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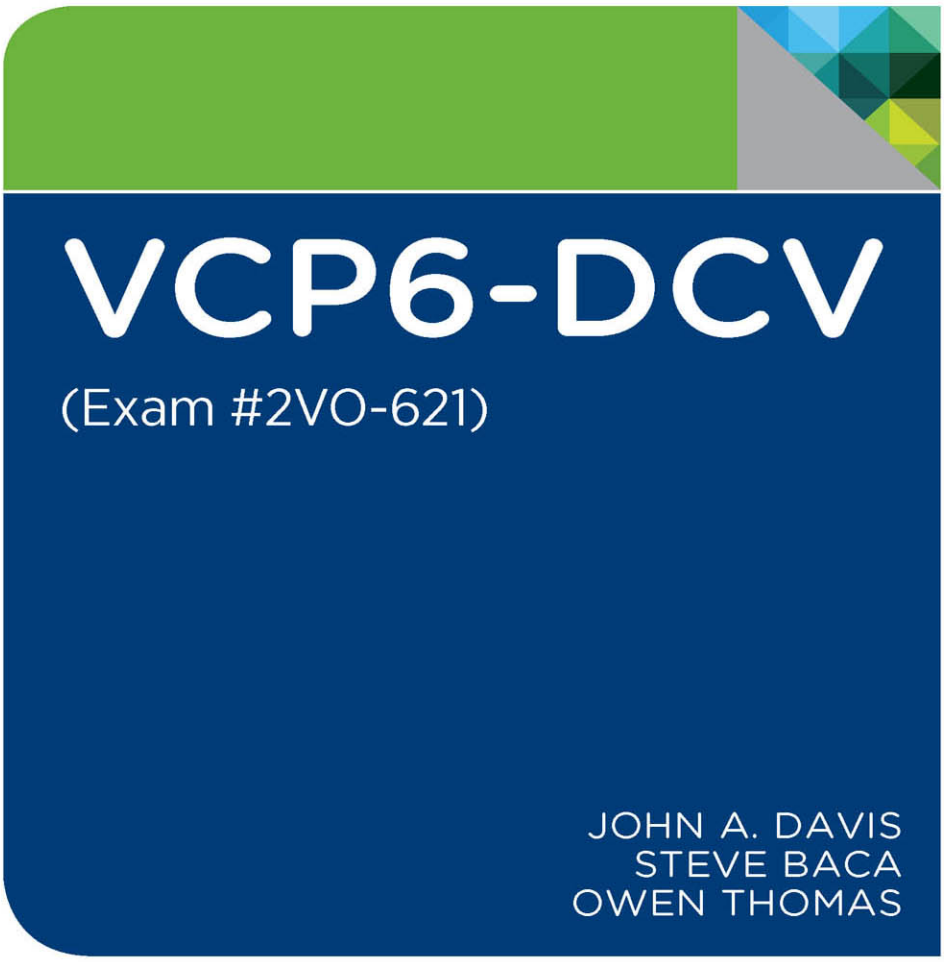

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Official Cert Guide
(Exam #2VO-621)

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VCP6-DCV Official Cert Guide

(Exam #2VO-621)

John A. Davis
Steve Baca
Owen Thomas

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VCP6-DCV Official Cert Guide (Exam #2VO-621)

Published by Pearson Education, Inc.

Publishing as VMware Press

ISBN-10: 0-7897-5648-X

ISBN-13: 978-0-7897-5648-0

Library of Congress Control Number: 2016903596

First Printing: May 2016

Warning and Disclaimer

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Dedication

She came to us in such a whirl,

This precious little angel girl.

A fragile life, doctors would say,

Yet perfect to us in every way.

She changed us all from the very start.

Touching each and every heart.

God loves us all, I'll always believe.

He sent his angel of proof to you and me.

Everything I see, Everything I do,

Madison Hope I think of you.

You now see us clearly, that I know,

For God has brought his angel home.

Dedicated to my oldest granddaughter,
Madison Hope Stith,
03/20/2000 to 01/17/2012

—With Love, Grampy (John Davis)

First and foremost, I would like to dedicate this book to my loving wife, Sharyl. Without your support I would not be able to commit the time necessary to co-author a book. Thank you for believing in me and allowing me to have the time for my many endeavors. I would also like to dedicate this book to my children: Zachary, Brianna, Eileen, Susan, Keenan, and Maura. Also a shout-out to my dog, Baxter, who helps me clear my head on our 3:00 walks to the park and back.

—Steve Baca

I would like to dedicate this book to my wife, Angela, and our daughter, Emma Jean. You have been very patient with the amount of time it has taken me to write, rewrite, research, and make sure that I have been as thorough as possible in my contributions to this book. Thank you for putting up with my nerding out and delving deeper into the world of VMware through all these years.

—Owen Thomas

About the Authors

John A. Davis, now a product architect at Rackspace, became a VMware Certified Instructor (VCI) and VMware Certified Professional (VCP) in 2004. Since then, all of his work has been completely focused on VMware-based technologies. He has experience in teaching official VMware curriculum in five countries and delivering VMware professional services throughout the United States. Recently, his work has involved designing solutions based on vRealize Operations and Site Recovery Manager. He has authored several white papers and co-authored the *VCAP5-DCA Cert Guide* (VMware Press). He holds several advanced certifications, including VCAP5-DCA, VCAP5-DCD, VCAP5-DTD, VCAP5-CID, and VCIX-NV. He has been a vExpert since 2014. He is author of the vLoreBlog.com and can be found on Twitter @johnnyadavis.

Steve Baca, VCAP, VCI, VCP, and NCDA, has been in the computer industry for more than 20 years. Originally a computer programmer and a system administrator working on Unix and Windows systems, he migrated over to technical training and wrote a course for Sun Microsystems. After teaching various courses for Sun, he eventually transitioned to VMware about 8 years ago, doing technical training and consulting as well as teaching for NetApp. Currently he lives in Omaha, Nebraska, and does a number of worldwide engagements. He thoroughly enjoys teaching and writing and believes that the constant evolution of the computer industry requires continuously learning to stay ahead. Steve can be found on Twitter @scbaca1.

Owen Thomas, VCI Level 2, VCP-DCV, VCP-Cloud, VCP-DT, VCAP-DCA, has been teaching various VMware classes since 2008. His first major IT position was in an enterprise-level NOC in Louisville, Kentucky, where he started in 2000 as a backup operator and transitioned to the role of NOC analyst. As his experience increased, he was tasked with training new staff. Introduced to VMware as of version 2 and trained in VI3, he became a VMware Certified Instructor at the end of 2007. Since then, he has taught hundreds of VMware classes for open enrollment and onsite classes for customers. Owen is a VMware partner and solutions provider as well as a technical trainer and performs JumpStarts, Audits, HealthChecks, Capacity Planning, and P2V migrations for SMBs.

About the Reviewers

Dave Davis has spent his career carrying out expert management and engineering innovations for corporate leaders in the virtualization space. Over the past 12 years, he has gained extensive experience and knowledge in the IT industry, backed by a abroad range of in-depth professional certifications like VCAP-DCD 5, VCAP-DCA 5, VCP5-DCV, VCP6-DCV, Cisco CCNA, and MCSA/E, with hopes of obtaining the VCDX in data center virtualization. Dave recently received VMware's vExpert 2016 for his contributions at www.virtualizestuff.com, where he talks about various VMware topics and about his home lab configuration.

As a VMware subject matter expert, **Jordan Roth** currently designs and builds VMware's VCA, VCP, and VCAP certification exam curriculum. Jordan's passion for virtualization started in 2006, with the release of VMware GSX. Ever since then, he has been at the forefront of architecture design and implementation for small business, healthcare, financing, and classified/unclassified federal, state, and local government entities. Jordan is a VMware Certified Professional on vSphere versions 3, 4, 5, and 6 as well as a VMware Certified Sales Professional with specialization in server sprawl reduction.

Acknowledgments

I would like to thank my wife and best friend Delores, who supports my late-night writing and gives me reason to be happy every day.

I would like to thank my parents, Monica and Norman Davis, who ensured that I received a solid education and learned from their great work ethics. My siblings and I did not attend preschool or kindergarten; my Mom taught us to read.

Thank you to Charlie Hagerty, the president of New Age Technologies, for molding me into a strong instructor and consulting engineer.

I would like to thank my co-authors Steve Baca and Owen Thomas, who were great partners in this adventure. Thanks to our technical editors, Dave Davis and Jordan Roth, for their hard work and dedication. Special thanks to Mary Beth Ray (executive editor) and Ellie Bru (development editor) for coordinating everything and keeping this project moving in spite of all of our obstacles.

Finally, I would like to thank my granddaughter and grandson, Emma and Jaxon Rosebush. They put a lot of joy in Delores's and my lives. I know I will be able to stay focused to complete my day's work on time whenever I plan to spend the afternoon or weekend with them. All work and no play makes Grampy a dull boy.

—John Davis

There are so many people to acknowledge and thank for making this book possible. First, thanks to my wife and family for supporting me while writing this book. I would also like to thank my fellow co-authors John Davis and Owen Thomas, who spent many hours working on this book, and contributing to our bi-weekly conference call with Ellie and Mary Beth. Thank you to the production team and editors at VMware Press/Pearson Publishing, Ellie Bru and Mary Beth Ray, and the rest of the team at Pearson Publishing, who do a tremendous amount of work from the initial planning of the book to the final printing.

—Steve Baca

I want to thank my wife and daughter for letting me have the time to contribute to this book. I would also like to thank John Davis and Steve Baca for allowing me to tag along with them on this book. Despite the blueprint changing halfway through, I think it has been a positive experience. I'd like to thank John Davis for starting me down the path to not just VMware but instruction as well. Who knows where my life would have taken me had I not taken his class all of those years ago? Thank you to Mary Beth Ray and Ellie Bru for keeping us all on track. I want to finally thank VMware for being this amazing ever-growing thing that has captivated my imagination and managed to hold onto it in a way that no other technology has.

—Owen Thomas

Contents at a Glance

Contents

Introduction

This book focuses on one major goal: helping you prepare to pass the VCP6-DCV exam (2V0-621). You may find this book useful for other purposes, such as learning how to troubleshoot vSphere or as a tool to partially prepare for other exams, but primarily you should use this book to prepare for the 2V0-621 exam.

The rest of this introduction focuses on two topics: the 2V0-621 exam and a description of this book.

The VMware Certified Professional 6—Data Center Virtualization (VCP6-DCV) Exam

The VCP6-DCV Exam is the second exam that is required to achieve VCP6-DCV certification. The exam became available August 30, 2015. The primary objective of the VCP6-DCV exam is to demonstrate that you have mastered the skills to successfully install, deploy, scale, and manage the VMware vSphere 6 environments. The format of the exam is multiple-choice questions in a proctored environment.

Contents of the VCP6-DCV Exam

Every student who ever takes an exam wants to know what's on the exam. For all of its exams, VMware publishes a set of exam topics that give general guidance about what's on the exam.

