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Next-Gen Virtualization

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Introduction

Why do you need a modern virtualization platform? Basically for the same reason you need a smartphone. Digital transformation is sweeping across all industries, and you need the right technology to capitalize on this wave.

To stay competitive in the new digital economy, your business needs a modern data center that is highly scalable, available, and secure. A modern data center enables your organization to move quickly and confidently into the new digitally driven world. You need a data center that gives you the ability to not only reliably run apps, but also connect apps across clouds and devices — and all under a constrained budget.

You can't make this leap forward with yesterday's approaches to IT infrastructure. You need a modernized data center that is fully virtualized, software defined, and highly automated, with a consistent infrastructure and application delivery across a hybrid cloud environment. In the age of the digital economy, this sort of modernized data center is no longer a nice-to-have; it's a *must-have*. It's a strategic priority.

About This Book

Next-Gen Virtualization For Dummies is your guide to taking the virtualized data center to an all-new level. So, how do you get there? The first step is to get intimately acquainted with the concepts explored in this book. I provide tips, insights, and advice for building a robust, agile virtualization platform to drive your digital transformation forward and create a clear route to the hybrid cloud.

Don't let the small size fool you. This book is loaded with information that can help you understand and capitalize on virtualization technologies to build your modern cloud platform. In plain and simple language, I explain what a next-generation virtualization and cloud platform is, why you need it, and what capabilities to look for when building one. I also offer tips and best practices to consider as you head down the road toward a modern virtualization platform and a hybrid cloud world.

Foolish Assumptions

In writing this book, I've gone out on a limb and made some assumptions about you. I assume the following:

- » You're an IT professional who is familiar with common terms in IT shops.
- » You're not content with the status quo — you want to use IT to empower the digital business.
- » You're concerned about managing hybrid cloud services in conjunction with traditional IT infrastructure.
- » You're going to love the capabilities of a fully featured modern virtualization platform.

Icons Used in This Book

To make it even easier to navigate to the most useful information, these icons highlight key text:



REMEMBER

Take careful note of these key takeaway points.



TIP

These tips can save you time and effort.



WARNING

Watch out for these potential pitfalls on the road ahead.



TECHNICAL
STUFF

Read these optional passages if you crave a more technical explanation.

Where to Go from Here

I wrote this book as a reference guide, so you can read it from cover to cover or jump straight to the topics you're most interested in. Whichever way you choose, you can't go wrong. Both paths lead to the same outcome — a better understanding of the characteristics of a modern virtualization platform and the steps and best practice to consider as you move forward.

For more information on next-gen virtualization, head to www.vmware.com/products/vsphere.

- » Highlighting market trends
- » Calling out key challenges for IT
- » Pointing to the path forward

Chapter 1

Considering the Rise of the Digital Economy

To understand the importance of next-gen virtualization to your organization, you first need to understand how the digital economy is playing an ever-increasing role in modern society. This expanding role is fundamentally changing how corporations need to plan for the future so that they aren't left behind as commerce evolves.

This chapter discusses the rise of the digital economy, the IT challenges it brings, and the need for a next-gen virtualization platform that creates the foundation for digital business transformation.

Understanding the Really Big Picture

In recent years, industry observers have talked often about the rise of the digital economy and how it will fundamentally change life as we know it for all businesses. Well, that change has come. The digital economy is here, and it is growing at bewildering speeds. In fact, IDC has predicted that through 2019, 40 percent of all IT projects will involve creating new digital services and revenue streams that monetize data. Yes, you read that right: 40 percent.

In this new application-driven world, digitally driven startup companies like Airbnb and Uber have become global powerhouses seemingly overnight. Along the way, companies like them are changing the ground rules for their industries.

Of course, it's not just the young upstarts that are fueling the growth of the digital economy. Well-entrenched companies are also rethinking their business models and investing heavily in software, data, and analytics. General Electric, for example, is probably best known as a hardware manufacturer. But GE has set the goal to become a top-ten software company and already has become a recognized leader in software for the Internet of Things (IoT).



REMEMBER

As the GE experience suggests, every company now needs to become more software-centric to stay relevant and thrive in the digital economy. Hardware may be familiar, but software is the arena where real change is happening.

