A blurred photograph of a server room. In the foreground, a person in a white lab coat and blue jeans is walking from left to right. In the background, another person in a white shirt and cap is walking from right to left. The room is filled with server racks and equipment. The floor is a light-colored tile.

Nick Marshall

with Mike Brown, G. Blair Fritz,
and Ryan Johnson

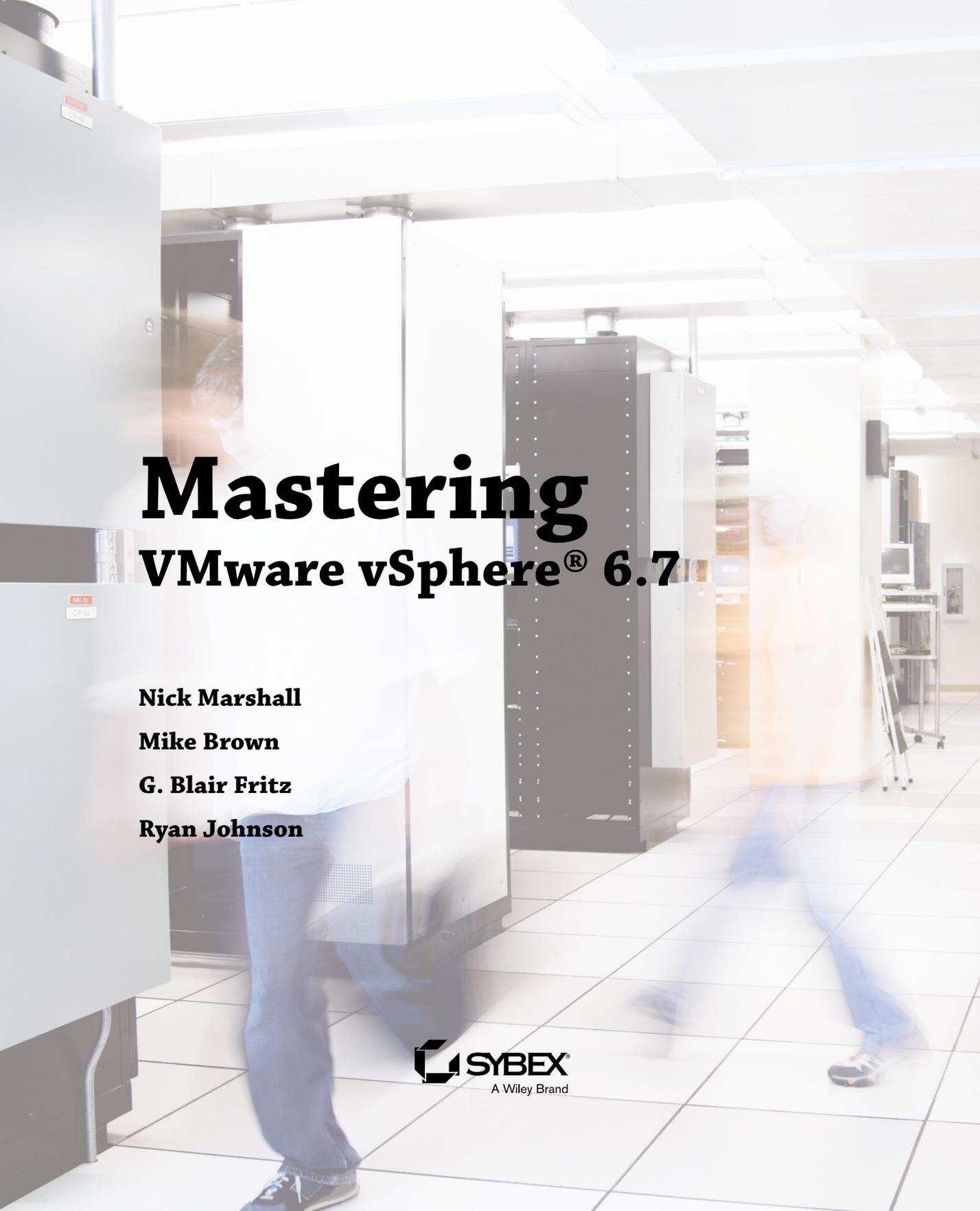
Foreword by Pat Gelsinger

Mastering VMware vSphere® 6.7

 **SYBEX**
A Wiley Brand



Mastering VMware vSphere® 6.7



Mastering VMware vSphere® 6.7

Nick Marshall

Mike Brown

G. Blair Fritz

Ryan Johnson

 **SYBEX**
A Wiley Brand

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10 9 8 7 6 5 4 3 2 1

I dedicate this book to my family. My wife Natalie, my son Ethan, and my daughters, Estelle and Eve.