You can find the exam topics at vmware.com. A good way to find the topics is to navigate to `www.vmware.com/certification` and look for the VCP6-DCV certification.

A big goal of this book is to make sure you are prepared for any topic you might encounter on the VCP6-DCV exam. Therefore, in addition to covering topics in the official recommended course list, this book covers topics not found in the list of courses.

Table I-1 lists the topics on the VCP6-DCV exam blueprint, with a reference to the chapter or chapters of this book that covers the topic.

Table I-1 VCP6-DCV Exam Topics and Chapter References

Exam Section/ Objective	Chapter Where Covered
Section 1: Configure and Administer vSphere 6.x Security	
Objective 1.1: Configure and Administer Role-based Access Control	Chapter 1
Objective 1.2: Secure ESXi, vCenter Server, and vSphere Virtual Machines	Chapter 1
Objective 1.3: Enable SSO and Active Directory Integration	Chapter 1
Section 2: Configure and Administer Advanced vSphere 6.x Networking	
Objective 2.1: Configure Advanced Policies/Features and Verify Network Virtualization Implementation	Chapter 2
Objective 2.2: Configure Network I/O Control (NIOC)	Chapter 3
Section 3: Configure and Administer Advanced vSphere 6.x Storage	
Objective 3.1: Manage vSphere Storage Virtualization	Chapter 4
Objective 3.2: Configure Software-defined Storage	Chapter 5
Objective 3.3: Configure vSphere Storage Multi-pathing and Failover	Chapter 5
Objective 3.4: Perform Advanced VMFS and NFS Configurations and Upgrades	Chapter 6
Objective 3.5: Setup and Configure Storage I/O Control	Chapter 6
Section 4: Upgrade a vSphere Deployment to 6.x	
Objective 4.1: Perform ESXi Host and Virtual Machine Upgrades	Chapter 7
Objective 4.2: Perform vCenter Server Upgrades	Chapter 7
Section 5: Administer and Manage vSphere 6.x Resources	
Objective 5.1: Configure Advanced/Multilevel Resource Pools	Chapter 8
Section 6: Backup and Recover a vSphere Deployment	
Objective 6.1: Configure and Administer a vSphere Backups/Restore/ Replication Solution	Chapter 9
Section 7: Troubleshoot a vSphere Deployment	
Objective 7.1: Troubleshoot vCenter Server, ESXi Hosts, and Virtual Machines	Chapter 10
Objective 7.2: Troubleshoot vSphere Storage and Network Issues	Chapter 11
Objective 7.3: Troubleshoot vSphere Upgrades	Chapter 11

Exam Section/ Objective	Chapter Where Covered
Objective 7.4: Troubleshoot and Monitor vSphere Performance	Chapter 12
Objective 7.5: Troubleshoot HA and DRS Configurations and Fault Tolerance	Chapter 13
Section 8: Deploy and Consolidate vSphere Data Center	
Objective 8.1: Deploy ESXi Hosts Using Autodeploy	Chapter 14
Objective 8.2: Customize Host Profile Settings	Chapter 14
Objective 8.3: Consolidate Physical Workloads using VMware Converter	Chapter 14
Section 9: Configure and Administer vSphere Availability Solutions	
Objective 9.1: Configure Advanced vSphere HA Features	Chapter 15
Objective 9.2: Configure Advanced vSphere DRS Features	Chapter 15
Section 10: Administer and Manage vSphere Virtual Machines	
Objective 10.1: Configure Advanced vSphere Virtual Machine Settings	Chapter 16
Objective 10.2: Create and Manage a Multi-site Content Library	Chapter 16
Objective 10.3: Configure and Maintain a vCloud Air Connection	Chapter 16

How to Take the VCP6-DCV Exam

At this time, VMware exclusively uses testing vendor Pearson Vue (www.vue.com) for delivery of all VMware career certification exams. See Chapter 17, "Final Preparation," for details on registering for the exam. Be sure to use the advice in Chapter 17 to finish your preparation prior to registering for the exam.

Who Should Take This Exam and Read This Book?

The VCP-DCV certification is the most popular certification at VMware, with more than 100,000 professionals certified around the world. This book is intended for anyone wanting to prepare for the 2V0-621 exam, which is a required exam for the certification. The audience includes IT professionals who use VMware for

virtualization. This book will help prepare you for the exam by explaining the objectives listed in the exam blueprint.

Candidates who are preparing for the VCP6-DCV exam fall into two categories: those who currently hold a VMware Certified Professional (VCP) certification and those who are new to VMware certification (or hold only expired VCP certifications). New candidates are required to take a qualifying course and pass the vSphere 6 Foundation Exam. Candidates who are holders of current VCP certification in any track (data center virtualization, desktop/mobility, cloud management or networking) and new candidates who already passed the vSphere 6 Foundation Exam are good candidates to take the VCP6-DCV exam and are the expected readers of this book.

Format of the VMware Certified Professional 6—Data Center Virtualization Exam

The VCP6-DCV exam follows the same general format as the other VMware exams. When you get to the testing center and check in, the proctor will give you some general instructions and then take you into a quiet room with a PC. When you're at the PC, you have a few things to do before the timer starts on your exam; for example, you can take a sample quiz to get accustomed to the PC and to the testing engine. Anyone who has user-level skills in getting around a PC should have no problems with the testing environment.

As mentioned previously, the exam is composed purely of multiple-choice questions, where each question either requires you to select a single choice or a specified number of choices from a list of provided choices. See Chapter 17 for more information on the exam and advice on taking it, such as good time management.

Book Features and Exam Preparation Methods

This book uses several key methodologies to help you discover the exam topics on which you need more review, to help you fully understand and remember those details, and to help you prove to yourself that you have retained your knowledge of those topics. This book does not try to help you pass the exam only by memorization but by truly learning and understanding the topics.

The book includes many features that provide different ways to study so you can be ready for the exam. If you understand a topic when you read it but do not study

it any further, you probably will not be ready to pass the exam with confidence. The features included in this book give you tools that help you determine what you know, review what you know, better learn what you don't know, and be well prepared for the exam. These tools include:

- **"Do I Know This Already?" Quizzes:** Each chapter begins with a quiz that helps you determine the amount of time you need to spend studying that chapter.
- **Foundation Topics:** These are the core sections of each chapter. They explain the protocols, concepts, and configuration for the topics in that chapter.
- **Exam Preparation Tasks:** This section of each chapter lists a series of study activities that should be done after reading the "Foundation Topics" section. Each chapter includes the activities that make the most sense for studying the topics in that chapter. The activities include the following:
  - **Key Topics Review:** The Key Topic icon appears next to the most important items in the "Foundation Topics" section of the chapter. The "Key Topics Review" section lists the key topics from the chapter and their page numbers. Although the contents of the entire chapter could be on the exam, you should definitely know the information listed in each key topic. Review these topics carefully.
  - **Memory Tables:** To help you exercise your memory and memorize some important facts, memory tables are provided. The memory tables contain only portions of key tables provided previously in the chapter, enabling you to complete the table or list. Appendix B, "Memory Tables," provides the incomplete tables, and Appendix C, "Memory Tables Answer Key," includes the completed tables (answer keys). These appendixes are also provided on the Companion Website that is provided with your book.
  - **Definition of Key Terms:** The VCP6-DCV exam requires you to learn and know a lot of related terminology. This section lists some of the most important terms from the chapter and asks you to write a short definition and compare your answer to the Glossary.
- **Practice Exams:** The companion website contains an exam engine

Companion Website

Register this book to get access to the Pearson IT Certification test engine and other study materials plus additional bonus content. Check this site regularly for new and updated postings written by the authors that provide further insight into the more troublesome topics on the exam. Be sure to check the box that you would like to hear from us to receive updates and exclusive discounts on future editions of this product or related products.

To access this companion website, follow the steps below:

1. Go to www.pearsonITcertification.com/register and log in or create a new account.
2. Enter the ISBN: 9780789756480.
3. Answer the challenge question as proof of purchase.
4. Click on the "Access Bonus Content" link in the Registered Products section of your account page to be taken to the page where your downloadable content is available.

Please note that many of our companion content files can be very large, especially image and video files.

If you are unable to locate the files for this title by following the steps at left, please visit www.pearsonITcertification.com/contact and select the "Site Problems/ Comments" option. Our customer service representatives will assist you.

Pearson IT Certification Practice Test Engine and Questions

The companion website includes the Pearson IT Certification Practice Test engine—software that displays and grades a set of exam-realistic multiple-choice questions. Using the Pearson IT Certification Practice Test engine, you can either study by going through the questions in Study Mode, or take a simulated exam that mimics real exam conditions. You can also serve up questions in a Flash Card Mode, which will display just the question and no answers, challenging you to state the answer in your own words before checking the actual answers to verify your work.

The installation process requires two major steps: installing the software and then activating the exam. The website has a recent copy of the Pearson IT Certification Practice Test engine. The practice exam (the database of exam questions) is not on this site.

NOTE The cardboard case in the back of this book includes a piece of paper. The paper lists the activation code for the practice exam associated with this book. Do not lose the activation code. On the opposite side of the paper from the activation code is a unique, one-time-use coupon code for the purchase of the Premium Edition eBook and Practice Test.

Install the Software

The Pearson IT Certification Practice Test is a Windows-only desktop application. You can run it on a Mac using a Windows virtual machine, but it was built specifically for the PC platform. The minimum system requirements are as follows:

- Windows 10, Windows 8.1, or Windows 7
- Microsoft .NET Framework 4.0 Client
- Pentium-class 1GHz processor (or equivalent)
- 512MB RAM
- 650MB disk space plus 50MB for each downloaded practice exam
- Access to the Internet to register and download exam databases

The software installation process is routine as compared with other software installation processes. If you have already installed the Pearson IT Certification Practice Test software from another Pearson product, there is no need for you to reinstall the software. Simply launch the software on your desktop and proceed to activate the practice exam from this book by using the activation code included in the access code card sleeve in the back of the book.

The following steps outline the installation process:

1. Download the exam practice test engine from the companion site.
2. Respond to windows prompts as with any typical software installation process.

The installation process will give you the option to activate your exam with the activation code supplied on the paper in the cardboard sleeve. This process requires that you establish a Pearson website login. You need this login to activate the exam, so please do register when prompted. If you already have a Pearson website login, there is no need to register again. Just use your existing login.

Activate and Download the Practice Exam

After the exam engine is installed, you should then activate the exam associated with this book (if you did not do so during the installation process) as follows:

1. Start the Pearson IT Certification Practice Test software from the Windows Start menu or from your desktop shortcut icon.
2. To activate and download the exam associated with this book, from the My Products or Tools tab, click the **Activate Exam** button.
3. At the next screen, enter the activation key from paper inside the cardboard sleeve in the back of the book. Once entered, click the **Activate** button.
4. The activation process will download the practice exam. Click **Next**, and then click **Finish**.