Considering the New Challenges for IT

To succeed in this new software-driven world, every company needs to accelerate the development and delivery of the applications and services that keep customers happy and the businesses competitive. The digital economy increases the pressure on you to redefine your processes and modernize your environments. Your goal should be to drive faster delivery of the resources that empower the business. But this isn't just about IT. Digital business transformation is also about being innovative and creating new products and services that are consumed by your customers.

And at this point, things get harder. In many IT shops, the route to a faster, more agile data center is riddled with roadblocks:

- » **Complexity:** Complex IT architectures and processes limit your agility and flexibility, and create barriers to change.
- » **Budget constraints:** Shrinking or static budgets make it difficult for you to meet the business demands with traditional infrastructure models.

- » **Compliance:** Business units are turning to public clouds for on-demand access to IT services, causing operational cloud silos and compliance risks.
- » **Out-dated architecture:** With current architectures, there is no easy way for you to offer services seamlessly and securely across traditional infrastructure, on-premises private clouds, and public clouds.

Challenges like these point to the need for some serious rethinking of IT architectures and processes. In particular, your organization needs to move to an agile, service-oriented model that is based on a flexible software-defined data center (SDDC) that leverages both private and public clouds.

Looking at the Path Forward

So, how do you get to where you need to be? The path forward begins with next-gen virtualization to increase IT agility and create a seamless foundation for the management of private and public cloud services alongside traditional data center infrastructure.

You can find more detailed information about the characteristics of a fully featured, modern virtualization platform in Chapter 3. For now, keep this thought in mind: In its work to drive the digital transformation, your IT organization is taking on a leadership role — and positioning the business for success in the digital economy.



REMEMBER

Here's the bottom line: To stay competitive, all businesses need to get on the path to digital transformation. And that path is paved with next-gen virtualization that spans from the traditional data center to private and public clouds.

- » Introducing virtualization
- » Explaining the hypervisor
- » Isolating key business benefits

Chapter 2

It All Begins with Virtualization

At the most fundamental level, the transformation of your business to compete in the new digital economy begins with virtualization.

This chapter provides a brief primer on virtualization and its evolution in the data center. You see where virtualization began, how virtualization works, and some of the benefits you'll gain through using virtualization.

Understanding Virtualization

Virtualization creates a software representation of the underlying hardware and enables you to run multiple virtual machines on top of a single host. Each virtual machine has its own operating system and application running inside. By doing so, virtualization enables much higher levels of utilization and efficiency.

The practice of virtualization began when IT organizations were wrestling with the limitations of x86 servers that were designed to run just one operating system and one application at a time. As a result of this limitation, even small data centers had to deploy

many servers, each operating at 5 percent to 15 percent of capacity. By any standards, utilization rates along those lines are not just inefficient; they're downright wasteful. Virtualization fixes this problem.

But why stop there? As virtualization technologies evolved, data center operators went beyond server virtualization and started also virtualizing storage and network resources. Today, many data centers are highly virtualized — which is a really good thing, given that the digital economy demands the agility of a virtualized IT infrastructure.

Introducing the Hypervisor: A Two-Minute Overview

A *virtual machine* (VM) is a tightly isolated software container with an operating system and application inside. Each self-contained VM is completely independent of other VMs running on the same host. This independence is made possible by a thin layer of software — called a *hypervisor* — that is installed on a host computer.

The hypervisor abstracts the underlying server resources and enables the hosting of virtual machines. The host and the resources it controls become part of a larger pool of resources that can be shared by VMs. The hypervisor controls how those resources are accessed by the VMs and dynamically allocates computing resources to each VM as needed.



REMEMBER

The whole idea behind a virtualized data center is to have a more efficient and flexible environment that's easier to manage. Hypervisors got the ball rolling by providing a way for applications to share compute resources transparently.

Hypervisors come in different flavors. Here are two of the most common:

- » **Bare-metal hypervisors:** These are commonly called Type 1 hypervisors, and they run directly on a physical host server. Type 1 hypervisors directly control the server hardware and manage guest operating systems. They partition the server

into multiple VMs that operate independently but share the same network resources.

