Veritas Storage Foundation™ in a VMware ESX Environment

Linux and Solaris x64 platforms

July 2012

Symantec™

Veritas Storage Foundation in a VMware ESX Environment

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http://www.symantec.com/connect/storage-management

Contents

Chapter 1

Overview

This chapter includes the following topics:

About this document

This document describes how to configure and use Veritas Storage Foundation in a VMware vSphere environment (including ESX and ESXi). The support outlined in this paper strictly covers VMware ESX and ESXi support starting with version 3.0.1.

There is no support planned for Storage Foundation with VMware Server, Workstation or Virtual Desktop. Because most features in Storage Foundation are supported in a VMware environment, this document focuses on the features that work differently in a VMware environment and why certain features are not supported.

The operating systems covered are Linux and Solaris x64. Windows is not covered in this document. In addition, the document is limited to Storage Foundation and Storage Foundation Cluster File System.

Veritas Cluster Server (VCS) information is not included in this document. For information about VCS support in a vSphere environment, see the following document:

http://www.symantec.com/connect/sites/default/files/Clustering_Conf_for_VCS_with_vSphere_0.pdf

This document assumes that the reader is familiar with VMware and the VMware architecture in addition to being familiar with Storage Foundation. Only in places

where it is absolutely necessary to share VMware specific information is there an explanation of the involved components.

Storage consumed by a virtual machine can be allocated directly over the virtual machine network interface (NFS, CIFS, iSCSI to mention a few protocols), bypassing the virtualization layer, and is therefore not affected by virtualization. Support of storage configured in such a way is not covered in this white paper and any statement of support is limited to Storage Foundation running in a VMware virtual machine.

Use of the VMware certification mark means that Version 5.0, 5.1, 5.1 SP1, and 6.0 of Veritas Storage Foundation has been certified to run in a VMware Virtual Machine environment.

See "Support matrix" on page 25.

As of this date, Symantec makes no representation with respect to future product versions and future certification standards.

Executive summary

VMware server virtualization is a technology that has significant benefits for a data center environment, and it is changing the architecture of data centers. However, while it is great at virtualizing operating system instances, it does not solve or address storage virtualization. VMware has simplistic storage functionality that successfully addresses the current VMware market; however, as more storage intensive applications are being deployed in virtual environments, better storage management technology is required.

Deploying Storage Foundation in a VMware environment makes storage easier to manage and use by creating a functional storage management layer that the storage administrator or system administrator can access and use as it is not hidden inside the VMware ESX server.

The benefits of using Storage Foundation in a VMware environment include the following:

- Standardization of tools.
  Reduce complexity and management overhead of day to day operation by standardizing on a single toolset for both physical and virtual environments.
- Facilitating consistent application performance.
  This is crucial for mission critical data center applications such as databases and mail servers. The architecture of the solution must be able to handle and support the same behavior as in a physical environment.
- Array migration and data migration.

Intrusive operations such as array migration and data migration can cause significant downtime for a large amount of servers, especially in a virtual environment where one physical server is hosting as many as 30-40 virtual servers. Having the tools and infrastructure available to support such operations is essential to the long-term success of the data center.

- Thin reclamation.
  Increase storage utilization by using Storage Foundation to reclaim space on thin storage.

Storage Foundation delivers on these items as well as numerous other functions that help the administrator manage the data center more efficiently.

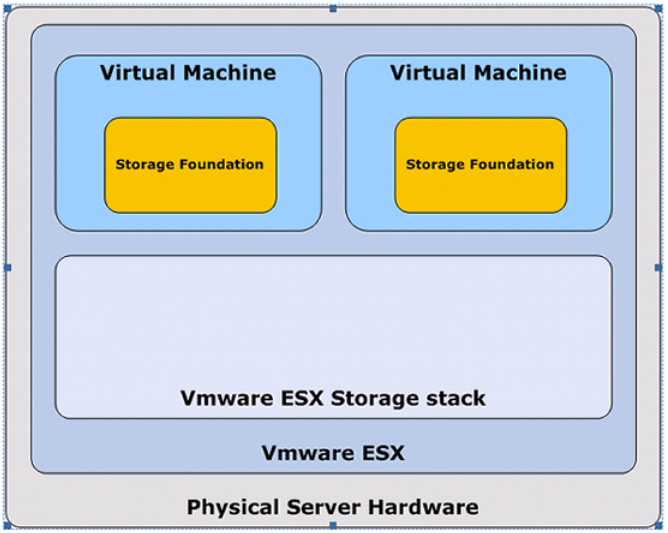
See "Storage Foundation benefits in a VMware environment" on page 15.