When the activation process completes, the My Products tab should list your new exam. If you do not see the exam, make sure that you have selected the **My Products** tab on the menu. At this point, the software and practice exam are ready to use. Simply select the exam and click the **Open Exam** button.

To update a particular exam you have already activated and downloaded, display the **Tools** tab and click the **Update Products** button. Updating your exams will ensure that you have the latest changes and updates to the exam data.

If you want to check for updates to the Pearson Cert Practice Test exam engine software, display the **Tools** tab and click the **Update Application** button. You can then ensure that you are running the latest version of the software engine.

Activating Other Exams

The exam software installation process, and the registration process, only has to happen once. Then, for each new exam, only a few steps are required. For instance, if you buy another Pearson IT Certification Cert Guide, extract the activation code from the cardboard sleeve in the back of that book; you do not even need the exam engine at this point. From there, all you have to do is start the exam engine (if not still up and running) and perform Steps 2 through 4 from the previous list.

Assessing Exam Readiness

Exam candidates never really know whether they are adequately prepared for the exam until they have completed about 30 percent of the questions. At that point, if you are not prepared, it is too late. The best way to determine your readiness is to work through the "Do I Know This Already?" quizzes at the beginning of each

chapter and review the foundation and key topics presented in each chapter. It is best to work your way through the entire book unless you can complete each subject without having to do any research or look up any answers.

Premium Edition eBook and Practice Tests

This book also includes an exclusive offer for 70% off the Premium Edition eBook and Practice Tests edition of this title. Please see the coupon code included with the cardboard sleeve for information on how to purchase the Premium Edition.

Book Organization

This book contains 17 chapters, plus appendixes. The topics all focus in some way on VCP6-DCV, making the topics somewhat focused but with deep coverage on those topics:

- **Chapter 1: "Security:"** This chapter discusses the security-related topics covered in the exam.
- **Chapter 2: "Networking, Part 1:"** This chapter discusses advanced policies and features of network virtualization as well as verifying existing configurations.
- **Chapter 3: "Networking, Part 2:"** This chapter delves into Network I/O Control (NIOC) and the changes to NIOC in vSphere 6.
- **Chapter 4: "Storage, Part 1:"** This chapter provides details on how to set up and use NFS, iSCSI, FC, and FCoE protocols. This chapter also discusses how to set up and configure these protocols.
- **Chapter 5: "Storage, Part 2:"** This chapter discusses VMware's software-defined storage solutions Virtual SAN (VSAN) and Virtual Volumes (VVOL). In addition, there is a section on multipathing and failover using Pluggable Storage Architecture.
- **Chapter 6: "Storage, Part 3:"** This chapter takes a closer look at file systems such as VMFS and NFS. Both of these types of file systems have different properties that affect how a datastore interacts with an ESXi Host. There is also a section on how to set up and configure Storage I/O Control (SIOC) for prioritization of virtual machines.
- **Chapter 7: "Upgrade a vSphere Deployment to 6.x:"** This chapter provides the information needed to upgrade the vSphere environment. Upgrading vCenter Server, ESXi Hosts, and other parts of vSphere are discussed.

- **Chapter 8: "Resource Pools:"** This chapter explains the benefits of using resource pools and explores features and settings, as well as how to plan for properly utilizing them.
- **Chapter 9: "Backup and Recovery:"** This chapter discusses how to provide data protection for your virtual machines using VMware Data Protection and vSphere Replication.
- **Chapter 10: "Troubleshoot Common Issues:"** This chapter discusses how to troubleshoot common vSphere issues.
- **Chapter 11: "Troubleshoot Storage, Networks, and Upgrades:"** This chapter discusses how to troubleshoot storage, network, and upgrade issues in vSphere.
- **Chapter 12: "Troubleshoot Performance:"** This chapter discusses how to troubleshoot performance-related issues.
- **Chapter 13: "Troubleshoot Clusters:"** This chapter covers the various issues that can occur with HA and DRS clusters, as well as fault tolerance (FT) and the changes to FT in vSphere 6.
- **Chapter 14: "Deploy and Consolidate:"** This chapter looks at the many pieces involved in configuring a successful Auto Deploy environment, and the host profiles that make this possible. The chapter then discusses VMware Converter for virtualizing workloads.
- **Chapter 15: "Configure and Administer vSphere Availability Solutions:"** This chapter provides information on the features of high availability (HA). Admission control and advanced cluster features are discussed in this chapter. Distributed Resource Scheduler (DRS), which is a vSphere cluster used to provide load balancing and VM placement, is also discussed.
- **Chapter 16: "Virtual Machines:"** This chapter discusses advanced settings, content libraries, and vCloud Air connectors.
- **Chapter 17: "Final Preparation:"** This chapter provides advice from the authors for final preparation. It discusses how to get ready to take the exam and tips for taking the exam.

In addition to the core chapters of the book, the book has several appendixes. Some appendixes exist in the printed book, whereas others exist on the Companion Website included with the book.

The following appendixes are printed in the book:

- **Appendix A, "Answers to the 'Do I Know This Already?' Quizzes and Review Questions:"** This appendix includes the answers to all the questions from Chapters 1 through 16.

The following appendixes are included on the the Companion Website:

- **Appendix B, "Memory Tables:"** This appendix holds the key tables and lists from each chapter, with some of the content removed. You can print this appendix and, as a memory exercise, complete the tables and lists. The goal is to help you memorize facts that can be useful on the exams.
- **Appendix C, "Memory Tables Answer Key:"** This appendix contains the answer key for the exercises in Appendix B.
- **Appendix D, "Study Planner:"** This appendix contains a study table to help guide the study process.
- **Glossary:** The glossary contains definitions for all the terms listed in the "Define Key Terms" sections at the conclusions of Chapters 1–16.

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This chapter covers the following objective:

- **Objective 3.1—Manage vSphere Storage Virtualization**
  - Discover new storage LUNs
  - Configure FC/iSCSI/FCoE LUNs as ESXi boot devices
  - Create an NFS share for use with vSphere
  - Enable/configure/disable vCenter Server storage filters
  - Configure/edit software iSCSI initiator settings
  - Configure iSCSI port binding
  - Enable/configure/disable iSCSI CHAP
  - Determine use cases for Fibre Channel zoning
  - Compare and contrast array and virtual disk thin provisioning

Storage, Part 1

In this chapter we will begin the first of three chapters related to storage. In vSphere storage can be either a block-based Storage Area Network (SAN) or a file-based Network Attached Storage (NAS) device. This chapter will concentrate on the requirements and capabilities of storage devices. The SAN protocols that an administrator will need to know are Fibre Channel, Fibre Channel over Ethernet, and iSCSI. The NAS protocol that VMware supports is Network File System (NFS). These protocols can be enabled, modified, and deleted in different ways. In addition, there are properties and features that you will need to know for the exam.

"Do I Know This Already?" Quiz

The "Do I Know This Already?" quiz allows you to assess whether you should study this entire chapter or move quickly to the "Exam Preparation Tasks" section. Regardless, the authors recommend that you read the entire chapter at least once. Table 4-1 outlines the major headings in this chapter and the corresponding "Do I Know This Already?" quiz questions. You can find the answers in Appendix A, "Answers to the 'Do I Know This Already?' Quizzes and Review Questions."

Table 4-1 "Do I Know This Already?" Foundation Topics Section-to-Question Mapping

Foundations Topics Section	Questions Covered in This Section
Discover New Storage LUNs	1, 2
Configure FC/iSCSI/FCoE LUNs as ESXi Boot Devices	3
Create an NFS Share for Use with vSphere	4
Enable/Configure/Disable vCenter Server Storage Filters	5
Enable/Disable Software iSCSI Initiator	10
Configure iSCSI Port Binding	9
Enable/Configure/Disable iSCSI CHAP	6

Foundations Topics Section	Questions Covered in This Section
Determine Use Cases for Fibre Channel Zoning	7
Compare and Contrast Array and Virtual Disk Thin Provisioning	8

1. ESXi Host does not need a VMkernel port for which type of network adapter?
   a. ESXi Host always requires a VMkernel port for iSCSI.
   b. Software iSCSI initiator
   c. Dependent hardware iSCSI initiator
   d. Independent hardware iSCSI initiator

2. What is the best approach for discovering new storage LUNs.?
   a. You do not need to do anything; storage is automatically presented to the ESXi Host.
   b. To scan for new storage, select **Home** > **Hosts and Clusters** > **Datacenter** > right-click **Storage** > **Rescan Storage** > **OK**.
   c. After the ESXi Host boots up, select the **Scan for New Storage** button.
   d. Highlight the LUN, right-click, and select **Scan for New Storage**.

3. Which of the following is an incorrect statement?
   a. In order for Fibre Channel (FC) to boot from a SAN, the `/etc/vmware/fc.conf` file must designate the FC adapter as a boot controller.
   b. When you boot from a SAN, each ESXi Host must have exclusive access to its own boot LUN.
   c. With FCoE, during the ESXi boot process, the parameters to find the boot LUN over the network are loaded into the system memory.
   d. If you are using a dependent hardware iSCSI or software iSCSI initiator, you must have an iSCSI boot-capable network adapter that supports the iSCSI Boot Firmware Table (iBFT) format.

4. The virtual disks that are created on an NFS datastore are _____.
   a. in a format dictated by the NFS server
   b. thin provisioned
   c. thick eager-zeroed
   d. thick lazy-zeroed

5. vCenter Server uses storage filters to prevent LUN filtering corruption. If you need VMs to access the same LUN, then they must share the same RDM mapping file. To set up a SCSi-3 quorum disk for MSCS, which configuration parameter filter would you need to disable in the advanced settings of vSphere Client?
   a. `config.vpxd.filter.rdmFilter` set to `false`
   b. `config.vpxd.filter.vmfsFilter` set to `false`
   c. `config.vpxd.filter.rdmFilter` set to `true`
   d. `config.vpxd.filter.vmfsFilter` set to `true`

6. Which CHAP security level is not supported with Independent Hardware iSCSI?
   a. Do Not Use CHAP
   b. Use Unidirectional CHAP if Required by Target
   c. Use Unidirectional CHAP Unless Prohibited by Target
   d. Use Unidirectional CHAP

7. If you are following best practices, where should LUN masking be configured?
   a. On the ESXi Host
   b. On the switch
   c. On the storage array
   d. On vCenter Server
   e. LUN masking is not supported in vSphere 6

8. Which statement about thin provisioning is incorrect?
   a. When a thin virtual disk is created, it does not preallocate capacity and does not zero out the data block on the VMFS file system.
   b. When you use Storage vMotion, there is an option to enable thin provisioning on a storage array.
   c. When writes occur and more space is needed, the VMkernel grows storage for VMFS 1 MB at a time.
   d. If the file system is NFS, which is by default thin provisioned, it grows 4 KB at a time.

9. Which of the following statement about iSCSI port binding is incorrect?
   a. You need to associate a VMkernel port with a specific iSCSI adapter in order to configure iSCSI port binding.
   b. For multipathing purposes, it is best to have two active network adapters connected to one VMkernel port.
   c. The iSCSI initiator for an ESXi Host can be either hardware or software based.
   d. Best practices say to designate a separate network adapter for iSCSI; this is done for performance and security.

