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Hyper-Converged Infrastructure

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Learn to:

- Use HCI to eliminate complexity, improve productivity, and reduce costs
- Achieve new levels of IT agility, control, and efficiency
- Dynamically control infrastructure services
- Get on the path to a software-defined data center

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Michael Haag

About VMware

VMware (NYSE: VMW), a global leader in cloud infrastructure and business mobility, helps customers accelerate their digital transformation. VMware enables enterprises to master a software-defined approach to business and IT with its Cross-Cloud Architecture™ and solutions for the data-center, mobility, and security. With 2015 revenues of $6.6 billion, VMware is headquartered in Palo Alto, California, and has over 500,000 customers and 75,000 partners worldwide.

About Intel

Intel (NASDAQ: INTC) expands the boundaries of technology to make the most amazing experiences possible. Intel and VMware have worked together for over a decade to optimize their products for one another. This effort helps maximize customer satisfaction as firms deploy Software Defined Data Center (SDDC) environments today and tomorrow. Information about Intel can be found at **intel.com**.

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Introduction

Welcome to *Hyper-Converged Infrastructure For Dummies,* your guide to catching the hyper-convergence wave that's sweeping through today's data centers.

Why should you care about catching the hyper-convergence wave? Well, as Stephen Covey once said, "You can't change the fruit without changing the root."

In this case, the fruit is the return on your data center infrastructure investments. Are you getting all you can get from your investments? Probably not, assuming you're using conventional approaches.

To get more fruitful returns on your investments, you have to change the root — your data center architecture — so you put less capital and staff time into operating and managing your infrastructure.

Hyper-converged infrastructure (HCI) does just that. HCI evolves how compute, storage, and management are delivered and provisioned to help you cut operational and capital costs, increase information technology (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 the data center. That's what this book is about.

About This Book

Don't let this book's small size fool you. *Hyper-Converged Infrastructure For Dummies* is loaded with information that can help you understand and capitalize on HCI. In plain and simple language, this book tells you

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

- How you can get started
- Where you'll get the biggest bang for your HCI buck

Foolish Assumptions

This book makes a few assumptions about you. If you're reading this book, I assume the following:

- You work in an IT shop.
- You're familiar with data center 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 the following eye-catching icons.

This book is designed to work as a reference book that you don't need to memorize. But 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. If you're short on time, you can skip these passages without missing the main point.

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 HCI, check out the VMware Hyper-Converged Infrastructure site at `www.vmware.com/products/hyper-converged-infrastructure`.

Chapter 1

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

In This Chapter

- Highlighting today's infrastructure challenges
- Exploring the software-defined data center
- Introducing hyper-converged infrastructure

Have you seen an information technology (IT) pro in pain over infrastructure issues? Just look around your data center. Maybe you can look in the mirror.

In the enterprise IT landscape, maintaining an agile data center infrastructure tends to be a source of headaches for IT leaders and administrators. Without fundamental changes, the pain will only get worse, as business moves further into the world of digital everything. That's because the demands on infrastructure are exploding.

A big part of the problem stems from runaway data growth. How fast is data growing? According to research by IDC (EMC Digital Universe Study, with data and analysis by IDC, April 2014), 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 (that's 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, lower-cost infrastructure, and ever-faster responses from the IT organization.

This new era of heightened expectation creates new requirements for your data center. In this chapter, I cover some of these requirements. I also explain the rise of the software-defined data center (SDDC) and what it means for you. Finally, I wrap up the chapter by explaining how hyper-converged infrastructure (HCI) helps you clear a path to the SDDC.

New Requirements for Your Data Center

Data storage capacity is growing like crazy. According to research from IDC, storage capacity is forecast to grow at an annual rate of 32 percent through 2020 (Doc #US41249416/ May 2016).

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 associated with increased capacity, performance, and management complexity often exceed the cost savings on storage hardware.

For many environments, storage now is the lion's share of IT spend. Given that reality, it's no surprise that 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.

The Rise of the Software-Defined Data Center

The SDDC promises to change how IT services are delivered. What was once static, inflexible, and inefficient becomes dynamic, agile, and optimized. In other words, the SDDC builds on the success of server virtualization to evolve the data center from the past to the future.

In this new, software-defined world, all IT infrastructure elements (including compute, storage, management, and networking) 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, especially storage.

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.

Hyper-Converged Infrastructure: The Fastest Route to the Software-Defined Data Center

Okay, we know that the SDDC helps IT pros overcome many common challenges stemming from legacy issues. So, how do you get there? Many roads will move you forward, but the fastest, most direct, and most popular route to the SDDC is HCI. Figure 1-1 shows how the SDDC provides an ideal architecture for private, public, and hybrid clouds, extending virtualization concepts to all data center resources and services.

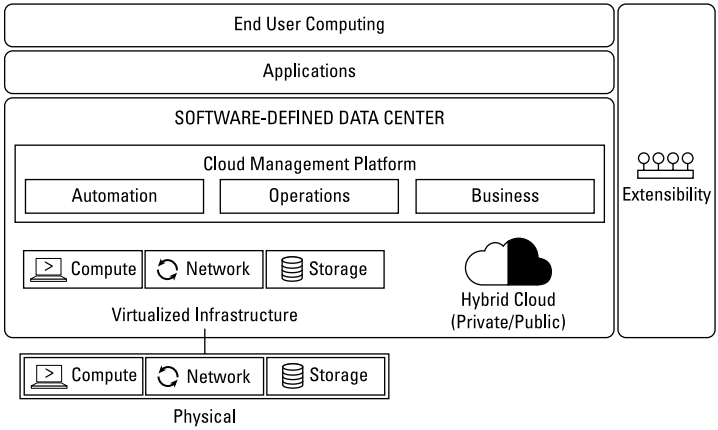

Figure 1-1: The software-defined data center.

HCI is the next big step in the evolution of data center architectures. This ongoing evolution first moved us from traditional silo-based infrastructure to converged infrastructure. And now it's moving us to HCI. In the following sections, I walk you through each of these types of infrastructure.

Traditional infrastructure

The traditional infrastructure model relies on proprietary, purpose-built hardware for storage and networking. These

components form separate silos with their own management software from numerous vendors. They work best when optimized and managed by dedicated specialists. Furthermore, because performance is set at the hardware layer, resources are not properly optimized and overprovisioning often occurs.

Figure 1-2 shows the traditional approach as an expensive solution to a general-purpose IT need. It results in an increased footprint, increased complexity, and increased staffing and specialization. Worse, today's dynamic applications and virtualized workloads require provisioning flexibility that hardware-centric approaches aren't designed to deliver. It's the opposite of simple and streamlined.

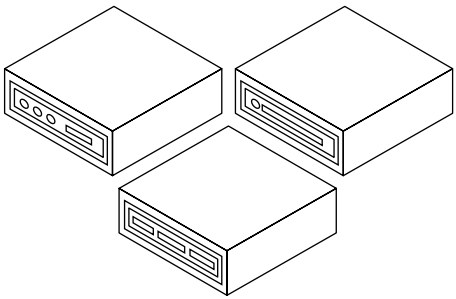

Figure 1-2: Traditional silo-based infrastructure.

Converged infrastructure

A converged infrastructure improves on the traditional model by bringing compute, storage, management, and networking into a single rack, as shown in Figure 1-3. Different specialty vendors typically still provide these elements. The overall management may be integrated and optimized, but separate systems, workflows, and management platforms are still required for many operations and troubleshooting tasks.

