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- Dynamically control storage services

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Pat O'Brien



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Software-Defined Storage For Dummies®, VMware Special Edition

Published by
John Wiley & Sons, Inc.
111 River St.
Hoboken, NJ 07030-5774
www.wiley.com

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ISBN 978-1-119-12586-0 (pbk); ISBN 978-1-119-12587-7 (ebk)

Manufactured in the United States of America

10 9 8 7 6 5 4 3 2 1

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Publisher's Acknowledgments

Some of the people who helped bring this book to market include the following:

Development Editor: Elizabeth Kuball

Copy Editor: Elizabeth Kuball

Acquisitions Editor: Katie Mohr

Editorial Manager: Rev Mengle

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Felicity Whyte

Production Editor: Kinson Raja

Introduction



Welcome to *Software-Defined Storage For Dummies*, your guide to catching the wave that's sweeping through today's data centers.

Why should you care about catching the SDS wave? Start with the big picture:

You can't change the fruit without changing the root.

—Stephen R. Covey

In this case, the fruit is the return on your storage investment. Are you getting all you can get from your investment? Probably not, if you're using conventional storage approaches.

To get more fruitful returns on your storage investment, you have to change the root — your storage architecture — so you put less capital and staff time into storing and managing data.

Software-defined storage, or SDS, does just that. SDS transforms how storage is provisioned and managed to help you cut operational and capital costs, increase IT and business agility, and improve application performance.

How do you get there? The first step is to immerse yourself in the concepts of this new approach to storage. That's what this book is about.

About This Book

Don't let this book's small size fool you. *Software-Defined Storage For Dummies* is loaded with information that can help you understand and capitalize on software-defined storage. In plain and simple language, this book tells you

- ✔ What SDS is all about
- ✔ Why it's such a hot topic

- ✓ How you get started
- ✓ Where you get the biggest bang for your SDS buck

Foolish Assumptions

This book makes a few assumptions about you. If you're reading this book, you're probably in storage management:

- ✓ You work in an IT shop.
- ✓ You're familiar with storage terminology.
- ✓ You understand the concept of virtualization.

Icons Used in This Book

To make it even easier to see the most useful information, *For Dummies* books use these eye-catching icons.



This book is designed to work as a reference book that you don't need to memorize. But this information marked with the Remember icon is so valuable, it's worth remembering, even if you don't memorize the whole book.



Check passages marked with the Technical Stuff icon for a detailed technical explanation.



Follow the target for advice that can save you time and effort.



Watch out for these potential pitfalls on the road ahead.

Where to Go from Here

For more information on SDS, check out www.vmware.com/products/virtual-san.

Chapter 1

The Data Center Has Evolved — Has Your Storage Kept Up?

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In This Chapter

- ▶ Moving to a software-defined data center
 - ▶ Highlighting new requirements for storage
 - ▶ Exploring concerns with current storage architectures
-

Have you seen an IT pro in pain over storage issues? Just look around your data center. Maybe you can look in the mirror.

In the enterprise IT landscape, storage always has been a thorny issue for IT leaders and administrators. Without fundamental changes, storage problems will only get worse, as business moves further into the world of digital everything. That's because storage demands are exploding.

How fast is data growing? According to research by IDC, the *digital universe* (the data we create and copy annually) is doubling in size every two years. By 2020 it will reach an unfathomable 44 zettabytes (44 trillion gigabytes).

This problem affects more than one part of a business. The coin has two sides:

- ✔ On one side, virtually every part of every organization is pushing the limits. They're generating more information, demanding new kinds of access, and planning to keep it

forever (or nearly so). In some cases, the need to acquire and harness information drives entire business models.

- ✔ On the flip side, cloud-savvy end-users are increasing their expectations. They expect ever-better performance for their applications and ever-faster responses from the IT organization.

When you put both sides together, users are demanding what a software-defined data center offers.

The Rise of the Software-Defined Data Center

The *software-defined data center* (SDDC) promises to change how IT services are delivered. *Static, inflexible, and inefficient* transform to *dynamic, agile, and optimized*. In other words, SDDC transforms from the *past* to the *future*.

In this new, software-defined world, all IT infrastructure elements (including compute, networking, and storage) are virtualized and delivered as a service. Resources are automatically deployed, with little (or no) human involvement. Everything is highly automated, controlled by software, and governed by policies that incorporate the logic of business requirements for IT.

In an SDDC, you don't spend weeks provisioning the infrastructure to support a new application. You can get an application running in minutes. That means

- ✔ Super-fast time to value
- ✔ Really happy business executives



For perspective, consider this: In many ways, the SDDC is the natural extension of server virtualization. Just as server virtualization helps you squeeze more value out of your computing systems, the SDDC helps you squeeze more value out of all the resources you use to host an application.

The software-defined approach is a much-needed framework for greater IT agility and more responsive IT service delivery, all at a lower cost. It's the key to the data center of the future — including the storage environment.

New Requirements for Storage

Data storage capacity is growing like crazy. According to research firm IDC, storage capacity is growing at an annual rate of *41 percent*.

That capacity growth comes with good news — and bad news:

- ✓ **The good news:** The cost of *storage hardware* continues to shrink.
- ✓ **The bad news:** The costs of *increased capacity, increased performance, and management complexity* often exceed the hardware cost reductions.

For many environments, storage now is the lion's share of IT spend. As volumes grow from terabytes to exabytes, storage efficiency is attracting more scrutiny from the business.

Additionally, end-user expectations are increasing because of the widespread use of server virtualization, the rise of cloud-based services, and the emergence of scale-out applications. End-users now expect better application performance and faster responsiveness from the IT services organization.

These expectations put more pressure on your IT team to increase infrastructure efficiency, while controlling cost.

You also need to consider these storage issues. They're among the most pressing challenges that end-users identified about storage systems, according to IDC research data:

- ✓ Meeting application service-level agreements (SLAs)
- ✓ Dealing with management complexity
- ✓ Troubleshooting IT issues

For many IT professionals, storage is the most important component when planning an SDDC implementation.

Exploring Issues with Current Storage Architectures

To achieve the potential of the software-defined data center, all the key components of the IT infrastructure must be virtualized, so they can be automated and controlled by software. This requirement foreshadows big changes for existing storage infrastructure that was built for the past.

In simple terms, old storage architectures have a hard time keeping up with the demands of the SDDC, let alone the demands of the digital era. But current storage infrastructure isn't all wrong. The reality is that storage today is a mixed bag. There are both the very good and the very not-so-good:

- ✓ On the upside, modern storage arrays offer great capabilities for storing, managing, and protecting data.
- ✓ On the downside, today's storage arrays are largely worlds unto themselves, like walled cities with their own cultures and their own ways of doing things.