10. Which of the following statements about iSCSI initiators is incorrect?
   a. The steps to enable a software iSCSI initiator begin with browsing to the host using the vSphere Web Client. Click **Manage** > **Storage** > **Storage Adapters** > **Add**.> **Storage > Storage Adapters** > **Add**.
   b. You need to activate a minimum of two software iSCSI adapters on each host.
   c. If the iSCSI software adapter was used to boot the ESXi Host, it will be reenabled the next time the host boots.
   d. The steps to disable the software iSCSI initiator begin with browsing to the host using the vSphere Web Client. Click the **Manage** tab and then click **Storage**. Click **Storage Adapters** and then highlight the iSCSI software adapter that you want to disable.

Foundation Topics

Objective 3.1—Manage vSphere Storage Virtualization

This section provides details on how to set up and use storage area network (SAN) and network access server (NAS) storage in a virtualized environment. vSphere storage virtualization combines APIs and features built into vSphere, which abstracts the physical layer of storage into storage space that can be managed and utilized by virtual machines. A virtual machine (VM) uses a virtual disk or disks to store files that it needs to run an operating system and an application or applications. The files comprising a virtual machine are detailed in Chapter 16, "Virtual Machines." One of the files that encompass a VM is a virtual disk, which contains the data for the VM.

This chapter concentrates on SAN- and NAS-based storage. A SAN is a block-based storage protocol that makes data available over the Ethernet or Fibre Channel network, using the Fibre Channel, FCoE, or iSCSI protocols. On the other hand, a NAS is a file-based storage system that makes data available over an Ethernet network, using the Network File System (NFS) protocol. Both a SAN and a NAS are shared devices that connect to an ESXi Host through a network or storage adapter. Now let's discuss how to configure and manage these shared storage protocols.

Storage Protocols

Storage is a resource that vSphere uses to store virtual machines. Four main protocols can be used within vSphere: Fibre Channel (FC), Fibre Channel over Ethernet (FCoE), Internet Small Computer System Interface (iSCSI), and Network File System (NFS). These protocols can be used to connect the ESXi Host with a storage device.

Identify Storage Adapters and Devices

A storage adapter connects the ESXi Host and a storage SAN/NAS device. There are different adapters, and interaction is dependent on how much intelligence is built into the card. Some adapters have firmware or integrated circuitry on the card that can improve performance between the ESXi Host and the storage device. A VM resides on a storage device and needs a software driver to control communication with the ESXi Host. No matter which protocol you use, the VM residing on the storage device relies on a SCSI device driver to communicate to the ESXi Host. The VM uses a virtual SCSI controller to access the virtual disks of the virtual machine. One factor that determines which storage adapter to use is what protocol is being utilized for the communication between the ESXi Host and the storage device. Before we discuss each of the storage protocols, this chapter shows how to

find the storage adapters and devices within vSphere using the vSphere Web Client. Then it describes each of these protocols and identifies important characteristics to consider when using each of these options.

Key Topic

NOTE You cannot use IDE/ATA or USB drives to store virtual machines that are powered on in vSphere 6.

Display Storage Adapters for a Host

The procedure to display all of a host's storage adapters using the vSphere Web Client is to highlight the ESXi Host in the hosts and clusters inventory. Then click the **Manage** tab, click **Storage**, and select **Storage Adapters**. In Figure 4-1 you can see four adapters. The last listed adapter, `vmhba33`, is a software-based iSCSI initiator.

Key Topic

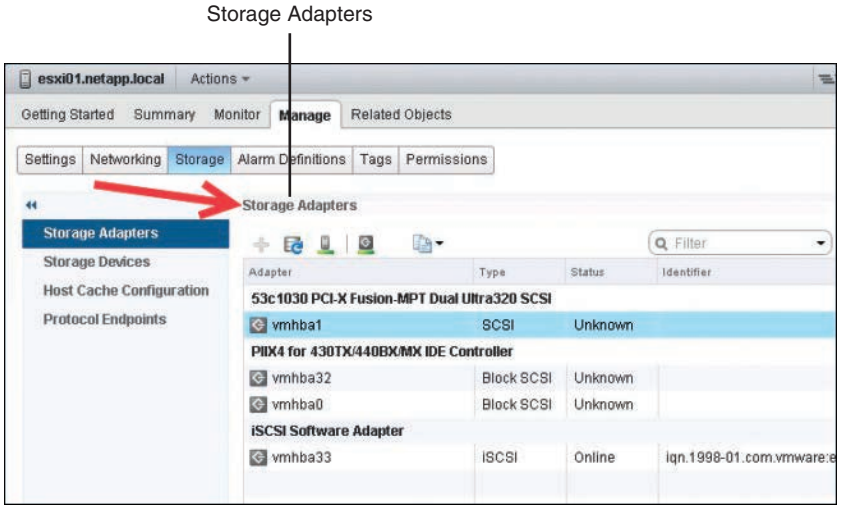

Figure 4-1 Storage Adapters

Storage Devices for an Adapter

Figure 4-1 shows connections between storage and the ESXi Host. You can have multiple storage devices reserved, and they can contain VMs. One method to distinguish one storage device from another is to use a logical unit number (LUN). A LUN is the identifier of a device that is being addressed by the SCSI protocol or similar protocols, such as Fibre Channel and iSCSI. The protocol may be used with any device that supports read/write operations, such as a tape drive, but the term is most often used to refer to a disk drive, and these terms are, in fact, often used synonymously. Tapes, CD-ROMs, and even scanners and printers can be connected to a SCSI bus and may therefore appear as LUNs.

Key Topic

NOTE The same LUN cannot be presented to an ESXi Host through different storage protocols, such as iSCSI and Fibre Channel.

A VMware VMDK (Virtual Machine Disk) becomes a LUN when it is mapped to a VM using the virtual SCSI adapter. *LUN* is one of the many terms that are used incorrectly most of the time. A SAN is structured just the same way as a traditional SCSI bus except that the old ribbon cable has been replaced with a network. This is why LUN masking is needed: SCSI is a master/slave architecture (initiator/target), and there is no authentication mechanism in the SCSI protocol to dictate which hosts can acquire a particular LUN; hence LUN masking "masks" (hides) LUNs from all hosts except the ones it is configured for.

The procedure to display a list of storage devices for a storage adapter on an ESXi Host is to highlight the ESXi Host in the hosts and clusters inventory. Then click the **Manage** tab, click **Storage**, and select **Storage Adapters**. Once you select the storage adapter, the storage devices that can be accessed through the adapter are displayed in the Adapter Details section by selecting **Devices**. In Figure 4-2, the iSCSI software adapter has been selected and is displaying three iSCSI LUN devices.

Key Topic

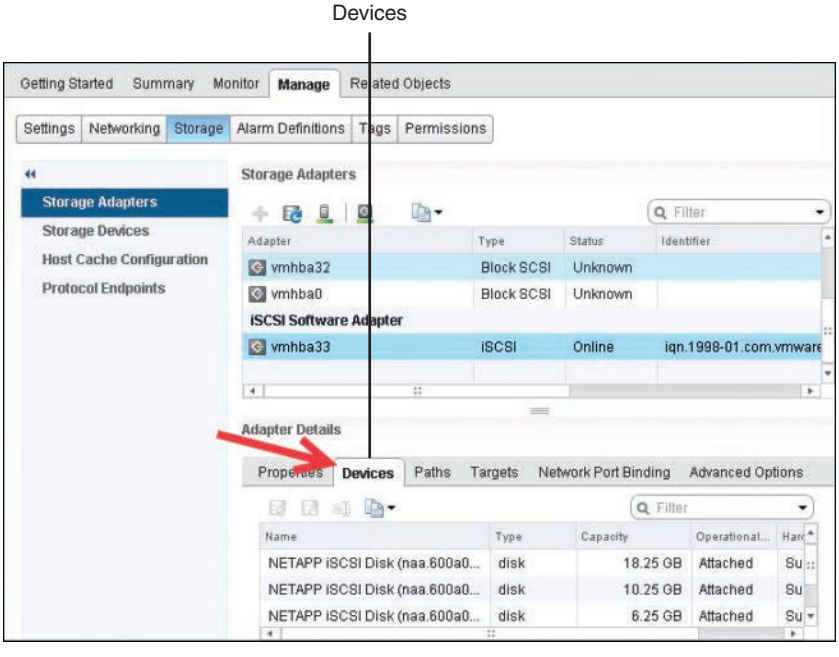

Figure 4-2 Available iSCSI LUNs

Fibre Channel Protocol

Fibre Channel (FC) is a transport layer that can be used to transmit data on a SAN. Many devices can communicate with each other on a SAN, such as switches, hubs, initiator HBAs, and storage adapters using the Fibre Channel Protocol (FCP). The protocol has been around since the mid-1980s, so it is a well understand topology, and it has been popular due to its excellent performance. Fibre Channel replaced Small Computer Systems Interface (SCSI) as the primary means of host-to-storage communication. In order to facilitate the compatibility, the FC frame encapsulates the SCSI protocol. Thus, FC is moving SCSI packets around its network.

The terms *initiator* and *target* were originally SCSI terms. FCP connects the actual initiator and target hardware, which must log into the fabric and be properly zoned (like VLANs) for storage discovery by the ESXi Host. The host operating system communicates via SCSI commands with the disk drives in a SAN. The cabling that FC uses can be either copper cables or optical cables. Using optical cables, the SCSI protocol is serialized (that is, the bits are converted from parallel to serial, one bit at a time) and transmitted as light pulses across the optical cable. Data runs at the speed of light, without the limitations of short-distance SCSI cables. Fibre Channel is like a SAN highway where other protocols such as SCSI and IP can drive.

Fibre Channel over Ethernet Protocol

The Fibre Channel over Ethernet (FCoE) is a protocol that takes a Fibre Channel (FC) packet and puts it over an Ethernet network of 10 Gbps or higher speeds. Each FC frame is encapsulated into an Ethernet frame with a one-to-one mapping. ESXi servers connect to a SAN fabric using host bus adapters (HBAs). Connectivity to FCoE fabrics is enabled through converged network adapters (CNAs). Each HBA/CNA can run as either an initiator (ESXi Host) or a target (storage array). Each adapter has a global unique address referred to as a World Wide Name (WWN). Each WWN must be known in order to configure LUN access on a NetApp storage array.

iSCSI Protocol

The Internet Small Computer System Interface (iSCSI) protocol provides access to storage devices over Ethernet-based TCP/IP networks. iSCSI enables data transfers by carrying SCSI commands over an IP network. Routers and switches can be used to extend the IP storage network to the wide area network—or even through the Internet with the use of tunneling protocols. The iSCSI protocol establishes communication sessions between initiators (clients) and targets (servers). The initiators are devices that request commands be executed. Targets are devices that carry out the commands. The structure used to communicate a command from an application

client to a device server is referred to as a *Command Descriptor Block* (*CDB*). The basic functions of the SCSI driver are to build SCSI CDBs from requests issued by the application and forward them to the iSCSI layer.