In addition, the hardware bundles are preconfigured to run specific workloads and can't be easily altered — resulting in a loss of flexibility. The physical boundaries may have been eliminated, but provisioning and operational challenges remain.

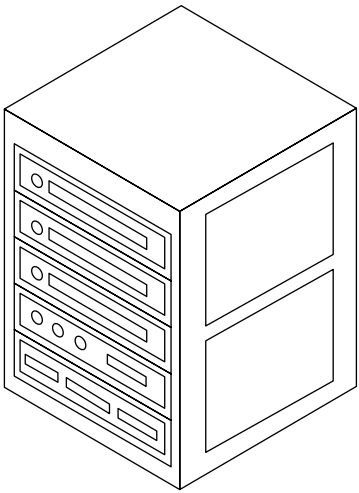

Figure 1-3: Converged infrastructure.

Hyper-converged infrastructure

Hyper-converged solutions take the next step: The storage and compute resource pillars are physically converged onto a single industry-standard x86 server, forming a seamless, software-defined environment well suited to today's IT challenges.

The secret sauce of HCI lies in the hypervisor (the source of the "hyper" in *hyper-convergence*). As shown in Figure 1-4, key data center functions — compute, storage, storage networking, and management — are now running as software on the hypervisor, enabling efficient operations, streamlined and speedy provisioning, and cost-effective growth.

Thanks to benefits like these, the HCI market has a huge amount of momentum. IDC predicts that the market for hyper-converged systems will experience a 60 percent compound annual growth rate from 2014 to 2019, when it will generate more than $3.9 billion in total sales (Doc #255614/Apr 2015).

When you deploy HCI, you're clearing your path to the SDDC. HCI natively integrates compute, storage, and storage networking functions, running them all in software on a virtualized platform along with common management tools. You can then build on your HCI foundation by adding automation and complete network virtualization capabilities to create your full SDDC.

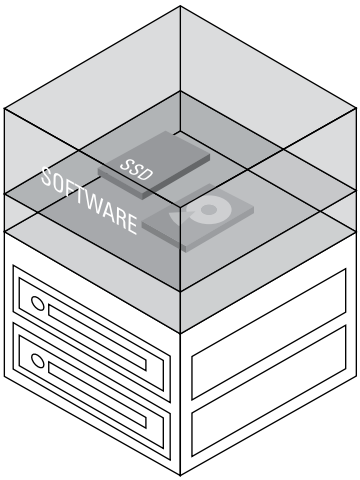

Figure 1-4: A hyper-converged infrastructure software stack.

Even better, you can extend your hyper-converged environment to your existing external storage arrays supported by vSphere to protect your current investments. Arrays that support VMware vSphere Virtual Volumes can be managed under the same storage policy-based management framework. Virtual Volumes is an industry-wide initiative supported by all major storage vendors that can coexist with VMware vSphere–based HCI solutions. This initiative allows you to leverage the unique capabilities of your current storage investments in a software-defined storage (SDS) environment or to simplify the modernization of your data center with non-disruptive migration based on proven features like VMware vSphere vMotion and Storage vMotion.

vSphere Virtual Volumes is an API integration framework that exposes virtual machine (VM) disks as native storage objects. This enables array-based operations at the virtual disk level. In other words, Virtual Volumes makes storage area network (SAN) and network-attached storage (NAS) devices VM-aware.

The Virtual Volumes framework also allows your storage arrays to integrate with the VMware SDS control plane, known as VMware Storage Policy-Based Management (SPBM). Through vSphere Virtual Volumes, you can then control your existing storage arrays via the VM-level policy mechanism. This means you can now transition easily, without disruption,

to a simpler and more efficient operational model that's optimized for virtual environments and works across all storage types.

You can get a deeper understanding of Virtual Volumes by visiting the VMware website at `www.vmware.com/products/vsphere/features/virtual-volumes.html`.

A gap is growing between traditional data center architectures and the requirements of the SDDC. Your organization needs a new approach to your architecture.

Chapter 2

A New Approach: Hyper-Converged Infrastructure

In This Chapter

- Exploring the trends driving hyper-converged infrastructure
- Interpreting the role of the hypervisor
- Highlighting success factors and use cases

This chapter explores some of the reasons hyper-converged infrastructure (HCI) is such a hot topic in information technology (IT) circles. You get a basic definition of HCI, explanation of the traits of a full-bodied solution, a walk-through of common use cases, and list the key benefits that stem from hyper-convergence.

Defining Hyper-Converged Infrastructure

First, let's lay out a basic definition. *Hyper-converged infrastructure,* as shown in Figure 2-1, collapses compute, storage (including storage networking), and management onto virtualized, standard hardware, enabling a building-block approach to infrastructure with scale-out capabilities.

In HCI, all key data center functions run as software on the hypervisor in a tightly integrated software layer. HCI is fundamentally about this final architecture; as a result, there are

different paths to the same end — from turnkey appliances to flexible hardware platforms installed with the hyper-converged infrastructure software.

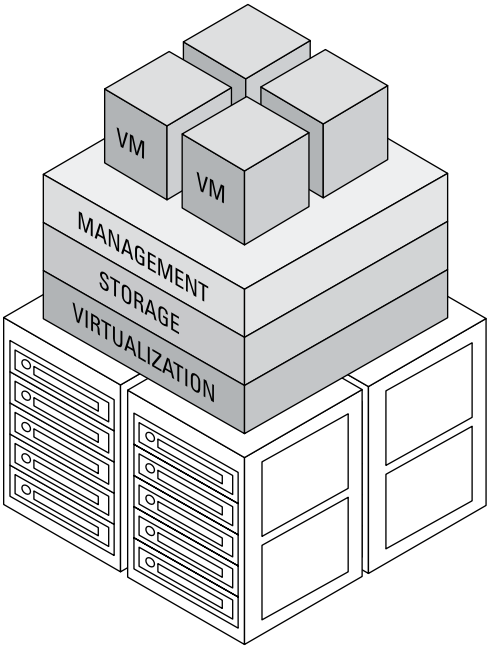

Figure 2-1: Hyper-converged infrastructure.

In an HCI environment, compute, storage, and management resources are delivered through an x86 Intel-based server platform. The server platform runs a hypervisor and pools direct attached storage devices — either flash devices like SSDs or hard disk drives — together from across multiple servers in the cluster to create shared storage, which acts like that provided by traditional storage area network (SAN) or network-attached storage (NAS) devices.

Identifying Trends Driving Hyper-Convergence

The hyper-converged engine is fueled by a number of key technology trends:

- Higher-density flash technologies that deliver higher performance at lower costs
- More powerful servers, thanks to advances in central processing unit (CPU) and memory densities
- Widespread adoption of server virtualization for most workloads
- Influence of cloud principles, economics, and cloud-native applications demanding an updated approach to IT

Hyper-convergence harnesses all these trends to deliver modern infrastructure with more performance and simplicity for less total cost.

Higher-density flash technologies

High-density flash and nonvolatile 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 HCI.

More powerful servers

With new multicore CPUs, industry-standard x86 servers keep getting more powerful. They're now so powerful that they can handle the workload requirements of high-performance storage in enterprise environments. Better still, if your HCI solution is based on Intel hardware, you have the assurances that come with a predictable cadence of performance increases with new processor platforms. With HCI, you can take advantage of those increases immediately as a software solution can easily be updated or expanded to run on the latest, off-the-shelf standard servers.

Here's where things get really good: The cost of x86 hardware, including flash memory, is usually a bargain compared to purpose-built storage arrays. As a result, HCI delivers considerable cost savings compared to deploying siloed servers, storage networking, and external storage solutions.

