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VCP4

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Professional
VCP-410 Exam

Second Edition

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VCP4

**VMware Certified
Professional,
Second Edition**

Elias Khnaser

VCP4 Exam Cram: VMware Certified Professional, Second Edition

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Contents at a Glance

	Introduction	1
CHAPTER 1	Introducing vSphere 4	13
CHAPTER 2	Planning, Installing, and Configuring ESX/ESXi 4.1	31
CHAPTER 3	vNetworking Operations	59
CHAPTER 4	vStorage Operations	97
CHAPTER 5	Administration with vCenter	135
CHAPTER 6	Virtual Machine Operations	165
CHAPTER 7	vSphere Security and Web Access	199
CHAPTER 8	Managing vSphere Resources	213
CHAPTER 9	Monitoring vSphere Resources	239
CHAPTER 10	Backup and High Availability	255
	VCP4 Practice Exam	281
	Answers to VCP4 Practice Exam	299
APPENDIX A	Need to Know More?	317
	Glossary	319
	Index	327

Table of Contents

Introduction	1
About the VMware VCP Program	1
About the VCP Exam	2
Exam Topics	3
The Ideal VCP Candidate	7
How to Prepare for the Exam	9
How to Use This Book and CD	10
Chapter Format and Conventions	10
Additional Elements and CD	11
Onward, Through the Fog!	11
CHAPTER 1:	
Introducing vSphere 4	13
What Is Virtualization?	14
Why You Need Virtualization	15
Types of Virtualization	15
Cram Quiz	17
Cram Quiz Answers	17
Virtual Machine Overview	18
Simulation and Emulation	20
Virtual and Physical Machine Comparison	21
Why vSphere 4?	22
Cram Quiz	23
Cram Quiz Answers	23
vSphere 4 Suite	24
VMware View	26
VMware vCenter Site Recovery Manager (SRM)	26
VMware vCenter Lab Manager	27
What Is VMFS?	27
The VMkernel	27
The Service Console	28
The vSphere Client	28
Cram Quiz	29
Cram Quiz Answers	29

CHAPTER 2:

Planning, Installing, and Configuring ESX/ESXi 4.1	31
ESX 4.1 Minimum Hardware Requirements	32
Disk Partitioning ESX 4.1	34
Cram Quiz	37
Cram Quiz Answers	37
Installing ESX 4.1 and ESXi 4.1	38
Installing ESX 4.1 Using a CD-ROM	38
Installing ESXi 4.1	45
Cram Quiz	49
Cram Quiz Answers	49
ESX 4.1 Post-Installation Configurations	50
Accessing ESX Using the vSphere Client	51
Accessing ESX Using SSH	52
Modifying Service Console Memory Allocation	54
Configuring NTP Client on ESX Server	54
Troubleshooting ESX 4.1 Installation	55
Cram Quiz	58
Cram Quiz Answers	58

CHAPTER 3:

vNetworking Operations	59
What Are Virtual Switches?	60
Cram Quiz	63
Cram Quiz Answers	63
Comparing Physical and Virtual Switches	64
Cram Quiz	66
Cram Quiz Answers	66
Standard Virtual Switches (vSS) and Port Group Types	67
Types of Virtual Switches	68
Types of Virtual Switch Port Groups	70
Cram Quiz	74
Cram Quiz Answers	74
VLANs in Virtual Networking	75
Trunk Ports	76
802.1Q VLAN Tagging	77
Private VLANs	78
Cram Quiz	79
Cram Quiz Answers	79

Virtual Switch Policies	80
Virtual Switch Security	81
Traffic Shaping	83
Physical Switch VLAN	84
Port Blocking	84
NIC Teaming	84
Cram Quiz	88
Cram Quiz Answers	88
vNetwork Distributed Switches	89
Advantages of vDS	90
vDS Components and Architecture	90
Cram Quiz	92
Cram Quiz Answers	92
Networking Maximums	93
Cram Quiz	95
Cram Quiz Answers	95

CHAPTER 4:**vStorage Operations 97**

Storage in vSphere 4	98
Fiber Channel	100
FC SAN Architecture	102
Masking	103
Zoning	104
FC Addressing	104
Cram Quiz	107
Cram Quiz Answers	107
iSCSI	108
iSCSI Addressing	109
Software Initiator	110
Hardware Initiator	115
Cram Quiz	116
Cram Quiz Answers	116
Network Attached Storage	117
ESX Features on NFS Datastores	118
Configuring NFS Datastores	119
Cram Quiz	120
Cram Quiz Answers	120
Virtual Machine File System	121

Extending a VMFS	123
Growing a VMFS	124
Multipathing	124
Pluggable Storage Architecture	125
Cram Quiz	128
Cram Quiz Answers	128
Thin Provisioning	129
Thin Provisioning in vSphere 4	130
Thin	131
Thick (Zeroedthick)	132
Eagerzeroedthick	132
Cram Quiz	134
Cram Quiz Answers	134

CHAPTER 5:

Administration with vCenter 135

Planning and Installing vCenter	136
vCenter Blueprint	137
vCenter Preinstallation	139
vCenter Database Design	140
vCenter Installation	142
vCenter Licensing	145
Cram Quiz	149
Cram Quiz Answer	149
Designing a Functional vCenter Inventory	150
Folders	151
Datacenters	151
Clusters	152
Cram Quiz	153
Cram Quiz Answers	153
Administration with vCenter	154
Linked Mode	155
vSphere Client Tabs	155
Lockdown Mode	159
Plug-ins	160
Client Settings	160
vCenter Maximums	160
Cram Quiz	161
Cram Quiz Answers	161

vCenter Server Backup and High Availability	162
vCenter Heartbeat	162
Clustering vCenter	162
Cram Quiz	164
Cram Quiz Answers	164

CHAPTER 6:**Virtual Machine Operations 165**

Virtual Machine Defined	166
Virtual Hardware	167
Virtual Machine Files	169
Virtual Machine Maximums	170
Cram Quiz	171
Cram Quiz Answers	171
Creating a Virtual Machine	172
Installing a Guest Operating System	173
Understanding VMware Tools	178
Cram Quiz	179
Cram Quiz Answers	179
Understanding and Working with Templates	180
Creating Templates	181
Guest OS Customization	182
Deploying Virtual Machines	183
Cram Quiz	185
Cram Quiz Answers	185
Managing Virtual Machines, Virtual Appliances, and vApps	186
Cold Migration	187
What Are Snapshots?	187
Deploying Virtual Appliances	188
What Is VMware vApp?	188
Cram Quiz	190
Cram Quiz Answers	190
Advanced VM Operations	191
Using VMware vCenter Converter	192
Using vCenter Guided Consolidation	194
Cram Quiz	197
Cram Quiz Answers	197

CHAPTER 7:	
vSphere Security and Web Access	199
vSphere Security Model	200
Users, Roles, Privileges, and Permissions	201
Working with Roles	201
Assigning Permissions	203
vCenter Security	204
ESX Server Security	205
Cram Quiz	206
Cram Quiz Answers	206
Web Access	207
Web Access Minimum Requirements	209
Remote Console URL	209
Cram Quiz	211
Cram Quiz Answers	211
CHAPTER 8:	
Managing vSphere Resources	213
VM CPU and Memory Management	214
Using Resource Pools to Govern CPU/Memory Resources	217
Cram Quiz	219
Cram Quiz Answers	219
vMotion and Storage vMotion	220
vMotion	221
Storage vMotion	226
Cram Quiz	229
Cram Quiz Answers	229
Distributed Resource Scheduler	230
DRS Automation Process	231
DRS Cluster Validity	234
DRS Rules	234
VMware EVC	236
Cram Quiz	238
Cram Quiz Answers	238
CHAPTER 9:	
Monitoring vSphere Resources	239
Resource Optimization Concepts	240
Virtual CPU	241
Virtual Memory	242

Cram Quiz	246
Cram Quiz Answers	247
Monitoring Virtual Machines and Hosts	248
CPU	249
Memory	250
Disk	251
Network	251
Monitoring with Alarms.	251
Cram Quiz	254
Cram Quiz Answer	254

CHAPTER 10:

Backup and High Availability 255

Backup Scenarios	256
Virtual Machine Backup Options	256
Host Backup Options	257
VMware Consolidated Backup	257
Data Recovery	259
Cram Quiz	263
Cram Quiz Answers	263
High Availability	264
Virtual Machine Failure Monitoring	265
HA Configuration Prerequisites.	266
Service Console Redundancy	266
Host Failover Capacity Planning	268
Host Isolation	270
Virtual Machine Recovery Priority	272
MSCS Clustering	273
VMware Fault Tolerance	274
Cram Quiz	279
Cram Quiz Answers	280

VCP4 Practice Exam 281

Answers to VCP4 Practice Exam 299

APPENDIX A:

Need to Know More?. 317

Glossary 319

Index. 327

Preface

Virtualization is one of the hottest topics in the tech industry today. The leader in the virtualization space at the present time is without a doubt VMware with its virtual infrastructure offering. As VMware software began to take its place in the data center and demand respect in the industry, the need for a certification path became clear. Such a certification separates those who have studied the technology and can apply it at a professional level from those who have just installed it and started messing with it. I am a big believer that there is no alternative to studying a technology thoroughly. There is only so much you can learn from installing it and using it in only a few specific circumstances, because that exposes you only to limited features and obscures you from harnessing the full potential of the software by leveraging features you probably never knew existed. For this reason and many more, I am a strong believer that you should study the software, learn it, and then use it hands on as much as possible. It is by doing this that you truly master the software.

When you have studied and understand a software, taking a certification exam becomes relatively easy. For example, if you've thoroughly studied, you know that the maximum amount of physical memory that ESX/ESXi 4.1 supports is 1TB. However, someone who just installs the software and starts using it may not know this because the software installation does not require this knowledge at the time of installation.

This book aims to present the information you need to recap and reinforce your existing knowledge of VMware vSphere 4 and properly prepare you to confidently take the VCP-410 exam. The book is structured in a way to help you with your final exam preparation and contains enough information to make it a true test preparation book, but in a concise manner.

About the Author

Elias Khnaser is an author, speaker, and IT consultant specializing in Microsoft, Citrix, and VMware virtualization technologies. With more than 14 years of experience, Elias is one of the world's leading experts on virtualization and cloud computing and is a recipient of the VMware vExpert award.

Elias is the practice manager for virtualization and cloud computing at Artemis Technology and is well known for his ability to relate highly technical concepts to align IT with business needs.

Elias is a highly sought-after and top-rated speaker for live and recorded events. He is a frequent contributor to *Forbes* and *InformationWeek*. He has written hundreds of white papers and countless articles. Elias has authored and co-authored many books and computer-based training products for EliasKhnaser.com and TrainSignal.com.

Elias has designed and deployed some of the largest Citrix and VMware implementations in the world.

His other publications and accomplishments include

- ▶ VMware vSphere 4 Training DVD at EliasKhnaser.com (May 2010)
- ▶ *VCP VMware Certified Professional Exam Cram* by Que Publishing, ISBN: 0-7897-3805-8 (December 2008)
- ▶ VMware VI3: ESX Server 3.5 & Virtual Center 2.5 Training DVD at EliasKhnaser.com (April 2008)
- ▶ “VMware ESX Server 3.0 CBT” at EliasKhnaser.com
- ▶ “Citrix MetaFrame XP CBT” at CBTnuggets.com

He is the co-author of three published books:

- ▶ *Citrix CCA MetaFrame Presentation Server 3.0 and 4.0 (Exams 223/256)* (Exam Cram) by Que Publishing, ISBN: 9780789732460
- ▶ *MCSE Designing Security for a Windows Server 2003 Network: Exam 70-298 Study Guide and DVD Training System* by Syngress Publishing
- ▶ *Citrix MetaFrame XP Including Feature Release 1* by Syngress Publishing

He has been a contributing author at

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- ▶ InformationWeek.com
- ▶ Dabcc.com

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Dedication

*To Maya and Peter, my gorgeous niece and nephew,
for all the joys you bring to our family.*

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No book would ever come to fruition without the incredible work done by everyone behind the scenes, and as such, I must extend a huge thank you to all the people at Pearson for their amazing work. To Dave Dusthimer, associate publisher, for his immediate interest and excitement about this book, thank you for trusting me on this one. To Betsy Brown, acquisitions editor extraordinaire, thank you so much for your promptness and patience. I'm very thankful to have had you on this project (honestly, it's true!). You're a pleasure to work with. To Drew Cupp, development editor, I can only imagine what you had to put up with to get this done. I enjoyed working with you again and thank you for everything. To Tonya Simpson and Geneil Breeze, thanks for correcting my shoddy grammar, pointing out the obvious mistakes, and tirelessly ensuring that I'm actually saying what I think I'm saying. Special thanks to all the production staff who silently (at least silently from my perspective) work to put everything together. As always, it looks fantastic! And finally, thanks to the great work of our technical editors, Gabriele van Zanten and Brian Atkinson, who provided excellent insight, suggestions, and corrections to my work. Of course, any errors or omissions are strictly my doing. These guys can't be expected to find everything!