» **Hosted hypervisors:** Commonly called Type 2 hypervisors, these are installed as virtual workstations on top of a server's existing operating system, such as Windows Server, Linux, or a custom operating system. The host OS has direct access to network resources and hardware, and manages OS connections to those resources. The hosted hypervisor coordinates calls between the VM and the resources it needs to access, including CPU, memory, storage, and the network.

Evaluating the Business-Driven Benefits

In any flavor, hypervisors make it possible for your organization to gain the benefits of virtualization. Let's look at a few of these business-driven benefits that come with the virtualization of IT resources on a full-featured platform (like VMware vSphere).

Cost savings

Right out of the gate, IT organizations turn to virtualization to cut costs. The virtualization of resources leads to increased utilization, reduction in numbers of servers (as well as the associated power and cooling requirements), and more efficient use of valuable data center floor space. And those are just the savings in capital expenses (CAPEX). Virtualization also drives a wide range of operating expense (OPEX) benefits, such as increasing IT productivity, simplifying management tasks, and enabling higher levels of automation.

Higher availability

Virtualization enables higher levels of availability by making it easy to keep workloads running in the event of both planned and unplanned downtime. Virtualization gives you a level of control and flexibility that would not be possible with hardwired resources dedicated to specific applications.

With the right virtualization solution in place, you can preemptively move live workloads freely across the boundaries of virtual switches, servers, and clusters, even over long distances in

anticipation of system outages due to maintenance or natural disasters. To put this into perspective, you can now perform a zero-downtime live migration of a workload from New York City to London. This capability completely changes the way data centers are planned because they can now be farther apart but still satisfy disaster avoidance requirements.

Virtualization also provides solutions for continuous availability in the face of hardware failures and other causes of unplanned downtime. For example, with a virtualized data center, you can implement fault tolerance solutions to provide continuous availability for your mission-critical applications by running two instances of an application in lockstep. If there is a problem with the primary instance, the secondary instance will pick up where the primary one left off, providing continuous availability for your most important workloads.

Better resource management

A virtualized environment is more fluid than a traditional hard-wired data center. Your IT administrators can rapidly provision and deploy services and reallocate resources on the fly to balance workloads and improve the performance and availability of applications. You no longer have to dedicate resources to specific applications.

Even better, with the right virtualization management tools in place, you can move an entire running virtual machine from one physical server to another with no downtime. This capability allows you to perform hardware maintenance without scheduled downtime, proactively migrate virtual machines away from failing or underperforming servers, and easily optimize and allocate entire pools of resources for maximum hardware utilization and application performance.

Centralized administration

When infrastructure resources are virtualized, they can all be monitored and managed from a single console. With the right virtualization management tools in place, you can easily provision and deploy virtual machines, manage security settings, move workloads around, and ensure that resources are optimally utilized in your data center. You can do so without continually switching back and forth between different interfaces.

Better still, with centralized management of virtualized hosts and virtual machines from a single console, you gain deep visibility into the configuration of the critical components of your virtual infrastructure. A single administrator might now be able to manage hundreds of workloads, more than doubling typical productivity levels when managing physical infrastructure.

With the right software tools in place, virtualization

- » Drives CAPEX and OPEX savings
- » Supports high-availability strategies
- » Simplifies resource management
- » Allows centralized administration

WHAT VIRTUALIZATION ISN'T

To this point, I've talked about what virtualization *is*. Here I note what it *isn't*. Virtualization is *not* the equivalent of cloud computing. Instead, virtualization is a key enabler of cloud computing. The path to the cloud starts with the virtualization of IT resources — including servers, storage, and networking. While delivering immediate benefits in terms of cost savings and IT efficiency, virtualization creates the foundation for more agile IT infrastructure and the move to cloud computing and cool capabilities like on-demand service provisioning. You can't get there without virtualization.

- » Introducing the universal application platform
- » Highlighting key platform characteristics
- » Supporting multiple environments
- » Replacing hardware with software

Chapter 3

Key Characteristics of Next-Gen Virtualization

A key point about next-gen virtualization is that it provides one unifying platform that is designed to do many things. And, like today's digitally driven world, it all starts with applications.