Given its advantages, widespread adoption of HCI is inevitable. In the coming months and years, you'll see HCI solutions in data centers everywhere.

Prevalence of server virtualization

The hypervisor breaks the ties that bind an application to a particular piece of hardware. It allows a physical server to act as a host for multiple guest operating systems, or 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, "The market has matured rapidly over the last few years, with many organizations having server virtualization rates that exceed 75 percent, illustrating the high level of penetration" (Gartner Press release, Gartner Says Worldwide Server Virtualization Market Is Reaching Its Peak, May 12, 2016, `www.gartner.com/newsroom/id/3315817h`). Most enterprises now operate with a *virtual first* policy — which means applications are deployed on virtual platforms by default.
- **IDC predicts that storage attached to virtual environments will make up more and more of all enterprise storage shipped.** By 2019, storage systems for virtual environments will make up more than two-thirds of all revenue generated by enterprise storage systems and approach $28 billion (Doc #258550, August 2015). This new reality makes server virtualization and VMs the primary workhorses for the storage infrastructure.

Because of this widespread use, the hypervisor is the obvious foundation for expanding on the benefits of server virtualization to cover storage, networking, and unified management — enabling a clear path to HCI and ultimately the SDDC without requiring forklift changes to current infrastructure and expertise.

Cloud principles and economics

The growth of on-demand, cloud-based services are being felt in the data center with administrators looking for simple and affordable ways to deliver business results. This is especially true for smaller companies or individual departments that are looking to architect a simple solution to meet their key IT needs.

This desire for cloud-type consumption is directly driving the adoption of HCI, which provides a much higher level of flexibility, simplicity, and on-demand growth than traditional data center infrastructure while delivering the on-premise benefits of high-performance, security, and control.

In addition, next-generation HCI solutions deliver strong support for deploying a hybrid cloud model, whether through integration with OpenStack technologies or supporting next-generation workloads, like cloud-native applications and containers.

Assembling the Ingredients for Success

Building an HCI environment has a lot in common with making a mouthwatering meal: Start with the best ingredients, combine carefully, and use proven techniques for making everything work together as a unified whole. The four key ingredients for HCI success are:

- A proven hypervisor
- Radically simple storage
- A unified management platform
- Flexible deployment choices

A proven hypervisor

In an HCI solution, the hypervisor forms your foundation — it's the "hyper" in hyper-converged, and plays a key role in ensuring data availability, storage efficiency, application performance, and flexible scalability.

Given that the benefits of virtualization — from operational efficiency to increased availability — all stem from the hypervisor, choosing the right hypervisor is critical. The more capable and feature-rich your hypervisor, the better your results.

For the past six years, VMware has been recognized as a leader in the Gartner Magic Quadrant for its x86 Server Virtualization Infrastructure, VMware vSphere hypervisor (Gartner, Magic Quadrant for x86 Server Virtualization Infrastructure, 14 July 2015). More than 500,000 enterprises — including 100 percent of the Fortune 100 — trust VMware as their virtualization infrastructure platform.

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Radically simple storage

In a hyper-converged solution, storage and storage networking are collapsed into the server and virtualized. This streamlines operations, costs, and overall physical footprint. However, not all approaches to software-defined storage in an HCI environment are created equal. Next-generation HCI solutions deliver extremely tight integration between the server and storage virtualization software. The tight integration eliminates the need for a separate virtual storage appliance deployed on each server, which leads to lower resource utilization and lower VM densities.

Unlike hardware-centric solutions, hyper-converged infrastructure software pools server-attached storage to create high-performance, resilient, shared storage that's optimized for VMs. What was previously complicated and expensive becomes just the opposite: simple, powerful, streamlined, and intelligent.

The right storage solution can lower operational expenditures (OpEx) by streamlining routine tasks, enabling better and more predictable performance, and allowing your organization and IT infrastructure to grow affordably without the need for large capital investments. Capital expenditure (CapEx) costs are greatly reduced by eliminating the need for purpose-built hardware and storage networking silos.

A unified management platform

You're now at the point in the recipe where you've virtualized your infrastructure (compute, storage, and storage networking) — which means you're halfway there! Next, you need a way to manage it. When selecting a management solution, you'll want to avoid creating a learning curve for users, or worse, multiple management silos that you have to juggle when managing or monitoring the different layers in the HCI.

What you do want is a familiar interface, one you already know how to use. And because simplicity and ease are also vital, look for a unified platform that manages the entire stack and seamlessly integrates all your workflows.

Flexible deployment choices

Software can't run on software — you need to put it on something. To ease your path forward, look for an HCI platform that gives you the broadest possible choices for the hardware platform. This flexibility helps you build an HCI environment that matches your needs and preferences exactly. It allows you to leverage the x86 infrastructure you already know — cost-effective, industry-standard, Intel Architecture–based servers, Intel Networking, and Intel storage products from a wide variety of computer manufacturers. This means no new hardware to learn, no new purchasing process, and no new support model to navigate.

A word to the wise: Don't scrimp

Scrimping on your ingredients by settling for less than the best can yield unsatisfactory results. Opting for initial cost savings or accepting performance limits will be a decision you'll likely regret sooner rather than later. It's important to consider the impact of your selection beyond the HCI solution.

To that end, ask yourself the following questions:

- How will it integrate with your existing environment?
- What are the operational impacts?
- Can the solution efficiently and cost-effectively grow when, where, and how you need it?

Choosing the best quality of your ingredients can help you avoid a half-baked solution that leaves you with silos, vendor lock-in, expensive upgrade and expansion paths, and unpredictable performance.

Looking at Key Use Cases for Hyper-Converged Infrastructure

The benefits of HCI emerge clearly across four common use cases:

- Business-critical applications (BCAs)
- Virtual desktop infrastructure (VDI)/end-user computing
- Remote office/branch office deployment
- Management clusters

Business-critical applications

Traditional infrastructure makes BCAs slow to provision and complicated to manage. Tasks like database processing, email server management, and Web 2.0 workloads require high levels of performance, availability, and reliability. Older architectures simply can't deliver without overprovisioned

storage, expensive purpose-built hardware, and siloed management tools.

Hyper-converged infrastructure software overcomes these challenges with a simple, distributed scale-out architecture, often optimized for high-performance flash devices, that puts IT back in charge of the applications that are so important to the business.

Virtual desktop infrastructure/ end-user computing

With so many end-user devices in play, the need for VDI has grown, but legacy systems make deployment a challenge. VDI requires a combination of high IOPs and low latency to ensure a "just-like-physical" user experience. It also needs to maintain low capital and operational costs to justify the return on investment (ROI).

Using traditional infrastructure, VDI is expensive to deploy and maintain, with high upfront capital requirements, as well as the high maintenance costs necessary to provide adequate performance and scale for virtual desktops and applications.

HCI delivers the perfect solution to these VDI challenges. It provides a high-performance and low-cost solution for a more consistent, predictable user experience, a lower CapEx requirement, and a simpler operational model.

Remote office/branch office deployment

Many organizations have remote offices and branch offices that rely on local IT infrastructure managed by IT staff at another location. This remote, distributed architecture presents a host of challenges that range from unpredictable performance to management complexity to poor reliability and availability.

IT teams need better visibility from a distance, along with tools that will make administration and management simpler

and less time-consuming. And as their businesses grow, they need the ability to scale without breaking the bank.

HCI is a perfect match for remote office/branch office deployment: It delivers a single, low-cost infrastructure solution with compute, storage, management, and networking integrated. In addition, the right HCI solution can be easily scaled up or down, and is flexible enough to accommodate changing needs — exactly what companies with remote offices need.