NFS Protocol

The Network File System (NFS) service lets you share files over a network between a storage device and an ESXi Host. The files are centrally located on the NFS server, which enables the NFS client access using a client/client architecture. The NFS server is the storage array, and it provides not only the data but also the file system. The NFS client is the ESXi Host, and the client code has been built into the VMkernel since 2002, running NFS version 3. Because the NFSv3 client is automatically loaded into the ESXi Host, it was the only version of NFS that VMware supported. What is new in vSphere 6.0 is that VMware reworked the source code to add support for both NFSv3 and NFSv4.1. NFS version 4.1 adds additional features that aid in interactions between the storage and the ESXi Host.

Authentication NFSv4.1 with Kerberos Authentication

NFSv4.1 supports both Kerberos and non-`root` user authentication. With NFSv3, remote files are accessed with `root` permissions, and servers have to be configured with the `no_root_squash` option to allow `root` access to files. This is known as an `AUTH_SYS` mechanism.

Native Multipathing and Session Trunking

The ability to add multiple IP addresses associated with a single NFS mount for redundancy is known as *session trunking*, or *multipathing*. In the server field, you add a comma to separate the IP addresses in a list to do load balancing or multipathing.

In-band, Mandatory, and Stateful Server-Side File Locking

In NFSv3 VMware does not use the standard lockd daemon because of how VMware's high availability conflicts with the standard server lock daemon. Thus, in NFSv3, VMware uses its own client-side locking mechanism for file locking. In NFSv4.1, VMware now uses the standard server-side lockd daemon.

NOTE vSphere 6.0 does not support pNFS (parallel NFS), which is a feature of NFSv4.1.

Identify Storage Naming Conventions

In the previous sections, you have learned that various protocols can be presented to vSphere. If you want to create a virtual machine, you need a place to store the virtual machine files, and thus you need a datastore. The naming convention is based on which protocol you use. In order to create a datastore, you need to ask the storage administrator to create either a LUN or an NFS server. If you are using local drives, iSCSI, or Fibre Channel, then the device naming begins with `vmhba`. If you are using NFS, the device naming includes the NFS export name. Each LUN or storage device can be identified by several names.

The procedure to display the storage paths using the vSphere Web Client is to highlight the ESXi Host in the hosts and clusters inventory. Then click the **Manage** tab, click **Storage**, and select **Storage Adapters**. Once you select the storage adapter, the storage devices that can be displayed through the adapter are displayed in the Adapter Details section when you select **Paths**. In Figure 4-3 the iSCSI software adapter is selected and showing three iSCSI LUN devices:

Key Topic

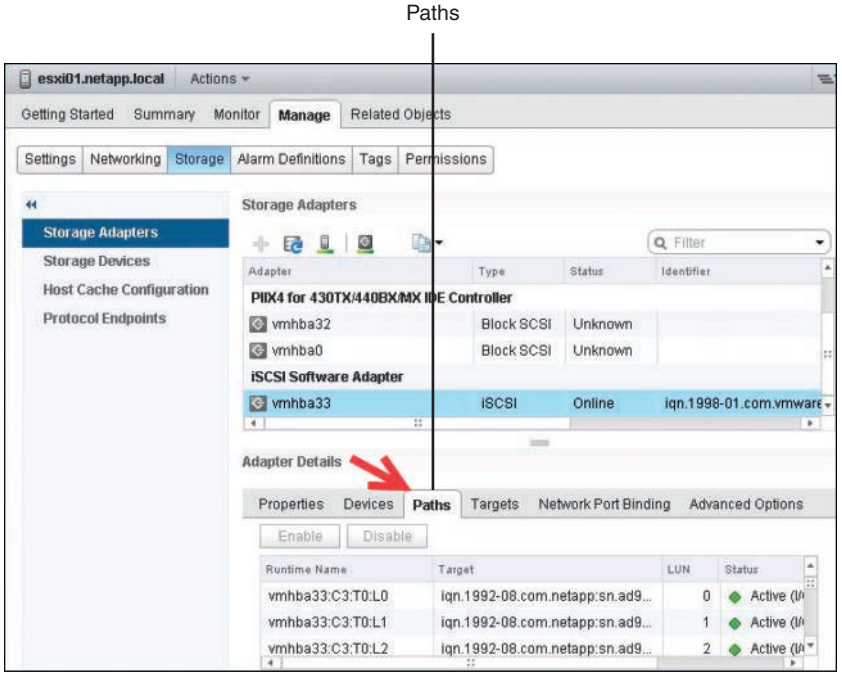

Figure 4-3 Displaying iSCSI LUN Paths

- **Runtime name:** `vmhbaAdapter:CChannel:TTarget:LLUN`
  - `vmhbaAdapter` is the name of the storage adapter. The name refers to the physical adapter on the host, not to the SCSI controller used by the virtual machine. In `vmhba` in Figure 4-3, `vm` refers to the VMkernel, and `hba` is the host bus adapter.
  - `CChannel` is the storage channel, if the adapter has multiple connections, the first channel is channel 0. Software iSCSI adapters and dependent hardware adapters use the channel number to show multiple paths to the same target.
  - `TTarget` is the target number. The target number might change if the mappings of targets visible to the host change or if the ESXi Host reboots.
  - `LLun` is the LUN, which shows the position of the LUN within the target. If a target has only one LUN, the LUN is always `0`.

    For example, `vmhba2:C0:T2:L3` would be LUN 3 on target 2, accessed through the storage adapter `vmhba2` and channel 0.
  - The target name shows the Network Address Authority (NAA) ID, which can appear in different formats, based on the device itself. In Figure 4-3, the target name is for a software-based iSCSI device that is using the `iqn` scheme.
- **LUN number:** This is the LUN for the device.

To display all device names using the CLI, type in the following command (see Figure 4-4):

```
# esxcli storage core device list
```

Key Topic

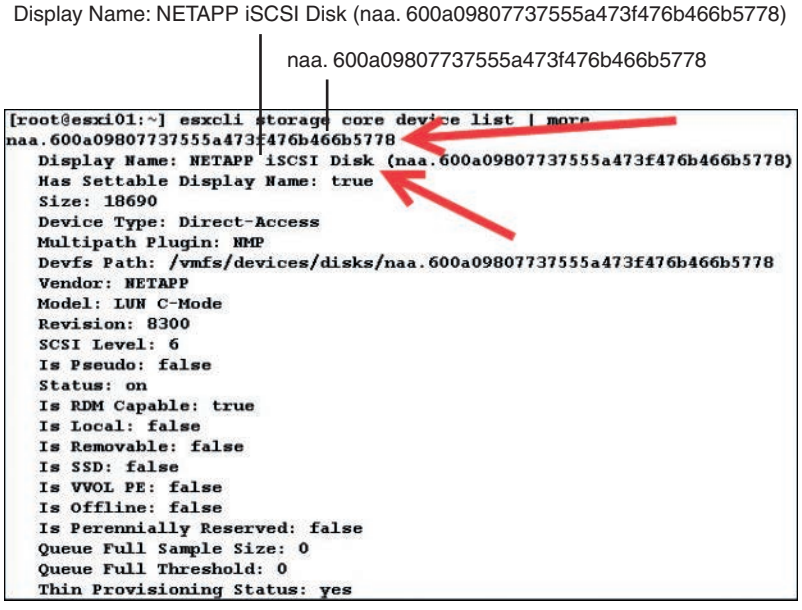

Figure 4-4 Use the CLI to Display Storage Device Information

Identify Hardware/Dependent Hardware/Software iSCSI Initiator Requirements

The ESXi Host uses the iSCSI protocol to access LUNs on the storage system and is the initiator over a standard Ethernet interface. The host needs a network adapter to send and receive the iSCSI packets over TCP/IP. There are three iSCSI initiator options available, as shown in Figure 4-5:

Key Topic

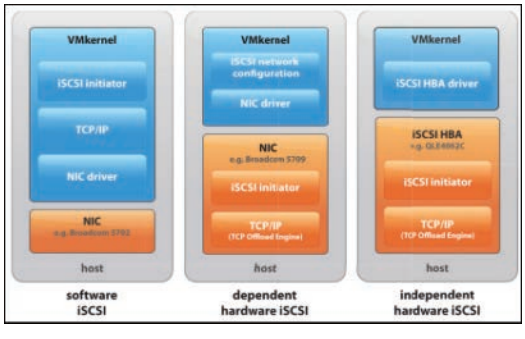

Figure 4-5 iSCSI Initiators

- **Software iSCSI initiator:** A software iSCSI initiator is a standard 1 GbE or 10 GbE NIC. There is nothing special about the network interface. A `Send Targets` command creates an iSCSI session between the initiator and the target on TCP port 3260. The VMkernel on the ESXi Host is responsible for discovering the LUNs by issuing the `Send Targets` request.
- **Dependent hardware iSCSI initiator:** A dependent hardware iSCSI initiator is a network interface card that has some built-in intelligence. It could be a chip or firmware, but either way, the card can "speak" iSCSI, which means the TCP offload function is on the card. However, not everything is done on the NIC; you must configure networking for the iSCSI traffic and bind the adapter to an appropriate VMkernel iSCSI port.
- **Independent hardware iSCSI initiator:** An independent hardware iSCSI initiator handles all network and iSCSI processing and management for the ESXi Host. For example, QLogic makes adapters that provide for the discovery of LUNs as well as the TCP offload engine (TOE). The ESXi Host does not need a VMkernel port for this type of card. This type of card is more expensive than the other types of NICs, but it also gets better performance.

Discover New Storage LUNs

When an ESXi Host boots up, it scans or sends a signal down its bus path, which discovers all the LUNs that are connected to the host. Then the host stops scanning for any new LUNs. I like to think of the host as being on siesta, taking a break from scanning for any new LUNs. While the host is on siesta, if the storage administrator presents any new LUNs to the ESXi Host, they will not be seen. So you need to wake up the ESXi Host by selecting Rescan Storage, as shown in Figure 4-6.

Key Topic

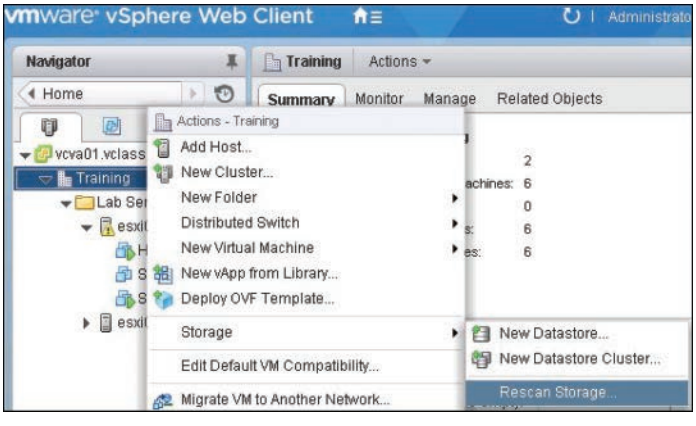

Figure 4-6 Rescan Storage

After you click **OK**, a new box pops up, with check boxes for **Scan for New Storage Devices** (to scan all host bus adapters looking for new LUNs) and **Scan for New VMFS Volumes** (to rescan all known storage devices for new VMFS volumes that have been added since the last scan).