The enterprise storage model hasn't changed much in the last 20 years: Providing storage services means acquiring *dedicated storage arrays* and surrounding them with *dedicated operating teams*. This model sometimes worked in the terabyte world, but not in today's petabyte and exabyte world.

Yesterday's enterprise storage model has many shortcomings:

- ✓ Most organizations rely on purpose-built, dedicated storage arrays. Each array has its own specialized functionality and operational procedures.
- ✓ Application needs and storage services aren't aligned. Application owners and virtual administrators can't easily or precisely specify what they need, and when they need it. The result is either
 - An inability to meet SLAs for applications
 - Overprovisioning of storage capacity and services

✓ Operational workflows are stove-piped between storage teams and application and virtualization teams.

Requests are made, meetings are held, sticky notes are posted on monitors, work is scheduled — and time is lost.



A gap is growing between storage architectures and SDDC requirements. Your organization needs a new approach to your storage architecture.

Chapter 2

A New Approach: Software-Defined Storage

In This Chapter

- ▶ Exploring the DNA of SDS
- ▶ Interpreting the role of the hypervisor
- ▶ Grasping the promise of SDS

The idea of the hypervisor is to bring to storage the same operational efficiency that server virtualization brought to compute. To do this, the VMware SDS model puts the application and its requirements at the top of the IT food chain; storage resources respond to the dynamic changes in application requirements. Now the application is the boss; the supporting resources are the workers who make sure the boss gets what he needs, when he needs it.

This is a change from the conventional *bottom-up* hardware-centric approach. This conventional approach usually requires your storage admins to create static pools of storage resources, then hope for alignment between the application's needs and the pre-provisioned storage services. This time-worn approach leads to wasted resources (because of overprovisioning to ensure against future growth).



A *storage service* is some combination of storage attributes needed by an application (such as capacity, performance, protection, encryption, or replication). SDS is all about changing how storage services are manipulated and automated.

Exploring the DNA of SDS

Before diving into the components of SDS and their interactions, there are a few core concepts and key attributes to understand in VMware's software-defined storage. Your IT shop may require different solution components based on your specific needs, but all of these concepts are important to an understanding of SDS as a whole.

A robust SDS environment delivers the following benefits:

- ✔ **Runs on x86 industry-standard hardware:** Although traditional external arrays will be part of the IT landscape, new storage architectures enable a new path to an SDDC. Software-only storage products that use your familiar x86 servers to deliver storage services give you more freedom and flexibility. Using commodity server hardware, you can design your environment to adjust to specific, ever-changing storage needs. These new storage architectures enable *hyper-converged infrastructure* (HCI). Chapter 3 has the details.
- ✔ **Supports conventional storage arrays:** When IT organizations bring in new technologies, they put a premium on the ability to continue to use existing investments. And that's the case with SDS. You control your existing storage solutions under SDS, where they can share in all the goodness described here.
- ✔ **Enables application-centric storage services:** SDS enables storage services to be tailored to the precise requirements of an application and adjusted as needed for each application, without affecting neighboring applications. Storage services become fluid; a little more for this application, a little less for that one.
- ✔ **Enables policy-driven automation:** In SDS, IT admins set policies for requesting, monitoring, and adjusting storage services for specific applications. SDS then enables the storage layer to figure out how to best satisfy those requirements.
- ✔ **Enables dynamic storage services:** Most of today's storage products use a static model to deliver storage services. All classes of service are physically pre-provisioned in storage volumes or logical unit numbers

(LUNs). SDS uses a dynamic model, like with virtualized compute. IT admins can precisely match demand and supply, according to specific application requirements, in the exact time the resources are needed.

- ✔ **Supports programmability:** SDS allows you to control the storage infrastructure using third-party cloud automation solutions or custom scripts that tap into application programming interfaces (APIs). This is the essence of anything software-defined — it allows for automated management of IT (particularly important for large-scale environments).

The Role of the Hypervisor

Okay, hypervisors enable virtualization. But what exactly is a hypervisor?

In the simplest terms, the *hypervisor* is a software package that delivers the necessary abstraction to decouple applications from the underlying hardware. Basically, a hypervisor breaks the ties that bind an application to a particular piece of hardware.

The hypervisor allows a physical server to act as a host for multiple guest operating systems. It parcels up a single machine into various *virtual machines* (VMs); each VM acts like its own system and runs its own applications. In the background, the hypervisor controls how the underlying server resources are accessed by the VMs.

With the widespread adoption of server virtualization, the hypervisor is everywhere in today's data centers. It has emerged as the standard platform for enterprise applications.

Consider these findings:

- ✔ **Server virtualization has become the de-facto platform to run enterprise applications.** According to Gartner Research, more than 70 percent of x86 server workloads have been virtualized. Most enterprises now operate with a *virtual first* policy — which means applications are deployed on virtual platforms by default.

- ✓ **IDC predicts that by 2018, more than 73 percent of storage capacity shipped for x86 platforms will be deployed in virtual environments.** This new reality makes server virtualization and VMs the primary workhorses for the storage infrastructure.

Driving Storage Innovation through the Hypervisor

The hypervisor has a long track record when it comes to storage innovation. In the specific case of VMware, the hypervisor has enabled all kinds of capabilities in the VMware vSphere environment to improve the management of storage systems.

A few examples:

- ✓ vSphere Thin Provisioning allows you to over-allocate storage capacity to increase utilization and simplify capacity management.
- ✓ vSphere Storage DRS continuously balances storage space usage and storage I/O load to help you prevent resource bottlenecks and meet your targeted application service levels.
- ✓ vSphere Replication enables you to replicate virtual machines across any kind of storage systems for data protection and disaster recovery.

With SDS, VMware continues along this path of driving storage transformation through the hypervisor. The ultimate goal is to bring to storage the same level of operational efficiency that server virtualization brought to compute. And this big step forward begins with the hypervisor.

The Hypervisor: The Ideal Place to Deliver SDS

Given its unique position — between the physical server and the VMs that run on it — the hypervisor has a unique vantage point. It basically sees everything, including applications and the host hardware.

This privileged location in the IT stack leaves the hypervisor uniquely positioned to act as a broker that balances the needs of a VM and the applications it runs — including requirements for compute, networking, and storage. The hypervisor has the eye-in-the-sky view that's needed to make intelligent placement decisions and manage ongoing workload optimizations.