And special thanks to the friends and family who had to once again endure the pressures and pains of book writing. They'll get used to it someday....

Happy reading, and good luck!

We Want to Hear from You!

As the reader of this book, *you* are our most important critic and commentator. We value your opinion and want to know what we're doing right, what we could do better, what areas you'd like to see us publish in, and any other words of wisdom you're willing to pass our way.

As an associate publisher for Pearson IT Certification, I welcome your comments. You can email or write me directly to let me know what you did or didn't like about this book—as well as what we can do to make our books better.

Please note that I cannot help you with technical problems related to the topic of this book. We do have a User Services group, however, where I will forward specific technical questions related to the book.

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Introduction

Welcome to the *VCP4 Exam Cram*. The purpose of this book is to properly prepare you and equip you with the needed knowledge to successfully sit and pass the VCP-410 exam. This introduction provides a general overview of the VMware certification program and the exam and covers how this *Exam Cram* book will help you reach your goals of becoming certified.

This book, as with its predecessors in the *Exam Cram* family of certification books, concentrates on reinforcing your knowledge of the subject matter at hand and preparing you to sit the exam. That being said, this book will not teach you everything there is to know about the technology because this is not its primary purpose. As a late-stage exam preparation resource, it concentrates on testing and reinforcing your knowledge of material that is most likely to appear on the exam.

Although reading a book is an excellent way of learning, I strongly recommend that you take the knowledge you acquire from book learning and use it to install and configure VMware ESX/ESXi and vCenter. Hands-on experience is imperative not only to your successful completion of the exam, but also to your successful endeavors in properly implementing and maintaining a vSphere infrastructure.

About the VMware VCP Program

The VMware VCP program was designed to allow candidates to demonstrate their expertise with the software by completing certain requirements and passing an exam. The program is open to any individual who completes the requirements. There are many advantages to becoming VCP certified. For some, it is for career advancement; for others, it is to become VMware partners, and so on.

The requirements set forth by VMware on becoming a VCP are as follows:

- ▶ Attend a VMware authorized course. These instructor-led courses provide a great learning method and hands-on exposure to the product.
- ▶ Gain hands-on experience with the product.
- ▶ Sit and pass the VCP-410 exam to demonstrate your expertise on the matter.

VMware also provides various documents on its website that help you gain a better understanding of the topics that you will be challenged on during the exam. I would like to single out the vSphere 4 Exam blueprint as a great reference for the exam, located here: http://mylearn.vmware.com/lcms/mL_faq/2726/VCPonvSphere4ExamBlueprint.pdf.

About the VCP Exam

Attending a VMware-authorized training class is one of the requirements from VMware Education to become a VMware Certified Professional (VCP). After you have attended the VMware-authorized class and have completed your preparations for taking the exam, you need to register at a VMware testing center in your area. Currently, all VMware certification exams are administered by Pearson VUE. You can register online at <http://www.pearsonvue.com/vmware> or by calling 1-800-676-2797 in the United States and Canada. Outside the Americas, please consult the Pearson VUE website for contact information in your region of the world.

The VCP-410 exam costs \$175 USD and must be booked at least 24 hours in advance. You may reschedule your exam up to 24 hours before the date you intend on taking it. Cancellation may be subject to a fee, so please consult the Pearson VUE website for more details on the policy.

In the test room, the administrator logs you in to your exam, verifying that your user ID and exam number are correct. After you review the introduction information, the exam begins.

The VCP-410 VMware Certification exam has 75 questions, and native English speakers have 105 minutes to complete the exam. Non-English speakers have an additional 30 minutes, for a total of 135 minutes. The testing application is Windows based and presents a single question per screen. On the top right, you find the time and number of questions remaining.

Questions are typically multiple choice, and the difficulty level varies from question to question. You can expect the following:

- ▶ **Select the correct answer:** With these types of multiple-choice questions, you are asked to choose the one correct answer that most appropriately answers the given question. In some situations, different answers may be correct under slightly different configurations, so make sure you read the question carefully and answer it according to what is asked in the specific question.

- ▶ **Select all that apply (or don't apply):** These types of questions ask you to select all the answers listed that correctly apply to the question given. None of the answers to all of them may apply, so be sure to read these types of questions carefully. In many cases, subtle wording has been purposely used to trip up those who aren't paying attention. Partial credit is not given for these types of questions. Unless the correct answer is given, you receive no credit for the question.
- ▶ **True or false:** These types of questions present you with the option to agree with the statement in the question or refuse it. Read the question carefully and choose true or false.

When your test is scored, no added penalty is given for a wrong answer compared to giving no answer at all, so answering every question asked is worthwhile even if you are not sure and must guess. VMware has attempted to make the questions as fair as possible and to ensure that all questions have a single correct answer. Of course, mistakes do happen, and a “poor” question may find its way onto your test, presenting you with a poorly worded or ambiguous question that may not have a clearly correct answer. In this situation, the best thing to do is to answer the question to the best of your knowledge.

After you complete the exam, the testing software responds with your score and informs you whether you have passed or failed. The VCP-410 exam requires a minimum passing score of 75%.

If you don't pass the exam, the key point is not to become discouraged. We have all had days when things just didn't quite go as well as we had hoped. The best method in this situation is to return as soon as possible to the study process and brush up on your weak areas in preparation for another exam attempt. You can reschedule a new test through Pearson VUE as soon as available if you so choose. We recommend that you schedule time sooner rather than later so that material that you have already studied is still fresh in your mind. You are required to pay the full fee to take the test again.

Exam Topics

Table I.1 lists the exam topics covered in this book and indicates the chapter where each is covered.

TABLE I.1 Exam Cram VCP4 Exam Topics

Exam Topic	Chapter
VMkernel	1
Service Console (SC)	
vCenter Database Design	
vCenter Preinstallation	
Update Manager	
VMware Symmetric Multi-Processing (SMP)	
vMotion	
Distributed Resource Scheduler (DRS)	
Virtual Machine File System (VMFS)	
VMware Consolidated Backup (VCB)	
High Availability (HA)	
Encapsulation	
Simulation	
Emulation	
Storage vMotion	
ESX Disk Partitions	2
Windows & Linux Filesystems	
ESX/ESXi System Requirements	
Load Drivers	
Creating Datastores	
Lockdown Mode	
SSH Access	
vSphere Client Access	
Configure NTP Client	
Port Trunking	3
802.1Q VLAN Tagging	
vNetwork Distributed Switches	
Virtual Ports	
Virtual Port Groups	
VMDirectPath	
Internal vSwitch	
Single Adapter vSwitch	
Multiple Adapter vSwitch	
Standard Virtual Switches (vSS)	
Physical Switches	
VMkernel	

Exam Topic	Chapter
Service Console	
Virtual Machine	
vCenter Object	
dvPort Groups	
dvPorts	
Trunk Ports	
Private VLANs	
Traffic Shaping	
NIC Teaming	
Port Blocking	
vSwitch Maximum Ports	
vSwitch Connection Types	
Fiber Channel Architectural Components	4
Fiber Channel Addressing	
Internet Small Computer System Interface (iSCSI)	
iSCSI Addressing	
iSCSI Targets Discovery	
Pluggable Storage Architecture (PSA)	
Network File System (NFS)	
NFS Features on ESX	
Configuring NFS	
Multipathing	
Extending a VMFS	
VMFS Volume Growth	
Zoning	
Thin Provisioning in vSphere	
Types of Virtual Disks	
vCenter Blueprint	5
vCenter Database Design	
vCenter Preinstallation	
Datacenters	
Folders	
Clusters	
Sphere Client Tabs	
Lockdown Mode	
vCenter Maximums	
VMware vCenter High Availability	

TABLE I.1 **continued**

Exam Topic	Chapter
VMware vCenter Clustering	
VMware vCenter Heartbeat	
Cold Migrations	6
Snapshots	
Guided Consolidation	
Virtual Appliances	
vApps	
Templates	
Open Virtualization Format (OVF)	
VMware Tools	
Virtual Disk	
VMware Converter	
Capacity Planner	
Virtual Hardware	
Virtual Machine Files	
Virtual Machine Maximums	
Roles	7
Privileges	
Permissions	
vpxuser	
Web Access	
Virtual Machine Shortcut	
WebAccess Tasks	
WebAccess Requirements	
Resource Pools	8
Clusters	
Shares	
Limit	
Reservation	
Expandable Reservation	
vMotion	
Storage vMotion	
Eagerzeroed	
Distributed Resource Scheduler (DRS) Cluster	
VMware EVC	
Affinity Rules	

Exam Topic	Chapter
Hyper-Threading	9
Hardware Execution Context (HEC)	
Transparent Memory Page Sharing	
Balloon-driver	
Hypervisor Swap	
Memory Compression	
Alarms	
Virtual CPU	
Virtual Memory	
CPU	
Memory	
Disk	
VMware Consolidated Backup (VCB)	10
High Availability (HA)	
Admission Control	
Host Backup	
Cluster-in-a-Box	
Cluster-across-Boxes	
Physical-to-Virtual Cluster	
Fault Tolerance	
Data Recovery	
MSCS Clustering	
Host Isolation	

The Ideal VCP Candidate

Before you attempt to take the VCP-410 exam and try to become a VMware Certified Professional (VCP), it is imperative that you know considerable information about VMware vSphere 4 and all its suite components.

To complete the VCP certification, you have to be a well-rounded ESX/ESXi Server-aware individual. The VCP certification is meaningful and maps closely to the everyday virtualization work environment found in the real world. With that said, you will also likely find this particular exam quite challenging to complete successfully.

The exam requires you to have at least a base level of knowledge about the entire vSphere suite. You need to know how ESX/ESXi 4 networking works, including the concept of virtual networking within a virtual infrastructure. You need to be intimately familiar with storage in a vSphere environment, including what types of storage are supported and how to best configure this storage for optimal performance of the virtual machines. Backup is no small task in any environment, and knowing how to safeguard your VMs and recover them when necessary is crucial to VCP certification. Monitoring and resource management are other areas where you will be tested without a doubt. And all these text topics are certainly not to dismiss vCenter in all its intricacies.

Increasing numbers of people are becoming VCPs, so the goal is within reach. If you're willing to tackle the process seriously and do what it takes to obtain the necessary experience and knowledge, you can take—and pass—the exam involved in obtaining a VCP certification.

Just to give you some idea of what an ideal candidate is like, here is some relevant information about the background and experience such an individual should have:

- ▶ Training or significant on-the-job experience in network theory, concepts, and operations is helpful. This includes everything from networking media and transmission techniques through network operating systems, services, and applications.
- ▶ Experience with any UNIX operating system is a plus to any candidate. Because the Service Console operating system is Linux based, knowing Linux in particular or UNIX in general will help you navigate better and use common UNIX commands in daily tasks.
- ▶ Training or significant on-the-job experience in storage technologies including Fiber Channel and iSCSI is a huge plus, but this book covers these concepts to the extent they are tested on the VCP exam. However, knowledge of these technologies will make you more comfortable with the material.
- ▶ A thorough understanding of how to install operating systems is required because these virtual machines require an OS installation.

How to Prepare for the Exam

Preparing for the VCP exam, as with any other technical exam, requires that you dedicate time to both acquiring and studying material directly related to the VCP-410 exam. To pass this exam, you are expected to know the different components and technologies that make up the VMware vSphere 4 suite, which includes intimate knowledge of both ESX/ESXi 4.1 and vCenter 4.1.

Note

There is significant information to absorb and go through that is required for you to pass the VCP-410 exam. Therefore, if your plan is to study the night before or a few days before the exam, don't expect to be fully prepared on the day of the exam.