You are the reason I do what I do.
—Nick Marshall

Acknowledgments

What a journey it has been the last few years since my previous Mastering vSphere book. When completing the last book, I had just moved to Palo Alto, California from Australia and was awaiting the arrival of my second child. The opportunity had come up to work out of VMware's headquarters on a beautiful campus not far from Stanford University. However, after a fantastic 2.5 years in the US, it was time to move back closer to our family in Australia.

When writing my last book, I spoke about my wife being my rock, and that has not changed. Our life is somehow even more chaotic with three kids, yet she amazingly handles it all in her stride. Nat, you are still my everything; I owe you more than I could possibly repay, but I hope a remote tropical holiday for two might be a good first step.

Thanks to my fellow authors, work mates and good friends, Mike Brown, Blair Fritz, and Ryan Johnson. You guys really knocked it out of the park with your contributions. Your dedication to refining and (re)writing your respective sections reinforces my respect for you as VMware authorities. The content of this book is so much better thanks to your involvement. . . even if you didn't know what you were getting yourselves into!

I'd also like to thank our technical editor, Rebecca Fitzhugh. Thanks for keeping us honest, Rebecca. Your technical review was most appreciated, and the feedback rightfully kept us on our toes.

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As always, I'd like to thank the VMware community as a whole. To all the bloggers, speakers, tweeters, and podcasters: without you all, I would never have started down this virtual road.

—*Nick Marshall*

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Nick Marshall is a Senior Integration Architect with nearly 20 years of IT experience. He is currently working for VMware in the Integrated Systems Business Unit.

Previously, Nick has worked in a number of roles, ranging from computer assembler, to infrastructure architect, to product manager. Nick loves to solve business problems with technical solutions.

Nick's passion for virtualization is evident by his involvement in starting the most popular virtualization podcast, *vBrownBag*, and writing on his personal blog, at www.nickmarshall.com.au. You can also find him speaking at industry conferences such as VMworld, VMUG (VMware User Group), and PEX (Partner Exchange). To recognize his contributions to the VMware community, Nick has been awarded the vExpert award each year since 2012.

Outside of his day job, Nick has a budding interest in woodworking, professional audio and video production, and volunteering at his local church.

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Contents at a Glance

<i>Foreword</i>	<i>xxiii</i>
<i>Introduction</i>	<i>xxv</i>
Chapter 1 • Introducing VMware vSphere 6.7	1
Chapter 2 • Planning and Installing VMware ESXi	23
Chapter 3 • Installing and Configuring vCenter Server	47
Chapter 4 • vSphere Update Manager and the vCenter Support Tools	117
Chapter 5 • Creating and Configuring a vSphere Network	179
Chapter 6 • Creating and Configuring Storage Devices	265
Chapter 7 • Ensuring High Availability and Business Continuity	369
Chapter 8 • Securing VMware vSphere	433
Chapter 9 • Creating and Managing Virtual Machines	495
Chapter 10 • Using Templates and vApps	549
Chapter 11 • Managing Resource Allocation	591
Chapter 12 • Balancing Resource Utilization	645
Chapter 13 • Monitoring VMware vSphere Performance	697
Chapter 14 • Automating VMware vSphere	735
Appendix A • The Bottom Line	775
<i>Index</i>	<i>801</i>