Why can the hypervisor act as a broker between applications and storage services? It's because of awareness and position:

- ✓ On one hand, the hypervisor is inherently *application-aware*. It has a direct line of sight into each application running on the VMs that are connected to the host server. It understands the application's storage requirements — that's part of its job.
- ✓ On the other hand, the hypervisor is *positioned in the I/O data path* between the host server and the hosted virtual machines, and it manages the underlying storage infrastructure. This coveted position allows the hypervisor to turn rock-hard physical resources into fluid pools of storage capacity and capabilities that can flow into applications as needed.

A New Abstraction to Store Your Data

The first big concept in SDS is the idea of abstracting physical storage constructs to allow flexible and precise consumption according to application requirements. In simple terms, SDS makes storage resources inherently aware of virtual machines, so you can have finer control over your storage, all the way down to the VM level.

There are two fundamentally different paths for abstracting storage to make it VM-aware. Here's the story.

Path 1: Specialized storage hardware

The first form of abstraction assumes that you continue to use your traditional storage architecture based on either storage

area network (SAN) or network-attached storage (NAS) systems. To enable this abstraction, SDS uses a new integration framework between the hypervisor and the traditional storage systems. Chapter 5 covers it in detail.

Path 2: x86 hardware

The second form of abstraction allows you to transition to flexible storage that uses industry-standard x86 hardware (not specialized, purpose-built storage hardware). Lots of good things result from this change. With the use of storage components built into industry-standard hardware, the storage environment bypasses the roadblocks that are built into conventional storage architectures.

The new software-defined systems are known as *hyper-converged infrastructure* (sometimes referred to as *server SANs*). This approach rewrites the old CapEx and OpEx rules for enterprise storage. Storage components no longer cost premium prices. Your IT shop is free to select the specific components that best meet your particular requirements for performance, cost, and capacity.

With hyper-converged infrastructure, storage components share compute and memory with the server infrastructure. This eliminates the need for separate storage arrays, controllers, memory, storage area networks, and more. All storage technologies are fully integrated into the virtualization cluster. It's like having a SAN tucked inside a server.



Today, there are two ways to implement this new storage architecture. These two approaches may seem a lot alike, but they're very different.

- ✓ Third-party software running in virtual machines that sit *on top of* a hypervisor (not *in* a hypervisor) to create *virtual storage appliances*, or VSAs.
- ✓ Storage functionality integrated directly *into* the hypervisor. This architecture is called *hyper-converged storage*. Chapter 3 explains this concept in detail.

A New Way to Manage Your Storage

The second key concept in software-defined storage is the notion of transforming the control plane to make it all about the application, not all about the hardware.



In simple terms, SDS changes the control plane to allow application requirements (not hardware resources) to drive your storage decisions.

Historically, storage-services management revolved around a rigid list of requirements for capacity, performance, protection, and other storage needs. These requirements were communicated from one team to another, then physically implemented as either LUNs or storage volumes. When they were executed, there was little room for change. The requirements were pretty much set in stone.

SDS rewrites this script. Application-centric storage policies replace this hardware-centric approach. Storage policies are associated with the virtual machines that run an application; these policies are automatically pushed down to the storage layer for implementation. Here's the payoff:

- ✓ Storage policies and the service levels they control are easily and dynamically changed as an application goes through its lifecycle, moving from development and testing to rollout and full production.
- ✓ It's far less wasteful than hardware-specific policies. Applications get exactly the storage services they need, when they need them, without routinely overprovisioning capacity or data services.
- ✓ The SDS control plane is a common standardized management approach that works and spans across different storage types and tiers. The control plane becomes a unified command-and-control center for your storage environment. You can manage the new hyper-converged storage architecture, plus traditional storage solutions (such as SAN and NAS), and collect all the benefits of application-centric storage policies.



SDS delivers a new abstraction for storage and a new control plane:

- ✓ Abstraction can be implemented on traditional storage, or you can implement an entirely new hyper-converged infrastructure architecture that abstracts storage resources attached to x86 server hardware.
- ✓ The control plane is a new dynamic way to manage storage services that is common across different types of storage.

The Promise of SDS

Basically, software-defined storage puts the application and its requirements at the top of the IT hierarchy. Now storage can respond to dynamic changes in application requirements.

SDS uses policies to create a *just-in-time* model for storage service delivery. Storage assets and capabilities aren't configured and assigned to specific applications until they're needed. Should the policy change, the storage environment responds with the requested new service level.

What matters are the needs of your business. In an age of digital everything and cloud-savvy end-users, you need to quickly deploy IT applications that dynamically adjust storage services so you deliver consistently great performance. Software-defined storage helps you get there today.

SDS creates a compelling opportunity for your IT team to fundamentally re-envision how data is stored and managed. Through the introduction of new technologies and associated operational models, you can get ahead of rising storage costs and deliver better and more tailored storage services.



Software-defined storage allows you to precisely and automatically match storage supply to application demand.

Chapter 3

A New Form of Storage for VMs: Hyper-Converged Infrastructure

In This Chapter

- ▶ Exploring hyper-convergence
- ▶ Introducing hyper-converged infrastructure
- ▶ Explaining the value of hypervisor integration

Hyper-converged infrastructure, or HCI, is a hot topic in IT circles. This chapter introduces this software-defined approach to data storage.

The road to understanding hyper-converged infrastructure and its storage architecture begins with a few simple facts:

- ✓ Compute, storage, and networking resources are delivered through a single x86 server platform.
- ✓ The server platform runs a hypervisor and includes virtualized storage devices.
- ✓ The storage software runs either in the hypervisor or in a virtual machine (VM).
- ✓ The storage components are typically a mix of hard disk drives (HDDs) and solid state drives (SSDs).

Hyper-converged infrastructure implements *shared storage* by pooling the storage resources distributed across multiple server nodes. You essentially end up with a storage area network inside an x86 server system.

In the simplest terms, hyper-converged infrastructure is a new way of abstracting storage attached to x86 servers, in order to use them as part of a virtualized environment.

Trends Driving Hyper-Convergence

The hyper-converged engine is fueled by two key technology trends: new flash memory technologies that reside on servers, and more powerful servers. Hyper-convergence harnesses them for more performance and less total cost.

New flash technologies

High-density flash and non-volatile memory technologies are rapidly evolving. These technologies can accelerate storage performance and reduce read-and-write latency.

