](#)
 - configuring NPIV
 - requirements [24](#)
 - requirements [21](#), [23](#)

I

- installation
 - text [3](#)
 - using Fibre Channel [9](#)
 - using iSCSI [9](#)
- introduction [1](#)

M

- Microsoft Hyper-V
 - configuration
 - configuring source volumes [27](#)

N

- NPIV
 - configuration
 - advanced [15](#)
 - Hyper-V [24](#)
 - server administration tasks [16](#)
 - verify [17](#), [27](#)
 - configuration requirements [24](#)
 - requirements [16](#)
 - snapshot [27](#)
 - storage administration tasks [16](#)

P

- physical environment
 - installation [9](#)
- pRDM disks [1](#)
- prerequisites [3](#)
- Prerequisites
 - VMware Tools
 - installing [12](#)
 - vSphere web services [11](#)
- provider parameters for VMware [12](#)
- provider settings for VMware [11](#)

R

- release notes [1](#)
- requirements [1](#)

S

- snapshot [27](#)
- snapshots
 - NPIV [17](#)
 - storage protocols [18](#)
 - using Hyper-V [22](#)
- storage
 - configuring [24](#)
- storage protocol priority [20](#)
- storage protocol setting [18](#)
- supported storage systems [1](#)

T

- troubleshooting [31](#)

U

- upgrading [5](#)
- user privileges [10](#)

V

- verify NPIV configuration [27](#)
- virtual port
 - create [24](#)
- VMware environments [1](#)
- VMware Tools
 - installing [12](#)
- vSphere web services [11](#)

Z

- zoning
 - create [24](#)



Printed in USA