

A blurred photograph of a server room. In the foreground, a person in a white shirt and blue jeans is walking towards the left. In the background, another person in an orange shirt and a cap is walking towards the right. The room is filled with server racks and has a tiled floor.

Scott Lowe

Mastering VMware vSphere® 5

A grayscale photograph of a server room. In the foreground, a person in a white shirt and dark pants is walking towards the left, slightly out of focus. In the background, another person is walking towards the right, also out of focus. The room is filled with server racks and has a tiled floor. The text "Mastering VMware vSphere® 5" is overlaid in the center-left of the image.

Mastering VMware vSphere® 5



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Scott Lowe



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A handwritten signature in black ink, appearing to read 'Neil Edde', written in a cursive style.

Neil Edde
Vice President and Publisher
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Above all, I dedicate this book to God, whose hand held me up when I needed strength (Psalm 37:24). You'd think after three books, this one would have been easy, but the Lord gave me the strength I needed to complete it. I also dedicate this book to my wife, Crystal, and my kids. Aside from the Lord, you guys are and always have been my source of inspiration and joy. Thank you!

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One thing I've learned now after writing three other books is that more people are involved than most folks ever realize. Unfortunately, there just isn't enough room on the cover to include everyone's name, even though they all deserve it.

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About the Author

Scott Lowe is an author, consultant, speaker, and blogger focusing on virtualization, storage, and other enterprise technologies. Scott is currently the CTO for the vSpecialist team at EMC Corporation. In this role, Scott provides technical leadership, support, and training to the vSpecialist team worldwide.

Scott's technical expertise extends into several areas. He holds industry certifications from Cisco, EMC, Microsoft, NetApp, VMware, and others. He also holds the premier VMware Certified Design Expert (VCDX) certification; Scott is VCDX #39. For Scott's leadership and involvement in the VMware community, he was awarded a VMware vExpert award by VMware three years in a row: 2009, 2010, and 2011.

As an author, Scott has contributed to numerous online magazines focused on VMware and related virtualization technologies. He is regularly quoted as a virtualization expert in virtualization news stories. He has three other published books: *Mastering VMware vSphere 4*, *VMware vSphere 4 Administration Instant Reference* (with Jase McCarty and Matthew Johnson), and *VMware vSphere Design* (with Forbes Guthrie and Maish Saidel-Keesing), all by Sybex.

Scott has spoken at several VMworld conferences as well as other virtualization conferences. He regularly speaks at VMware user group meetings, both locally and abroad.

Scott is perhaps best known for his acclaimed virtualization blog at <http://blog.scottlowe.org>, where he regularly posts technical articles on a wide variety of topics. VMware, Microsoft, and other virtualization industry leaders regularly refer to content on his site, and it is regularly voted among the top five virtualization weblogs worldwide. Scott's weblog is one of the oldest virtualization-centric weblogs that is still active; he's been blogging since early 2005, and his weblog was among the very first blogs to be aggregated on VMware's Planet V12n website.

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Forbes is the lead author of the acclaimed *VMware vSphere Design* (co-authored by Scott Lowe, along with Maish Saidel-Keesing), also published by Sybex.

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Introduction

I remember in 2004 (or was it 2003?) when I first started describing the use of server virtualization to a colleague of mine. VMware was pretty much the only vendor in the server virtualization space at the time, and I was describing to him how you could use virtualization to run multiple instances of an operating system on the same physical hardware. I was so excited. He merely asked, “Why in the world would you want to do that?”

The times have changed quite a bit since that time, and now virtualization—especially server virtualization—is readily embraced in corporate datacenters worldwide. VMware has gone from a relatively small vendor to one of the corporate heavyweights, garnering a commanding share of the server virtualization market with their top-notch virtualization products. Even now, when other companies such as Microsoft and Citrix have jumped into the server virtualization space, it’s still VMware that’s almost synonymous with virtualization. For all intents and purposes, VMware invented the market.

If you’re reading this, though, there’s a chance you’re just now starting to learn about virtualization. What is virtualization, and why is it important to you?

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 information technology 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 singlehandedly, VMware’s enterprise-grade virtualization solution has revolutionized how organizations manage their datacenters. Prior to the introduction of VMware’s 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 operating at only a fraction of their total capacity, 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 needs to be purchased only when capacity needs dictate. No longer do organizations need to 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 reducing 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 why virtualization is important to you.