Contents

<i>Foreword</i>	<i>xxiii</i>
<i>Introduction</i>	<i>xxv</i>
Chapter 1 • Introducing VMware vSphere 6.7	1
Exploring VMware vSphere 6.7	1
Examining the Products in the vSphere Suite	3
Examining the Features in VMware vSphere	8
Licensing VMware vSphere	17
Why Choose vSphere?	20
The Bottom Line	22
Chapter 2 • Planning and Installing VMware ESXi	23
VMware ESXi Architecture	23
Understanding the ESXi Hypervisor	23
Examining the ESXi Components	24
Planning a VMware vSphere Deployment	25
Choosing a Server Platform	26
Determining a Storage Architecture	28
Integrating with the Network Infrastructure	29
Deploying VMware ESXi	30
Installing VMware ESXi Interactively	31
Performing an Unattended Installation of VMware ESXi	35
Deploying VMware ESXi with vSphere Auto Deploy	38
Performing Post-installation Configuration	40
Reconfiguring the Management Network	40
Using the vSphere Host Client	42
Configuring Time Synchronization	43
Configuring Name Resolution	45
The Bottom Line	46
Chapter 3 • Installing and Configuring vCenter Server	47
Introducing vCenter Server	47
Centralizing User Authentication Using vCenter Single Sign-On	49
Understanding the Platform Services Controller	52
Using the vSphere Web Client for Administration	53
Providing an Extensible Framework	54
Choosing the Version of vCenter Server	55
Planning and Designing a vCenter Server Deployment	56
Sizing Hardware for vCenter Server	56
Planning for vCenter Server Availability	58

Running vCenter Server and Its Components as VMs	60
Installing vCenter Server and Its Components	63
Installing vCenter Server in an Enhanced Linked Mode Group	74
Exploring vCenter Server	77
The vSphere Web Client Home Screen	78
Using the Navigator	80
Creating and Managing a vCenter Server Inventory	80
Understanding Inventory Views and Objects	80
Creating and Adding Inventory Objects	83
Exploring vCenter Server’s Management Features	86
Understanding Basic Host Management	86
Examining Basic Host Configuration	89
Using Scheduled Tasks	93
Using the Events and Events Consoles in vCenter Server	95
Working with Host Profiles	95
Tags and Custom Attributes	99
Managing vCenter Server Settings	102
General vCenter Server Settings	102
Licensing	105
Message of the Day	106
Advanced Settings	106
Auto Deploy	106
vCenter HA	106
Key Management Servers	106
Storage Providers	106
vSphere Web Client Administration	106
Roles	107
Licensing	107
vCenter Solutions Manager	107
System Configuration	107
VMware Appliance Management Administration	109
Summary	110
Monitor	111
Access	113
Networking	113
Time	113
Services	113
Update	114
Administration	114
Syslog	114
Backup	115
The Bottom Line	115
Chapter 4 • vSphere Update Manager and the vCenter Support Tools . . .	117
vSphere Update Manager	117
vSphere Update Manager and the vCenter Server Appliance	120
Installing the Update Manager Download Service (Optional)	121
The vSphere Update Manager Plug-in	122

Reconfiguring the VUM or UMDS Installation with the Update Manager Utility	123
Upgrading VUM from a Previous Version	124
Configuring vSphere Update Manager	124
Creating Baselines	130
Routine Updates	134
Attaching and Detaching Baselines or Baseline Groups	135
Performing a Scan	137
Staging Patches	141
Remediating Hosts	142
Upgrading VMware Tools	145
Upgrading Host Extensions	148
Upgrading Hosts with vSphere Update Manager	148
Importing an ESXi Image and Creating the Host Upgrade Baseline	148
Upgrading a Host	151
Upgrading VM Hardware	152
Performing an Orchestrated Upgrade	154
Investigating Alternative Update Options	155
Using vSphere Update Manager PowerCLI	155
Upgrading and Patching without vSphere Update Manager	156
vSphere Auto Deploy	157
Deploying Hosts with Auto Deploy	157
vCenter Support Tools	172
ESXi Dump Collector	172
Other vCenter Support Tools	175
The Bottom Line	176
Chapter 5 • Creating and Configuring a vSphere Network	179
Putting Together a vSphere Network	179
Working with vSphere Standard Switches	182
Comparing Virtual Switches and Physical Switches	183
Understanding Ports and Port Groups	184
Understanding Uplinks	186
Configuring the Management Network	189
Configuring VMkernel Networking	192
Enabling Enhanced Multicast Functions	197
Configuring TCP/IP Stacks	198
Configuring Virtual Machine Networking	200
Configuring VLANs	202
Configuring NIC Teaming	207
Using and Configuring Traffic Shaping	219
Bringing It All Together	220
Working with vSphere Distributed Switches	224
Creating a vSphere Distributed Switch	224
Removing an ESXi Host from a Distributed Switch	229
Removing a Distributed Switch	230
Managing Distributed Switches	231
Working with Distributed Port Groups	234
Managing VMkernel Adapters	240