Overview of Veritas Storage Foundation in VMware environment

Using Veritas Storage Foundation in a VMware environment means that Storage Foundation is running in the operating system, inside the Virtual Machine. Storage Foundation does not run inside the VMware ESX kernel or in the Hypervisor.

Figure 1-1 shows the high-level architecture diagram.

Figure 1-1 Architecture overview



VMware has several different methods to allocate block storage to a virtual machine:

- File-based virtual disks created in VMFS or from NFS - Virtual Disk
- Block storage mapped from local disk, Fibre Channel LUNs or iSCSI – Raw Device Mapping

VMware product details are only covered briefly in this document. If you are not familiar with these VMware terms, read the VMware documentation. See the VMware web site:

www.vmware.com

Specific configuration of VMware is required for certain features of Veritas™ Volume Manager to operate as it does in a physical server environment. For example, the basic operation of initializing a disk in Veritas Volume Manager requires a change of the default disk format (except in the case of raw device mapping, physical mode).

See "Raw Device Mapping" on page 12.

Dynamic Multi-Pathing functionality is limited in VMware virtual machines.

The details for Storage Foundation as well as how the specific VMware configuration affects VMware functionality are listed in the following sections.

Virtual Machine File System

Virtual Machine File System (VMFS) is VMware's clustered file system that is integrated into the VMKernel, providing a type of storage infrastructure for virtual machines. Its primary purpose is to store virtual machine disk images (Virtual Disks); however, virtual machine configuration files and REDO-logs are also stored in the file system.

Virtual Disk

A Virtual Disk is stored as a file (also referred to as a VMDK) in VMFS or in an NFS mount point on the VMware ESX server. For the virtual machine, a virtual disk appears as a SCSI disk, independent of what storage is used for VMFS. Virtual Disks are supported with Veritas Volume Manager but with some limitations.

See "Storage Foundation limitations with VMware ESX" on page 20.

Raw Device Mapping

Raw Device Mapping (RDM) enables a virtual machine to have direct access to the storage rather than going via VMFS. RDM is configured on a per physical storage

device, i.e. a disk or LUN is assigned to one or more virtual machines. It is not possible to assign a part of a physical storage device to a virtual machine. Different types of storage (local SCSI disks, iSCSI disks, Fibre Channel disks) can be used with raw device mapping; Veritas Volume Manager supports all three types of disks. It is important to understand that there are two different modes for raw device mapping; the different modes affect the functionality and behavior of Storage Foundation and it is important to use the correct mode for the desired functionality.

Logical mode offers the same functionality and compatibility as a Virtual Disk with respect to VMware ESX features.

Physical mode is the most similar method to storage access in a non-virtual environment. Only one SCSI command, REPORT_LUNS, is virtualized as it is required to enable VMotion and a few other features in VMware. Physical mode is recommended as it enables maximum functionality of Veritas Volume Manager in a VMware environment.

When to use Raw Device Mapping and Veritas Storage Foundation

The benefit of each storage access method is dependent on the workload in the virtual machine. It is easy to get started with one way of deploying storage without considering the long-term implications because of the ease of use of the virtual environment. For applications with little to no storage need, using raw device mapping is overkill and not recommended. Also, if your environment depends on VMware snapshots, using Raw Device Mapping in physical mode is not possible as it is not supported by VMware.

Raw Device Mapping is a great fit for:

- Applications with large storage needs
- Applications that need predictable and measurable performance
- Multi-node clusters utilizing disk quorums
- Applications with storage that is currently managed by Storage Foundation but is moving into a virtual environment
- Applications that require direct access to storage, such as storage management applications

Chapter 2

Storage Foundation functionality in a VMware environment

This chapter includes the following topics:

Storage Foundation benefits in a VMware environment

This section describes the benefits that Storage Foundation provides in a VMware environment.

