Nick Marshall
with Mike Brown, G. Blair Fritz,
and Ryan Johnson
Foreword by Pat Gelsinger

Mastering VMware vSphere® 6.7

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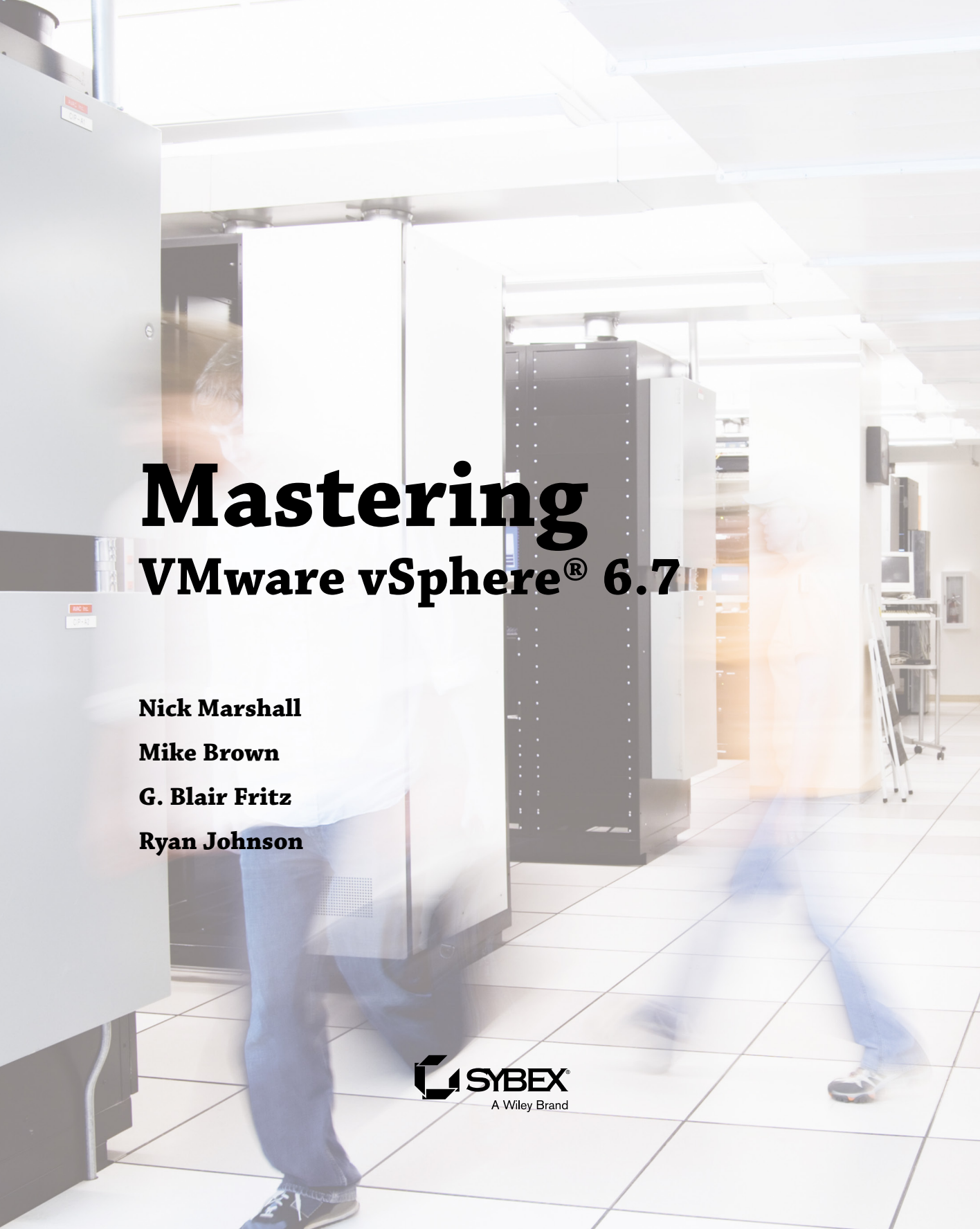
VMware vSphere® 6.7



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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

About the Author

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.

Nick lives in Melbourne, Australia with his wife, Natalie, and their three children, Ethan, Estelle, and Eve.

About the Contributors

The following individuals also contributed to this book.

Mike Brown (Chapters 5 and 6) is a Senior SDDC Integration Architect in VMware's Integrated Systems Business Unit. He currently focuses on Architecture and Design for the core vSphere, Networking, and NSX components of the VMware Validated Designs.

Mike is a double VMware Certified Design Expert (VCDX #71) in Datacenter and Network Virtualization. He also holds many other industry certifications. He has been awarded the VMware vExpert award each year since 2011.

Mike has been working in IT since 1997 where he worked for a small VAR. Since then he has worked both in a customer environment and also as a consultant for a few local companies before joining VMware's Professional Services team in 2012. Since joining VMware, Mike spent two years as a Senior Consultant before moving into the vCloud Suite Technical Marketing Team where he spent another two years before moving into the VMware Validated Design Architect's team.

Mike lives in Houston, Texas with his amazing wife, Courtney, and five children Brycen (11), Brennan (9), Bronson (6), Joy (3), and Joss (1).

G. Blair Fritz (Chapters 3, 4, and 8) is a SDDC Integration Architect in VMware's Integrated Systems Business Unit, alongside Mike, Ryan, and Nick, where he currently focuses on Architecture and Design for the core vSphere, Operation Management (including vRealize Operations and vRealize Log Insight), and Lifecycle Management of the VMware Validated Designs and VMware Cloud Foundation.

Blair has been working in IT since 2003 where he started his adventures by working at The Children's Museum of Indianapolis. Since then, he's had over 15 years of experience as a support engineer and technologist, ranging from systems engineer, staff escalation engineer, technical lead, and solutions architect roles.

Blair lives in Indianapolis, Indiana with his wonderful wife, Jenny, and their two dogs, Theo and Olive. When he isn't working, you'll likely find him bike riding, playing tennis, or playing Dungeons and Dragons.

Ryan Johnson (Chapters 11, 12, and 14) is a Senior Solutions Architect in the Integrated Systems Business Unit at VMware where he is an architect, author, and product owner for both the VMware Validated Designs and VMware Cloud Foundation.

Ryan has over 23 years of experience as a technologist, ranging from systems engineer, enterprise architect, and solutions architect roles.

Ryan lives in Tallahassee, Florida with his incredibly patient wife, Darcie, and their two creative boys, Nolan and Parker. You are likely to find him on one of many nearby trails.

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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.