Using NetFlow on vSphere Distributed Switches	245
Enabling Switch Discovery Protocols	247
Enabling Enhanced Multicast Functions	248
Setting Up Private VLANs	249
Configuring LACP	252
Configuring Virtual Switch Security	256
Understanding and Using Promiscuous Mode	257
Allowing MAC Address Changes and Forged Transmits	258
The Bottom Line	262
Chapter 6 • Creating and Configuring Storage Devices	265
Reviewing the Importance of Storage Design	265
Examining Shared Storage Fundamentals	267
Comparing Local Storage with Shared Storage	269
Defining Common Storage Array Architectures	271
Explaining RAID	273
Understanding vSAN	278
Understanding Midrange and External Enterprise Storage Array Design	282
Choosing a Storage Protocol	284
Making Basic Storage Choices	299
Implementing vSphere Storage Fundamentals	301
Reviewing Core vSphere Storage Concepts	302
Understanding Virtual Volumes	318
SCs vs. LUNs	320
Storage Policies	320
Virtual Volumes	321
Working with VMFS Datastores	322
Working with Raw Device Mappings	337
Working with NFS Datastores	339
Working with vSAN	347
Working with Virtual Machine–Level Storage Configuration	349
Leveraging SAN and NAS Best Practices	361
The Bottom Line	366
Chapter 7 • Ensuring High Availability and Business Continuity	369
Understanding the Layers of High Availability	369
Clustering VMs	371
Introducing Network Load Balancing Clustering	371
Introducing Windows Server Failover Clustering	372
Implementing vSphere High Availability	384
Understanding vSphere High Availability Clusters	384
Understanding vSphere High Availability’s Core Components	385
Enabling vSphere HA	389
Configuring vSphere High Availability	393
Configuring vSphere HA Groups, Rules, Overrides, and Orchestrated VM Restart	409
Managing vSphere High Availability	413

Introducing vSphere SMP Fault Tolerance	415
Using vSphere SMP Fault Tolerance with vSphere High Availability	421
Examining vSphere Fault Tolerance Use Cases	421
Planning for Business Continuity	422
Providing Data Protection	422
Recovering from Disasters	426
Using vSphere Replication	427
The Bottom Line	432
Chapter 8 • Securing VMware vSphere	433
Overview of vSphere Security	433
Securing ESXi Hosts	434
Working with ESXi Authentication	434
Controlling Access to ESXi Hosts	439
Keeping ESXi Hosts Patched	447
Managing ESXi Host Permissions	447
Configuring ESXi Host Logging	455
Securing the ESXi Boot Process	456
Reviewing Other ESXi Security Recommendations	459
Securing vCenter Server	459
Managing vSphere Certificates	460
Working with Certificate Stores	460
Getting Started with Certificate Management	463
Authenticating Users with Single Sign-On	465
Understanding the vpxuser Account	469
Managing vCenter Server Permissions	470
Configuring vCenter Server Appliance Logging	482
Securing Virtual Machines	483
Configuring a Key Management Server for VM and VSAN Encryption	483
Virtual Trusted Platform Module 2.0	490
Configuring Network Security Policies	491
Keeping VMs Patched	492
The Bottom Line	492
Chapter 9 • Creating and Managing Virtual Machines	495
Understanding Virtual Machines	495
Examining Virtual Machines from the Inside	495
Examining Virtual Machines from the Outside	498
Creating a Virtual Machine	503
Choosing Values for Your New Virtual Machine	513
Sizing Virtual Machines	514
Naming Virtual Machines	516
Sizing Virtual Machine Hard Disks	516
Virtual Machine Graphics	518
Installing a Guest Operating System	518
Working with Installation Media	519
Using the Installation Media	521