This chapter explores the characteristics of a next-gen virtualization platform that drives digital transformation.

Looking at a Universal Application Platform

As the momentum for digital transformation grows, you need to support an ever-widening range of next-gen applications. Gone are the days when your IT team could focus mainly on traditional business-critical applications. In the new world, next-gen applications are becoming just as important as those used to run traditional businesses.



I'm keeping the discussion at a general level, but it's worth noting that you can find all the characteristics discussed here in the latest generation of the VMware vSphere product suite. The vSphere product suite is designed specifically to enable next-gen virtualization for the digital business.

The need to support cloud-native, distributed, and other next-gen applications alongside traditional applications creates new IT challenges. Next-gen applications often have substantially different characteristics than their traditional counterparts, and they may incorporate evolving technologies, which introduces greater complexity.

Next-gen applications also place new demands on your infrastructure. Although scale-up applications, such as those in traditional enterprise systems, may be very resource-intensive, scale-out applications, such as those for data analytics, may require distributed architectures, large cluster sizes, and fast deployment models. And, of course, you now have to figure out where an application should run. Is it best in a private cloud? A public cloud? A virtual machine (VM)? A container?

Challenges like these underscore the need for a universal application platform that enables your IT organization to support both traditional and next-gen applications with common management processes across both private and public clouds. Although these categories of applications may have very different characteristics, both require next-gen virtualization and robust infrastructure with the scale, performance, and availability to run well.



A next-gen virtualization platform supports the requirements of a wide range of applications, including those incorporating technologies for 3D graphics, desktop virtualization, big data, machine learning, in-memory, and cloud-native deployments. At the same time, the platform supports traditional business-critical applications, along with those used by software development and testing teams. In short, it's a unifying platform for *all* your applications — regardless of where you run them.

Infrastructure for connected micro-services

Micro-services are small strings of modular code that are written to run particular processes. The concept of micro-services is built on the need to develop apps faster, be more resilient, and offer

a better user experience. Next-gen virtualization enables your software developers to rapidly deliver the infrastructure for connected micro-services, as well as any other workloads that you run in your data center or from a cloud.



TIP

An important platform capability here is the ability to orchestrate the restart of micro-services, in which some processes may depend on other processes. Orchestrated restart improves the recoverability of applications that run across multiple VMs. This is done by creating dependency chains between VMs via VM-to-VM restart rules. These restart rules enforce the restart order for each VM within the dependency chain, increasing the likelihood that an impacted application will properly recover when VMs are restarted.

Support for containers and containerized workloads

Today's scale-out next-gen applications are increasingly built using Linux *containers*. Containers bundle an application and everything needed to run it, including system tools and libraries, into a neat package — a complete file system, actually — that can move easily from one computing environment to another. You may have heard of Docker; it's a well-known software containerization platform.

A fully featured virtualization platform allows your IT operations team to run containerized workloads alongside traditional applications on a common infrastructure. Supporting containers in their virtualized environments gives you the best of both worlds — all within a single platform:

- » Your IT teams get the security, isolation, and management of VMs, along with the ability to leverage tools and processes they have used for years to maintain control over applications.
- » Your developers gain the speed and agility of containers, along with the ability to use tools they are familiar with.

The result: Everybody is happy.

Understanding Key Platform Characteristics

There are a number of important characteristics you'll want to look for in a next-gen virtualization platform. The following sections provide an overview of these attributes. A fully featured virtualization platform has all these characteristics.

Simplicity

In today's corporate IT environments, new apps are coming online all the time — apps that need to be maintained, supported, and secured. And it's not just *more* apps; it's also *more complex* apps.

And then consider this: IT teams aren't growing as fast as the number of apps they're expected to support, if they're growing at all. This fact of life in today's IT shops points to the need for a virtualization platform that *simplifies* the user experience while enabling automation and management at scale.

Let's look at some of the capabilities of this end-to-end virtualization and cloud platform, and see how they simplify the IT environment.