Management clusters

Business-critical applications may get most of the attention, but management clusters play a critical, behind-the-scenes role in keeping the overall IT environment running smoothly. A management cluster is a dedicated group of hosts reserved for running VMs that provide management services to infrastructure environments, which can include directory services, domain name system (DNS), Dynamic Host Configuration Protocol (DHCP), and VMware vCenter Server.

Their vital role makes it imperative that management clusters are always available and always have adequate resources. In the case of a site-wide failure, they must be brought online first, as quickly as possible. It's important to keep them in an isolated environment and sized to allow you to bring them up rapidly.

Traditionally, these clusters resided on expensive hardware to ensure high availability and high performance. If they lived on shared resources for the purpose of reducing costs, they had to compete with business workloads for compute and storage resources and made recovery more challenging.

HCI helps you manage these challenges. It enables simplified management, faster restoration, and disaster recovery, and allows you to isolate infrastructure without high capital costs.

Keep in mind that the HCI use cases cited here aren't a complete list. HCI solutions can also be used to meet a wide range of other IT needs, such as systems for hybrid cloud support, disaster recovery sites, secondary data centers, DMZ deployments, and test and development functions.

The Big Payoff: The Benefits of Hyper-Converged Infrastructure

Now let's get to the dessert — the business and IT benefits of an HCI solution that has all the right ingredients.

Simplicity

With a fully featured HCI environment, you can eliminate many of the components and hardware silos found in traditional infrastructure. In simple terms, with HCI you need a lot less stuff in your data center. This simplicity helps you reduce operational time and complexity across your data center.

To help you simplify your environment, HCI

- Provides a single, integrated software stack that runs on industry-standard servers
- Delivers ease of deployment and maintenance, with policy-driven automation
- Reduces physical components to manage, monitor, and maintain

Performance

HCI accelerates applications and enhances the user experience. To drive performance gains, HCI

- Delivers all-flash optimizations for application fast response times
- Enables easy scale-out and scale-up capabilities
- Ensures predictable performance to keep users happy

Cost

HCI can help you greatly reduce infrastructure spending across your data center. In particular, HCI

- Generates cost and storage efficiency
- Leverages technical resources and expertise you already have
- Eliminates overprovisioning with granular grow-as-you-go scaling

Flexibility

With a data center built around HCI, your IT organization is poised to rapidly respond to changing business demands. To deliver this flexibility, HCI

- Offers broad deployment choice — no hardware vendor lock-in
- Enables a future-proof IT environment, with support for today's traditional applications, as well as new cloud native applications and container technologies
- Allows you to scale up and scale out to easily meet specific application needs

Availability

HCI helps you minimize risk with a proven, secure platform that

- Ensures predictable performance with quality of service (QoS)
- Delivers high availability and resiliency with no single point of failure
- Builds confidence on the foundation of a proven, industry-leading hypervisor

Ultimately, HCI is a natural evolution in your data center. If you're in a VMware vSphere environment, you are among the 500,000+ customers who know and use vSphere and all the familiar tools, and you already virtualize industry-standard Intel-based hardware. For your organization, HCI will deliver major advantages with minimal change and learning.

Chapter 3

Extending Virtualization to Storage: Software-Defined Storage

In This Chapter

- Introducing software-defined storage
- Exploring the DNA of a new approach to storage
- Explaining the value of hypervisor integration

This chapter explores the big picture of software-defined storage (SDS), which is one of the key building blocks for hyper-converged infrastructure (HCI) and the software-defined data center (SDDC). SDS abstracts physical storage constructs to enable flexible and precise consumption according to application requirements. This goodness is all made possible by the hypervisor, which acts as a broker that balances the needs of a virtual machine (VM) and the applications it runs.

The Problems with Your Grandfather's Storage Model

To achieve the potential of the SDDC, all the key components of the information technology (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. In reality, 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 operational shortcomings. For example:

- **Most organizations rely on purpose-built, dedicated storage arrays.** Each array has its own specialized functionality and operational procedures tied to the hardware and not the applications or VMs.
- **Application needs and storage services aren't aligned.** Application owners and virtualization administrators can't easily or precisely specify what they need and when they need it. The result is either an inability to meet service-level agreements (SLAs) for applications or overprovisioning of storage capacity and services.
- **Operational workflows are stove-piped between storage, application, and virtualization teams.** Requests are made, meetings are held, sticky notes are posted on monitors, work is scheduled — and time is lost.

Clearly, yesterday's approaches to infrastructure fall far short today's needs. We need an all-new approach. A software-defined approach.

Reinventing the Storage Model

SDS reinvents the storage model by eliminating legacy silos and enabling the true pooling of storage resources. The

hypervisor brings to storage the same operational efficiency that server virtualization brings to compute.

To enable this shift, SDS puts the application and its requirements at the top of the IT food chain, enabling storage resources to 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 the boss needs when the boss needs it.

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

In an HCI environment built on SDS, the x86 server platform runs a hypervisor and includes virtualized storage devices. The storage software runs either in the hypervisor or in a VM. The storage components are typically a mix of solid-state drives (SSDs) or hard-disk drives (HDDs). Newer all-flash HCI solutions are built from SSDs (like Intel SSD Data Center Series), PCIe devices, or other flash technologies.

HCI implements *shared storage* by pooling the storage resources distributed across multiple server nodes. You essentially end up with a storage area network (SAN) inside an x86 server system.

In the simplest terms, HCI extends the server virtualization technology you already know by abstracting and pooling storage attached to the x86 servers, and incorporating them as part of the virtualized environment.

Exploring the DNA of Software-Defined Storage

Before diving into the components of SDS and their interactions, there are a few core concepts and key attributes to understand in VMware's SDS. Your IT shop may require

different solution components based on your specific needs, but all these concepts are important to an understanding of SDS as a whole.

A robust SDS environment delivers the following benefits:

- **It 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.
- **It 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 best to satisfy those requirements.
- **It 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, as with virtualized compute. IT admins can precisely match demand and supply, according to specific application requirements, in the exact time the resources are needed.
- **It 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 VMware's approach to SDS. Existing SAN and network-attached storage (NAS) storage systems can coexist with server-attached storage pools or can leverage the storage-policy based management system with VMware Virtual Volumes.

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 for 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 (Distributed Resource Scheduler) 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 VMs 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 Software-Defined Storage

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, storage, and networking. 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 VMs, 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.

Two Abstraction Paths to SDS

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 VMs, 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.

Path 1: Specialized storage hardware

The first form of abstraction assumes that you continue to use your traditional storage architecture based on either SAN or NAS systems. To enable this abstraction, SDS uses a new integration framework between the hypervisor and the traditional storage systems to introduce a new, granular management solution that delivers per-VM control.

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 Intel-based hardware, the storage environment bypasses the roadblocks that are built into conventional storage architectures.

The new software-defined systems are sometimes referred to as *server SANs,* which is really just another way of saying "hyper-converged infrastructure" or HCI. This approach rewrites the old capital expenditure (CapEx) and operational expenditure (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 HCI, storage components share compute and memory with the server infrastructure. This eliminates the need for separate storage arrays, controllers, memory, SANs, 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 very different ways to implement an SDS architecture on x86 hardware and direct attached storage:

- Third-party software running in VMs that sit *on top of* a hypervisor (not *in* a hypervisor) to create virtual storage appliances (VSAs).
- Storage functionality integrated directly *into* the hypervisor. This architecture is called *hyper-converged storage.* It's the approach used in HCI solutions.