But there's a catch: To fully realize the potential performance gains of these new memory technologies, you must eliminate the *network hop* where data passes through bridges, routers, or gateways. The goal is to bring the data much closer to the CPUs — onto the same server. This is the hyper-converged approach, which gets a big boost from flash technologies.

As the cost of flash devices continues to decrease, the price per IOPs becomes more attractive — and leads to more adoption of hyper-converged infrastructure.

More powerful servers

With new multicore CPUs, industry-standard x86 servers keep getting more powerful. They're so powerful that they can handle the workload requirements of high-performance storage in enterprise environments.

Here's where things get really good. The cost of x86 hardware, including flash memory, usually is a bargain compared to purpose-built storage devices. Hyper-converged infrastructure cashes you in on the cost savings of today's off-the-shelf servers.

Given its advantages, hyper-converged infrastructure is inevitable. In the coming months and years, you'll see it in data centers everywhere.

The VMware Approach to Hyper-Converged Infrastructure

There are two approaches to hyper-converged infrastructure. Although they may seem similar, these approaches are fundamentally different:

- ✓ Bolting storage software *onto* a hypervisor (see the nearby sidebar)
- ✓ Building the storage software *into* the hypervisor

The common bolt-on approach to hyper-convergence runs third-party storage software in virtual machines that sit on top of a hypervisor.

Although it enables hyper-convergence, the bolt-on architecture approach has some distinct disadvantages. These limitations stem from the creation of a separate storage layer that runs as a guest VM with dedicated resources.

Some of the biggest disadvantages of bolt-on hyper-convergence are

- ✓ Excessive resource use
- ✓ Potentially lower performance
- ✓ Limited integration with the existing management and operational environment

The VMware approach to *hyper-converged infrastructure* is “built in.” In this innovative approach, the storage software is built into the hypervisor. This means convergence does not happen *on* the hypervisor using a virtual appliance, but instead happens *inside* the hypervisor.

The advantages of the hyper-converged approach are compelling:

- ✓ Reduced resource use
- ✓ Better performance
- ✓ Tight integration with the SDS management and operational model



Here are a few examples of the advantages of built-in hyper-converged storage:

- ✓ There's no need to dedicate certain virtual CPUs (vCPUs) to a virtual storage appliance (VSA) on a per-host basis.
- ✓ There's no need to reserve CPUs for the worst-case scenario. CPU resources are used only when they're needed.
- ✓ You save CPU cycles by going through *one* stack (hypervisor), not *two* (hypervisor plus a guest OS of the VSA). It's plain math.



With hyper-converged storage, convergence takes place *in* the hypervisor, not in a virtual machine that runs *on* the hypervisor.

Attributes of Hyper-Converged Storage

Hyper-converged storage has several essential characteristics. It enhances performance, administration, and physical upgrades.

Integration with the hypervisor

Any hyper-converged solution uses the hypervisor to support and deliver storage functions in software. There's no need

for separate dedicated hardware, such as a storage array or a Fiber Channel switch.

This means there are fundamental performance and operational advantages in storage software that's built from the ground up to be integrated with the hypervisor.

Performance advantages

Because software-defined storage depends on the hypervisor, the hypervisor is like the engine that moves the load along. So top-notch hypervisor performance is key to top-notch storage performance.

In the case of the VMware vSphere virtualization environment, the ESXi hypervisor is specifically designed to offer great storage performance. This didn't happen by chance. The ESXi hypervisor has been optimized for external storage arrays for more than ten years. With hyper-converged designs, the functionality that used to be implemented by the disk array moves onto the same hosts where the workloads or VMs run.

Operational advantages

Operational advantages are perhaps the biggest win of the hyper-converged approach. A hyper-converged storage approach is built from the ground up to integrate and leverage all the functionality of the hypervisor, without more operational overhead or any reduction of core functionality.

If you use the VMware vSphere environment, you probably appreciate the functionality of your virtualization layer (including such things as vSphere High Availability [HA] and vSphere vMotion). Presto! Now you can have the same functionality in vSphere-based hyper-converged storage, because it's all embedded in the hypervisor.



The VMware hyper-converged approach also delivers the storage abstraction that enables operations at the VM level and management through the new SDS control plane. The details are in Chapter 4.

Independence from hardware

To deliver the full value and flexibility of SDS, and ultimately the SDDC, a hyper-converged storage solution shouldn't be tied to any specific hardware platform. This is where a hyper-converged SDS solution, delivered through the hypervisor, offers maximum value:

- ✓ **True SDS allows storage vendors to integrate their products with the storage software to deliver various options.** They can offer everything from reference architectures to long lists of supported components that you can use to customize your storage infrastructure. The flexibility of hyper-converged SDS puts the end-user in the driver's seat.
- ✓ **There's a fast track to hyper-converged infrastructure through a growing range of prepackaged solutions.** These offerings are delivered as hardware appliances with locked-down configurations. It's a little less flexible, but you gain the immediate benefits of hyper-convergence for targeted storage needs.

Elastic, nondisruptive scaling

Hyper-converged storage is designed with a distributed architecture that allows for elastic, nondisruptive scaling. This is a key architectural advantage of using the x86 platform. You can run your data center in a modular fashion, like a cloud service provider.



This *grow-as-you-go* model helps you spread your investments over time.

There are two ways to scale. They're both pretty simple:

- ✓ **Scaling out** increases capacity and performance at the same time by adding a new host to the cluster.
- ✓ **Scaling up** increases capacity and performance independently by adding new drives to existing hosts.

Your best option for scaling up depends on your needs:

- Add flash devices for maximum speed.
- Add hard disk drives (HDDs) for low-cost capacity.



The ideal storage for VMs

After reviewing all the characteristics of hyper-converged storage, it's apparent that this new approach offers advantages that make it the ideal storage for virtual machines.

The most valuable advantages of hyper-converged storage include

- ✓ Better price-performance — the gains you expect with today's servers
- ✓ Integration of storage with the hypervisor and its powerful capabilities

- ✓ Flexible options for deploying and scaling your storage environment

Such benefits are the reasons that hyper-converged storage has become the ideal storage for VMs. It's the purest form of software-defined storage and the fastest onramp to the SDDC.

The VMware Implementation: Virtual SAN

The VMware implementation of hyper-converged storage, VMware Virtual SAN, provides hyper-converged software-defined storage for virtual machines.

Virtual SAN brings server-attached hard disk drives and solid state drives into clusters of storage capacity. It creates a shared datastore designed for virtual environments. This datastore is highly resilient and optimized for flash memory.