Simple life-cycle management

In the typical data center, too much time is spent just keeping the lights on, or maintaining the upkeep of the platform, instead of innovating. A full-featured virtualization platform makes it easier to manage the end-to-end life cycle of the platform itself and the apps that it supports, freeing up time for more innovation. Tasks such as installing, updating, provisioning, deploying, and moving workloads around are completed in significantly less time and with less effort. This is accomplished by making the tasks simpler to accomplish, easily scalable, and automated.

Intuitive and powerful interface

A key component of a simplified management experience is the graphical user interface (GUI) in the virtualization environment. It's really the IT administrator's window into the virtualized data center. To improve the view, modern platforms need to be cross-platform, intuitive, and responsive.

Modern platforms should also empower the administrator to see and do more in less time via dashboard views that offer holistic and deep visibility into the environment and provide quick access to key functionality for specific tasks. These same dashboards should be easily sharable within and across teams, for empowered collaboration.

Streamlined administration

A next-gen virtualization platform streamlines and centralizes management of your virtualized infrastructure — both virtualized hosts and virtual machines. It gives you simple and automated control over your entire virtual environment, including deep visibility into the configuration and operation of the critical components of your virtual infrastructure.

Everything is managed from a common vantage point. From a single console, your IT administrators can analyze and remediate issues, manage availability and security, balance workloads for better application performance, and carry out countless other day-to-day tasks. Furthermore, many tasks such as host and network configuration are more scalable through centralized management, enabling you to configure once and apply everywhere.

Automation

To support business growth and the rapid deployment of new services, a future-ready virtualization platform couples a simplified user experience with automation at scale. The goal is to safely automate management of infrastructure with features for guided remediation, fine-grained controls, policies, and customizable actions.

Automation isn't bolted on. It's built into the virtualization platform and often enacted through application programming interfaces (APIs) to help you easily accomplish tasks and maintain a performant environment with little or no intervention and time spent. Automation allows your IT teams to work where they add most value — and have the power to say “yes” to your business more often.



REMEMBER

A next-gen virtualization platform offers *automation with control*. For example, problem alerts based on multiple symptoms with guided remediation and custom policies help keep IT in control of the automated environment.

Resilience

A modern virtualization platform incorporates built-in features to help ensure the availability and recoverability of virtualized workloads. The goal is to ensure that data is always available and that applications and services are not interrupted when infrastructure fails.

Policy-driven

In a fully virtualized environment, policy-driven automation simplifies the provisioning and ongoing management of logical compute, storage, and network services. Policy-driven approaches enable IT agility and efficiency. They help you attain new levels of infrastructure utilization and staff productivity, reducing both CAPEX and OPEX.

For example, storage policy-based management (SPBM) allows consistent management across storage tiers and dynamic storage class of service automation. With the right management tools in place, SPBM allows you to capture your storage requirements for capacity, performance, and availability in the form of templates. 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.

Intelligence

In a digital economy, business units expect the IT organization to deliver new services at unprecedented speeds. Although that's a great goal, speed at any cost isn't an option. Typically, IT teams must address the need for speed within existing budgets and staffing.

This mismatch creates the need for a virtualization platform with capabilities for intelligent operations management. Capabilities like automated workload placement and continual resource optimization help your IT team maintain the performance and availability of infrastructure and apps in a manner that meets the quality of service expectations from business units, as well as end customers.

At the same time, this isn't just about the performance and reliability of your IT services. It's also about economics. To contain

costs, an intelligent virtualization platform supports policy-driven governance capabilities to help ensure you're using your resources efficiently on an ongoing basis.

In the following sections, I walk through some of the specific features of an intelligent virtualization platform.

Predictive analytics for proactive management

Improving performance and reducing downtime remain complex and expensive challenges for IT teams. A fully featured virtualization platform helps you take control with powerful analytics capabilities that enable proactive management of the virtualized environment.

In particular, an intelligent virtualization platform leverages self-learning algorithms and predictive analytics to help you gain the insights you need to improve performance and avoid IT disruption. Analytics tools correlate monitoring data and provide intelligent alerts on underlying performance issues. They also provide clear recommendations for corrective action, enabling faster problem resolution.