Configure FC/iSCSI/FCoE LUNs as ESXi Boot Devices

You can set up your ESXi Host to boot from a FC or iSCSI LUN instead of booting from a local hard disk. The host's boot image is stored on the LUN that is being used exclusively for that ESXi Host. Thus, vSphere supports an ESXi Host's ability to boot from a LUN on a SAN. The ability of an ESXi Host to boot from a SAN is supported using FC and iSCSI. This capability does require that each host have unique access to its own LUN. You also need to enable the boot adapter in the host BIOS.

Key Topic

NOTE When you boot from a SAN, each host must have its own boot LUN.

FC

In order for a Fibre Channel (FC) device to boot from a SAN, the BIOS of the FC adapter must be configured with the World Wide Name (WWN) and LUN of the boot device. In addition, the system BIOS must designate the FC adapter as a boot controller.

iSCSI

It is possible to boot an ESXi Host using an independent hardware iSCSI, dependent hardware iSCSI, or software iSCSI initiator. If your ESXi Host uses an independent hardware iSCSI initiator, you need to configure the adapter to boot from the SAN. How you configure the adapter varies, depending on the vendor of the adapter.

If you are using a dependent hardware iSCSI or software iSCSI initiator, you must have an iSCSI boot-capable network adapter that supports the iSCSI Boot Firmware Table (iBFT) format. iBFT is a protocol defined in Advanced Configuration and Power Interface (ACPI) that defines parameters used to communicate between the storage adapter and the operating system. This is needed because the ESXi Host needs to load up enough information from the firmware to discover the iSCSI LUN over the network.

FCoE

You can boot an ESXi Host from a Fibre Channel over Ethernet (FCoE) network adapter. The FCoE initiator must support the FCoE Boot Firmware Table (FBFT) or FCoE Boot Parameter Table (FBPT). During the ESXi boot process, the parameters to find the boot LUN over the network are loaded into the system memory.

Create an NFS Share for Use with vSphere

The Network File System (NFS) is a client/server service that allows users to view, store, and modify files on a remote system as though they were on their own local computer. NFS allows systems of different architectures running different operating systems to access and share files across a network. The ESXi Host is the NFS client, while typically a SAN device such as EMC or NetApp acts as an NFS server. The NFS server shares the files, and the ESXi Host accesses the shared files over the network. How you create an NFS server and set up NFS shares depend on the system that is being used as the NFS server.

Enable/Configure/Disable vCenter Server Storage Filters

vCenter Server provides storage filters to avoid presenting storage that should be avoided due to performance problems or unsupported storage devices. The vSphere environment provides four storage filters that can affect the action of the vCenter Server when scanning storage. Without these filters, when vCenter Server is scanning for storage, all storage that is found could be presented to vSphere, even if it is in use. The filters prevent this type of unwanted activity. However, some specific use cases can affect what storage devices are found during scanning. By default, the storage filters are set to `true` and are designed to prevent specific storage datastore problems. Except in certain situations, it is best to leave the storage filters in their enabled state. Table 4-2 displays the vCenter Server storage filters and their respective Advanced Setting keys:

Table 4-2 vCenter Server Storage Filters

Filter	Advanced Setting Key
RDM	`config.vpxd.filter.rdmFilter`
VMFS	`config.vpxd.filter.vmfsFilter`
Host Rescan	`config.vpxd.filter.hostRescanFilter`
Same Host and Transports	`config.vpxd.filter.SameHostAndTransportsFilter`

Key Topic

- **RDM filter:** Filters out LUNs that have been claimed by any RDM on any ESXi Host managed by vCenter Server. This storage filter can be used in a situation such as when using Microsoft Cluster Server. When set to `false`, the filter is disabled, allowing a LUN to be added as an RDM, even though the LUN is already being utilized as an RDM by another VM. To set up a SCSI-3 quorum disk for MSCS, this storage filter needs to be disabled.
- **VMFS filter:** Filters out LUNs that have been claimed and VMFS formatted on any ESXi Host managed by vCenter Server. Thus, in the vSphere client, when you go to the Add Storage Wizard, you do not see any VMFS-formatted LUNs. If the setting is switched to `false`, the LUN is seen as available by the vSphere Client, and any ESXi Host could attempt to format it and claim it.
- **Host Rescan filter:** By default, when a VMFS volume is created, an automatic rescan occurs on all hosts connected to the vCenter Server. If the setting is switched to `false`, the automatic rescan is disabled when creating a VMFS datastore on another host. For example, you could run a PowerCLI `cmdlet` to add 100 datastores; you should wait until the `cmdlet` is finished before scanning all the hosts in the cluster.
- **Same Host and Transports filter:** Filters out LUNs that cannot be used as VMFS datastore extents due to host or storage incompatibility. If the setting is switched to `false`, an incompatible LUN could be added as an extent to an existing volume. An example of an incompatible LUN would be adding a LUN as an extent that is not seen by all of the hosts.

As an example, the Host Rescan filter could be set to `false` to stop an automatic rescan when you create a new datastore. Since you are going to run a PowerCLI `cmdlet` to add 100 datastores, you would want to turn this off until the `cmdlet` is finished running. Thus, after the 100 datastores are added, you could scan to discover all of the new storage. Figure 4-7 displays the vCenter Advanced Settings screen, which is where storage filters can be enabled. The steps to turn off the filter begin by using the vSphere Web Client navigator and starting at **Home** and selecting **Hosts and Clusters**. Then highlight your vCenter Server, click the **Manage** tab, and click **Settings**. To disable a filter, first add it by clicking **Advanced Settings** and then **Edit**. This opens the Edit Advanced vCenter Server Settings window. At the bottom of the window, in the **Key** box, type in the storage filter **config.vpxd.filter.hostRescanFilter** and add the Value **false** to enable the storage filter, as shown in Figure 4-7.

Key Topic

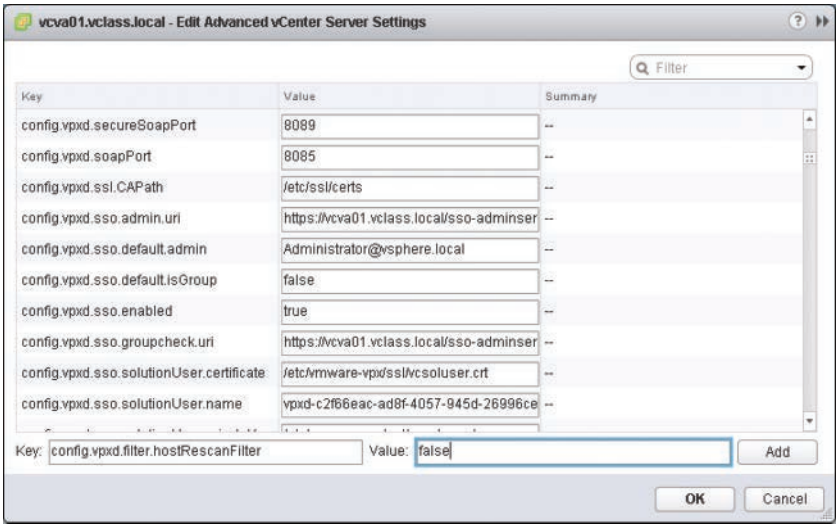

Figure 4-7 Enable a Storage Filter

iSCSI

vSphere provides support for several different methods of booting up using an iSCSI LUN. An independent hardware iSCSI adapter, such as a QLogic iSCSI HBA, first needs to boot from the VMware installation media, which loads an iSCSI HBA configuration menu. The HBA config menu allows you to configure host adapter settings.

In addition to the independent hardware adapter, the ESXi Host can boot from a software adapter or dependent hardware iSCSI adapter. The network adapter must support the iSCSI Boot Firmware Table (iBFT) format to deploy an ESXi Host from an iSCSI SAN. The iBFT allows for communicating parameters about the iSCSI boot device to an operating system.

Configure/Edit Hardware/Dependent Hardware Initiators

A hardware initiator or a dependent initiator is a network adapter that has either firmware or a chip built in to the adapter that speaks iSCSI. The network adapter can handle standard networking as well as the iSCSI offload engine. After you install the hardware initiator, it appears in the list of network adapters. However, you need to associate a VMkernel port with the adapter before you can configure the iSCSI settings.

Enable/Disable Software iSCSI Initiator

A software iSCSI initiator is a standard 1 GB or 10 GB network adapter. It is simply a supported adapter, but nothing on the physical card is designed with SCSI in mind. The network adapter relies on the VMkernel to handle discovery and sends the processing of encapsulation and de-encapsulation of network packets up to the kernel. You need to activate only one software iSCSI adapter on the ESXi Host.

Enable a Software iSCSI Initiator

The steps to enable the software iSCSI initiator begin with browsing to the host using the vSphere Web Client. Click the **Manage** tab and then click **Storage**. Click **Storage Adapters** and then click **Add**. As you can see in Figure 4-8, select **Software iSCSI Adapter** and confirm that you want to add the driver to your ESXi Host.

Key Topic

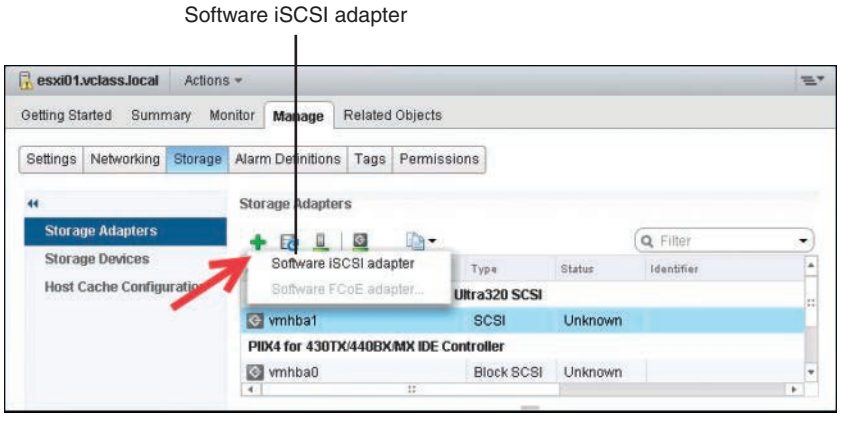

Figure 4-8 Enable a Software iSCSI Initiator

Disable a Software iSCSI Initiator

The steps to disable the software iSCSI initiator begin with browsing to the host using the vSphere Web Client. Click the **Manage** tab and then click **Storage**. Click **Storage Adapters** and then highlight the iSCSI software adapter that you want to disable. Underneath Storage Adapters is the Adapter Details section; click **Properties** and click the **Disable** button. Disabling the adapter marks it for removal, but the adapter is not removed until the next host reboot. Figure 4-9 shows the iSCSI initiator being disabled. After you reboot the host, the iSCSI adapter no longer appears in the list of storage adapters.