Virtual SAN works with both flash and hard disk drives in standard x86 servers to deliver enterprise-class storage for virtualized applications. This is high-performance storage that's built for the challenges of your business-critical applications.

Even better, Virtual SAN works seamlessly with VMware vSphere and the rest of the VMware software stack. This makes it the simplest storage platform for your virtual machines.



Keep these key facts in mind:

- ✓ Virtual SAN is storage software that's built into the VMware vSphere hypervisor.
- ✓ Virtual SAN takes the flash and disk drives inside servers and turns them into a pool of shared storage.
- ✓ Virtual SAN provides resilient, incredibly fast, enterprise-grade storage services.

Because Virtual SAN is embedded inside the vSphere kernel, Virtual SAN can deliver the highest levels of performance without taxing the CPU with additional overhead. This is a major difference from the many virtualized storage appliances that run separately on top of the hypervisor.



Virtual SAN can be configured as either *all-flash* or *hybrid* storage. In a hybrid storage architecture, Virtual SAN pools server-attached HDDs and SSDs to create a distributed shared datastore:

- ✓ Flash is used as a read cache/write buffer to accelerate performance.
- ✓ HDDs are used for data persistence.

This implementation cost-effectively delivers very high performance.

Chapter 4

Transforming the Operational Model

In This Chapter

- ▶ Taking operations down to the VM level
- ▶ Using policy-driven automation
- ▶ Enabling dynamic control of storage services
- ▶ Leveraging public APIs

Ready to jump down into the trenches of storage operations? This chapter shows how software-defined storage transforms storage operations.

Taking Operations Down to the VM Level

At its essence, enterprise IT is all about application delivery. That's how users see the world: through the lens of their applications. Software-defined storage is in sync with this view. With SDS, you can adjust all your storage services for specific applications and the VMs where they reside.



SDS conforms to how users see the world, not how IT defines infrastructure components.

This is quite different from the status quo in storage. Today's storage devices usually have poor knowledge of applications. They see the world as storage-centric LUNs and file systems; each offers a container with a static combination of capacity, performance, and protection.

Leveraging the storage abstraction that SDS delivers at the data plane level (for example, created by your hyper-converged storage solution), SDS gives you much finer control over storage services, all the way down to the VM level. This means you can create storage services driven by application requirements, not by physical storage constraints. In other words, it's all about the needs of the applications and the end-users, *not* the backend hardware.

Automation Driven by Policies

To enable more efficient operations, SDS uses storage policies to drive automation. You can set policies for an application's requirements for capacity, performance, availability, redundancy, and the like.



Basically, policies are templates that spell out storage requirements for virtual machines and the applications they run.

The management control plane (introduced in Chapter 2) automates VM placement. It does this by identifying available datastores that meet the application's storage requirements. This allows you to avoid the tedious work that comes with provisioning VMs on a case-by-case basis.

The combination of automation and policy-based management helps you simplify storage management. Better, it helps you quickly deliver value to your customers — the people who use your IT services. For example:

- ✓ Application admins can consume storage as a service, without being slowed down by the service-fulfillment bottlenecks that come with conventional approaches to storage provisioning.
- ✓ Storage resources are provisioned to the precise requirements of an application. The application admins get just what they need, without costly overprovisioning.



After storage policies are configured, your application admins can choose their needed application or virtual machine template. The control plane's policy engine reads the associated storage policy and then precisely provisions storage resources to match the application's requirements.

Dynamic Control of Storage Services

With today's static storage model, storage admins must estimate (or make guesstimates) about the needs of different applications well in advance of deployment. They then acquire the physical hardware and allocate it into pre-provisioned resource pools with different service levels for capacity, performance, and protection. At that point, the application is made available for consumption.

It's easy to see why this conventional model isn't ideal. Here are a few of the many problems with this approach:

- ✓ If an application's requirement doesn't precisely fit one of the pre-established storage service levels, the storage admins must make compromises.
- ✓ If an application's requirements move outside the range provided by the predefined storage resource pool, the storage admins must do more work to move the application to the appropriate pool.
- ✓ If actual aggregate storage demand doesn't line up with the pre-allocated buckets, resources either are wasted or don't meet demand.

Software-defined storage shatters the conventional mold. With SDS, all hardware and software resources are presented as large pools of storage services that can be allocated to applications. When application requests come in for a specific storage service, SDS dynamically configures the precise mix of data services — just the right amount of capacity, performance, and protection — to meet the needs of the application.

Much as you do with virtualized compute today, a software-defined storage environment enables your IT team to precisely match demand and supply — without having much foreknowledge of the specific application requirements. You're prepared for whatever comes your way.

Programmable via APIs

As shown in Chapter 2, APIs are at the heart of anything that's software-defined. APIs give you the flexibility to tailor your SDS environment to different use cases.



Specifically, the policy-driven control plane provides integration points, using APIs, to enable the agile delivery of IT services in private cloud environments and self-service consumption of storage services by application owners. These APIs allow you to integrate your SDS environment with data center management tools, such as scripting and cloud automation solutions for self-service consumption of storage.

The VMware Implementation: vSphere Storage Policy- Based Management

In a VMware environment, the foundation for the policy-based control plane is called VMware vSphere Storage Policy-Based Management (SPBM, for short).

SPBM allows you to capture your storage requirements for capacity, performance, and availability in the form of templates, called *VM storage policies*. Based on these policy templates, SPBM automates the provisioning and monitoring of storage services. As the needs of individual VMs change, SPBM gives them the storage resources they need. All this adds up to faster storage provisioning for new applications.

The use of policies also simplifies the change process. The virtual infrastructure (VI) admin can make changes to policies at any time, and the necessary infrastructure changes are configured through automation. This makes it easier to keep your applications in step with the changing needs of the business.

The combination of Virtual SAN and SPBM gives you the full SDS stack — both data plane and control plane — in a hyper-converged infrastructure architecture, with all software components delivered by VMware.

Chapter 5

Managing Traditional Storage through SDS

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In This Chapter

- ▶ Making SAN and NAS arrays VM-aware
 - ▶ Enabling common management across devices
 - ▶ Renewing data center friendships
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A software-defined storage environment is a launching pad for the future. But what about your existing investment? How do you manage legacy systems (including high-value storage arrays) in an SDS environment? Here come the answers.

Making Storage Arrays VM-Aware

Extending the benefits of SDS management to traditional external storage arrays compels the level of abstraction that's required to consume storage flexibly on a per-VM basis. VMware SDS introduces application programming interfaces (APIs) for storage. These APIs define a new communication standard between the hypervisor and the storage array that allows resources to be consumed in new ways.