Working in the Virtual Machine Console	523
Installing VMware Tools	524
Installing VMware Tools in Windows	525
Installing VMware Tools in Linux	529
Managing Virtual Machines	532
Adding or Registering Existing VMs	532
Changing VM Power States	534
Removing VMs	535
Deleting VMs	535
Modifying Virtual Machines	536
Changing Virtual Machine Hardware	536
Using Virtual Machine Snapshots	541
The Bottom Line	546
Chapter 10 • Using Templates and vApps	549
Cloning VMs	549
Creating a Customization Specification	550
Cloning a Virtual Machine	555
Introducing vSphere Instant Cloning	558
Creating Templates and Deploying Virtual Machines	561
Cloning a Virtual Machine to a Template	563
Deploying a Virtual Machine from a Template	564
Using OVF Templates	566
Deploying a VM from an OVF Template	567
Exporting a VM as an OVF Template	569
Examining OVF Templates	571
Using Content Libraries	573
Content Library Data and Storage	573
Content Library Synchronization	574
Creating and Publishing a Content Library	574
Subscribing to a Content Library	575
Operating Content Libraries	577
Working with vApps	579
Creating a vApp	580
Editing a vApp	581
Changing a vApp's Power State	586
Cloning a vApp	586
Importing Machines from Other Environments	587
The Bottom Line	588
Chapter 11 • Managing Resource Allocation	591
Reviewing Virtual Machine Resource Allocation	591
Working with Virtual Machine Memory	594
Understanding ESXi Advanced Memory Technologies	595
Controlling Memory Allocation	599

Managing Virtual Machine CPU Utilization	608
Default CPU Allocation	609
Setting CPU Affinity	610
Using CPU Reservations	611
Using CPU Limits	612
Using CPU Shares	613
Summarizing How Reservations, Limits, and Shares Work with CPUs.	615
Using Resource Pools.	615
Configuring Resource Pools	616
Understanding Resource Allocation with Resource Pools	619
Regulating Network I/O Utilization.	625
Controlling Storage I/O Utilization	630
Enabling Storage I/O Control.	632
Configuring Storage Resource Settings for a Virtual Machine.	635
Using Flash Storage	639
The Bottom Line	643
Chapter 12 • Balancing Resource Utilization	645
Comparing Utilization with Allocation	645
Exploring vMotion	646
Examining vMotion Requirements	650
Performing a vMotion Migration Within a Cluster	653
Ensuring vMotion Compatibility.	656
Using Per-Virtual-Machine CPU Masking	656
Using Enhanced vMotion Compatibility.	658
Using Storage vMotion	662
Combining vMotion with Storage vMotion	665
Cross-vCenter vMotion	668
Examining Cross-vCenter vMotion Requirements	669
Performing a Cross-vCenter Motion	670
Exploring vSphere Distributed Resource Scheduler.	671
Understanding Manual Automation Behavior.	672
Reviewing Partially Automated Behavior.	672
Examining Fully Automated Behavior	673
Working with Distributed Resource Scheduler Rules.	674
Working with Storage DRS.	682
Creating and Working with Datastore Clusters	683
Configuring Storage DRS.	686
The Bottom Line	694
Chapter 13 • Monitoring VMware vSphere Performance	697
Overview of Performance Monitoring	697
Using Alarms	698
Understanding Alarm Scopes	700
Creating Alarms	700
Managing Alarms	706

Working with Performance Charts	708
Overview Layout	708
Advanced Layout	710
Working with <i>esxtop</i>	719
Monitoring CPU Usage	721
Monitoring Memory Usage	725
Monitoring Network Usage	727
Monitoring Disk Usage	729
The Bottom Line	732
Chapter 14 • Automating VMware vSphere	735
Why Use Automation?	735
vSphere Automation Options	736
Automating with PowerCLI	737
PowerShell and PowerCLI	737
What's New in PowerCLI 10	741
Installing and Configuring PowerCLI on Windows	741
Installing and Configuring PowerCLI on macOS	745
Installing and Configuring PowerCLI on Linux	747
Additional PowerCLI Capabilities	749
Getting Started with PowerCLI	750
Building PowerCLI Scripts	755
PowerCLI Advanced Capabilities	767
Additional Resources	771
The Bottom Line	772
Appendix A • The Bottom Line	775
Chapter 1: Introducing VMware vSphere 6.7	775
Chapter 2: Planning and Installing VMware ESXi	776
Chapter 3: Installing and Configuring vCenter Server	777
Chapter 4: vSphere Update Manager and the vCenter Support Tools	780
Chapter 5: Creating and Configuring a vSphere Network	781
Chapter 6: Creating and Configuring Storage Devices	783
Chapter 7: Ensuring High Availability and Business Continuity	787
Chapter 8: Securing VMware vSphere	788
Chapter 9: Creating and Managing Virtual Machines	790
Chapter 10: Using Templates and vApps	792
Chapter 11: Managing Resource Allocation	794
Chapter 12: Balancing Resource Utilization	796
Chapter 13: Monitoring VMware vSphere Performance	798
Chapter 14: Automating VMware vSphere	799
<i>Index</i>	801