Standardization of tools

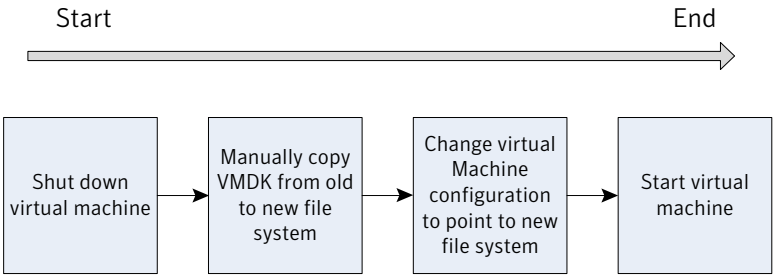
Independent of how an operating system is hosted, consistent storage management tools will save the administrator time and reduce the complexity of the environment. Storage Foundation in the virtual machine can provide the same command set, storage namespace and environment as in a non-virtual environment.

Array migration

Array migration is a task that all organizations do more and more often as storage needs continue to grow. With VMware it is impossible to do online array migration, causing significant downtime for users of virtual machines.

Figure 2-1 describes the high level process for VMware.

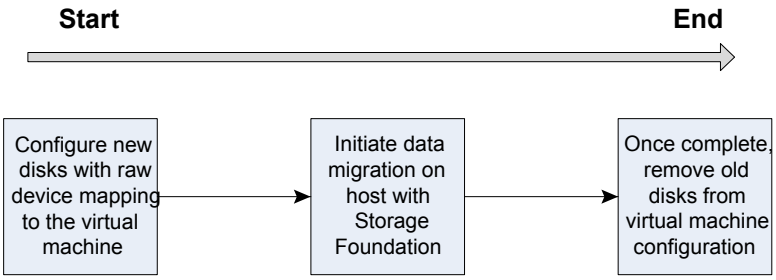
Figure 2-1 Virtual machine data migration with ESX tools



In VMware ESX 3.x and beyond, it is possible to add disks to the ESX server and the virtual machine without reboot. This makes it possible to offer a better process utilizing Storage Foundation together with raw device mapped storage for online data migration.

Figure 2-2 describes the high level process for Storage Foundation.

Figure 2-2 Virtual machine data migration with Storage Foundation



Data migration for Storage Foundation can be executed either locally in the virtual machine with Veritas Volume Manager or in a central location, migrating all storage from an array utilized by Storage Foundation managed hosts. This powerful, centralized data migration functionality is available in Veritas Storage Foundation Manager 1.1 (and later versions).

See the following Web site for information about Veritas Storage Foundation Manager.

http://www.symantec.com/sfm

Mirroring

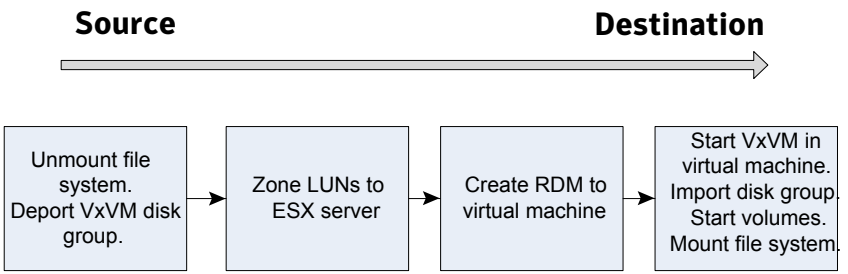
In VMware vSphere, VMFS does not have the capability to mirror storage. This forces users to use mirrored LUN's to provide this functionality to the virtual machines. With Veritas Volume Manager running in the virtual machine, utilizing raw device mapping, data can be protected with mirroring in the virtual machine, including the ability to mirror between storage arrays.

Moving storage between physical and virtual environments

Storage Foundation can make painful migrations of data from physical to virtual environments easier and safer to execute. With Storage Foundation there is no need to actually copy any data from source to destination; rather, the administrator re-assigns the same storage (or a copy of it for a test migration) to the virtual environment. Once the storage is assigned and configured into the virtual machine, Veritas Volume Manager will scan the device tree and discover the disk group and volume structure.