This new model centers on the application, not infrastructure. Essentially, your external storage arrays become VM-aware. This model creates a new conversation between what applications need and what storage arrays provide. Complex, inefficient manual processes aren't required.



While making storage arrays VM-aware, SDS gives you more control:

- ✓ **Your physical hardware resources become flexible pools of virtualized capacity.** SDS eliminates the need for traditional physical pools of capacity in the form of LUNs. Instead, SDS creates virtual datastores that can be configured and used flexibly. You can change these capacity pools any time without disruption.
- ✓ **You have finer control at the virtual machine level.** SDS defines a new form of storage container that represents the virtual machine disk natively on the array; VM becomes the primary unit of data management at the array level. The container approach turns the virtual datastore into a pool of storage capacity focused on the needs of the VM. After you've made this leap, you can provision native array-based data services to individual VMs, so they get just-right service levels.

When you make storage arrays VM-aware, they can be managed by the SDS control plane. You can leverage these attributes (see Chapter 4) in your SAN and NAS arrays:

- ✓ Taking operations down to the VM level
- ✓ Automation driven by policy
- ✓ Dynamic control of storage services
- ✓ Programmability via APIs

SDS allows the requirements of your applications to drive storage provisioning decisions, which can help you minimize or eliminate overprovisioning.

Enabling Common Management across Devices

The storage industry often tries to define standards to facilitate external control of storage arrays from different vendors. This goal has been difficult to achieve, in part because every storage system speaks its own language. Different systems support different sets of APIs, handle specific requests in their own ways, and communicate results in nonstandard ways. (For example, there are no standard definitions of the exact meaning of a “data snapshot.”)

As a result, multivendor storage environments can be difficult to automate. That's a problem, because the need for heterogeneous storage is increasing. Today's enterprise data centers must support a widening range of applications, and no single storage system meets every application requirement.

By introducing this new set of APIs that use the hypervisor's position of privilege as a hardware-agnostic abstraction layer, VMware SDS facilitates a standard method of communication with any and all external storage arrays. (Chapter 2 has the story.) VMware storage partners then design their storage systems to integrate with VMware vSphere.

With the help of these open APIs, VMware SDS allows you to manage storage devices from different vendors with different models through a common framework. This framework is VMware's SDS control plane, Storage Policy-Based Management. (It's highlighted in Chapter 4.)

Renewing the Friendship between the VI Admin and the Storage Admin

In today's data centers, virtual infrastructure (VI) administrators and storage administrators are caught up in a codependent relationship. Neither can function without the other. This codependency can lead to an IT tug-of-war, with each side pulling on the other to get things done.

Using Storage Policy-Based Management (SPBM), SDS eliminates reasons for this tug-of-war. SPBM simplifies storage operations, automates manual tasks, and eliminates the operational dependencies between the VI admin and the storage admin. SPBM separates the provisioning of storage infrastructure from the consumption of storage by VMs.

In this software-defined world, the VI admin doesn't depend on the storage admin to fulfill infrastructure change requests:

- ✔ The storage admin is responsible for the upfront setup of the storage capacity and data services, which are published as the so-called *virtual datastore*. The storage

admin is always in control of the resources that are available for consumption, so the job is more efficient.

- ✓ The VI admin uses the virtual datastore as a menu of storage items to serve the needs of VMs. The VI admin is self-sufficient — policies can be changed any time. And, like storage administration, VI administration is more efficient because the necessary infrastructure changes are configured through automation.

The VI admin and the storage admin no longer depend on each other to get things done every day. Each can be self-sufficient for many day-to-day tasks. Hey, they can be friends again!



Administrators have two basic roles in an SDS environment:

- ✓ The storage admin makes large resource pools available for dynamic consumption.
- ✓ The VI admin defines policies and monitors execution.

The VMware Implementation: vSphere Virtual Volumes

To extend SDS to your existing external storage arrays, deploy VMware vSphere Virtual Volumes. vSphere Virtual Volumes is the API integration framework that exposes virtual machine disks as native storage objects. This enables array-based operations at the virtual disk level. In other words, vSphere Virtual Volumes makes SAN and NAS devices VM-aware.

The Virtual Volumes framework also allows your storage arrays to integrate with the VMware SDS control plane, SPBM. Through vSphere Virtual Volumes, you can control your existing storage arrays via the VM-level policy mechanism explained in Chapter 4.

vSphere Virtual Volumes is an industry-wide initiative supported by all major storage vendors. This initiative allows you to leverage the unique capabilities of your current storage investments in an SDS environment. With vSphere Virtual Volumes, you can transition easily, without disruption, to a simpler and more efficient operational model that's optimized for virtual environments and works across all storage types.

Chapter 6

Getting Started with SDS

In This Chapter

- ▶ Extending SDS to external storage
- ▶ Exploring options for SDS deployments

This chapter shows the resources you need to implement SDS on your terms and timelines.

Implementing the SDS Stack

VMware Virtual SAN provides hyper-converged software-defined storage designed from the ground up to store virtual machine data in enterprise environments.

By being software-defined and delivered from the hypervisor, Virtual SAN is completely hardware independent; it works with any x86 vSphere-compatible server. This means that, when you're ready to get rolling with SDS, you have a broad range of VMware and third-party components and options for configuring and deploying Virtual SAN nodes, whether you're looking for maximum flexibility or fastest time to market.

There are two ways to implement hyper-converged infrastructure with Virtual SAN:

- ✓ Certified hardware with Virtual SAN Ready Nodes
- ✓ Integrated systems through the EVO family

Certified Hardware with Virtual SAN Ready Nodes

You can deploy Virtual SAN with certified hardware from the OEM vendor of your choice. VMware and server OEMs have jointly validated numerous server configurations that are ready to run Virtual SAN. This approach allows you to build Virtual SAN nodes that cater to different workload capacity and performance needs, by selecting the Ready Node of your choice from the menu of options that are provided by each vendor. The Ready Nodes can be purchased as is or further customized to meet your needs.

In short, Virtual SAN Ready Nodes are ideal as hyper-converged building blocks for large data center environments looking for automation and customizable hardware configurations.

Why choose a Virtual SAN Ready Node?