The following is a general list of material that can be helpful in preparing you for the VCP-410 exam:

- ▶ This *Exam Cram* book, which provides you with a concise and thorough review of the material considered vital to your exam-taking success. This book serves as a supplement to reinforce your knowledge of the technology.
- ▶ VMware vSphere 4 evaluation kits from VMware. By acquiring an evaluation of the software, installing it, and getting intimately familiar with it, you are training yourself hands on, and this knowledge is extremely valuable as you learn better as you do things. This step also takes you from the theoretical to the practical.
- ▶ VMware-authorized training course. The instructor-led four-day class enables you to focus your training on a mixture of lecture and hands-on labs. The instructor-led class is filled with valuable information and helpful labs and is sure to prime you for the VCP exam in addition to its being a requirement for fulfilling the VCP requirements.
- ▶ VMware vSphere 4 Training DVD from <http://www.eliaskhnaser.com> is a great way to learn, reinforce existing knowledge, or simply have handy as a reference any time you need it. The DVD is filled with information and goes beyond the VCP-410 requirements. It is a study-at-your-own-pace training course.

- ▶ Exam preparation tests from respectable vendors. Getting accustomed to the types of questions that are asked on the VCP exam is extremely helpful; you will find that VMware has some sample questions on its website. You may also find certification exam vendors that sell respectable preparation tests.
- ▶ VMware vSphere 4 documentation is an imperative part of your testing preparation. We would like to highlight the Configuration Maximums for vSphere 4 and 4.1, and the vSphere 4 Resource Management Guide, all of which are available via the vSphere 4 documentation page: http://www.vmware.com/support/pubs/vs_pages/vsp_pubs_esxi41_i_vc41.html.

How to Use This Book and CD

vSphere 4 is a large topic, and covering it in technical detail is an immense task. What we did in this book is laser focus on the topics and technical details that you need to know to pass the exam. This book should be used to reinforce your knowledge and help you prepare. The accompanying CD holds practice exams and a digital copy of the tear-out cram sheet available in the beginning of the book.

Chapter Format and Conventions

Every Exam Cram chapter follows a standard structure and contains graphical clues about important information. The structure of each chapter includes the following:

- ▶ **Opening topics list:** This defines the exam topics to be covered in the chapter.
- ▶ **Cram Saver questions:** At the beginning of each section is a quiz. Take the quiz to assess how well versed you are in that section's topics. From there, you can read the section or move on to the Exam Alerts and questions at the end.
- ▶ **Topical coverage:** The heart of the chapter. Explains the topics from a hands-on and a theory-based standpoint. This includes in-depth descriptions, tables, and figures that are geared to build your knowledge so that you can pass the exam.
- ▶ **Exam Alerts:** These are interspersed throughout the book. Watch out for them!

ExamAlert

This is what an Exam Alert looks like. Normally, an alert stresses concepts, terms, hardware, software, or activities that are likely to relate to one or more certification test questions.

- ▶ **Cram Quiz questions:** At the end of each section is a quiz. The Cram Quizzes, and ensuing explanations, gauge your knowledge of the subjects. If the answers to the questions don't come readily to you, consider reviewing the section.

Additional Elements and CD

Beyond the chapters, two more tools help you prepare for the exam:

- ▶ **Practice exams:** There are two practice exams, consisting of 75 questions each. One is located in the printed book, and the other is in the exam engine on the CD.
- ▶ **Cram Sheet:** The tear out Cram Sheet is located right in the beginning of the book. This is designed to jam some of the most important facts you need to know for the exam into one small sheet, allowing for easy memorization.

Onward, Through the Fog!

After you've assessed your readiness, undertaken the right background studies, obtained the hands-on experience that will help you understand the products and technologies at work, and reviewed the many sources of information to help you prepare for a test, you'll be ready to take a round of practice tests. When your scores come back positive enough to get you through the exam, you're ready to go after the real thing. If you follow this regimen, you'll know not only what you need to study, but also when you're ready to take the exam. Good luck!

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CHAPTER 8

Managing vSphere Resources

This chapter covers the following VCP exam topics:

- ▶ Resource Pools
- ▶ Clusters
- ▶ Shares
- ▶ Limit
- ▶ Reservation
- ▶ Expandable Reservation
- ▶ vMotion
- ▶ Storage vMotion
- ▶ Eagerzeroed
- ▶ Distributed Resource Scheduler (DRS) Cluster
- ▶ VMware EVC
- ▶ Affinity Rules

(For more information on the VCP exam topics, see “About the VCP Exam” in the introduction.)

Understanding resource management is the single most important component of designing and maintaining your virtual infrastructure. To properly identify how many virtual machines (VMs) you can load on your ESX/ESXi hosts, you must understand how resource management works. Furthermore, to plan for scalability and high availability, you must thoroughly understand resource management. This chapter covers resource management in a VMware Infrastructure 3 environment.

VM CPU and Memory Management

- ▶ **Limit**
- ▶ **Reservation**
- ▶ **Shares**
- ▶ **Resource Pools**
- ▶ **Clusters**
- ▶ **Expandable Reservation**

CramSaver

If you can correctly answer these questions before going through this section, save time by skimming the Exam Alerts in this section and then completing the Cram Quiz at the end of the section.

1. Which items are not settings that would affect a virtual machine's resource allocation? (Select all that apply.)
 - A.** Cycles
 - B.** Expandable
 - C.** Reservations
 - D.** Shares

2. When do CPU Shares kick in?
 - A.** They are on at all times to balance and regulate.
 - B.** When there is a shortage of resources.
 - C.** When you enable DRS.
 - D.** When you enable High Availability.

Answers

1. **A** and **B** are correct. Cycles and Expandable are not settings that you can use to control a virtual machine's resource allocation. Cycles is not valid, and Expandable is available only on resource pools. The three settings that affect a VM's resource allocation in terms of CPU and Memory are Shares, Reservations, and Limits; therefore, answers C and D are incorrect.
2. **B** is correct. CPU Shares only kick in when there is a shortage of resources. Shares enforce quality of service for VMs from a vCPU perspective. Answers A, C, and D are incorrect.

Understanding how virtual machines address their resources, particularly their CPU and memory resources, is extremely important. As Figure 8.1 illustrates, the three settings that control the VM's CPU and Memory resource management are as follows:

- ▶ *Limit* defines the maximum that a VM can consume in CPU (measured in megahertz, or MHz) and memory (measured in megabytes, or MB).
- ▶ *Reservation* is the minimum that a VM needs in terms of CPU and memory resources to be able to function properly.
- ▶ *Shares* identify the frequency and priority a VM has in terms of accessing time slices on the physical CPU and memory. All VMs are assigned shares. The more shares a VM is assigned, the more priority it has over physical resources.

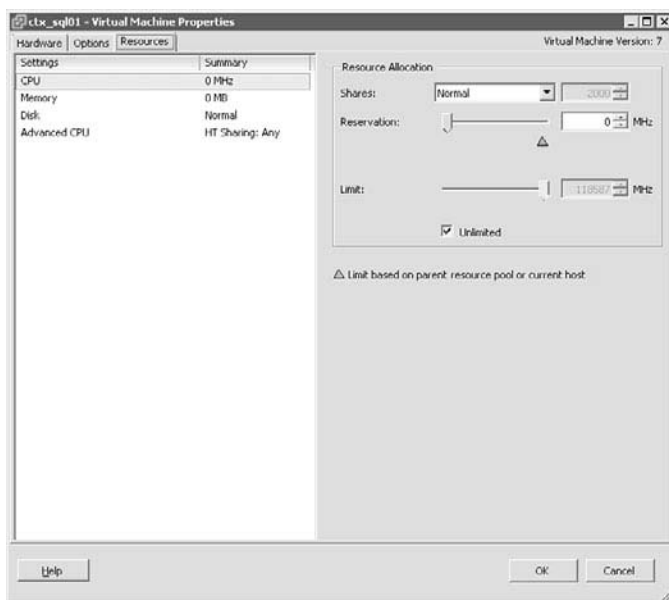


FIGURE 8.1 Virtual machine resource management.

A virtual machine's vCPUs are always scheduled at the same time. When you're assigning shares, keep in mind the number of vCPUs configured for any given VM. A reservation of 1,000 MHz might be adequate for a VM that has only one vCPU, but a VM of two vCPUs will have to divide these 1,000 MHz into 500 MHz per vCPU, and that might or might not be adequate depending on what this VM's function will be. Similarly, reservation of 1,000 MHz for a VM that has four vCPUs renders each vCPU with 250 MHz, which further diminishes the functionality of the VM.

ExamAlert

Shares are ignored when there is no resource contention. For example, two VMs with varying CPU share reservations get equal access to the host's CPU when there is no shortage of resources. Therefore, shares only kick in when there is a shortage of resources.

The Available Memory setting, which is a fourth setting option enabled only for the memory configuration of a VM, is the initial memory that you configure for a VM during its creation. You can always modify this option, after the VM is created. With this in mind, if the Available Memory and Reservation values differ, the VMkernel compensates for this discrepancy by creating a swap file for the difference between the two values. An example of this would be if the Available Memory setting is configured for 2GB and the reservation is set to 1GB; then the VMkernel creates a swap file to compensate for the difference.

Note

A virtual machine does not power on if its CPU and memory reservation is not met by the ESX/ESXi host it is running on.

When assigning shares to a virtual machine, you have four options: High, Normal, Low, and Custom. Table 8.1 outlines how these settings translate in number of shares for CPU and memory. The values in Table 8.1 are currently valid for resource pools; as for VMs, the values should read High=2000, Normal=1000, and Low=500.

TABLE 8.1 CPU/Resource Pools CPU and Memory Share Value Calculations

Share Setting	Number of CPU Shares	Number of Memory Shares
High	2000 * # of vCPUs	20 * Available memory
Normal	1000 * # of vCPUs	10 * Available memory
Low	500 * # of vCPUs	5 * Available memory
Custom	Manually specified	Manually specified

Using Resource Pools to Govern CPU/Memory Resources

A *resource pool* enables you to group virtual machines and apply the same resource policy on them. Resource pools can be created for a single ESX/ESXi host or to a *Distributed Resource Scheduler (DRS)* cluster to govern the CPU and memory resources. Grouping virtual machines also makes it easier to implement security and delegate administration to other users and groups. You should also know that you can create child resource pools and further compartmentalize VMs.

ExamAlert

Every ESX/ESXi host, by default, is a resource pool known as the Root Resource Pool. The Root Resource Pool exists prior to your creating any resource pools under this host.

Resource pools have the same settings as virtual machines; therefore, you can control a resource pool's CPU and memory shares, limits, and reservations. As Figure 8.2 illustrates, a resource pool has an additional *expandable reservation* option, which allows a child resource pool to tap into the parent resource pool and harness whatever resources are available to satisfy its own shortage. An expandable resource is used only when the resource pool cannot secure enough resources to satisfy its policy.

Tip

Use expandable reservation wisely because it can consume all the parent's resources.

You can view a resource pool's data using either of the following methods:

- ▶ Highlight the resource pool in the inventory and then select the Summary tab.
- ▶ Choose the Resource Allocation tab while the resource pool is selected in the inventory.

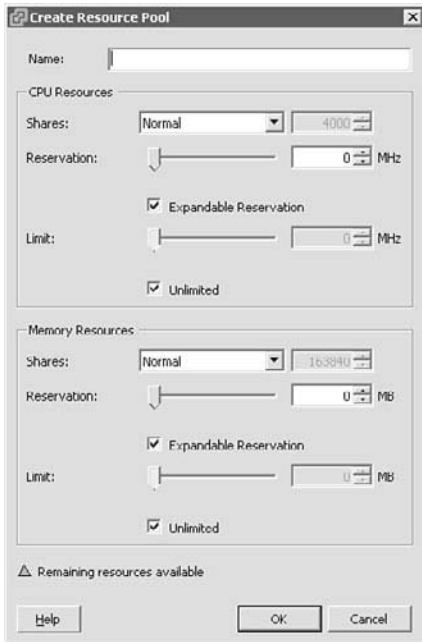


FIGURE 8.2 Resource pool properties.

Cram Quiz

Answer these questions. The answers follow the last question. If you cannot answer these questions correctly, consider reading the section again.