Figure 2-3 describes an example workflow.

Figure 2-3 Migration workflow



Veritas Volume Manager is ignorant of the actual physical device entry, i.e. Veritas Volume Manager does not care if the device is /dev/sdb or /dev/sdaz. This transparency makes it easy to move storage from one node to another, or between physical and virtual machines.

Storage Foundation functionality and compatibility matrix

Table 2-1 shows the Storage Foundation functionality and compatibility with VMware ESX disk modes.

Table 2-1 Storage Foundation functionality and compatibility matrix with VMware disk modes

Storage Foundation	VMware ESX disk mode: Virtual Disk (VMDK)	VMware ESX disk mode: Raw Device Mapping Logical mode	VMware ESX disk mode: Raw Device Mapping Physical mode
VxVM Disk format: simple, sliced	Yes	Yes	Yes
VxVM Disk format: cdsdisk	Yes	Yes	Yes
I/O fencing	Yes (with non-SCSI3-PR based fencing)[1]	Yes (with non-SCSI3-PR based fencing) [1]	Yes (with disks configured in RDM-P mode) [1]
Portable Data Containers	No	No	Yes
Dynamic Multi-Pathing	No	No	No
Volume Replicator	Yes	Yes	Yes
CVM/VVR	Yes	Yes	Yes
Bunker node (non-CVM environment)	Yes	Yes	Yes
DDL extended attributes	No	No	Yes
Thin reclamation	No	No	Yes[2]

1. Details are provided in the section on I/O fencing.

See "I/O Fencing" on page 23.

2. Thin reclamation is supported for ESX 4.0 and ESX 4.1 (U1 or later).

VMware

The following sections describe VMware functionality as it relates to Storage Foundation and Storage Foundation Cluster File System.

VMware snapshots

VMware snapshots are point in time copies of a virtual machine. Snapshots allow the administrator to go back to a specific point in time, including the memory state. VMware snapshots should not be confused with array-based snapshot technologies or Veritas Volume Manager snapshot functionality. VMware snapshots are not supported when raw device mapping is used in physical mode. This is un-related to whether Storage Foundation is installed or not. The REDO-log functionality that is required for VMware Snapshots is not available with Raw Device Mapping - physical mode. Raw device mapping in logical mode and VMware snapshots are supported as RDM-logical mode use the same level of SCSI virtualization as VMDK files.

See Figure 2-4 on page 20.

VMotion (Live Migration)

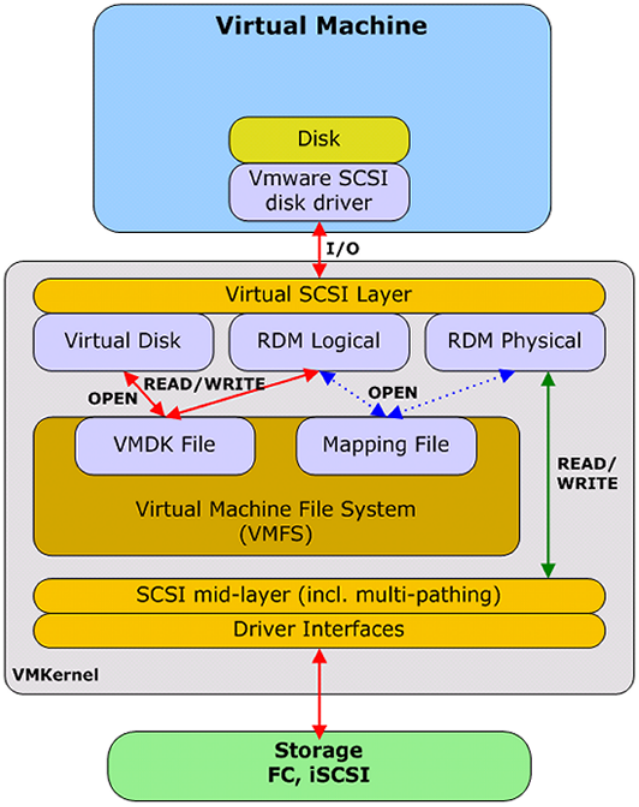
VMware VMotion allows virtual machines to be migrated between physical servers without noticeable downtime. VMotion works at the Hypervisor level; hence, the operating system is not even aware that it has been moved to a different physical server and applications running within the operating system are typically not affected by VMotion.