Virtual SAN Ready Nodes help you simplify the buying decision, take control of your hyper-converged infrastructure, and accelerate time-to-value by providing the following benefits:

- ✔ **Choice of hardware:** Select a server OEM of your choice and choose a Ready Node designed for your workload needs. Each solution profile provides a different price/performance focus.
- ✔ **Easy to order and customize:** Purchase a single SKU preconfigured with CPU, memory, network, I/O controller, HDDs, and SSDs, and also preloaded with vSphere and Virtual SAN. Buy as is or customize to your specific needs.
- ✔ **License options:** Leverage your existing enterprise license agreements or simplify procurement of licenses as a new customer.

Here's how to choose the right Virtual SAN Ready Node:

1. **Refer to the Virtual SAN Hardware Quick Reference Guide** ([http://partnerweb.vmware.com/programs/vsan/Virtual SAN Hardware Quick Start Guide.pdf](http://partnerweb.vmware.com/programs/vsan/Virtual%20SAN%20Hardware%20Quick%20Start%20Guide.pdf)) for pointers on how to identify the hardware requirements for your workload profile and the category of Ready Node that meets your needs.
2. **Choose Ready Nodes from your vendor of choice listed in the VMware Hardware Compatibility Guide that corresponds to the category that you identified for your workload in Step 1.**

Follow the vSphere Compatibility Guide

Be sure to follow the guidelines and advice in the vSphere Compatibility Guide for Virtual SAN. This online tool is regularly updated to provide the latest guidance from VMware. Follow it precisely.



Always verify that VMware supports any hardware components you plan to use for your Virtual SAN deployment.

Create balanced configurations

As a best practice, deploy ESXi hosts with similar or identical configurations across all cluster members, including similar or identical storage configurations. This ensures an even balance of virtual machine storage components across the disks and hosts cluster.

Design for the lifecycle of the Virtual SAN cluster

For both hybrid and all-flash configurations, it's important to scale in a way that you have an adequate amount of cache and capacity for your workloads.



Consider choosing hosts that have disk slots for additional capacity and provide an easy way to install additional devices into these slots.

Size for capacity, maintenance, and availability

A configuration with four nodes (or more) provides more availability options than a three-node configuration. Be sure you have enough storage capacity to not only meet your availability requirements but also allow for a rebuild of components after a failure.

Integrated Systems from the EVO Family

Integrated Systems from the EVO family are powered by VMware's hyper-convergence software, vSphere for virtualization, and Virtual SAN for storage. Integrated Systems combine VMware compute, networking, and storage software with certified partner hardware into hyper-converged infrastructure appliances. The result is an all-in-one, easy-to-deploy, simple-to-manage appliance.

Regardless of the deployment model you choose, with Virtual SAN you gain server-side economics. You can lower your storage capital expenses by taking advantage of lower-cost, industry-standard storage components — while gaining all the other benefits of the SDS operational model.

Extending SDS to Third-Party Storage

vSphere Virtual Volumes introduces a new way of managing storage in virtualized environments by integrating external arrays with the SDS operational framework of Storage Policy-Based Management (introduced in Chapter 4).

All storage vendors apply several basic concepts and ground rules about vSphere Virtual Volumes.



The actual implementation of vSphere Virtual Volumes for each storage type and vendor depends on the vendor. Each vendor defines how to deploy all the necessary components for vSphere Virtual Volumes. The vendor also spells out scalability and technical limitations.

vSphere Virtual Volumes

The concept of virtual volumes (VVol) usually refers to the overall framework that VMware introduced to allow integration of third-party storage solutions with the SDS control plane, SPBM. However, there's also the concept of a virtual volume in the specific context of the storage array that's enabled for vSphere Virtual Volumes.

A virtual volume is a new type of virtual machine object that's created and stored natively on the storage array. The virtual volume is stored in storage containers and mapped to virtual machine files or objects, such as VM swap, virtual machine disks (VMDKs), and their derivatives. Therefore, a group of virtual volumes represents a whole virtual machine on the storage array.

Vendor provider

The *vendor provider* (VP), also known as the *VASA (vSphere APIs for Storage Awareness) provider*, is a storage-side software component that acts as a storage awareness service for vSphere. The VP mediates out-of-band communication between VMware vCenter Server and ESXi hosts on one side and a storage system on the other.

Vendor providers are developed by storage vendors. ESXi hosts and vCenter Server connect to the VP and obtain information about available storage topology, capabilities, and status. Subsequently, vCenter Server provides this information to vSphere clients; it exposes the capabilities that the administrator may apply through storage policies in SPBM.

Vendor providers typically are set up and configured by the vSphere administrator in one of two ways:

- ✓ Automatically through the array vendor's plug-in
- ✓ Manually through the vCenter Server

Storage container

Unlike traditional LUN- and NFS-based vSphere storage, vSphere Virtual Volumes functionality doesn't require preconfigured volumes on the storage side. Instead, vSphere Virtual Volumes uses a *storage container* (SC), which is a pool of raw storage capacity and/or storage capabilities (data services) that a storage system can provide. Depending on the storage array implementation, a single array may support multiple storage containers. Storage containers are typically set up and configured by storage administrators.

Containers are used to define

- ✓ Storage capacity allocations and restrictions
- ✓ Data service capabilities available for consumption through policy settings

Virtual Datastore

A Virtual Datastore is the representation of a storage container in a vCenter Server instance and the vSphere Web Client. The Virtual Datastore has a one-to-one mapping to the storage system's storage container. So, the Virtual Datastore represents the logical pool where individual virtual volumes are created (same as with the storage container). Virtual Datastores are typically set up and configured by vSphere administrators.

Protocol endpoints

Although storage systems manage all aspects of virtual volumes, ESXi hosts don't have direct access to virtual volumes on the storage side. Instead, ESXi hosts use a logical

I/O proxy, the *protocol endpoint* (PE), to communicate with virtual volumes. ESXi uses protocol endpoints to establish a data path on demand from virtual machines to their virtual volumes.

Protocol endpoints are set up and configured by storage administrators.

Configuring vSphere Virtual Volumes

The configuration of vSphere Virtual Volumes requires that both the storage system and the vSphere environment are prepared correctly. From a storage perspective, the components for vSphere Virtual Volumes must be configured. This includes the protocol endpoints and storage containers.

The procedure for configuring the vSphere Virtual Volumes components on the storage system depends on the vendor implementation and the array brand and model. For detailed information on the procedures to configure the vSphere Virtual Volumes required components, refer to the storage system's documentation or contact your storage vendor.

Chapter 7

Seven Reasons to Love SDS

In This Chapter

- ▶ Exploring operational benefits of SDS
- ▶ Highlighting business benefits of SDS
- ▶ Understanding evolving application needs

This book saves the best for last (or next to last, if you're a stickler about chapter numbers). Here's the payoff for software-defined storage (SDS): really good outcomes for business and IT.