Foreword

When *Mastering VMware vSphere 6.0* was released in 2015, Nick Marshall stopped by my office for a chat. We discussed the vSphere 6.0 release, of course, but we also discovered we had a number of things in common. Obviously, we have a love for virtualization, some would be aware of our strong Christian faiths, but maybe more obscurely, we discovered that we have both written books for (Wiley) Sybex. During this meeting, Nick also asked me if I would write the foreword for the next *Mastering VMware vSphere* book. As you can see, he's been planning this one for a while!

Fast forward to 2018, and it brings us to a very exciting year in virtualization. VMware released vSphere 6.7, and Nick has now released the long-awaited *Mastering VMware vSphere 6.7* to accompany it. This is Nick's third revision of the best-selling vSphere book after being handed the mantle from Scott Lowe. Stepping back a little, there are some anniversaries to celebrate this year too. This is the 10-year mark from when Chris McCain released the very first *Mastering VMware* book, *Mastering VMware Infrastructure 3*. Also, VMware celebrates its 20th year since being founded by Diane Greene, Mendel Rosenblum, Scott Devine, Edward Wang, and Edouard Bugnion.

Looking back at these milestones gives us an opportunity to also consider where virtualization sits in today's IT environment. We've come a long way since IBM enabled multitasking by partitioning their mainframes into virtual machines. The days of traditional client/server workloads are definitely diminishing, and we are well and truly in the cloud era, a multi-cloud world. Even though we are moving into a new era, virtualization is still the foundation of both public and private clouds. And of course, the best, most advanced virtualization platform is still VMware vSphere.

With VMware vSphere 6.7, we have taken the world's best hypervisor, ESXi, and added improvements in scale, performance, and even more stability. VMware has enabled even more seamless cross-cloud mobility with features like Per-VM EVC, and we've doubled down on security with features like TPM, vTPM, and FIPS compliance.

In this book, you'll find all the features and functionality available to you in vSphere, not just the things that have changed in 6.7. Nick and his coauthors have made sure that both new and old features are covered so that you can understand everything there is to know.

Well done on another release of this bit of VMware history, Nick. I know the readers will appreciate your continued dedication to their understanding of vSphere and the value it can bring them.

—Pat Gelsinger, VMware CEO

Introduction

It seems like a lifetime ago, 2005. That was the year that I tried to convince my boss to use VMware GSX Server on our new DL385 and thus the start of my journey delving into the depths of virtualization. The world of information technology (IT) has definitely shifted a couple of times since then. The two most obvious changes are the proliferation of virtualization and the subsequent widespread adoption of cloud computing.

Virtualization—especially server virtualization—is readily embraced in datacenters worldwide. VMware has gone from being a relatively small vendor to having the commanding share of the server virtualization market. Over the years, other companies such as Microsoft, Red Hat, and Citrix have jumped into the server virtualization space, but after all this time, it's still VMware that's synonymous with virtualization. For all intents and purposes, VMware invented the market.

Cloud Computing is a somewhat natural evolution of virtualization. If virtualization is the abstraction of individual server hardware, cloud computing is the abstraction of entire datacenters' worth of hardware. The scale can be smaller or larger, but the abstraction type is the same. But I'm getting ahead of myself. If you're reading this, there's a chance you're just now starting to learn about virtualization. What is virtualization, and why is it important to you?

As I mentioned, I define *virtualization* as the abstraction of one computing resource from another computing resource. Consider storage virtualization—in this case, you are abstracting servers (one computing resource) from the storage to which they are connected (another computing resource). This holds true for other forms of virtualization, too, like application virtualization (abstracting applications from the operating system). When most IT professionals think of virtualization, they think of hardware (or server) virtualization: abstracting the operating system from the underlying hardware on which it runs and thus enabling multiple operating systems to run simultaneously on the same physical server. That is the technology on which VMware has built its market share.