Key Topic

NOTE If the iSCSI software adapter was used to boot the ESXi Host, it is reenabled the next time the host boots.

Key Topic

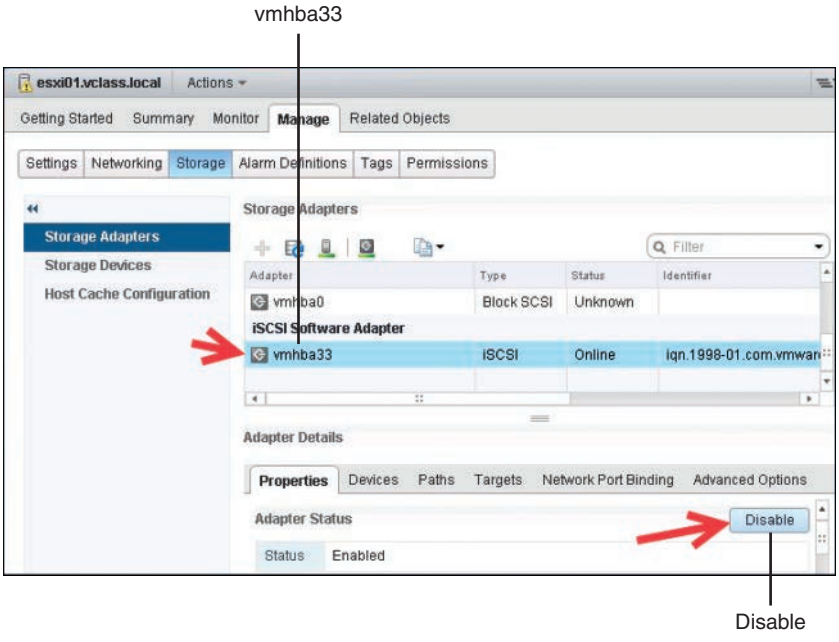

Figure 4-9 Disable a Software iSCSI Initiator

Configure/Edit Software iSCSI Initiator Settings

There are several different settings you can make on an iSCSI initiator. The settings can be configured in the Adapter Details section. One option is to enable and disable paths for the iSCSI adapter. Another option when you are editing an iSCSI initiator is to use dynamic or static discovery. With dynamic discovery, the iSCSI initiator sends a `Send Targets` request to the storage array, which returns a list of available targets to the initiator. The other option is to use static discovery, where you manually add targets. Also, you can set up CHAP authentication, which is discussed in an upcoming section of this chapter.

Determine Use Case for Hardware/Dependent Hardware/Software iSCSI Initiator

A good reason to use a software iSCSI initiator is that you do not need to purchase a specialized network adapter. You only need to buy a standard 1 GB or 10 GB network adapter. Another reason you might use a software initiator is that it is the only initiator that supports bidirectional CHAP.

The benefit of a dependent hardware iSCSI initiator is that part of the processing happens on the network adapter and part on the CPU. The adapter offloads iSCSI processing to the adapter, which speeds up processing of the iSCSI packets. It also reduces CPU overhead because only part of the processing of the iSCSI packets happens on the CPU, and part happens on the network adapter.

You use an independent hardware iSCSI initiator when performance is most important. This adapter handles all its own networking, iSCSI processing, and management of the interface.

Configure iSCSI Port Binding

For most implementations, iSCSI storage is connected to the ESXi Hosts and is used to host virtual machines. The ESXi Host is then considered to be the initiator because it is requesting the storage, and the iSCSI storage device is considered the target because it is delivering the storage. The initiator for the ESXi Host can be software or hardware based. A software iSCSI initiator is included and built in to the VMkernel. When using a software iSCSI initiator, a standard 1 GB or 10 GB network adapter is used for storage transport. You might have multiple network adapters, and iSCSI port binding enables you to specify the network interface that iSCSI can use.

NOTE iSCSI ports of the storage array must reside in the same broadcast domain and IP subnet as the VMkernel adapters.

A VMkernel port must be configured on the same network as the storage device to use the software iSCSI initiator. This is because you need to associate a VMkernel port with a specific iSCSI adapter in order to configure iSCSI port binding. The initiator uses the first network adapter port it finds that can see the storage device and use it exclusively for transport. This means that just having multiple adapter ports is not enough to balance storage workloads. However, you can achieve load balancing by configuring multiple VMkernel ports and binding them to multiple adapter ports.

After you load the software iSCSI kernel module, the next step is to bind the iSCSI driver to a port. There is a one-to-one relationship between the VMkernel port and the network adapter. This is a requirement for iSCSI port binding and multipathing. Only one port can be in the active state for a VMkernel adapter. Because only one port can be in the active state, you need to make sure that all other ports are set to Unused.

From the **Home** page, go to **Hosts and Clusters**. Select the ESXi Host in the inventory, click the **Manage** tab, and click the **Networking** tab. Choose the virtual switch that you want to use to bind the VMkernel port to a physical adapter. Next, choose the VMkernel adapter by highlighting the network label as shown in Figure 4-10 (step 1), which turns the VMkernel adapter blue. Then click the **Edit Settings** icon, shown as step 2 in Figure 4-10, which opens the Edit Settings window.

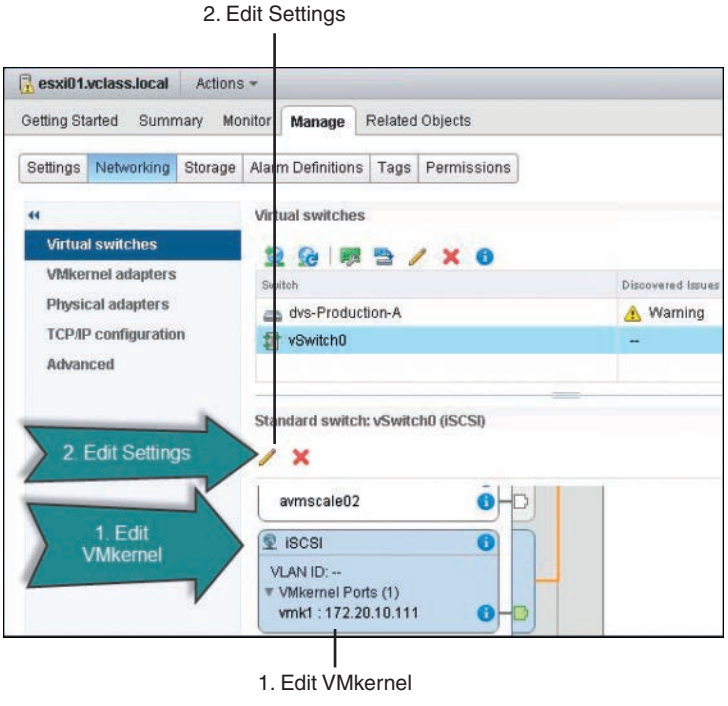

Figure 4-10 Select the VMkernel Port to Bind

The final step is to bind the VMkernel port to a network adapter. This can be accomplished by selecting the override switch failover order option, where one port is active and all of the other ports are set to the Unused state. The Edit Settings for the iSCSI VMkernel adapter then appear. To modify the vmnics, click **Teaming and Failover**. Select the check box for failover order **Override**. Then highlight all vmnics except for the one vmnic that will remain active. Move all other vmnics to Unused adapters using the blue down arrow. Then click **OK**.

NOTE Designate a separate network adapter for iSCSI for performance and security.

Enable/Configure/Disable iSCSI CHAP

There is an optional security feature you can enable for iSCSI, called Challenge Handshake Authentication Protocol (CHAP). CHAP is a method for authenticating the ESXi Host and a storage device using password authentication. The authentication can be either one-way (unidirectional CHAP) or two-way (bidirectional, or mutual, CHAP):

- **Unidirectional:** Also called one-way CHAP. The storage array or target authenticates the ESXi Host or initiator. With unidirectional CHAP, the ESXi Host does not authenticate the storage device. The ESXi Host authenticates by sending the CHAP secret to the storage target.
- **Bidirectional:** Also called mutual CHAP. Authentication is done both ways, and the secret is different in the two directions. vSphere supports this method for software and dependent hardware iSCSI adapters only.

CHAP is a three-way handshake used to authenticate the ESXi Host, and bidirectional CHAP also authenticates the storage array. The CHAP secret is nothing more than a password. For both software iSCSI and dependent hardware iSCSI initiators, ESXi also supports per-target CHAP authentication.

As shown in Figure 4-11, in order to enable and configure iSCSI CHAP on ESXi Host, begin at **Home** then **Hosts and Clusters** and select the host on which you want to configure CHAP. Then select **Manage**, click **Storage**, and then **Storage Adapters**. Highlight **iSCSI Software Adapter**, and in the Adapter Details section, select the **Properties** tab and click the **Edit** button for authentication to set up CHAP.

Key Topic

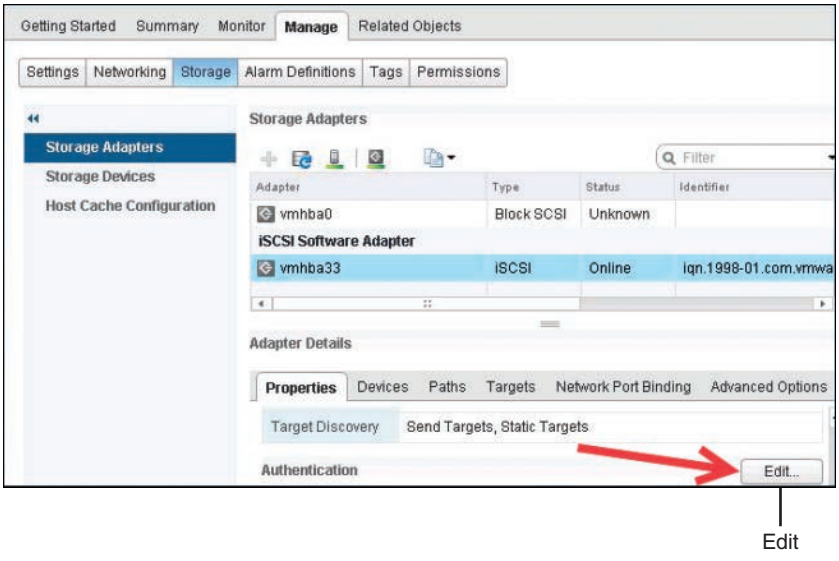

Figure 4-11 iSCSI CHAP's Edit Button

The CHAP authentication method needs to match the storage array's CHAP implementation and is vendor specific. You need to consult the storage array's documentation to help determine which CHAP security level is supported. When you set up the CHAP parameters, you need to specify which security level for CHAP should be utilized between the ESXi Host and the storage array. The different CHAP security levels, descriptions, and their corresponding supported adapters are listed in Table 4-3.