1. Which setting controls the maximum CPU time measured in MHz that a virtual machine is allowed to use?
 - A. Limit
 - B. Reservation
 - C. Shares
 - D. Affinity
2. True or false: If a virtual machine's available memory and its reservation memory setting differ, the VMkernel generates a VM-specific swap file for the difference between the two settings.
 - A. True
 - B. False
3. What is the name given to the topmost resource pool?
 - A. Resource Pool
 - B. Default Resource Pool
 - C. Root Resource Pool
 - D. Master Resource Pool
4. True or false: Resource pools can be used with a standalone ESX/ESXi host or a DRS cluster.
 - A. True
 - B. False

Cram Quiz Answers

1. **A** is correct. Limit is the setting that controls the maximum a CPU can use measured in MHz; therefore, answers B, C, and D are incorrect.
 2. **A**, True, is correct. When the Available Memory and the Memory Reservation settings differ, the VMkernel generates a swap file for the difference.
 3. **C** is correct. The Root Resource Pool is the name given to the topmost resource pool; therefore, answers A, B, and D are incorrect.
 4. **A**, True, is correct. Resource Pools can be created for a single ESX/ESXi host or for a DRS cluster.
-

vMotion and Storage vMotion

- ▶ vMotion
- ▶ Storage vMotion
- ▶ Eagerzeroed

CramSaver

If you can correctly answer these questions before going through this section, save time by skimming the Exam Alerts in this section and then completing the Cram Quiz at the end of the section.

1. Which of the following is not a requirement of the source and destination host for vMotion to work properly?
 - A. Gigabit Ethernet
 - B. Virtual switches that are configured and labeled identically
 - C. Access to the same shared storage
 - D. Access to each host's Service Console

2. Which of the following circumstances will prevent the vMotion process from being successfully completed? (Choose two.)
 - A. CPUs with different multimedia instruments
 - B. CPUs with different numbers of cores
 - C. CPU of different manufacturers
 - D. If Hyperthreading is enabled on one of the hosts

Answers

1. **D** is correct. Access to each host's service console is not a requirement for the successful vMotion process; therefore, answers A, B, and C are incorrect.
2. **A** and **C** are correct. The vMotion process will not successfully complete if you are trying to vMotion across CPUs from Intel and AMD for example. The process will also fail if the multimedia instruments on the CPUs differ.

vMotion is probably the most popular and most sought after feature in the VMware infrastructure suite. The vMotion feature allows a running virtual machine to be migrated without interruption from one host to another, provided that some prerequisites are met on the originating and destination hosts.

Storage vMotion, on the other hand, allows you to migrate a VM's data files from one storage location to another without interruption. The vMotion suite collectively allows you to control a VM's host placement and its data file placement at any time for performance or organization purposes without downtime.

vMotion

vMotion is an enterprise-level feature and thereby requires vCenter before it can be enabled. vMotion, as you see later in the section “Distributed Resource Scheduler,” is used in conjunction with DRS to make sure VMs are always spread out on the most appropriate host, thereby balancing the resource availability of these hosts.

vMotion Host Prerequisites

With vMotion, for the VM to successfully port from one host to another, the following requirements must be satisfied on the source and destination hosts:

- ▶ Access to all datastores on which the VM is configured
- ▶ Virtual switches that are labeled the same, so that when the VM is ported from one host to another, its configuration is the same and finds the same resources
- ▶ Access to the same physical networks for the VM to continue to function after being ported from one host to another
- ▶ Compatible CPUs
- ▶ Gigabit network connection

When you initiate a vMotion from one host to another, the wizard that starts the process warns you if there are errors that prevent the migration from completing successfully. The vMotion wizard also provides warnings that you take into account and possibly address after the migration is completed. Warnings do not prevent the vMotion process from completing successfully, whereas errors do. Table 8.2 outlines the different scenarios that might generate an error or a warning.

TABLE 8.2 vMotion Errors and Warnings

vMotion Errors	vMotion Warnings
A VM is connected to an internal vSwitch on the source host.	A VM is configured for an internal vSwitch but is not connected to it.
A VM has a removable disk such as a CD/DVD-ROM or floppy connected to it.	A VM is configured for a removable CD/DVD-ROM or floppy but is not connected to it.
A VM has CPU affinity assigned.	A VM has a snapshot. A heartbeat cannot be detected from the VM to be migrated.

Tip

If your ISO or FLP image files are mounted in a shared network location where all the ESX/ESXi hosts involved have access, you receive a warning only during vMotion. That's whether the virtual CD or floppy drive is connected.

Enabling vMotion

To enable vMotion, you need to create a VMkernel port group with vMotion enabled on all ESX/ESXi hosts that will participate in the vMotion process, as shown in Figure 8.3. The virtual switch where this port group is created should bear the same label on all ESX/ESXi hosts. Typically, vMotion is configured on a dedicated virtual switch on all ESX/ESXi hosts.

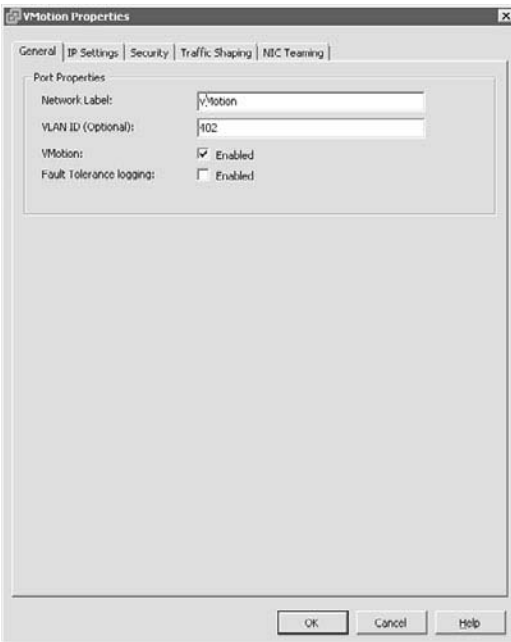


FIGURE 8.3 Port group with vMotion enabled.

vMotion also requires that the physical NIC that you choose to service the virtual switch where vMotion is enabled should be a Gigabit or higher.

vMotion CPU Requirements

One of the main obstacles to a successful vMotion migration is the CPU; vMotion requires a strict CPU approach, so keep the following guidelines in mind:

- ▶ vMotion does not work across CPU vendors, so if you have an ESX/ESXi host that is running an AMD processor and one that is running an Intel processor, vMotion errors out and does not work.
- ▶ vMotion does not work across CPU families, so you are not able to migrate between a Pentium III and a Pentium 4, for example.
- ▶ Hyperthreading, the number of CPU cores, and the CPU cache sizes are not relevant to vMotion.
- ▶ vMotion does not work across CPUs with different multimedia instructions—for example, a CPU with *Streaming SIMD Extensions 2* (SSE2) and a CPU with *Streaming SIMD Extensions 3* (SSE3).
- ▶ NX/XD hides or exposes advanced features in the CPU of an ESX Server. In most cases, this hidden feature is controlled by VMware for stability reasons (see Figure 8.4). In the event that the guest operating system requires it, however, the vSphere client exposes this feature in the properties of a VM. If it is enabled, the CPU characteristics of the host and destination must match; if disabled, an occurring mismatch is ignored and vMotion proceeds.

CPU vendors Intel and AMD now offer a technology known as *virtualization assist* that aids virtualization. Intel has its VT technology, and AMD has its AMD-V technology, both of which are enabled in the BIOS of a computer.

Note

Virtualization assist needs to be enabled before you can migrate 64-bit VMs from one host to another.

In the presence of these technologies, you can enable the VMs whose operating system supports the virtualization assist technology to improve their performance. To do this, you can right-click the VM in question and click Edit Settings. Click the Options tab, find the Paravirtualization section, and enable it. Figure 8.5 illustrates this process clearly.

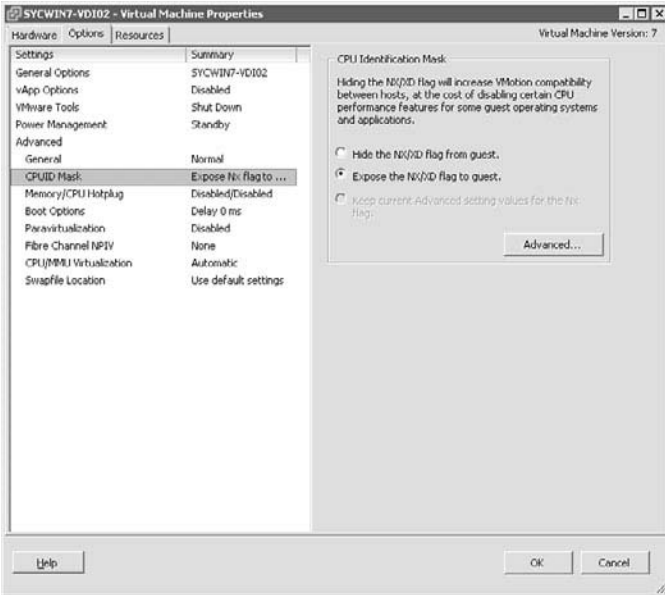


FIGURE 8.4 NX/XD feature exposed in vSphere client.

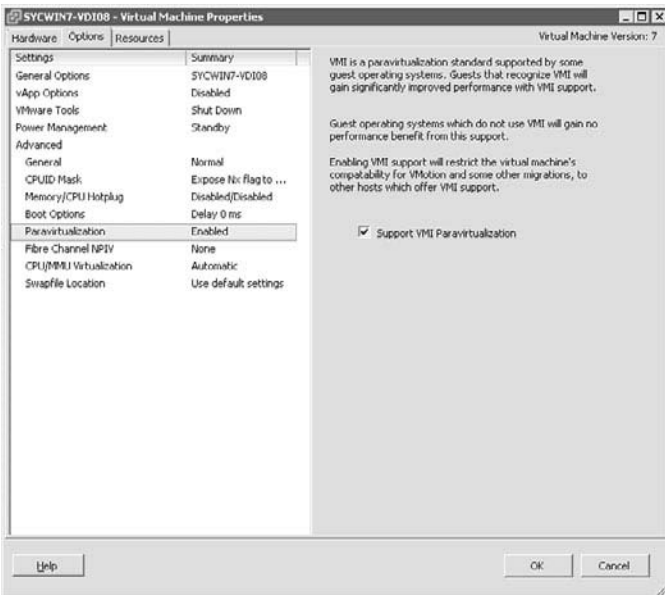


FIGURE 8.5 Enabling Paravirtualization.

The vMotion Stages

Because the virtual machine to be vMotioned resides on a datastore that is visible and accessible to both the source and the destination ESX/ESXi host, the only thing that vMotion needs to do is to copy the VM's memory from one host to another. Because the VM's memory resides on the physical memory of the source host, that memory is what needs to be copied. That being said, the two ways to initiate a vMotion are as follows:

- ▶ Select one or more VMs and then right-click and choose Migrate.
- ▶ Simply choose the Change host option.

When the vMotion process begins, the four stages that it goes through are as follows:

1. Once vMotion is initiated, a memory bitmap is created to track the changes, and the process of copying the physical RAM from one host to another begins.
2. Quiesce the VM and copy the contents of the memory bitmap. Quiesce can be defined in simpler terms as a cut-over. This is the only time at which the VM is unavailable. This is a short period of time that for the most part is transparent to the user.

ExamAlert

The Quiesce period is the only time during which the VM is not available, but the outage time is short, typically between 1/2 to 1 1/2 seconds. This time period is so transparent that you may lose a single ping in some cases.

3. The virtual machine on the destination host starts and moves all connectivity to it from the source host to the destination host.
4. The VM is removed from the source host.

During your monitoring of the vMotion process, you might notice that it pauses at 10% completion as part of the identification process.

Note

The speed at which vMotion completes its process depends on bandwidth availability and congestion on the vMotion network, as well as the size of the RAM dedicated to the VM being moved.

Storage vMotion

Storage vMotion is the process of migrating all the VM's files from one storage to another while the VM is powered on and without any interruption. Traditional vMotion moves the logical representation of a VM from one ESX/ESXi host to another while it is powered on while keeping the files that constitute this VM in the same storage space. Storage vMotion complements this by allowing you to move the VM files as well thereby contributing to a complete VM migration from one location to another without an interruption in service.