A New Way to Manage Your Storage

The second key concept in SDS is the notion of transforming management and provisioning to make it all about the application, not all about the hardware.

In simple terms, SDS changes the management layer 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 VMs that run an application; these policies are automatically pushed down to the storage layer for implementation and enforcement. Here's the payoff:

- Storage policies and the service levels they control are easily and dynamically changed as an application goes through its life cycle, 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.
- SDS delivers a common standardized management approach that works and spans across different storage types and tiers. The policy-based management 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 HCI 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 Software-Defined Storage

Basically, SDS 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. SDS helps you get there today.

SDS creates a compelling opportunity for your IT team to fundamentally reenvision 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.

SDS allows you to precisely and automatically match storage supply to application demand.

Toward a Software-Defined Everything

Compute virtualization is a mature category that has enabled benefits in performance and scalability. Today we are seeing other critical data center components also advancing and becoming dynamic resource pools that can scale. We are seeing the rise of software-defined everything — from software-defined networking to software-defined storage and hyperconverged-infrastructure to software-defined application services. These all pave the way for the software-defined data center (SDDC), which is a software abstraction of your entire data center.

VMware NSX is the network virtualization platform for the software-defined data center. NSX embeds networking and security functionality that is typically handled in hardware directly into the hypervisor. The NSX network virtualization platform fundamentally transforms the data center' network operational model like server virtualization did ten years ago, and is helping thousands of customers realize the full potential of an SDDC.

With NSX, you can reproduce in software your entire networking environment. NSX provides a complete set of logical networking elements and services, including logical switching, routing, firewalling, load balancing, VPN, QoS, and monitoring. Virtual networks are programmatically provisioned and managed independent of the underlying hardware.

Chapter 4

The VMware Approach to Hyper-Converged Infrastructure

In This Chapter

- Highlighting the routes to hyper-converged infrastructure
- Introducing VMware-powered hyper-converged infrastructure
- Explaining the attributes of VMware Virtual SAN

This chapter looks at how hyper-converged infrastructure solutions powered by VMware Virtual SAN offer the advantages of an in-kernel architecture. This chapter also looks at the benefits of the VMware software stack and introduces the advantages of flexible deployment choices.

Two Different Routes to Hyper-Converged Infrastructure

From a storage architecture standpoint, there are two common paths to delivering HCI. Although they may seem similar, these approaches are fundamentally different:

- Bolting storage software *onto* a hypervisor
- Building storage software *into* the hypervisor

The common bolt-on approach to hyper-convergence runs third-party storage software in virtual machines (VMs) 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 on each server that consumes dedicated resources from each server.

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

- Excessive resource use
- Lower performance and longer latencies
- Limited integration with the existing management and multiple operational environments

The VMware approach to HCI is "built in." In this innovative approach, the storage software is in-kernel, or built directly 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 and lower latencies
- Tight integration enabling end-to-end management from a single tool and a simplified operational model

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

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

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

VMware-Powered HCI

To enable HCI solutions, VMware converges compute, storage (including storage networking), and management onto a single, integrated layer of software that can run on industry-standard Intel-based hardware, as shown in Figure 4-1. You can radically simplify your data center and deliver low-cost, high-performance compute and storage powered by VMware Hyper-Converged Infrastructure software and Intel processors and solid-state drives (SSDs). It is the ideal combination of proven Intel hardware and VMware software for high performance and exceptional reliability.

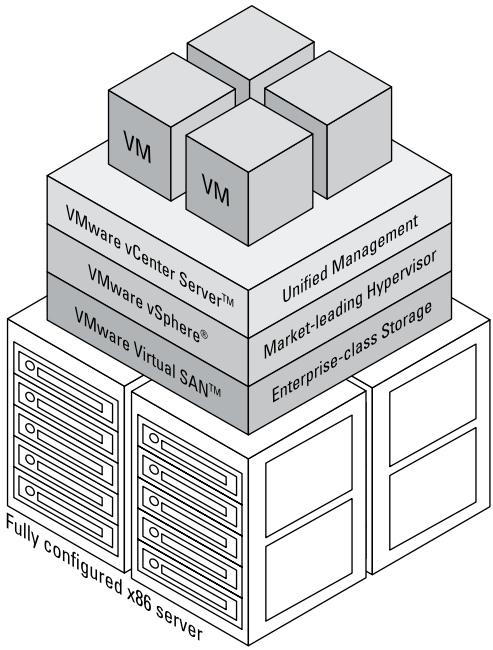

Figure 4-1: VMware-powered Hyper-Converged Infrastructure.

The VMware Hyper-Converged Infrastructure software stack is composed of three widely trusted solutions:

- **VMware vSphere:** The hypervisor that defines the industry standard

- **VMware Virtual SAN:** A radically simple, enterprise-class storage solution that is uniquely embedded in the hypervisor
- **VMware vCenter Server:** A unified and extensible management solution

Hyper-Converged Infrastructure solutions powered by VMware are available through a broad set of deployment options, ranging from turnkey HCI appliances to more than a hundred precertified servers through the Virtual SAN Ready Node program.

Powered by VMware Virtual SAN

The VMware implementation of hyper-converged storage, VMware Virtual SAN, pools together server-attached storage (SSDs, HDDs, and other flash devices), as shown in Figure 4-2. It creates a shared datastore with advanced data services designed for virtual environments. This datastore is highly resilient with no single point of failure and optimized for the latest flash technologies.

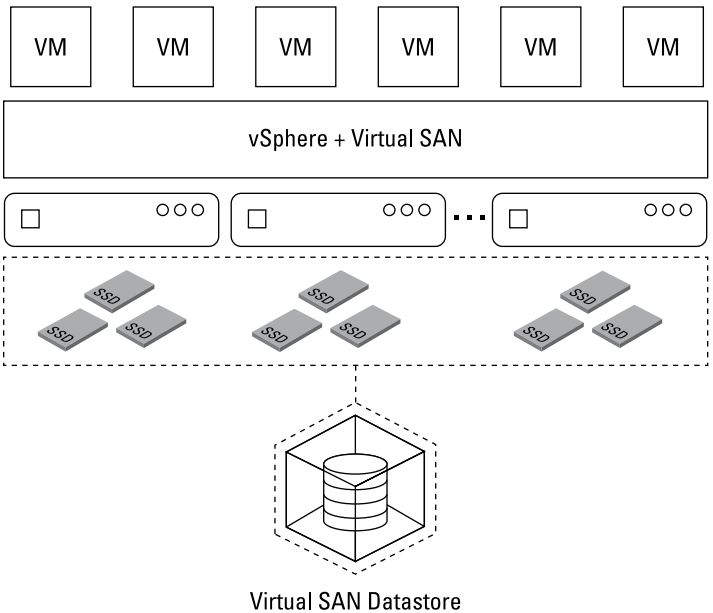

Figure 4-2: VMware Virtual SAN.

Virtual SAN works with both flash drives and HDDs in standard x86 Intel-based 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 seamlessly works with the rest of the VMware software stack. Management is simplified by using standard, Intel-based hardware and common VMware tools and interfaces across compute, storage, and networking. This makes Virtual SAN the simplest storage platform for your VMs.

In the following sections, I walk you through the attributes of VMware Virtual SAN.

In-kernel integration

Hyper-converged solutions use the hypervisor to support and deliver storage functions and storage networking in software. There's no need for dedicated storage hardware, such as a storage array, or for complex storage networking, such as a Fiber Channel switch.