Improve Operational Efficiency

One thing stands out when comparing SDS workflows with traditional storage workflows: There are far fewer steps, and they're usually done by far fewer people. This is intentional. Software-defined storage environments are designed to be automated from the outset, not as an afterthought.

Here's an example of how SDS improves operational efficiency: Instead of carrying out the same storage provisioning tasks over and over, you set policies and let software do the job for you initially and then make any necessary adjustments in storage allocations over time.

Enable Dynamic Responsiveness

Application storage service requirements change over time. An application moves from pilot to production. A heavy workload needs more storage resources. Another workload needs to be decommissioned.

In a hardware-centric world, these changes can bring a lot of heavy lifting for your IT staff. But not in the application-centric world of SDS. SDS environments are designed for agility. Change the application policy, and the infrastructure responds transparently and automatically, thanks to Storage Policy-Based Management (SPBM). You gain more reliable service levels and save time and resources.

Improve Precision and Granularity

In hardware-centric conventional storage environments, overprovisioning is the norm. Admins configure static pools of storage resources according to their best guestimates about the maximum storage an application needs. This leads to a lot of wasted capacity.

In an SDS environment, storage services are consumed when they're needed, so there's little (or no) waste. Applications get just the performance, capacity, and protection they need — and no more. In an SDS environment, gross approximations give way to fine adjustments, and overprovisioning becomes a relic of the past.

Enable Flexible Consumption

In traditional storage environments, your hands are tied by the physical storage pre-allocations you make in the form of logical unit numbers (LUNs). If you want something different, go back to your storage admin to check what's available.

In an SDS environment, storage admins can make large virtualized resource pools available for dynamic consumption. They meet the changing needs of virtual machines and the applications they support. The virtual infrastructure (VI) admin then sets policies for individual virtual machines and lets the management control plane do the rest.

Scale Elastically

In hyper-converged infrastructure with Virtual SAN, you can scale in an elastic, nondisruptive manner by leveraging x86 servers for storage:

- ✓ Both capacity and performance can be scaled out at the same time by adding a new host to the cluster.
- ✓ Capacity and performance can be scaled up independently merely by adding new drives to existing hosts; just add solid state drives (SSDs) for more performance or hard disk drives (HDDs) for more capacity.

This grow-as-you-go model provides both linear and granular scaling in an affordable manner. Buy only what you need, when you need it, and spread your investments out over time.

Improve Cost Efficiency

With a hyper-converged infrastructure, you can cut costs by using commodity server hardware as the basis for your storage systems. Off-the-shelf hardware can cut acquisition costs and reduce ongoing maintenance expenses, compared to the costs of buying and maintaining proprietary solutions. The result is an overall drop in capital and operational expenditures.

Prepare for Future Applications

A new style of application is becoming more common in IT environments. Whether it's a mobile application, predictive analytics, or new integrations among existing application components, these newer applications are far more dynamic in their resource requirements than traditional enterprise applications. This puts new demands on your IT infrastructure.

The old approach of making static upfront assumptions about an application's requirements no longer flies. Instead, the underlying infrastructure should be poised to make automatic adjustments to answer the application's changing needs. That's software-defined storage.

Chapter 8

Ten Top Resources for SDS

In This Chapter

- ▶ Highlighting Virtual SAN and vSphere Virtual Volumes resources
- ▶ Linking to videos, white papers, and trial software

Ready for a deeper dive into SDS? Here are ten top resources for Virtual SAN and Virtual Volumes:

- ✔ **Virtual SAN product page** (www.vmware.com/products/virtual-san): Here you can find the basics about Virtual SAN, as well as resources to get you started.
- ✔ **Virtual SAN free trial** (<https://my.vmware.com/web/vmware/evalcenter?p=vsan>): Try Virtual SAN for 60 days at no cost in your own environment.
- ✔ **Virtual SAN hands-on lab** (<http://labs.hol.vmware.com/HOL/catalogs>): Try Virtual SAN for free with this easy-to-use online environment.
- ✔ **Virtual SAN TCO and Sizing Calculator** (<https://vsantco.vmware.com>): Quantify the economic impact that Virtual SAN can have in your environment.
- ✔ **5 Ways Virtual SAN Saves Time and Money infographic** (www.vmware.com/files/pdf/vmw-infographic-vmware-5-ways-virtual-san.pdf): Understand the value proposition of Virtual SAN in five simple steps.
- ✔ **Virtual Volumes product page** (www.vmware.com/products/vsphere/features/virtual-volumes.html): Learn the basics about Virtual Volumes and find resources to get you started.

- ✓ **Virtual Volumes hands-on lab** (<http://labs.hol.vmware.com/HOL/catalogs>): Try Virtual Volumes for free with this easy-to-use online environment.
- ✓ **What's New: VMware vSphere Virtual Volumes white paper** (www.vmware.com/files/pdf/products/virtualvolumes/VMware-Whats-New-vSphere-Virtual-Volumes.pdf): Read this document to understand Virtual Volumes concepts in depth.
- ✓ **Virtual Volumes Getting Started Guide** (www.vmware.com/files/pdf/products/virtualvolumes/vmw-vsphere-virtual-volumes-getting-started-guide.pdf): Use this document to understand the operational requirements of a Virtual Volumes implementation.
- ✓ **VMware storage blog “Virtual Blocks”** (<http://blogs.vmware.com/storage>): Learn about all the latest news and information in the VMware Software-Defined Storage world.

Maximize resources with smarter softer

As the data explosion rumbles on, IT organizations continue to throw more money and manpower at their storage challenges — in terms of new systems, management tools, and admin time. But does that solve the problem? Or does it just mask the symptoms of underlying issues?

Software-defined storage, or SDS, transforms how storage is provisioned and managed to help you make better use of your storage capacity and increase IT and business agility. In other words, SDS delivers a much bigger bang for your storage buck.

- *See the big picture* — learn what SDS is and how it differs from conventional storage architectures
- *Measure the change* — see how SDS shifts the storage focus from hardware to applications
- *Understand the architecture* — explore the DNA of SDS, the role of the hypervisor, and how to implement traditional storage or hyper-converged infrastructure
- *Learn how to get started* — pick up essential skills for the implementation of SDS and explore best practices and common pitfalls

Pat O'Brien is the Senior Content Developer for Petrus LLC, a resource for corporate and consumer technical communication based in Indianapolis, Indiana.



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