Storage vMotion was introduced in Virtual Infrastructure 3.5 but only at the command-line level; with vSphere 4, you can now do Storage vMotion from a GUI. To initiate a Storage vMotion from the GUI you follow the same steps as you would for a normal vMotion, which is to right-click a VM and select Migrate. The difference is the screen shown in Figure 8.6 has been completely changed with the following options:

- ▶ **Change Host:** This is obviously the traditional vMotion option, which moves the VM while it is powered on or off from one ESX/ESXi host to another.
- ▶ **Change Datastore:** This is the option to do a Storage vMotion thereby moving all the VM's files from one storage to another while the VM is powered on or off.
- ▶ **Change Both Host and Datastore:** As the name implies you can move both the VM and its corresponding files from one host to another with one catch, the VM has to be powered off.

Note

While the option to simultaneously move host and datastore cannot be done while the VM is powered on there is no reason why you cannot run these tasks consecutively thereby achieving the goal of migrating the VM and its files while it is powered on.

The next screen shown in Figure 8.7 prompts you to select the destination datastore where you want to move the files to. It is important to note that with vSphere 4 all protocols are now supported, which means, iSCSI, Fiber Channel, Fiber Channel over Ethernet (FCoE), NFS, and RDMS.

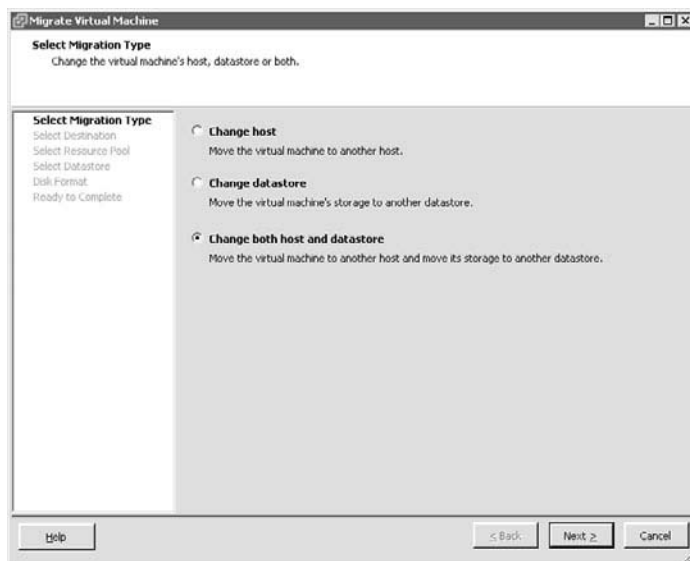


FIGURE 8.6 Migrate Wizard.

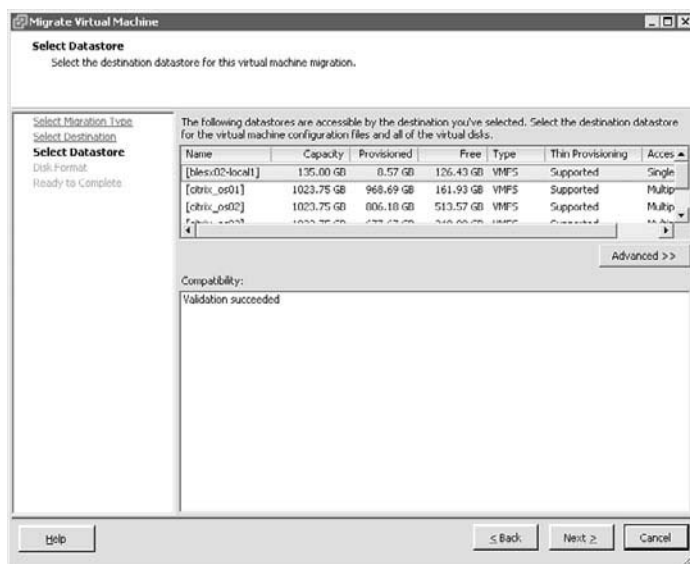


FIGURE 8.7 Datastore destination.

This brings us to the last step in the Storage vMotion wizard, which is the disk format. While Storage vMotion is primarily used to move VM files from one storage to another you might find this tool useful to change the disk format from Thin to Thick or vice versa. In Figure 8.8, note two options for disk type: Thin and Thick. The important thing to note here is that the reference to Thick is the Eagerzeroedthick, which means that the VMDK will be zeroed, thus thin provisioning will not be possible once this is converted to this type of Thick.

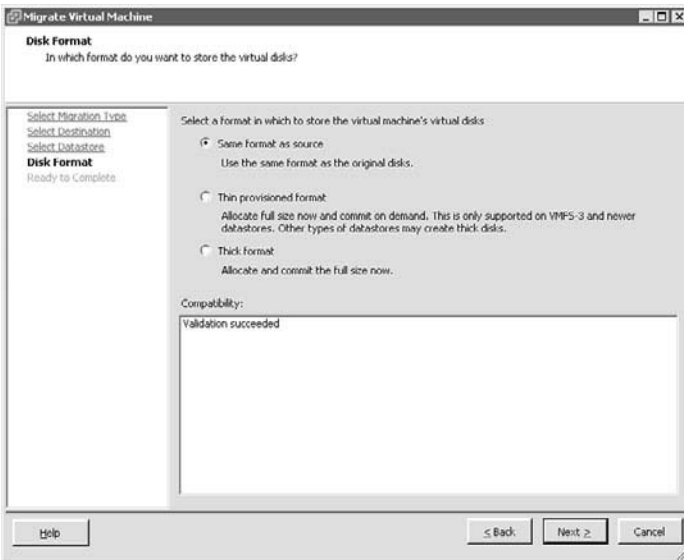


FIGURE 8.8 Disk format type.

Cram Quiz

Answer these questions. The answers follow the last question. If you cannot answer these questions correctly, consider reading the section again.

1. Storage vMotion and vMotion can be run simultaneously while_____.
 - A. The VM is powered on.
 - B. The VM is powered off.
 - C. The VM is powered on or off.
 - D. They cannot be run simultaneously under any circumstance.

2. Which virtual disk type writes zeros across all the capacity of the virtual disk?
 - A. Eagerzeroed
 - B. Eagerzeroedthick
 - C. Zeroedthick
 - D. Thick

Cram Quiz Answers

1. **B** is correct. You cannot run Storage vMotion and vMotion simultaneously while the VM is powered on. You can run them while the VM is powered off, or you can schedule them to run consecutively.
 2. **B** is correct. Eagerzeroedthick is the virtual disk type that writes zeroes across the entire capacity of the disk and commits it all, thereby thin provisioning would not be possible. All other types are incorrect.
-

Distributed Resource Scheduler

- ▶ Distributed Resource Scheduler (DRS) Cluster
- ▶ Affinity Rules
- ▶ VMware EVC

CramSaver

If you can correctly answer these questions before going through this section, save time by skimming the Exam Alerts in this section and then completing the Cram Quiz at the end of the section.

1. What color is assigned to a DRS cluster that is overcommitted?
 - A. Red
 - B. Orange
 - C. Blue
 - D. Yellow

2. How do you configure two VMs so that they are never present on the same host at the same time?
 - A. Affinity
 - B. Policy
 - C. Permissions
 - D. Anti-Affinity

Answers

1. **D** is correct. A DRS cluster that is overcommitted is assigned the color yellow; therefore, answers A, B, and C are incorrect.
2. **D** is correct. Configuring an Anti-Affinity rule would be the correct course of action and the correct answer to the question. Affinity rules force VMs to stay together on the same host. Choices B and C are incorrect.

VMware DRS is an enterprise-level feature that uses vMotion to load balance the CPU and memory resources of all ESX/ESXi hosts within a given DRS cluster. DRS is also used to enforce resource policies and respect placement constraints.

DRS functions efficiently using *clusters*. A cluster is the implicit collection of CPU and memory resources across ESX/ESXi hosts that are members of this cluster to allow for the creation of VMware DRS clusters and VMware High

Availability (HA) clusters. A cluster is an object that appears in the vCenter inventory and, like all other objects, can be assigned permissions. It can have a maximum of 32 nodes, or 320 VMs per host, or 3000 VMs per cluster, whichever maximum is reached first.

In other words, you can have 32 hosts in the cluster, but you are then limited to only 93 VMs per host, or you can have 300 VMs on 10 hosts, or 20 hosts with 150 VMs, and so on.

After you add ESX/ESXi hosts as nodes in a DRS cluster, DRS then monitors these ESX/ESXi hosts. If DRS detects high CPU utilization or high memory utilization on a particular host, it uses vMotion to migrate some VMs off the host with resource constraints to a host that is not experiencing resource constraints. DRS constantly plays this role to ensure that all ESX/ESXi hosts never have resource constraints.

DRS Automation Process

The DRS automation process involves *initial placement* of the virtual machines when they are first powered on and later on dynamically load balancing VMs on the best-suited host that will render the best performance. As shown in Figure 8.9, the automation process options are as follows:

- ▶ **Manual:** If you select this option, vCenter suggests which VM needs to be initially placed on which host at power on and later suggests which VM should be migrated to a different host; however, vCenter does not perform either task automatically.
- ▶ **Partially Automated:** If you select this option, VMs are automatically placed at power on; however, for future load balancing, vCenter only suggests the migration but does not perform it.

Note

The advantage of using Manual or Partially Automated is that you get greater control of which VMs are moved where and when. The disadvantage, of course, is you have to manually intervene for this task to be completed. Typically, Manual or Partially Automated is used on sensitive VMs that you want to constantly monitor.

- ▶ **Fully Automated:** If you select this option, vCenter suggests and performs the initial placement of VMs at power on and automatically migrates them to maintain the most adequate load balancing.

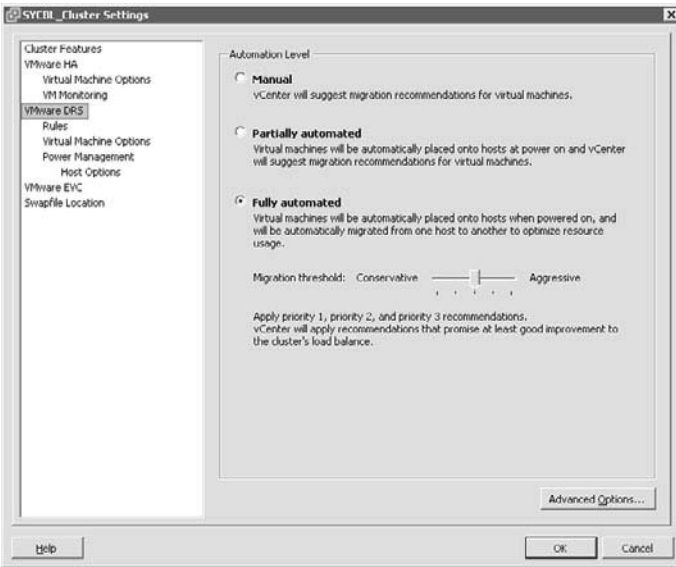


FIGURE 8.9 DRS cluster automation.

When set to Manual or Partially Automated, DRS recommends VMs that need to be migrated to improve performance and maintain proper load balancing in the cluster. To view these recommendations, you can select the DRS cluster in the vCenter inventory and click the DRS Recommendations tab, as shown in Figure 8.10.

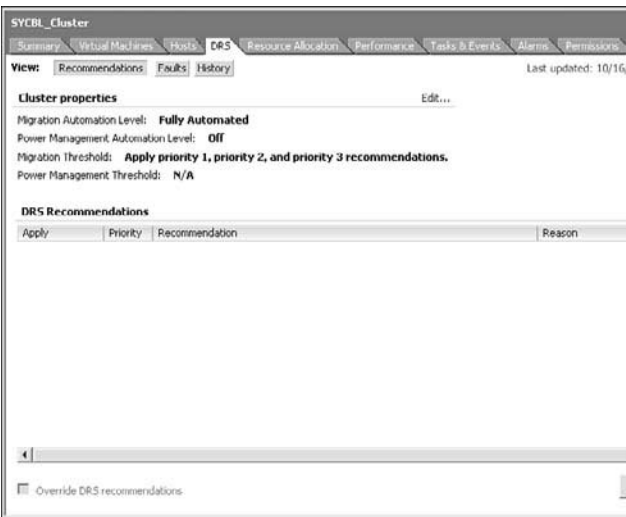


FIGURE 8.10 DRS recommendations.

ExamAlert

The DRS recommendations are available as long as they are valid. If anything should change that would render them inaccurate, these recommendations are changed or updated.

Automation levels set at the virtual machine level override those set at the DRS cluster level.