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. In addition, the in-kernel architecture simplifies management and eliminates risk associated with extra components and points of integration. This is a major difference from the many virtualized storage appliances that run separately on top of the hypervisor.

Flash-optimized performance

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 on flash hardware. This didn't happen by chance. The ESXi hypervisor has been optimized 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.

Virtual SAN extends this performance advantage at the hypervisor layer with a distributed storage system architected from the ground up to streamline storage operations and utilize the capabilities of the latest flash technologies. As a result, applications benefit from fast response times and IT administrators enjoy higher levels of VM density.

Efficiency advantages

In addition, advanced storage efficiency features include deduplication, compression, and erasure coding. Intel processors and SSDs provide the performance to run these efficiency and data reduction technologies inline before any data is written to the capacity tier of Virtual SAN. These features drastically improve the storage utilization rate (meaning you need less physical storage to store the same amount of data).

And thanks to integration, those features — which can consume a significant amount of CPU and memory overhead on VSA-based HCI solutions — have minimal impact on the compute overhead. This means you can turn them on and forget them, even for mixed workload environments. No complicated planning, no tough decisions, no need to monitor or adjust the environment based on changing workloads.

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 run a vSphere environment, you probably appreciate the functionality of your virtualization layer (including such things as vSphere High Availability 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.

Hardware choice

To deliver the maximum value and flexibility, and ultimately a path to the complete software-defined data center (SDDC), an HCI solution shouldn't be tied to a specific hardware platform. This is where the hardware-agnostic approach to deploying VMware HCI solutions delivers differentiating choice, letting you control your infrastructure.

- **True HCI flexibility allows you to choose your x86 server platform and vendor.** All major x86 server vendors provide precertified hardware solutions ready to run Virtual SAN. Choose from existing hardware bundles, called Virtual SAN Ready Nodes, or pick supported components to customize your infrastructure. This flexibility puts you in the driver's seat.
- **There's a fast track to VMware-powered HCI through turnkey appliances.** These offerings are delivered as hardware appliances with more controlled configurations. It's a little less flexible, but you gain the immediate benefits of faster deployment, integrated life cycle management, and simplified purchasing.

Elastic, nondisruptive scaling

VMware Virtual SAN 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. As business needs change, HCI solutions powered by Virtual SAN can scale up or scale out to meet the exact needs of your applications.

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

There are two ways to scale, and both are 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.

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, although with flash prices declining and advanced space efficiency features available, the tipping point is quickly shifting to all-flash configurations being both faster and lower cost.

The ideal storage for virtual machines

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 VMs.

Here are the most valuable advantages of hyper-converged storage:

- 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 SDS and the fastest on-ramp to the SDDC.

Chapter 5

Transforming the Operational Model with Unified Management

In This Chapter

- Managing and monitoring the hyper-converged infrastructure environment
- Taking operations down to the virtual machine level
- Using policy-driven automation
- Enabling dynamic control of storage services

Ready to jump down into the information technology (IT) operations trenches? This chapter shows how hyper-converged infrastructure (HCI) transforms the operational model with simple, unified management of resources.

Single-Pane-of-Glass Management

If you're in IT operations, you know all about swivel-chair management — when you hop from one interface to another to manage different aspects of your environment. HCI helps you simplify your life with single-pane-of-glass management.

In a VMware environment, you can use your familiar vSphere tools — specifically VMware vCenter Server — to manage compute, storage, and networking from a common interface.

vCenter Server gives you simple and automated control over the virtual environment — deploy, manage, and monitor in one place with no additional tools required. You'll breathe easier when you eliminate the need for multiple tools.

But don't assume that all HCI environments offer unified management. Be on the lookout for systems that require different tools for HCI system, hypervisor, and/or storage management.

Advanced Monitoring

When it comes to system monitoring, your HCI environment should incorporate built-in monitoring features.

For example, in a VMware environment, advanced performance and capacity monitoring are built directly into vCenter. Check capacity usage quickly. Easily verify that your hardware is running the latest, certified firmware. Ensure performance is meeting your required levels.

If you want to enrich your VMware-powered HCI solution with proactive, sophisticated performance monitoring and analytics features — think custom dashboards and historical trends — you have the option to add the advanced capabilities of VMware vRealize Operations Manager and vRealize Log Insight.

Capabilities like these help you gain the deep operational visibility and an end-to-end picture of the software stack and environment for proactive monitoring and faster troubleshooting.

Taking Operations Down to the Virtual Machine Level

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

HCI 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 logical unit numbers (LUNs) and file systems; each offers a container with a static combination of capacity, performance, and protection.

Leveraging storage abstraction at the data plane level, HCI 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, next-generation HCI systems 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 VMs and the applications they run.

The management control plane 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 VM 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 preestablished 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 preallocated buckets, resources either are wasted or don't meet demand.

Using software-defined storage (SDS), HCI shatters the conventional storage mold. 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 based on a given policy, HCI 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, HCI uses SDS to enable 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 Application Programming Interfaces

Application programming interfaces (APIs) are at the heart of anything that's software-defined. APIs give you the flexibility to tailor your HCI 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 HCI 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).

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.

Renewing the Friendship between the Virtual Infrastructure Admin and the Storage Admin

In today's data centers, 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 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.

Chapter 6

Getting Started with Hyper-Converged Infrastructure

In This Chapter

- Introducing deployment choices for VMware-powered HCI
- Exploring certified solutions
- Explaining hyper-converged infrastructure appliances

Ready to put theory to practice? This chapter highlights resources you can leverage to implement hyper-converged infrastructure (HCI) on your terms and timelines.

Implementing VMware-Powered HCI: Deployment Choices

You have two main options for implementing VMware-based HCI, as shown in Figure 6-1:

- Certified solutions based on VMware Virtual SAN Ready Nodes and Intel hardware
- Integrated systems in the form of the turnkey VCE VxRail HCI Appliance

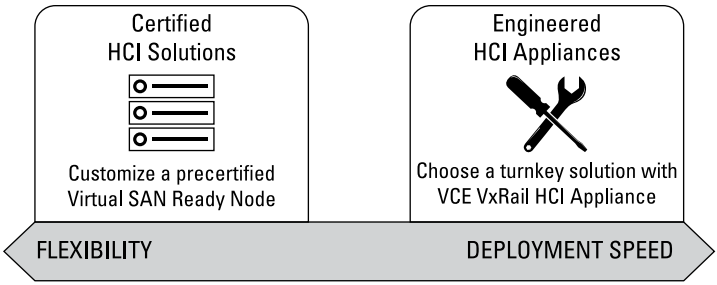

Figure 6-1: HCI deployment models.

Either of these options will radically simplify your data center and deliver low-cost, high-performance compute and storage powered by VMware Virtual SAN along with Intel processors and solid state drives (SSDs). The natively integrated software combines Virtual SAN, vSphere, and vCenter with HCI deployment choices on industry-standard Intel architectures.

VMware Virtual SAN offers the best storage value with radically simple management, high performance, low cost and a future-proof road map supporting any app and any scale.

Intel Xeon processor–based servers are optimized for virtualization and uptime. High-performance Intel Xeon processor servers with Intel SSDs caching, and Intel Ethernet Converged Network Adapters deliver consistent, high bandwidth and low latency.

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 HCI, 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 the fastest time to market.

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 Intel-based storage components — while gaining all the other benefits of the SDS operational model.

Certified Solutions: Virtual SAN Ready Nodes

You can deploy Virtual SAN with a certified hardware platform from the original equipment manufacturer (OEM) vendor of your choice. These precertified platforms, called Virtual SAN Ready Nodes, include a full hardware stack composed of the server, controller, and drives. 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 — for example, including more memory, central processing units (CPUs), or drives.