Table 4-3 CHAP Security Levels

CHAP Security Level	Description	Supported
None	CHAP authentication is not used. Select this option to disable authentication if it is currently enabled.	Software iSCSI Dependent hardware iSCSI Independent hardware iSCSI
Use Unidirectional CHAP if Required by Target	Host prefers non-CHAP connection but can use CHAP if required by the target.	Software iSCSI Dependent hardware iSCSI
Use Unidirectional CHAP Unless Prohibited by Target	Host prefers CHAP but can use non-CHAP if the target does not support CHAP.	Software iSCSI Dependent hardware iSCSI Independent hardware iSCSI

CHAP Security Level	Description	Supported
Use Unidirectional CHAP	Host requires CHAP authentication. The connection fails if CHAP negotiation fails.	Software iSCSI Dependent hardware iSCSI Independent hardware iSCSI
Use Bidirectional CHAP	Host and target both support bidirectional CHAP.	Software iSCSI Dependent hardware iSCSI

To configure CHAP, after selecting the **Properties** tab, click the **Edit** button to open up the Edit Authentication window, as shown in Figure 4-12. This is where you set up CHAP to authenticate. Keep in mind that CHAP does not encrypt anything; the communication between the initiator and target are in the clear. The CHAP name should not exceed 511 alphanumeric characters, and the CHAP secret should not exceed 255 alphanumeric characters. Also note that some hardware-based iSCSI initiators might have lower limits. For example, the QLogic adapter limits the CHAP name to 255 alphanumeric characters and the CHAP secret to 100 alphanumeric characters.

Key Topic

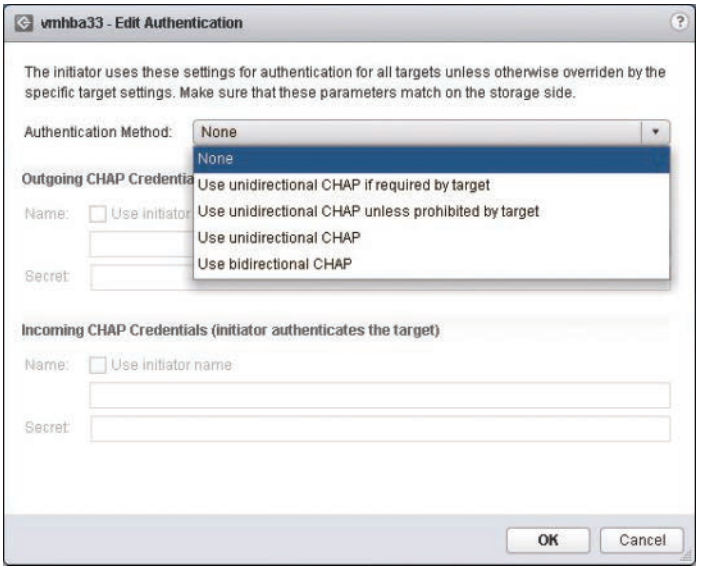

Figure 4-12 CHAP Setup Options

Determine Use Cases for Fibre Channel Zoning

One goal in storage is to make sure the host communicates with the correct storage and the storage communicates with the correct host. This can be challenging because many devices and nodes can be attached to a SAN. FC and FCoE switches use zoning and LUN masking to isolate communication between ESXi Hosts and storage devices. Zoning blocks communication between targets and initiators to isolate traffic to scan only devices that should be seeing each other. There are two kinds of zoning: hard zoning, which uses the physical switch port IDs, and soft zoning, which uses the WWPNs of the initiators and targets. Hardware and software zoning both attempt to reduce the number of targets and LUNs presented to the host. The best practice with LUN masking is to configure it on the storage array. The storage administrator configures which hosts have access to a LUN using masking. As a VMware best practice, LUN masking should be done on the ESXi Host using CLI but not in the vSphere client.

Compare and Contrast Array and Virtual Disk Thin Provisioning

Thin provisioning involves presenting more storage space to the hosts connecting to the storage system than is actually available on the storage system. For example, say that a storage system has usable capacity of 500 GB. The storage administrator then presents two hosts, each with a LUN of 300 GB. The mapping of these two LUNs means the storage array is presenting more storage to both hosts than is physically available on the storage array. When a LUN is created, the storage array does not dedicate specific blocks out of the volume for the LUN at the time of provisioning; rather, blocks are allocated when the data is actually written to the LUN. In this way, it is possible to provision more storage space, as seen from the connected ESXi Hosts, than actually physically exists in the storage array.

Array Thin Provisioning

ESXi supports thin-provisioned LUNs. *Array thin provisioning* simply means that the thin provisioning is done on the storage array, which reports the LUN's logical size instead of the real physical capacity of the LUN. When a LUN is thin provisioned, the storage array does not assign specific blocks for the LUN; instead, it waits until blocks are going to be written to zero out the data blocks and then performs the write. The storage array vendor uses its own file system and bookkeeping for the LUN, thus filling the LUN capacity on demand and saving storage space. By promising more storage space than the LUN actually has, you can overallocate storage. One built-in advantage that many storage array vendors have is the ability to grow the volume automatically when it is running out of space. Many storage vendors have automatic processes to grow the volume or delete certain file system constructs such as array-based snapshots.

Virtual Disk Thin Provisioning

When a thin virtual disk is created, it does not preallocate capacity, and it does not zero out the data block on the VMFS file system and the backend storage. Instead, the virtual disk consumes storage space only when data is required due to write to a disk. Initially, the VMDK's actual space usage starts out small and grows as more writes to disk occur. However, the guest OS sees the full allocated disk size at all times. The VMDK hides from the guest OS the fact that it is has not actually claimed all of the data blocks. The virtual machine's disk consumes only the amount of space that is needed for the current files in the file system. When writes occur and more space is needed, the VMkernel grows storage for VMFS 1 MB at a time. So as writes are committed and the 1 MB data block fills up, another 1 MB is allocated to the virtual disk. If the file system is NFS, which is by default thin provisioned, it grows 4 KB at a time, which is the size of its data block. Since the VMFS datastore is shared, SCSI locking needs to be performed by VMware vStorage API for Array Integration (VAAI). The metadata operation of SCSI locking is accomplished by VAAI.

To put array-based and virtual disk thin provisioning into perspective, the new data block or blocks need to be zeroed out when you are working with a virtual thin disk and new writes occur. However, before this operation can occur, the thin disk might have to obtain additional capacity from the datastore. Therefore, the storage array's math depends on how much space it has available compared to the ESXi Host. Thus, the thin provisioning is working at different levels.

Determine Use Case for and Configure Array Thin Provisioning

The ESXi Host can use storage arrays that present thin-provisioned storage. When a LUN is thin provisioned, it reports the logical size of the LUN and not its actual physical size. The storage array can promise more storage than its physical capacity. For example, an array may report that the LUN has 3 TB of space, when it really physically has 2 TB of disk space. The VMFS datastore is going to believe it has 3 TB of disk space that it can use. Thin provisioning is useful in virtual desktop environments where the system disk is shared among a number of users. You can save money by not having to reserve storage for each desktop's system disk. On the server side, thin provisioning can also be useful when you want to save money. However, be careful to monitor growth because running out of space with certain types of applications can be hazardous to your employment.

Key Topic

NOTE Array-based thin provisioning is dependent on the storage array itself. If the LUN becomes full, the storage array decides what action to take. It is most likely to go offline. ESXi does not support enabling and disabling of thin provisioning on a storage device.

Summary

You have now read the chapter covering exam topics on storage. You should use information in the following sections to complete your preparation for Objective 3.1.

Exam Preparation Tasks

Review All the Key Topics

Table 4-4 provides a reference to each of the key topics identified in this chapter. Take a few moments to review each of these specific items.

Table 4-4 Key Topics for Chapter 4

Key Topic Element	Description	Pages
Note	No IDE/ATA/USB support to store VMs	164
Figure 4-1	Displaying storage adapters	164
Note	LUN presentation	165
Figure 4-2	iSCSI LUNs that are available	165
Note	Parallel NFS not supported	167
Figure 4-3	Displaying iSCSI LUN paths	168
Figure 4-4	Using CLI to display storage device information	170
Figure 4-5	iSCSI initiators	170
Figure 4-6	Rescanning storage	171
Note	SAN booting, with each host having its own boot LUN	172
Bulleted list	vCenter Server storage filters	174
Figure 4-7	Enabling storage filter	175
Figure 4-8	Enabling a software iSCSI initiator	176
Note	iSCSI adapter reenabled after boot	177
Figure 4-9	Disabling software iSCSI initiator	177
Note	iSCSI ports in the same domain and subnet as adapters	178
Figure 4-10	Selecting the VMkernel port to bind	179
Note	Separate network adapter for iSCSI	179

Key Topic Element	Description	Pages
Figure 4-11	iSCSI CHAP's Edit button	181
Figure 4-12	CHAP setup options	182
Note	No support for modifying thin provisioning at a storage device	184

Complete the Tables and Lists from Memory

Print a copy of Appendix B, "Memory Tables" (found on the CD), or at least the section for this chapter, and complete the tables and lists from memory. Appendix C, "Memory Tables Answer Key," also on the CD, includes completed tables and lists to check your work.

Definitions of Key Terms

Define the following key terms from this chapter and check your answers in the glossary.

Small Computer Systems Interface (SCSI), Fibre Channel (FC), Fibre Channel over Ethernet (FCoE), Internet Small Computer System Interface (iSCSI), Network File System (NFS), Kerberos, Parallel NFS (pNFS), software iSCSI initiator, independent hardware iSCSI initiator, dependent hardware iSCSI initiator, vCenter Server storage filters, Challenge Handshake Authentication Protocol (CHAP)

Answer Review Questions

The answers to these review questions can be found in Appendix A.

1. Which device cannot appear as a LUN?
   a. Tape device
   b. iSCSI
   c. FC
   d. NFS

2. Which of the following statements is not correct?
   a. A CD-ROM can be connected to a SCSI bus and appear as a LUN.
   b. You do not need to configure networking for a dependent hardware iSCSI initiator.
   c. A software iSCSI initiator is a standard 1 GbE or 10 GbE NIC.
   d. The ESXi Host does not need a VMkernel port for an independent hardware iSCSI initiator.

3. What TCP port is the default iSCSI port?
   a. 3620
   b. 3720
   c. 3270
   d. 3260

4. Which NFS protocols are not supported in vSphere 6.0? (Choose two.)
   a. NFSv3
   b. NFSv4.0
   c. NFSv4.1
   d. pNFS

5. Which of the following statements about iSCSI is incorrect?
   a. CHAP is a method for authenticating the ESXi Host and a storage device using password authentication.
   b. CHAP is a required security feature for iSCSI.
   c. With unidirectional CHAP, the ESXi Host does not authenticate the storage device.
   d. vSphere supports bidirectional CHAP for software and dependent hardware iSCSI adapters only.

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