If you choose a fully automated load-balancing schedule, you can also control the frequency at which migrations occur. DRS analyzes the VMs and rates them on a five-star basis, with five stars meaning the VM must move from one host to another and one star meaning the VM does not necessarily need to move or, if moved, the change is not significant. Your options are as follows:

- ▶ **Most Conservative:** This option means DRS migrates VMs very infrequently and only when it must (that is, when VMs have five stars).
- ▶ **Moderately Conservative:** This option means that DRS migrates VMs with four stars or more. This option promises significant improvement.
- ▶ **Default:** This option moves VMs with three stars or more and promises good improvement.
- ▶ **Moderately Aggressive:** This option moves VMs with two stars or more and promises moderate improvement.
- ▶ **Aggressive:** This option migrates VMs with one star or more and promises slight improvement.

DRS automation levels can also be managed on the virtual machine level, where you manually assign the automation level for each VM in the cluster. To configure the automation level based on the VM, right-click the cluster where the VM is a member and go to Edit Settings. On the left pane, select Virtual Machine Options. You then are presented with a list of VMs that are members of this cluster on the right. You can change the automation level manually. Figure 8.11 shows an example.

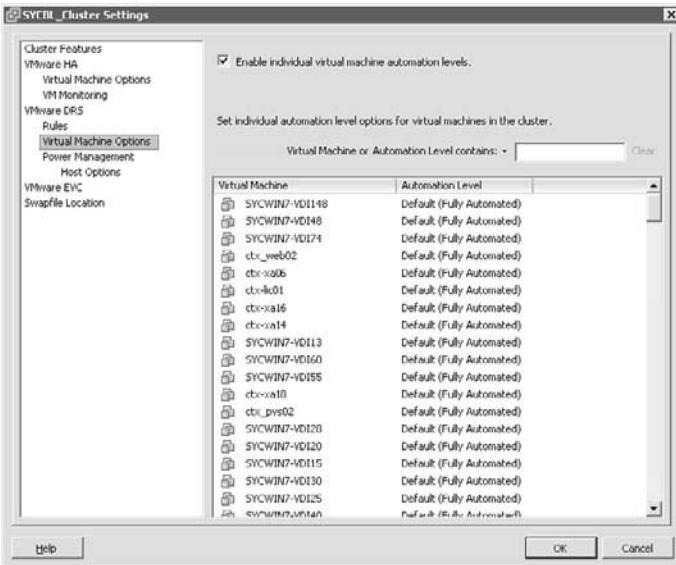


FIGURE 8.11 VM level automation.

DRS Cluster Validity

Monitoring a DRS cluster to ensure that there are no errors is critical. A resource pool can be in one of three states: valid, overcommitted, or invalid. A DRS cluster is considered to be valid, functioning, and healthy when the resource availability satisfies all the reservations and supports all running VMs. In the event that a DRS cluster is not considered valid, resource pools notify you that there is a problem by changing the color of the resource pool in the vSphere client as follows:

- ▶ *Yellow* means that the resource pool is *overcommitted* in terms of resources.
- ▶ *Red* means that the resource pool has violated the DRS cluster rules or high-availability rules and is thereby considered *invalid*.

DRS Rules

DRS enables you to set rules that govern whether VMs can exist on the same ESX/ESXi host at the same time or if they should always be separated and never exist on the same host at the same time. This capability can be useful if you are trying to avoid a single point of failure for a particular VM and want

to make sure that the DRS algorithm never places VMs assigned in the rules on the same host. That being said, you can choose to have the VMs on the same host at all times, so if one VM is migrated, the other follows as well. These rules are known as VM-VM Affinity rules and have two options:

- ▶ **Affinity:** This rule implies that VMs should be on the same ESX/ESXi host at all times.
- ▶ **Anti-Affinity:** This rule implies that VMs cannot exist on the same ESX/ESXi host at the same time.

The release of vSphere 4.1 introduced a new Affinity rule known as *VM-Host Affinity Rules*. These rules determine whether groups of VMs can or cannot exist on groups of ESX/ESXi hosts. With these rules, you can build groups of specific VMs and groups of specific ESX/ESXi hosts and then implement Affinity or Anti-Affinity rules. VM-Host affinity rules have the following options:

- ▶ **Must run on hosts in group:** This rule implies it is a requirement that the VM group be on the same ESX/ESXi host group at all times.
- ▶ **Should run on hosts in group:** This rule implies it is preferred that the VM group be on the same ESX/ESXi host group at all times.
- ▶ **Must not run on hosts in group:** This rule implies it is a requirement that the VM group NOT be on the same ESX/ESXi host group at all times.
- ▶ **Should not run on hosts in group:** This rule implies it is preferred that the VM group NOT be on the same ESX/ESXi host group at all times.

ExamAlert

Affinity rules changed with the release of vSphere 4.1; they now fall under two categories, VM-VM Affinity rules, which are the traditional affinity rules known as Affinity and Anti-Affinity, and the new VM-Host Affinity rules. The VCP exam may test your knowledge on this topic.

You can access these rules by right-clicking your cluster and pointing to Edit Settings. You then see the Rules section on the left. Select it and click Add. Figure 8.12 shows an example of how you can set a rule to never allow two VMs to be on the same host at the same time.

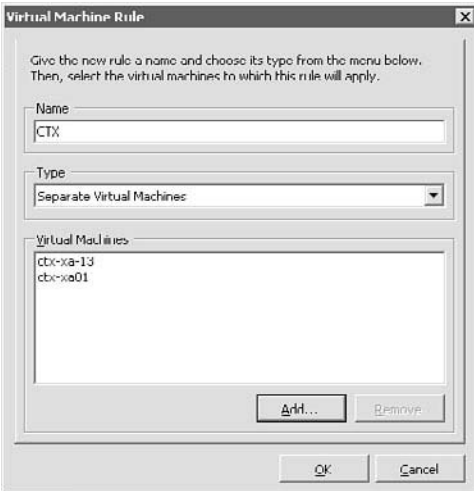


FIGURE 8.12 DRS rules.

VMware EVC

As we have been discussing in this chapter, vMotion has certain CPU requirements that need to be met before a successful live migration of VMs can take place between hosts. Considering OEM server manufacturers constantly upgrade the CPUs that ship with their server models, it can become challenging when you purchase servers at different intervals. At some point, you are bound to have hardware of different CPU families.

VMware Enhanced vMotion Compatibility is similar in function to the NX/XD feature, except it is configured on a cluster basis and affects the hosts in the cluster while the NX/XD feature is implemented on a VM level. When creating an EVC cluster, you are instructing vSphere to find the lowest common denominator between all the hosts' CPUs thereby allowing the highest level of vMotion compatibility.

As you can see in Figure 8.13, creating a VMware EVC cluster is easy. Choose Edit Settings on your existing DRS cluster and select VMware EVC from the left pane. You can then configure the options appropriately.

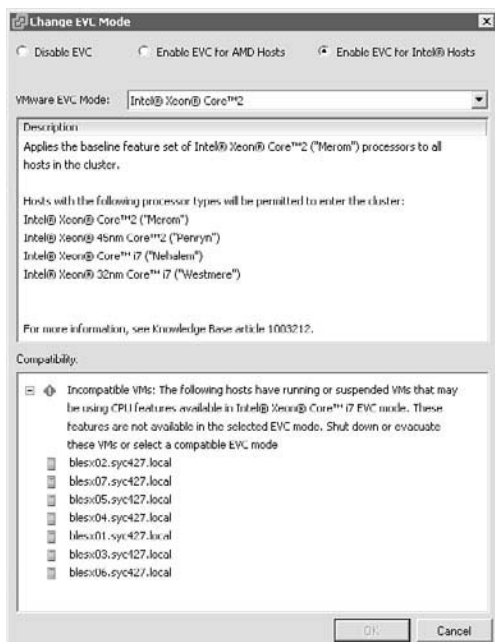


FIGURE 8.13 VMware EVC enabled cluster.

Cram Quiz

Answer these questions. The answers follow the last question. If you cannot answer these questions correctly, consider reading the section again.

1. Which setting is an invalid level when Fully Automated DRS cluster load balancing is selected?
 - A. Conservative
 - B. Aggressive
 - C. Default
 - D. Low

2. Which of the following is not a DRS cluster automation level? (Select all that apply.)
 - A. Manual
 - B. Semi Manual
 - C. Fully Automated
 - D. Semi Automated

3. How many cluster nodes are supported for each DRS cluster?
 - A. 16
 - B. 24
 - C. 32
 - D. 36

Cram Quiz Answers

1. **D** is correct. Low is not a valid frequency level when Fully Automated is selected; therefore, answers A, B, and C are incorrect.
 2. **B** and **D** are correct. Semi Manual and Semi Automated are invalid and do not exist. The three levels of automation are Manual, Partially Automated, and Fully Automated; therefore, answers A and C are incorrect.
 3. **C** is correct. VMware DRS clusters support up to 32 ESX/ESXi hosts or nodes per cluster; therefore, answers A, B, and D are incorrect.
-

Index

802.1Q VLAN tagging, 77

A

access, ESX 4.1

- SSH (Secure Shell), 52-53
- vSphere client, 51-52

Active Directory Interface (vCenter), 138

Additional Services (vCenter), 138

addressing

- Fiber Channel, 104-107
- iSCSI, 109

administration (vCenter), 135, 139, 154-155

- blueprint, 137-139
- Client Settings, 160
- clustering, 162-164
- clusters, 152-153
- database design, 140-142
- datacenters, 151-152
- folders, 151
- functional inventory design, 150-153
- HA (high availability), 162
- hardware requirements, 139
- Heartbeat, 162
- installation, 142-144
- installing, 136-137
- licensing, 145, 147-149
- linked mode, 155
- Lockdown mode, 159
- maximums, 160-161
- plug-ins, 160
- server backup, 162
- software requirements, 139-140
- vSphere client tabs, 155-159

Administration tab (vSphere client), 157-158

Administrator (ESX), 201

Affinity rule (DRS), 235

Agent component (vCenter Converter), 192

alarms, virtual machines, monitoring, 251-254

alpha folder (vCenter), 151

Anti-Affinity rule (DRS), 235

appliances, virtual, deploying, 188

Application Programming Interface (API), 139

application virtualization, 16

architecture

Fiber Channel SANs, 102-103

storage, 98

vCenter, 137-139

vDS (vNetwork Distributed Switches), 90-92

assigning permissions, 203-204

authentication, SQL, 141

automation process, DRS (Distributed Resource Scheduler), 231-234

B

backups, 256

Data Recovery Application, 259

backing up virtual machines, 260-261

configuring, 260

restoring virtual machines, 262-263

hosts, 257

VCB (VMware Consolidated Backup), 257-259

virtual machines, 256-257

balloon-driver, 243-244

bandwidth, traffic shaping, 83

bare-metal hypervisors versus host-based hypervisors, 16

block-level data transfers, 99

blueprint, vCenter, 137-139

Bugnion, Edouard, 28

C

Capacity Planner Service (vCenter), 144

capacity planning, High Availability, 268-270

CD-ROM, ESX 4.1, 38-45

CHAP authentication, iSCSI, 114-115

CIFS (Common Internet File System) shares, Data Recovery, backing up to, 259

Citrix, 15

CLI component (vCenter Converter), 192

Client Plug-in component (vCenter Converter), 192

Client Settings, vCenter, 160

clients, vSphere, 28-29

cloning vCenter Converter, 193-194

cluster-across-boxes scenario (ESX), 273

cluster-in-a-box scenario (ESX), 273

clusters

DRS (Distributed Resource Scheduler), 230-231

automation process, 231-234

validity, 234

MSCS clustering, 273-274

vCenter, 152-153, 162-164

cold cloning (vCenter Converter), 193

cold migrations, virtual machines, 187

Common Internet File System (CIFS) shares, Data Recovery, backing up to, 259

community secondary node mode, private VLANs, 78

compatibility, virtual machines, 20
compression, memory, 244-245
configuration

Data Recovery Application, 260
 ESX 4.1, 50-51
 ESXi 4.1, 46-49
 High Availability, 266
 NFS datastores, 119-120
 NTP clients, ESX Server, 54-55
 virtual machines, maximums,
 170-171

**Consolidation tab (vSphere
 client), 159**

control plane (vDS), 91

Converter, 137

**Converter Enterprise Service
 (vCenter), 144**

Core Services (vCenter), 138

CPUs

ESX/ESXi 4.1, 33
 managing, virtual machines, 214-219
 resource pools, 216-219
 vCenter, 139
 vCPUs (virtual CPUs), 241-242
 virtual machines, monitoring,
 249-250
 vMotion, requirements, 223-224