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.

Looking at the benefits of a Virtual SAN Ready Node

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

- **Choice of hardware:** Select a server OEM of your choice and choose from more than 100 precertified Ready Nodes designed for your workload needs. Each solution profile provides a different price/performance focus.
- **Elimination of silos:** Deploy your HCI environment on the x86 platforms you already know and use. This means no new hardware to learn, no new procurement process to establish, and no new support model to manage.
- **Ease of order and customization:** Purchase a single stock keeping unit (SKU) preconfigured with CPU, memory, network, I/O controller, hard disk drives

(HDDs), and SSDs, and also optionally preloaded with vSphere and Virtual SAN. Buy as is or customize to your specific needs.

- **Licensing options:** Leverage your existing enterprise license agreements or simplify procurement of licenses as a new customer.

Choosing the right Virtual SAN Ready Node

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

1. **Refer to the Virtual SAN Hardware Quick Reference Guide for pointers on how to identify the hardware requirements for your workload profile and the category of Ready Node that meets your needs:** `http://partnerweb.vmware.com/programs/vsan/Virtual SAN Hardware Quick Start Guide.pdf`.
2. **Visit the Virtual SAN Ready Node Configurator for step-by-step help picking a profile and identifying the options from your vendor of choice:** `http://vsanreadynode.vmware.com/RN/RN`.

Implementing your Virtual SAN Ready Node

Here are some tips for implementing your Virtual SAN Ready Node:

- **Follow the vSphere Compatibility Guide.** Be sure to follow the guidelines and advice in the vSphere Compatibility Guide for Virtual SAN. This online tool (available at `https://www.vmware.com/resources/compatibility/search.php?deviceCategory=vsan`) 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 (VM) storage components across the disks and hosts cluster.
- **Design for the life cycle of the Virtual SAN cluster.** For both hybrid and all-flash configurations, it's important to scale in a way that enables 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: VCE VxRail HCI Appliances

The VCE VxRail Appliance is a fully integrated, preconfigured, and pretested VMware HCI appliance family. Built on VMware vSphere and Virtual SAN, VxRail delivers an all-in-one information technology (IT) infrastructure transformation solution by leveraging a known and proven building block for the software-defined data center (SDDC).

Storage area network power in just two racks

With the power of a whole storage area network (SAN) in just two rack units, these appliances provide a simple, cost-effective hyper-converged solution for a wide variety of applications and workloads. VxRail Appliances deliver features for resiliency, quality of service (QoS), and centralized

management functionality, enabling faster, better, and simpler management of consolidated workloads, virtual desktops, business-critical applications, and remote office infrastructure.

A familiar experience

Built on the foundation of VMware Hyper-Converged Infrastructure and managed through the familiar VMware vCenter Server, VxRail Appliances provide current VMware customers with a familiar experience, plus the hallmark benefits of the virtual computing environment (VCE) — increased agility, simplified operations, and lower risk.

VxRail Appliances are fully loaded with integrated EMC mission-critical data services, including replication, backup, and cloud tiering, at no additional charge. As a VMware-based solution, the appliances also integrate with VMware's cloud management platform and end-user computing solutions. VxRail is also a platform for introducing advanced SDDC offerings like VMware NSX, vRealize Air Automation, and Horizon Air Hybrid Mode.

Additionally, VxRail Appliances are discoverable and visible in VCE Vision Intelligent Operations for a comprehensive IT core-to-edge management ecosystem. It provides a turnkey solution for the simplest and fastest deployment.

HCI capabilities are also available in Integrated Systems from VMware. These systems are powered by VMware's hyper-convergence software, vSphere for virtualization, and Virtual SAN for storage. Integrated Systems combine VMware compute, storage, and networking with certified partner hardware into HCI appliances. The result is an all-in-one, easy-to-deploy, simple-to-manage data center systems.

Chapter 7

Ten Reasons to Love Hyper-Converged Infrastructure

In This Chapter

- Exploring operational benefits of hyper-converged infrastructure
- Highlighting business benefits of hyper-converged infrastructure
- 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 hyper-converged infrastructure (HCI): really good outcomes for both business and information technology (IT).

Improving Cost Efficiency

With an HCI, you can cut costs by using standards-based 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 expenditures (CapEx) and operational expenditures (OpEx).

Improving Operational Efficiency

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

Here's an example of how HCI 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. Then make any necessary adjustments in storage allocations over time. And even better, this can all be done through familiar tools you already know and trust!

Enabling 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 HCI. HCI 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.

Improving Precision and Granularity

In hardware-centric conventional storage environments, overprovisioning is the norm. Admins configure static pools of

storage resources according to their best guesstimates about the maximum storage and application needs. This leads to a lot of wasted capacity.

In an HCI 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. Gross approximations give way to fine adjustments, and overprovisioning becomes a relic of the past.

Enabling Flexible Consumption

In traditional storage environments, your hands are tied by the physical storage preallocations 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 HCI environment, storage admins can make large virtualized resource pools available for dynamic consumption. They meet the changing needs of virtual machines (VMs) and the applications they support. The virtual infrastructure (VI) admin then sets policies for individual VMs and lets the management control plane do the rest.

Scaling Elastically

In HCI with Virtual SAN, you can scale in an elastic, nondisruptive manner by taking advantage of x86 servers for storage:

- **Scale-out:** Both capacity and performance can be scaled out at the same time by adding a new host to the cluster.
- **Scale-up:** 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.

Preparing for Future Applications

A new style of application is becoming more common in IT environments. Whether it's a mobile application, big data analytics, or new cloud-native applications, these newer applications are far more dynamic in their resource requirements than traditional enterprise applications. The rising popularity of containers and cloud applications is placing 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 HCI.

Providing Consistent Performance for Every Application

Ensure you can run any application with confidence — from business-critical applications to future cloud-native applications. Scale knowing that performance will not be compromised. And with options for all-flash, you get the most cost-efficient performance. Additionally, you can utilize space efficiency features with minimal impact on CPU and memory overhead.

Providing Enterprise-Class Availability

With HCI, you can eliminate costly downtime. Enable maximum levels of data protection and availability with built-in failure tolerance, asynchronous long-distance replication, and

stretched clusters. With five-nines (99.999%) availability, you have peace of mind — even when the unexpected occurs.

Providing a Building Block toward the Private Cloud

HCI, with its modular architecture, is the fundamental building block toward the private cloud. And for companies wanting to move toward SDDC, the right HCI vendor will provide a path to do so with additional networking and advanced management capabilities, and enable you to utilize the same data management services across physical, virtual, and cloud environments. Achieve the next generation of hyper-convergence with VMware through the most comprehensive, integrated, and interoperable software-defined data center stack.

What is VMware Cloud Foundation?

VMware Cloud Foundation is based on a modular, hyper-converged architecture, leveraging the hypervisor to deliver compute, storage, and networking in single software layer (see the following figure).

The foundational components of VMware' HCI solution are VMware vSphere, VMware Virtual SAN, and VMware vCenter Server, which allow the convergence of compute, storage, and management onto a single layer of software that can run on any commodity x86 infrastructure. vSphere abstracts and aggregates compute and memory resources into logical pools of compute capacity, while Virtual SAN, embedded in vSphere, pools server-attached storage to create a high-performance, shared datastore for virtual machine storage.