- Storage Foundation (standalone)
  All features of standalone Storage Foundation work with VMotion. However, make sure you read the next paragraph to understand the limitations of VMotion and virtual SCSI controller sharing.
- Storage Foundation Cluster File System & Veritas Cluster Server
  VMware VMotion has a limitation that affects all clustering software; it is not supported when a virtual SCSI controller is set to have sharing enabled. Virtual SCSI controller sharing is a Virtual Machine attribute and is required to be set for virtual machines that share storage between each other (on the same physical ESX server or between physical ESX servers); essentially all clustering products that rely on SAN storage require this to be set. Storage Foundation Cluster File System requires shared storage to operate; hence, VMotion functionality is not available for Virtual Machines running Storage Foundation Cluster File System. Virtual Machines that do not have the sharing attribute turned on their virtual SCSI controllers are not affected by this limitation.

NPIV (N-Port ID Virtualization)

NPIV used with Storage Foundation is fully supported. No additional setup tasks are required for Storage Foundation when using NPIV-enabled storage. I/O fencing with NPIV for any other 3rd party clustering software other than MSCS is currently not supported by VMware. In VMware environments, SFHA and SFCFS will support I/O Fencing using the Coordination Point Server as an arbitration mechanism. Storage Foundation 5.0 MP3 and ESX 3.5 update 2 are minimum versions required for NPIV support. NPIV does not enable any previously unavailable functionality such as Veritas Dynamic Multi-Pathing.

Figure 2-4 I/O path from Virtual Machine to Storage



Storage Foundation limitations with VMware ESX

This section describes limitations using Storage Foundation and Storage Foundation Cluster File System with VMware ESX.

Storage Foundation

This section describes the functionality of Storage Foundation and Storage Foundation Cluster File System with VMware ESX.

Portable Data Containers

Portable Data Containers combines functionality from Veritas File System and Veritas Volume Manager, enabling movement of data (volume/file system) between supported operating systems. While the Portable Data Containers functionality is executed by a file system command, it also depends on the Veritas Volume Manager disk format, cdsdisk. Portable Data Containers can therefore only be used with raw device mapping in physical mode.

Veritas Volume Manager limitations with VMware ESX

The following limitations apply for Veritas Volume Manager with VMware ESX.

Sharing VMDK files between virtual machines

When sharing VMDK files between virtual machines, SCSI BUS sharing mode for the corresponding SCSI controllers can be set to either “Physical” or “Virtual” modes. Setting this mode to “Physical” causes SCSI reservation conflict and I/O error on DMP This issue occurs in LVM and raw disks also.

Solution:

Disable simultaneous write protection for the shared VMDK files, using the procedure from the following VMware Knowledge Base article:

http://kb.vmware.com/kb/1034165

Disk format

Veritas Volume Manager supports three disk formats, simple, sliced and cdsdisk. The cdsdisk format was introduced in Veritas Storage Foundation 4.0 and is the default disk format in Veritas Storage Foundation 4.1, 5.0 and 5.1. The cdsdisk format is required for Portable Data Containers functionality.

Disk initialization

When initializing a disk in VMware, the Veritas Volume Manager disk format limitation comes into play. Selecting the wrong disk format will give an error message when trying to initialize the disk. Table 1 outlines what disk formats are supported on the different types of VMware storage access methods.

Veritas Volume Replicator

Veritas Volume Replicator (VVR) is supported inside a Virtual Machine. Keep in mind that VVR can use a significant amount of network bandwidth (depends on the amount of data written to disk) and this can reduce the available network bandwidth for other virtual machines. Since the network card is a shared resource, ensure that enough bandwidth is available to sustain the writes happening to disk.