D

Data Recovery Application, 259

backing up virtual machines, 260-261
 configuring, 260
 restoring virtual machines, 262-263

data transfers, 99

database design, vCenter, 140-142

Database Interface (vCenter), 138

datacenters, vCenter, 151-152

datastores (NFS), 118

configuring, 119-120

**designing vCenter functional
 inventory, 150-153**

**Destination Virtual Disks, Data
 Recovery Appliance, adding to, 259**

Devine, Scott, 28

diagnostic data, 56

**Discovery and Analysis task (vCenter
 Guided Consolidation), 195-196**

disk contention, virtual machines, 251

disk partitioning, ESX 4.1, 34-37

**disk-based cloning (vCenter
 Converter), 194**

distributed port groups (vDS), 90

distributed ports (vDS), 90

**Distributed Resource Scheduler (DRS)
 cluster. See DRS (Distributed
 Resource Scheduler)**

Distributed Services (vCenter), 138

**DNS (domain name system)
 servers, 15**

DNS resolution, 266

domain controllers, 15

Domain directory (vCenter), 205

**domain name system (DNS)
 servers, 15**

**DRS (Distributed Resource
 Scheduler), 22, 25, 217, 230-231**

automation process, 231-234

clusters, validity, 234

rules, 234-236

VMware EVC, 236-238

dvPorts (vDS), 90

Dynamic Discovery tab (iSCSI), 114

E

**Eagerzeroedthick virtual disks,
 132-134**

earnings, vMotion, 221-222

emulation versus virtualization, 20

encapsulation, virtual machine, 19

**Enhanced vMotion Compatibility
 (EVC), 236-238**

errors, vMotion, 221-222

ESX

- clustering, 273-274
- HA (High Availability), 73
- iSCSI multipathing, 111-113
- minimum hardware requirements, 32-34
- network failover detection, 85
- NFS datastores, 118
 - configuring, 119-120
- privileges, 202
- roles, 201-202

ESX 4.1

- configuring, 50-51
- disk partitioning, 34-37
- installing, 38
 - CD-ROM, 38-45
 - troubleshooting, 55-58
- minimum hardware requirements, 32-34
- Service Console, memory allocation, 54
- SSH (Secure Shell), 52-53
- vSphere client, 51-52

ESX server

- NTP clients, configuring on, 54-55
- security, 205-206

ESX/ESXi, 25

- High Availability, 265-280

ESX/ESXi Host Management (vCenter), 138

ESX/ESXi hosts, backups, 257

ESXi 4.1

- configuring, 46-49
- installing, 45-49

EVC (Enhanced vMotion Compatibility), 236-238

Events tab (vSphere client), 157

expandable reservation, resource pools, 217

Explicit Failback Order policy, virtual switches, 87-88

F

Failback policy, virtual switches, 86

Fault Tolerance (FT), 274-280

- enabling, 277-280
- requirements, 276-277

Fiber Channel SANs, 100-102

- addressing, 104-107
- architecture, 102-103
- masking, 103-104
- zoning, 104

file extensions, virtual machines, 19

file systems

- Linux, 35
- VMFS, 121-122
 - extending, 123-124
 - multipathing, 124
- Volume Grow, 124
- Windows, 35

file-level data transfers, 99

files

- restoring, Data Recovery Application, 262-263
- virtual machines, 169
 - configuration maximums, 170-171

fixes PSPs, 126

folders, vCenter, 151

Forged Transmits, virtual switches, 82

FT (Fault Tolerance), 274-280

- enabling, 277-280
- requirements, 276-277

fully automated process, DRS (Distributed Resource Scheduler), 231

functional inventory (vCenter)

- clusters, 152-153
- datacenters, 151-152
- designing, 150-153
- folders, 151

G

Generate Virtual Machine Shortcut window, 210

GINA (Graphical Identification and Authentication), 173

**graphical mode, ESX 4.1
installation, 39**

“Guest Operating System Installation Guide,” 174

**guest operating systems, installing,
173-177**

guest OS customization, 182-183

Guided Consolidation, 137, 194-195

Discovery and Analysis task, 195-196

Plan Consolidation task, 196-197

H

HA (High Availability). See High Availability (HA)

hard zoning, Fiber Channel SANs, 104

hardware, virtual machines, 167-169

**hardware independence, virtual
machines, 19**

hardware initiator (iSCSI), 115-116

hardware requirements

ESX/ESXi 4.1, 32-34

vCenter, 139

Heartbeat (vCenter), 162

High Availability (HA), 255, 264-280

configuring, 266

host failover capacity planning,
268-270

host isolation, 270-271

reactive system, 265

Service Console redundancy,
266-267

vCenter, 162

virtual machines

failure monitoring, 265-266

recovery priority, 272-273

VMware Fault Tolerance (FT),
274-280

enabling, 277-280

requirements, 276-277

**host failover capacity planning, High
Availability, 268-270**

**host isolation, High Availability,
270-271**

host prerequisites, vMotion, 221-222

**host-based hypervisors, versus bare
metal hypervisors, 16**

hosts

backups, 257

ESX, High Availability, 265-280

monitoring, 248-254

hot cloning (vCenter Converter), 193

hyperthreading, 223

vCPUs (virtual CPUs), 242

hypervisor, 15

hypervisor type-1 virtualization, 16

hypervisor type-2 virtualization, 16

hypervisors, 27-28

bare metal, 16

host-based, 16

swapping, virtual memory, 245-247

I

I/O plane (vDS), 91

IIS (Internet Information Services), 15

independent disks, 176

initial placement, 231

installation

ESX 4.1, 38

CD-ROM, 38-45

ESXi 4.1, 45-49

guest operating systems, 173-177

vCenter, 136-137, 142-144

vCenter Converter, 193

internal virtual switches, 68

Internet Information Services (IIS), 15

Internet Small Computer System Interface (iSCSI). See **iSCSI (Internet Small Computer System Interface)**

Inventory tab (vSphere client), 155-156

iqn (iSCSI Qualified Name), 109

iSCSI (Internet Small Computer System Interface), 108-109

- addressing, 109
- hardware initiator, 115-116
- multipathing, 111-113
- software initiator, 110-115
 - CHAP authentication, 114-115
 - Dynamic Discovery tab, 114
 - enabling, 110-111
 - software port group, 111

“iSCSI SAN Configuration Guide,” 113

isolated secondary node mode, private VLANs, 78

isolation, virtual machines, 19

L

LANs (local area networks)

- 802.1Q VLAN tagging, 77
 - private VLANs, 78-79
 - trunk ports, 76-77
- VLANs, 75-76

Layer 2 security policies, virtual switches, 81-83

license key (vCenter), 147

License Server (vCenter), 144

Licenses (Administration tab), 157

licensing vCenter, 145-149

- managing, 41

linked mode (vCenter), 155

Linux, VMware ESX Server, 27-28

Linux file system, 35

load balancing, vCPUs (virtual CPUs), 242

load balancing policies, virtual switches, 84-85

load drivers (ESX 4.1), 40

local cloning (vCenter Converter), 194

Local directory (vCenter), 204

Lockdown mode, vCenter, 159

LUN masking, Fiber Channel, 103-104

M

Management Web Services (vCenter), 144

managing

- licensing, vCenter, 145-149
- virtual machines, 186

manual automation process, DRS (Distributed Resource Scheduler), 231

Maps tab (vSphere client), 158-159

masking Fiber Channel SANs, 103-104

maximums, virtual machines, 170-171

memory

- managing, virtual machines, 214-219
- resource pools, 216-219
- vCenter, 139
- virtual memory, 242-243
 - balloon-driver, 243-244
 - hypervisor swap, 245-247
 - memory compression, 244-245
 - transparent memory page sharing, 243

memory allocation, Service Console, 36, 54

memory compression, 244-245

memory usage, virtual machines, 250

Microsoft Exchange servers, 15

Migrate Wizard, 227

minimum hardware requirements

- ESX/ESXi 4.1, 32-34
- vCenter, 139

minimum requirements

- vCenter, 139-140
- Web Access, 209

monitoring

- hosts, 248-249
- virtual machines, 248-249
 - alarms, 251-254
 - CPUs, 249-250
 - disk contention, 251
 - memory usage, 250
 - network bandwidth, 251

Most Recently Used (MRU) PSPs, 126

mount points, 34

Mount Service for vCenter Service (vCenter), 144

MPP (Multiple Multipathing Plugins), 125

MSCS (Microsoft Clustering Services), 273-274

multipathing

- iSCSI, 111-113
- VMFS, 124

multiple adapter virtual switches, 69

Multiple Multipathing Plugins (MPP), 125

multiple Service Console ports, 71

N

naming virtual machines, 167

NAS (Network Attached Storage), 117-118

Native Multipathing Plugin (NMP), 125

network bandwidth, virtual machines, 251

network failover detection, 85

networking, vCenter, 139

networking maximums, 93

NFS datastores, 118

- configuring, 119-120

NIC teaming

- VLANs, 84-88
- vSwitch, 69

NMP (Native Multipathing Plugin), 125

No Access role (ESX), 201

nonpersistent independent disks, 177

Notify Switches policy, virtual switches, 86

NTP clients, ESX Server, configuring on, 54-55

NX/XD, 223-224

O

Open Virtualization Format (OVF), 188

operating systems

- guest operating systems, installing, 173-177

- guest OS customization, 182-183

Orchestrator Configuration (vCenter), 144

OVF (Open Virtualization Format), 188

P

paravirtualization, 224

partially automated process, DRS (Distributed Resource Scheduler), 231

partitioning ESX 4.1, 34-37

Path Selection Plugins (PSPs), 125-128

per instance licensing, vCenter, 148

per processor licensing, vCenter, 147

per virtual machine, vCenter, 148-149

permissions, 201

- assigning, 203-204

persistent independent disks, 177

physical machines versus virtual machines, 21

physical switch VLANs, 84

physical switches versus virtual switches, 64-66

physical-to-virtual cluster scenario (ESX), 273

Plan Consolidation task (vCenter Guided Consolidation), 196-197

plug-ins, vCenter, 160

Pluggable Storage Architecture (PSA).

See PSA (Pluggable Storage Architecture)