VMware Cloud Foundation takes HCI one step further by extending the convergence of compute and storage to include networking with VMware NSX. NSX decouples the networking functionality from the physical switches and embeds it into the hypervisor for enhanced security, greater network efficiency and elastic scalability at data-center scale. And for organizations that want advanced automation and monitoring for their SDDC, Cloud Foundation can be enhanced with additional cloud automation and cloud operation solutions.

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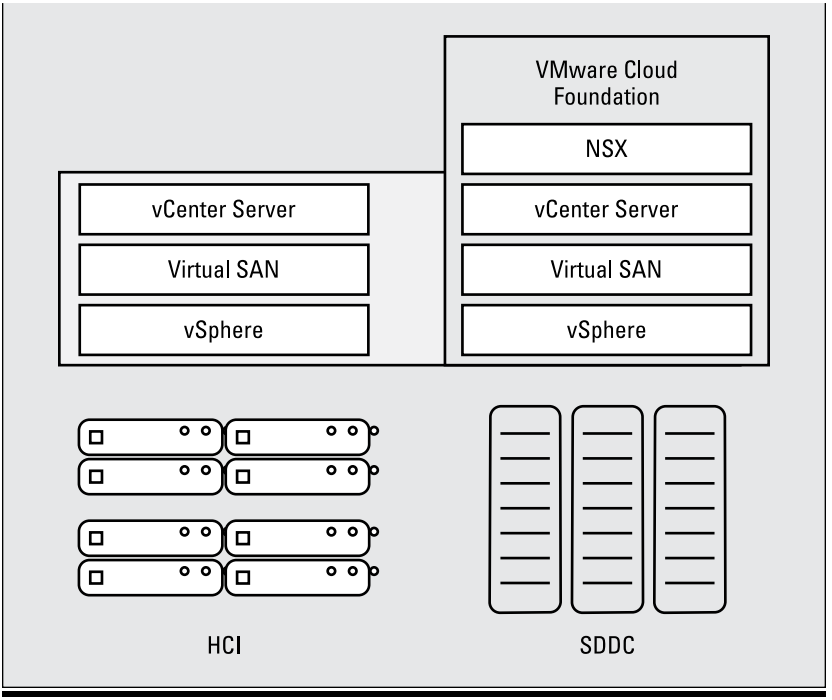

Notes

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Appendix

Resources

Ready for a deeper dive into hyper-converged infrastructure (HCI)? Here are some top resources for your further exploration.

HCI Backgrounders

Why HCI and Why Now? Explore the data center infrastructure strategy that radically simplifies storage. `http://learn.vmware.com/36403_vSAN_HCI_ToF_Reg?asset=vsantech&touch=1`

IDC: Trends in Hyper-Converged Storage: Gain insight into industry trends and ways that VMware VSAN addresses hyper-converged storage concerns. `http://learn.vmware.com/36403_vSAN_HCI_ToF_Reg?asset=whitepaper&touch=1`

IDC: Reviewing the Current State of Hyperconvergence and Real-World Benefits of VMware Virtual SAN Deployments: Learn about the trends driving organizations to deploy HCI and discover the benefits of the solution and the amount of CapEx and OpEx savings that VMware Virtual SAN customers are seeing today. `http://learn.vmware.com/36403_vSAN_HCI_ToF_Reg?asset=currentstate&touch=1`

Why Enterprises Are Embracing Hyper-Converged Infrastructure: Learn why growing numbers of enterprises are catching the HCI wave. `http://learn.vmware.com/36403_vSAN_HCI_ToF_Reg?asset=vsan094&touch=1`

What to Look for in Hyper-Converged Infrastructure: A Handy Checklist: Explore the requirements for a fully featured HCI solution. `http://learn.vmware.com/36403_vSAN_HCI_ToF_Reg?asset=buyersguide&touch=1`

Free eLearning

VMware Virtual SAN Fundamentals [V5.5]: Learn how to deploy and manage a software-defined storage solution with VMware Virtual SAN. https://mylearn.vmware.com/mgrreg/courses.cfm?ui=www_edu&a=one&id_subject=55806

Software-Defined Storage Fundamentals: Learn about the storage pillars of a Software-Defined Data Center and how VMware's Software-Defined Storage (SDS) strategy helps to mitigate the storage challenges faced by the Hardware-Defined Data Centers. https://mylearn.vmware.com/mgrreg/courses.cfm?ui=www_edu&a=one&id_subject=64761

Free Preview of Courses

Sneak Peek – On Demand Classroom for Virtual SAN: Deploy and Manage [V6]: Learn how to deploy and manage Virtual SAN, and configure Virtual SAN networks and clusters. Guide-me videos and lab exercises included. https://mylearn.vmware.com/mgrreg/courses.cfm?ui=www_edu&a=one&id_subject=70577

Other Resources

VMware HCI site: Explore deployment options and find resources to get you started down the path to HCI. www.vmware.com/products/hyper-converged-infrastructure.html

Virtual SAN hands-on lab: Get hands-on HCI experience via this easy-to-use online environment. www.vmware.com/go/try-vsan-hol?cid=70134000001MBhr

Virtual SAN free trial: Try Virtual SAN for 60 days at no cost in your own environment. https://my.vmware.com/web/vmware/evalcenter?p=vsan

Virtual SAN TCO and Sizing Calculator: Quantify the economic impact that Virtual SAN can have in your environment. `https://vsantco.vmware.com`

5 Reasons to Choose VMware Hyper-Converged Software: Discover how VMware makes HCI simple and effective. `http://learn.vmware.com/36403_vSAN_HCI_ToF_Reg?asset=techbrief&touch=1`

Virtual Volumes product page: Learn the basics about Virtual Volumes and find resources to get you started. `www.vmware.com/products/vsphere/features/virtual-volumes.html`

Virtual Volumes hands-on lab: Try Virtual Volumes for free with this easy-to-use online environment. `http://labs.hol.vmware.com/HOL/catalogs`

"What's New: VMware vSphere Virtual Volumes" white paper: Read this document to understand Virtual Volumes concepts in depth. `www.vmware.com/files/pdf/products/virtualvolumes/VMware-Whats-New-vSphere-Virtual-Volumes.pdf`

Virtual Volumes Getting Started Guide: Use this document to understand the operational requirements of a Virtual Volumes implementation. `www.vmware.com/files/pdf/products/virtualvolumes/vmw-vsphere-virtual-volumes-getting-started-guide.pdf`

VMware storage blog "Virtual Blocks": Gain insights into current trends and developments in HCI and software-defined storage (SDS). `http://blogs.vmware.com/virtualblocks`

Catch the hyper-convergence wave!

Hyper-converged infrastructure (HCI) is the next big step in the evolution of data center architectures. This ongoing evolution moved us from traditional infrastructure dominated by IT siloes to converged infrastructure that integrates compute, storage, and networking into a single rack. Today, HCI is taking the concept of converged infrastructure to a new level.

In an HCI environment, the resource pillars are physically converged onto a single industry-standard x86 server, forming a seamless, software-defined environment well suited to today's IT challenges. This next step in the evolution of IT infrastructure creates the fastest path to the benefits of the software-defined data center.

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

Michael Haag, a veteran of the SAN storage industry, helps lead the VMware product marketing team responsible for Virtual SAN, Virtual Volumes, and SRM. He is a published author and frequent speaker at industry-leading events including VMworld, HP Discover, SNW, and Interop. Michael holds a master's degree in electrical engineering from Rice University in Texas.

Open the book and find:

- **Guidance on upgrades with current infrastructure architectures**
- **Tips on implementing and managing hyper-converged infrastructure**
- **How to dynamically control storage services**
- **HCI deployment options**

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