Almost single-handedly, VMware's enterprise-grade virtualization solution has revolutionized how organizations manage their datacenters. Before VMware introduced its powerful virtualization solution, organizations bought a new server every time a new application needed to be provisioned. Over time, datacenters became filled with servers that were all using only a fraction of their overall capacity. Even though these servers were underutilized, organizations still had to pay to power them and to dissipate the heat they generated.

Now, using VMware's server virtualization products, organizations can run multiple operating systems and applications on their existing hardware, and new hardware is purchased only when capacity needs dictate. No longer must organizations purchase a new physical server whenever a new application needs to be deployed. By stacking workloads together using

virtualization, organizations derive greater value from their hardware investments. They also reduce operational costs by reducing the number of physical servers and associated hardware in the datacenter, in turn decreasing power usage and cooling needs in the datacenter. In some cases, these operational cost savings can be quite significant.

But consolidation is only one benefit of virtualization; companies also realize greater workload mobility, increased uptime, streamlined disaster-recovery options, and a bevy of other benefits from adopting virtualization. And virtualization, specifically server virtualization, has created the foundation for a new way of approaching the computing model: cloud computing.

Cloud computing is built on the tenets of broad network access, resource pooling, rapid elasticity, on-demand self-service, and measured service. Virtualization, such as that provided by VMware's products, enables the IT industry to embrace this new operational model of more efficiently providing services to their customers, whether those customers are internal (their employees) or external (partners, end users, or consumers). That ability to efficiently provide services is the reason virtualization is important to you.

This book provides all the information you, as an IT professional, need to design, deploy, configure, manage, and monitor a dynamic virtualized environment built on VMware's enterprise-class server virtualization product: vSphere 6.7.

—*Nick Marshall, Author*

What Is Covered in This Book

This book is written with a start-to-finish approach to installing, configuring, managing, and monitoring a virtual environment using the VMware vSphere 6.7 product suite. The book begins by introducing the vSphere product suite and all of its great features. After introducing all of the bells and whistles, the book details an installation of the product and then moves into configuration. This includes configuring vSphere's extensive networking and storage functionality. We wrap up the configuration discussion with chapters on high availability, redundancy, and resource utilization. After completing the installation and configuration, we move into virtual machine creation and management and then into monitoring and troubleshooting. You can read this book from cover to cover to gain an understanding of the vSphere product suite in preparation for a new virtual environment, or you can use it as a reference if you are an IT professional who has begun your virtualization and wants to complement your skills with real-world tips, tricks, and best practices as found in each chapter.

This book, geared toward the aspiring as well as the practicing virtualization professional, provides information to help implement, manage, maintain, and troubleshoot an enterprise virtualization scenario.

Here is a glance at what's in each chapter and the appendix:

Chapter 1: Introducing VMware vSphere 6.7 We begin with a general overview of all the products that make up the vSphere 6.7 product suite. This chapter also covers vSphere licensing and provides some examples of benefits that an organization might see from adopting vSphere as its virtualization solution.

Chapter 2: Planning and Installing VMware ESXi This chapter looks at the architecture of the VMware hypervisor, ESXi, along with selecting the physical hardware, choosing your

version of VMware ESXi, planning your installation, and installing VMware ESXi, both manually and in an unattended fashion.

Chapter 3: Installing and Configuring vCenter Server In this chapter, we dive deep into planning your vCenter Server environment. vCenter Server is a critical management component of vSphere, so this chapter discusses the proper design, planning, installation, and configuration for vCenter Server.

Chapter 4: vSphere Update Manager and the vCenter Support Tools This chapter describes what is involved in planning, designing, installing, and configuring the vSphere Update Manager along with some of the other vCenter tools. You'll use vCenter Update Manager to keep your vSphere environment patched and up-to-date.

Chapter 5: Creating and Configuring a vSphere Network This virtual-networking chapter covers the design, management, and optimization of virtual networks, including features like the vSphere Distributed Switch. In this chapter, we also initiate discussions and provide solutions on how to integrate the virtual networking architecture with the physical network architecture while maintaining network security.