policies, virtual switches, 80-88

port blocking, VLANs, 84

port groups, 70, 83

networking maximums, 93-95

Service Console, 70-72

virtual machine, 73-74

VMkernel, 72-73

primary private VLANs, 78

print servers, 15

private VLANs, 78-79

privileges, 200-201

processors, ESX/ESXi, 33

Promiscuous Mode, virtual switches, 82

promiscuous secondary node mode, private VLANs, 78

provision virtual disks, 176

provisioning, thin provisioning, 129-134

PSA (Pluggable Storage Architecture), 125-128

PSOD (Purple Screen of Death), 56

PSPs (Path Selection Plugins), 125-128

Purple Screen of Death (PSOD), 56

Q-R

Quiesce period, 225

Read-Only role (ESX), 201

redundancy, Service Console, 266-267

remote cloning (vCenter Converter), 194

remote console URL, 209-211

resource optimization, 240-241

virtual CPUs (vCPUs), 241-242

hyperthreading, 242

load balancing, 242

virtual memory, 242-243

balloon-driver, 243-244

hypervisor swap, 245-247

memory compression, 244-245

transparent memory page sharing, 243

resource pools, 216-219

expandable reservation, 217

roles, 200-203

Roles panel, 202

Roles tab (Administration tab), 157

root folder, vCenter, 151

Root Resource Pool, 217

Rosenblum, Mendel, 28

Round Robin PSPs, 126

Route-based policies, 85

rules, DRS (Distributed Resource Scheduler), 234-236

S

SAN Boot ESX, 101

SANs (storage area networks), Fiber Channel, 100

addressing, 104-107

architecture, 102-103

masking, 103-104

zoning, 104

SATPs (Storage Array Type Plugins), 125

Scheduled Tasks tab (vSphere client), 156-157

SCSI (small computer system interface) adapters, 19

SDK (Software Development Kit), 139

secondary node modes, private VLANs, 78

secondary private VLANs, 78

security, virtual switches, 81-83

security model, 200

assigning permissions, 203-204

ESX server, 205-206

- permissions, 201
- privileges, 201
- remote console URL, 209-211
- roles, 200-203
- users, 201
- vCenter, 204
- Web Access, 207-209
- serial ports, 19**
- server backup, vCenter, 162**
- Server component (vCenter Converter), 192**
- Service Console, 28**
 - ESX 4.1
 - memory allocation, 54
 - memory allocation, 36
 - port groups, 70-72
 - redundancy, 266-267
- Service Console NIC team, 71-72**
- services, vCenter, 143-144**
- Sessions (Administration tab), 157**
- shares, 216**
- simulation versus virtualization, 20**
- single adapter virtual switches, 69**
- small computer system interface (SCSI) adapters, 19**
- SMP (Symmetric Multi-Processing), 25**
- snapshots, 187**
- soft zoning, Fiber Channel SANs, 104**
- Software Development Kit (SDK), 139**
- software initiator (iSCSI), 110-115**
 - CHAP authentication, 114-115
 - Dynamic Discovery tab, 114
 - enabling, 110-111
 - software port group, 111
- software requirements, vCenter, 139-140**
- SQL authentication, 141**
- SQL servers, 15**
- SSE2 (Streaming SIMD Extensions 2), 223**
- SSE3 (Streaming SIMD Extensions 3), 223**
- SSH (Secure Shell), ESX 4.1 access, 52-53**
- stages, vMotion, 225**
- Standard Virtual Switches (vSS), 61, 67-68, 91**
- storage, 98-99**
 - architectures, 98
 - Fiber Channel, 100-103
 - addressing, 104-107
 - architecture, 102-103
 - masking, 103-104
 - zoning, 104
 - iSCSI, 108-109
 - addressing, 109
 - hardware initiator, 115-116
 - software initiator, 110-115
 - NAS (Network Attached Storage), 117-118
 - PSP (Pluggable Storage Architecture), 125-128
 - templates, 182
 - thin provisioning, 129-134
 - vCenter, 139
 - VMFS (Virtual Machine File System), 121-122
 - extending, 123-124
 - multipathing, 124
 - Volume Grow, 124
- Storage Array Type Plugins (SATPs), 125**
- storage virtualization, 16**
- Storage vMotion, 25, 220, 226-229**
- Streaming SIMD Extensions 2 (SSE2), 223**
- Streaming SIMD Extensions 3 (SSE3), 223**
- swapping hypervisors, virtual memory, 245-247**

switches

- vDS (vNetwork Distributed Switches), 89-90
 - architecture, 90-92
 - benefits, 90
 - components, 90-92
- virtual switches, 60-63
 - internal virtual switches, 68
 - multiple adapter virtual switches, 69
 - policies, 80-88
 - port groups, 70-74
 - single adapter virtual switches, 69
 - versus physical switches, 64-66

System Logs (Administration tab), 158

system reconfiguration (vCenter Converter), 193

T

templates, 180-181

- creating, 181-182
- guest OS customization, 182-183
- storage, 182
- virtual machines
 - cold migration, 187
 - deploying, 183-185
 - managing, 186

text mode, ESX 4.1 installation, 39

thick virtual disks, 132

thin provisioning, 129-134

thin virtual disks, 131-132

Tools Service (vCenter), 144

traffic shaping, virtual switches, 83

transparent memory page sharing, 243

troubleshooting, ESX 4.1, 55-58

trunk ports, VLANs, 76-77

U

UNIX, VMware ESX Server, 27-28

Update Manager, 25, 137

Update Manager Service (vCenter), 144

uplinks (vDS), 90

Use Explicit Failover Order load balancing policy, 85

users, 201

V

VAAI (vStorage APIs for Array Integration), 26

validity, clusters, DRS (Distributed Resource Scheduler), 234

vApp, 188-190

VCB (VMware Consolidated Backup), 26, 257-259

vCenter, 135, 139, 154-155, 266

Active Directory Interface, 138

Additional Services, 138

administration

Client Settings, 160

clustering, 162-164

HA (high availability), 162

Heartbeat, 162

linked mode, 155

Lockdown mode, 159

maximums, 160-161

plug-ins, 160

server backup, 162

vSphere client tabs, 155-159

API (Application Programming Interface), 139

blueprint, 137-139

clusters, 152-153

Converter, 137

Core Services, 138

database design, 140-142

Database Interface, 138

- datacenters, 151-152
- Distributed Services, 138
- editions, 145
- ESX/ESXi Host Management, 138
- folders, 151
- functional inventory, designing, 150-153
- Guided Consolidation, 137
- hardware requirements, 139
- installation, 142-144
- installing, 136-137
- licensing, 145-149
- managing licenses, 41
- security, 204
- services, 143-144
- software requirements, 139-140
- Update Manager, 137
- vSphere Software Development Kit (SDK), 139
- vCenter Converter, 192**
 - cloning, 193-194
 - installing, 193
- vCenter for Essentials Kits, 145**
- vCenter Foundation, 145**
- vCenter Guided Consolidation, 194-195**
 - Discovery and Analysis task, 195-196
 - Plan Consolidation task, 196-197
- vCenter Server Service, 144**
- vCenter Standard, 145**
- VCMSDS (vCenter), 144**
- vCPUs (virtual CPUs), 241-242**
- vDS (vNetwork Distributed Switches), 61, 89-90**
 - architecture, 90-92
 - benefits, 90
 - components, 90-92
- virtual appliances, deploying, 188**
- virtual CPUs (vCPUs), 241-242**
- virtual disks, 174-175**
 - Eagerzeroedthick virtual disks, 132
 - provision virtual disks, 176
 - thin virtual disks, 131
 - zeroedthick virtual disk, 132
- Virtual Machine Failure Monitoring (HA), 265-266**
- Virtual Machine File System (VMFS), 27**
- virtual machines, 18-20, 165-167**
 - backups, 256-257
 - Data Recovery Application, 260-261
 - benefits, 19
 - cold migration, 187
 - compatibility, 20
 - configuration maximums, 170-171
 - CPUs, managing, 214-219
 - creating, 172-179
 - deploying, 183-185
 - encapsulation, 19
 - file extensions, 19
 - files, 169
 - guest operating systems, installing, 173-177
 - hardware, 167-169
 - hardware independence, 19
 - High Availability, Virtual Machine Failure Monitoring, 265-266
 - host isolation, 270-271
 - isolation, 19
 - managing, 186
 - memory managing, 214-219
 - monitoring, 248-249
 - alarms, 251-254
 - CPUs, 249-250
 - disk contention, 251
 - memory usage, 250
 - network bandwidth, 251

virtual machines

- naming, 167
- port groups, 73-74
- recovery priority, 272-273
- restoring, Data Recovery Application, 262-263
- snapshots, 187
- templates, 180-181
 - creating, 181-182
 - guest OS customization, 182-183
- vApp, 188-190
- versus physical machines, 21
- VMFS, 121-122
 - extending, 123-124
 - multipathing, 124
 - Volume Grow, 124
- VMFS (Virtual Machine File System), 27
- VMware vCenter Converter, 192
 - cloning, 193-194
 - installing, 193

virtual memory, 242-243

- balloon-driver, 243-244
- hypervisor swap, 245-247
- memory compression, 244-245
- transparent memory page sharing, 243

virtual networking, 59

- private VLANs, 78-79
- vDS (vNetwork Distributed Switches), 89-90
 - architecture, 90-92
 - benefits, 90
 - components, 90-92
- virtual switches, 60-63
 - versus physical switches, 64-66
- VLANs, 75-76

virtual ports, networking maximums, 93, 95**virtual switches, 60-63, 83**

- internal virtual switches, 68
- multiple adapter virtual switches, 69

- networking maximums, 93, 95
- OSI model, layers, 62
- policies, 80-88
 - load balancing, 84-85
- port groups, 70
 - Service Console, 70-72
 - virtual machine, 73-74
 - VMkernel, 72-73
- security, 81-83
- single adapter virtual switches, 69
- Standard Virtual Switches (vSS), 61, 67-68
- traffic shaping, 83
- vDS (vNetwork Distributed Switches), 89-90
 - architecture, 90-92
 - benefits, 90
 - components, 90-92
- versus physical switches, 64-66
- vNetwork Distributed Switches (vDS), 61

virtualization, 13-17

- application virtualization, 16
- benefits, 15
- hypervisor, 15
- hypervisor type-1 virtualization, 16
- hypervisor type-2 virtualization, 16
- paravirtualization, 224
- storage virtualization, 16
- versus emulation, 20
- versus simulation, 20
- virtual machines, 18-20, 165-167
 - compatibility, 20
 - encapsulation, 19
 - file extensions, 19
 - hardware independence, 19
 - isolation, 19
 - versus physical machines, 21
- vSphere4, benefits, 22-23

VLANs (virtual LANs), 75-77

- NIC teaming, 84-88
- physical switch VLANs, 84
- port blocking, 84
- private VLANs, 78-79
- trunk ports, 76-77

VM-Host Affinity Rules, 235**vmdk file extension, 19****VMFS (Virtual Machine File System), 27, 121-122**

- extending, 123-124
- multipathing, 124
- Volume Grow, 124

VMkernel, 27-28

- origins, 28
- port groups, 72-73

vmmemctl, 243-244**vMotion, 25, 220-221**

- CPU requirements, 223-224
- enabling, 222
- errors, 221-222
- host prerequisites, 221-222
- stages, 225
- Storage vMotion, 226-229
- warnings, 221-222

VMs (virtual machines). See virtual machines**VMware, vApp, 188-190****VMware Capacity Planner Service, 144****VMware Consolidated Backup (VCB), 26, 257-259****VMware Converter Enterprise Service, 144****VMware ESX 4.1**

- accessing
 - SSH (Secure Shell), 52-53
 - vSphere client, 51-52
- configuring, 50-51
- disk partitioning, 34-37

installing, 38

CD-ROM, 38-45

troubleshooting, 55-58

Service Console, memory allocation, 54

VMware ESX Server, operating system, 27-28**VMware ESX/ESXi, 25****VMware ESX/ESXi 4.1, 31**

minimum hardware requirements, 32-34

VMware ESXi 4.1

configuring, 46-49

installing, 45-49

VMware EVC (Enhanced vMotion Compatibility), 236-238**VMware Fault Tolerance (FT), 163, 274-280**

enabling, 277-280

requirements, 276-277

VMware License Server, 144**VMware Mount Service for vCenter Service, 144****VMware Tools Service, 144, 178-179****VMware Update Manager Service, 137, 144****VMware vCenter Converter, 25, 137, 192**

cloning, 193-194

installing, 193

VMware vCenter Guided Consolidation, 137**VMware vCenter Lab Manager, 27****VMware vCenter Management Web Services, 144****VMware vCenter Orchestrator Configuration, 144****VMware vCenter Server Service, 144****VMware vCenter Site Recovery Manager (SRM), 26****VMware VCMSDS, 144****VMware View, 26**

VMware Virtual Symmetric Multi-Processing (SMP), 25**vmx file extension, 19****vNetwork Distributed Switches (vDS).**
See vDS (vNetwork Distributed Switches)**Volume Grow (VMFS), 124****volume-based cloning (vCenter Converter), 194****vSphere 4, 24**

benefits, 22-23

Distributed Resource Scheduler (DRS), 25

High Availability (HA), 25

licensing, 146

security model, 200

assigning permissions, 203-204

ESX server, 205-206

permissions, 201

privileges, 201

remote console URL, 209-211

roles, 201-203

users, 201

vCenter, 204

Web Access, 207-209

storage, 98-99

Fiber Channel, 102-107

Fiber Channel SANs, 100-102

iSCSI, 108-116

 NAS (Network Attached Storage),
 117-118 PSP (Pluggable Storage
 Architecture), 125-128

thin provisioning, 129-134

 VMFS (Virtual Machine File
 System), 121-124

Storage vMotion, 25

Update Manager, 25

vMotion, 25

VMware Consolidated Backup
(VCB), 26

VMware ESX/ESXi, 25

VMware vCenter, 25

VMware vCenter Converter, 25

VMware Virtual Symmetric Multi-
Processing (SMP), 25vStorage APIs for Array Integration
(VAAD), 26**vSphere Application Programming
Interface (API), 139****vSphere client, 28-29**

ESX 4.1 access, 51-52

vSphere client tabs, vCenter, 155-159**vSS (Standard Virtual Switches), 61,
67-68, 91****W-X-Y-Z**

Web Access

minimum requirements, 209

security, 207-209

Windows file system, 35**zeroedthick virtual disks, 132****zoning**

Fiber Channel SANs, 104