This book provides all the information you, as an information technology professional, need to design, deploy, configure, manage, and monitor a dynamic virtualized environment built on VMware's fifth-generation enterprise-class server virtualization product, vSphere 5.

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 5 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, this book details an installation of the product and then moves into configuration. This includes configuring vSphere's extensive networking and storage functionality. I wrap up the configuration section with sections on high availability, redundancy, and resource utilization. Upon completion of the installation and configuration, I move into virtual machine creation and management and then into monitoring and troubleshooting. This book can be read from cover to cover to gain an understanding of the vSphere product suite in preparation for a new virtual environment. Or it can also be used as a reference for IT professionals who have begun their virtualization and want to complement their 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:

Chapter 1: Introducing VMware vSphere 5 I begin with a general overview of all the products that make up the vSphere 5 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 selecting the physical hardware, choosing your version of VMware ESXi, planning your installation, and actually installing VMware ESXi, both manually and in an unattended fashion.

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

Chapter 4: Installing and Configuring vSphere Update Manager This chapter describes what is involved in planning, designing, installing and configuring vSphere Update Manager. You'll use vCenter Update Manager to keep your vSphere environment patched and up to date.

Chapter 5: Creating and Configuring Virtual Networks The virtual networking chapter covers the design, management, and optimization of virtual networks, including new features like the vSphere Distributed Switch and the Cisco Nexus 1000V. In addition, it initiates discussions and provides 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. This chapter discusses 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. I 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. I also discuss backup options using vSphere's Storage APIs—Data Protection and Data Recovery.

Chapter 8: Securing VMware vSphere Security is an important part of any implementation, and in this chapter I 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. I also touch on the VMware vShield family of products and discuss some techniques for incorporating security through the vSphere environment.

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 Chapter 10 introduces the idea of templates, a mechanism for more rapidly deploying standardized VM images. I also discuss cloning and the concept of a vApp—a specialized container used by vSphere for the distribution of multi-VM environments. I also discuss the OVF standard used by VMware and other vendors for distributing VMs.

Chapter 11: Managing Resource Allocation In this chapter I provide a comprehensive look at managing resource allocation. From individual virtual machines to resource pools to 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 Chapter 13 I 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.

Chapter 14: Automating VMware vSphere Many tasks VMware vSphere administrators face are repetitive, and here automation can help. In Chapter 14 I discuss several different ways to bring automation to your vSphere environment, including vCenter Orchestrator and PowerCLI.

Appendix A: Solutions to the Master It Problems 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

Because of the specificity of the hardware for installing VMware vSphere 5, it can be 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 to follow along with the book; however, the lab will require specific hardware and might be quite costly. Be sure to read Chapter 2 and Chapter 3 before you attempt to construct any type of environment for development purposes.

For the purpose of writing this book, I used the following hardware configuration:

- ◆ Four Cisco UCS B200 blade servers connected to a pair of UCS 6120 fabric interconnects
- ◆ Four Dell PowerEdge R610 servers
- ◆ Several models of Fibre Channel host bus adapters (HBAs) and Fibre Channel over Ethernet (FCoE) converged network adapters (CNAs), including adapters from both QLogic and Emulex
- ◆ Intel X520 10 Gigabit Ethernet network adapters

- ◆ A number of different storage arrays, including
 - ◆ NetApp FAS6080
 - ◆ EMC Symmetrix VMAX
 - ◆ EMC VNX7500
- ◆ Several models of Fibre Channel switches, including Cisco MDS 9134 and MDS 9148, Brocade 200e, and Brocade Silkworm 3800 Fibre Channel switches
- ◆ Several models of Ethernet switches, including Cisco Nexus 5010 and Dell PowerConnect 6248

Clearly, this is not the sort of environment to which most people have access. For entry-level NFS and iSCSI testing, a number of vendors including EMC, HP, and NetApp offer virtual storage appliances or simulators that you can use to gain some familiarity with shared storage concepts and that specific vendor's products. I encourage you to use these sorts of tools where applicable in your learning process.

Special thanks go to Brocade, Cisco, Dell, EMC, Intel, and NetApp for their help in supplying the equipment used during the writing of this book.