Dynamic Multi-Pathing

Dynamic Multi-Pathing (DMP) is an integral part of the data path of Storage Foundation and cannot be disabled. When Storage Foundation is used in a VMware environment, DMP performs device management tasks such as device discovery and thin reclamation. However, due to the architecture of VMware, DMP does not perform multi-pathing for the Virtual Machine.

Figure 2-4 illustrates the data path for a Virtual Machine. As Figure 2-4 shows, the Virtual Machine is only presented with a single path and the Hypervisor layer takes care of the multi-pathing. Therefore, DMP in the guest is not used for multi-pathing in the Virtual Machine. It is technically possible to configure the same disk, with raw device mapping, over two different host bus adapters to a virtual machine. However, this is not supported because running two multi-pathing solutions on top of each other is a bad practice and will yield un-predictable failover results.

Veritas Dynamic Multi-Pathing for VMware is a separate product from Symantec that performs storage multi-pathing at the ESX Hypervisor layer.

See the following web site for more information:

http://www.symantec.com/dynamic-multi-pathing-for-vmware

Veritas File System

All features in Veritas File System are supported in a VMware virtual machine environment.

Storage Foundation Cluster File System

Storage Foundation Cluster File System (SFCFS) is supported when running inside a virtual machine; however, if I/O fencing is used then it requires special attention (see I/O fencing section).

I/O Fencing

VMware does not support SCSI-3 Persistent Reservations (and hence I/O Fencing) with any other 3rd party clustering software with RDM logical mode or VMDK-based virtual disks. In VMware environments, SFHA and SFCFS support the following methods of fencing:

- disk-based fencing with RDM-P mode.
  Available starting with SFHA and SFCFS version 5.1 Service Pack 1 Rolling Patch 1.
  See the following tech note for details.
  http://www.symantec.com/business/support/index?page=content&id=TECH169366
- non-SCSI-3 PR-based Fencing using the Coordination–Point Server.
  The Coordination-Point Server provides arbitration amongst the multiple nodes.

I/O fencing utilizes HBA World Wide Numbers (WWNs) to create registrations on the storage; this has implications in a virtual environment where the HBA is shared between virtual servers on the same physical ESX host as the WWN used for I/O fencing ends up being the same for each virtual machine. Therefore, SFCFS virtual machines (in the same SFCFS cluster) cannot share physical servers as the I/O fencing behavior will result in all nodes from that physical ESX host being fenced out if an event triggers the fencing functionality. In short, if I/O fencing is configured, the SFCFS nodes (in the same SFCFS cluster) have to be running on separate physical ESX hosts.

Chapter 3

Support matrix

This chapter includes the following topics:

Support matrix

Table 3-1 shows the platforms that have been tested and are supported with Storage Foundation running within the virtual machine on VMware ESX starting with version 3.0.1. VMware ESX versions earlier than 3.0.1 have not been tested and are not officially supported.

Note: This document is focused on supported Storage Foundation Linux and Solaris platforms and does not include Windows information.

The following versions of VMware ESX and ESXi are supported:

ESX 3.0.1, 3.15, 4.0 and ESXi 4.0, 4.1, 5.0

Future major releases of VMware ESX are not automatically supported.

Storage Foundation for Databases (Oracle, DB2 and Sybase) are supported with Storage Foundation 5.0 MP3. Earlier versions of Storage Foundation have not been tested. Later versions of maintenance packs are automatically supported unless otherwise noted.

Support for Storage Foundation Cluster File System (SFCFS) is the same as support for SF, except SFCFS is only supported on 64-bit.

Table 3-1 Support Matrix for Storage Foundation in a VMware ESX environment

Operating System	SF 5.0 X86_64 (64-bit)	SF 5.1 X86_64 (64-bit)	SF 5.1SP1 X86_64 (64-bit)	SF 6.0 X86_64 (64-bit)
Red Hat Enterprise Linux 4	Yes[1]	N/A	N/A	N/A
Red Hat Enterprise Linux 5	Yes[2]	Yes	Yes	Yes
Red Hat Enterprise Linux 6	N/A	N/A	Yes[3]	Yes
SUSE Linux Enterprise Server 9	Yes[1]	N/A	N/A	N/A
SUSE Linux Enterprise Server 10	Yes[2]	Yes	Yes	Yes[4]
SUSE Linux Enterprise Server 11	N/A	Yes	Yes	Yes[5]
Sun Solaris 10 x64	Yes	Yes	Yes	Yes