Chapter 6: Creating and Configuring Storage Devices This in-depth chapter provides an extensive overview of the various storage architectures available for vSphere. In this chapter, we discuss vSAN, Fibre Channel, iSCSI, and NAS storage design and optimization techniques as well as storage features like thin provisioning, multipathing, and round-robin load balancing.

Chapter 7: Ensuring High Availability and Business Continuity This exciting chapter covers the hot topics regarding business continuity and disaster recovery. We provide details on building highly available server clusters in virtual machines. In addition, this chapter discusses the use of vSphere High Availability (HA) and vSphere Fault Tolerance (FT) as ways of providing failover for virtual machines running in a vSphere environment. We also discuss backup options using vSphere's Storage APIs.

Chapter 8: Securing VMware vSphere Security is an important part of any implementation, and in this chapter, we cover different security management aspects, including managing direct ESXi host access and integrating vSphere with Active Directory. This chapter also covers how to manage user access for environments with multiple levels of system administration and how to employ Windows users and groups in conjunction with the vSphere security model to ease the administrative delegation that comes with enterprise-level deployments.

Chapter 9: Creating and Managing Virtual Machines This chapter introduces the practices and procedures involved in provisioning virtual machines through vCenter Server. In addition, you're introduced to timesaving techniques, virtual machine optimization, and best practices that will ensure simplified management as the number of virtual machines grows larger over time.

Chapter 10: Using Templates and vApps This chapter introduces the idea of templates, a mechanism for more rapidly deploying standardized virtual-machine images. We also discuss the different types of cloning and the concept of a vApp—a specialized container used by vSphere for the distribution of multi-VM applications. In addition, we discuss the Open Virtualization Format (OVF) standard used by VMware and other vendors for distributing virtual machines.

Chapter 11: Managing Resource Allocation In this chapter, we provide a comprehensive look at managing resource allocation. From individual virtual machines to resource pools and clusters of ESXi hosts, this chapter explores how resources are consumed in vSphere and addresses the mechanisms you can use—reservations, limits, and shares—to manage and modify that resource allocation.

Chapter 12: Balancing Resource Utilization Resource allocation isn't the same as resource utilization, and this chapter follows up the discussion of resource allocation in Chapter 11 with a look at some of the ways vSphere offers to balance resource utilization. In this chapter, you'll learn about vSphere vMotion, Enhanced vMotion Compatibility, vSphere Distributed Resource Scheduler (DRS), Storage vMotion, and Storage DRS.

Chapter 13: Monitoring VMware vSphere Performance In this chapter, we look at some of the native tools in vSphere that give virtual infrastructure administrators the ability to track and troubleshoot performance issues. The chapter focuses on monitoring CPU, memory, disk, and network adapter performance across ESXi hosts, resource pools, and clusters in vCenter Server. In this chapter, you'll also learn about vCenter Operations Manager.

Chapter 14: Getting Started with vSphere Automation Many tasks that VMware vSphere administrators face are repetitive, but automation can help. In this chapter, we close out the book by discussing several different ways to bring automation to your vSphere environment, including PowerCLI and the vSphere APIs.

Appendix: The Bottom Line This appendix offers solutions to the Master It problems at the end of each chapter.

The Mastering Series

The *Mastering* series from Sybex provides outstanding instruction for readers with intermediate and advanced skills, in the form of top-notch training and development for those already working in their field and clear, serious education for those aspiring to become pros. Every *Mastering* book includes the following:

- ◆ Real-World Scenarios, ranging from case studies to interviews, that show how the tool, technique, or knowledge presented is applied in actual practice
- ◆ Skill-based instruction, with chapters organized around real tasks rather than abstract concepts or subjects
- ◆ Self-review test questions, so you can be certain you're equipped to do the job right

The Hardware Behind the Book

Starting out, it can seem difficult to build an environment in which you can learn by implementing the exercises and practices detailed in this book. It is possible to build a practice lab with minimal hardware, and we encourage you to follow along with the book. If you're just starting, we recommend that you build a nested virtual lab on your laptop or desktop computer. A nested lab runs the hypervisor itself, ESXi, as a virtual machine. It needs VMware Workstation or Fusion installed and at least 16 GB of RAM. Be sure to read Chapters 2 and 3 before you attempt to construct any type of environment for development purposes.