Who Should Buy This Book

This book is for IT professionals looking to strengthen their knowledge of constructing and managing a virtual infrastructure on vSphere 5. While the book can also be helpful for those new to IT, a strong set of assumptions is made about the target reader:

- ◆ A basic understanding of networking architecture
- ◆ Experience working in a Microsoft Windows environment
- ◆ Experience managing DNS and DHCP
- ◆ A basic understanding of how virtualization differs from traditional physical infrastructures
- ◆ A basic understanding of hardware and software components in standard x86 and x64 computing

How to Contact the Author

I welcome feedback from you about this book or about books you'd like to see from me in the future. You can reach me by writing to scott.lowe@scottlowe.org or by visiting my blog at <http://blog.scottlowe.org>.



Chapter 1

Introducing VMware vSphere 5

Now in its fifth generation, VMware vSphere 5 builds on previous generations of VMware's enterprise-grade virtualization products. vSphere 5 extends fine-grained resource allocation controls to more types of resources, enabling VMware administrators to have even greater control over how resources are allocated to and used by virtual workloads. With dynamic resource controls, high availability, unprecedented fault-tolerance features, distributed resource management, and backup tools included as part of the suite, IT administrators have all the tools they need to run an enterprise environment ranging from a few servers up to thousands of servers.

In this chapter, you will learn to

- ◆ Identify the role of each product in the vSphere product suite
- ◆ Recognize the interaction and dependencies between the products in the vSphere suite
- ◆ Understand how vSphere differs from other virtualization products

Exploring VMware vSphere 5

The VMware vSphere product suite is a comprehensive collection of products and features that together provide a full array of enterprise virtualization functionality. The vSphere product suite includes the following products and features:

- ◆ VMware ESXi
- ◆ VMware vCenter Server
- ◆ vSphere Update Manager
- ◆ VMware vSphere Client and vSphere Web Client
- ◆ VMware vShield Zones
- ◆ VMware vCenter Orchestrator
- ◆ vSphere Virtual Symmetric Multi-Processing
- ◆ vSphere vMotion and Storage vMotion
- ◆ vSphere Distributed Resource Scheduler
- ◆ vSphere Storage DRS
- ◆ Storage I/O Control and Network I/O Control

- ◆ Profile-Driven Storage
- ◆ vSphere High Availability
- ◆ vSphere Fault Tolerance
- ◆ vSphere Storage APIs for Data Protection and VMware Data Recovery

Rather than waiting to introduce these products and features in their own chapters, I'll introduce each product or feature in the following sections. This will allow me to explain how each product or feature affects the design, installation, and configuration of your virtual infrastructure. After I cover the features and products in the vSphere suite, you'll have a better grasp of how each of them fits into the design and the big picture of virtualization.

Certain products outside the vSphere product suite extend the vSphere product line with new functionality. Examples of these additional products include VMware View, VMware vCloud Director, VMware vCloud Request Manager, VMware vCenter AppSpeed, and VMware vCenter Site Recovery Manager, just to name a few. Because of the size and scope of these products and because they are developed and released on a schedule separate from VMware vSphere, they are not covered in this book.

As of the writing of this book, VMware vSphere 5 is the latest release of the VMware vSphere product family. This book covers functionality found in version 5. Where possible, I've tried to note differences between 4.x and 5. For detailed information on VMware vSphere 4.0, refer to *Mastering VMware vSphere 4*, also published by Sybex.

To help simplify navigation and to help you find information on the breadth of products and features in the vSphere product suite, I've prepared Table 1.1, which contains cross-references to where you can find more information about that particular product or feature elsewhere in the book.

Table 1.1: Product and feature cross-references

VMWARE VSPHERE PRODUCT OR FEATURE	MORE INFORMATION FOUND IN THIS CHAPTER
VMware ESXi	Installation – Chapter 2 Networking – Chapter 5 Storage – Chapter 6
VMware vCenter Server	Installation – Chapter 3 Networking – Chapter 5 Storage – Chapter 6 Security – Chapter 8
vSphere Update Manager	Chapter 4
vSphere Client and vSphere Web Client	Installation – Chapter 2 Usage – Chapters 3–14
VMware vShield Zones	Chapter 8