1. Storage Foundation 5.0 GA (minimum)
2. Storage Foundation 5.0 MP3 (minimum)
3. Storage Foundation 5.1SP1PR2 supports RHEL6.
4. Storage Foundation 6.0 requires SLES 10SP4 (minimum)
5. Storage Foundation 6.0 requires SLES 11SP1 (minimum)

Common configurations explored

This section explores common configurations and determines if they are supported. Note that even if the configuration is supported, some constraints may be present hence assuming the product will work as in a physical environment may be

incorrect. The previous pages in this document has explored all the constraints for running Storage Foundation in a ESX environment and should be read in detail.

Common Configurations

- I would like to run Storage Foundation with vSphere 4.1 and use VMotion?
  Fully supported configuration.
- I would like to run Storage Foundation with vSphere 4.1 and use VMotion and NPIV?
  Fully supported configuration.
- I would like to run Storage Foundation Cluster File System with vSphere 4.1 and use NPIV?
  Fully supported configuration.
- I would like to run Storage Foundation Cluster File System with vSphere 4.1 and use NPIV and I/O Fencing on the same physical ESX server?
  Fully supported configuration.
- I would like to run Storage Foundation Cluster File System with vSphere 4.1 and use NPIV and I/O Fencing on two different physical ESX servers?
  Fully supported configuration.
- I would like to run Storage Foundation Cluster File System with vSphere 4.1 and use NPIV and VMotion?
  Not supported due to VMware limitations with VMotion.
- I would like to run Storage Foundation Cluster File System with vSphere 4.1 and use NPIV, I/O fencing and VMotion on the same physical ESX server?
  Not supported due to VMware limitations with VMotion.
- I would like to run Storage Foundation Cluster File System with vSphere 4.1 and use NPIV, I/O fencing and VMotion on two different physical ESX servers?
  Not supported due to VMware limitations with VMotion.
- I would like to run Storage Foundation HA (not VCS for ESX) with vSphere 4.1 and use VMotion?
  Not supported due to VMware limitations with VMotion.

FAQ

- Does Storage Foundation have any components that run at the Hypervisor level, i.e. inside VMware ESX?
  No, Storage Foundation has no components and does not require any components to run at the Hypervisor level or in VMware ESX Service Console.
- Is iSCSI storage supported?

All block storage topologies that are supported with ESX are supported when Storage Foundation is running inside a Virtual machine. The storage specific details are hidden for Storage Foundation by VMware hence FC, iSCSI and locally attached disks are supported. The Storage Foundation Hardware Compatibility List (HCL) includes that information and the HCL can be found here:

- What Storage Foundation products are supported in a VMware ESX environment?
  Storage Foundation and Storage Foundation Cluster File System have both been tested and are supported in VMware ESX Virtual Machines. Details are provided in previous sections in the current document.
- Are there any plans for support of older versions of VMware ESX?
  There are no plans to support older versions (earlier than 3.0.1) of VMware ESX.
- Is there any way to get DMP to work in a Virtual Machine?
  The VMware architecture does not allow for VMware Multi-Pathing to be turned off or bypassed, hence there is no way to reliably use DMP for multi-pathing in the Virtual Machine. As part of Storage Foundation, DMP is active inside the Virtual Machine, but does not perform multi-pathing. Veritas Dynamic Multi-Pathing for VMware is a separate product from Symantec that performs storage multi-pathing at the ESX Hypervisor layer. See the following web site for more information:
  http://www.symantec.com/dynamic-multi-pathing-for-vmware
- Is Veritas Volume Replicator supported in VMware?
  VVR is fully supported in a virtual machine.
- Is Storage Foundation Cluster File System supported in VMware?
  Yes, Storage Foundation Cluster File System is fully supported. Please read the details in this document with regards to I/O fencing limitations.
- Is NPIV supported?
  NPIV has been tested with SF 5.0 MP3 and ESX 3.5 update 2 and is fully supported. It is not supported with earlier versions of Storage Foundation or ESX.