REMEMBER

Analytics capabilities embedded in a fully featured virtualization platform include performance indicators to help you improve the health and efficiency of your virtualized infrastructure while managing risks through proactive identification of emerging issues.

Insights

Your IT teams need meaningful insights — all in one place, across the whole stack, leveraging all types of monitoring data — so you can work proactively to optimize your virtualized environment. Better insights lead to better IT. That's why a next-gen virtualization platform incorporates intelligent operations management capabilities that adapt to your environment and give you the insights you need to identify and remediate issues before they impact users.



TIP

Analyzing insights contained in metrics available from monitoring tools and those in log data together enables significantly faster root-cause analysis. This gain can help your team reduce or avoid costly downtime.

Health and performance management

A modern business can't tolerate system downtime or poor application performance. This reality of the digital economy means that IT teams need to work proactively to enable higher performance and availability for infrastructure and applications — long before end users report issues.

To meet this need, a fully featured virtualization platform includes robust health monitoring and performance management capabilities that help you get the best performance, availability, and efficiency from your infrastructure and applications. The platform provides an in-depth view into all areas of your infrastructure, so you can quickly identify and analyze performance anomalies, faults, resource constraints, and bottlenecks. This same view helps you simplify deployment and proactively manage compute, memory, and storage resources with centralized control.



TIP

To enable health and performance management, vRealize Operations provides smart alerts about health degradations, performance bottlenecks, resource contentions, capacity shortfalls, and compliance issues. You can visually trace degradations in health or performance back to specific configuration changes at the infrastructure and guest OS levels, and also quickly identify and analyze performance anomalies, faults, resource constraints, and bottlenecks.

Capacity optimization

To help your IT organization become more efficient in resource utilization and deliver better application performance, a modern virtualization platform incorporates intelligent capacity optimization capabilities, including tools that help you right-size workloads and reclaim unused capacity.

Via a single interface, you can use intelligent capacity optimization tools to

- » View usage trends, projections, and extended forecasts
- » Identify idle or overprovisioned VMs at a glance
- » Delete or right-size VMs to reclaim unused resources

Capabilities like these help you improve utilization, boost consolidation ratios, and save big on hardware costs by making full use of your existing resources.

Capacity planning

Every IT administrator could benefit from a crystal ball that provides a clear view of what lies ahead. That's basically the idea of the capacity planning tools incorporated in a next-gen virtualization platform.

These tools give you a clear view of performance trends, projections, and extended forecasts, along with guidance in intelligent capacity planning to help you address future needs. With the right platform in place, you can

- » Run “what-if” scenarios to develop resource optimization strategies without the need for spreadsheets or complex scripts
- » Save “what-if” scenarios for future reference
- » Commit capacity models to an analytics engine to influence capacity calculations and alerts

Risk avoidance

Predictive analytics capabilities in a comprehensive virtualization platform help you mitigate the risk of poorly performing business services by proactively identifying emerging issues.

For example, predictive analytics capabilities help you see system utilization trends and understand when you're going to run out of capacity. Similarly, these capabilities can help you identify your most constrained resources, so you can rebalance workloads in a proactive manner.

In addition, a next-gen virtualization platform can help you satisfy disaster avoidance requirements by making it easier to create and replicate copies of virtual machines and by enabling those VMs to move freely across data centers.

Visibility

A modern virtualization platform gives you comprehensive visibility into your IT environment from a single vantage point: your management console. This view is enriched by analytics capabilities that call your attention to issues your team needs to focus on to maintain the health and improve the efficiency of your virtualized environment.



TIP

Storage analytics provide deep visibility into your virtualized storage resources to help your administrators easily identify configuration errors, resource starvation, and emerging performance issues.

Workload placement and balancing

To become more efficient in resource utilization and to maintain application performance, you need to balance workloads on an ongoing basis. The right virtualization platform simplifies this process.

Proactive load balancing features — enabled by self-learning algorithms, predictive analytics, and automation — keep an eye on usage patterns and take action to rebalance workloads in advance of upcoming demands and spikes in traffic. This feature eliminates resource contention before it happens so your workloads get the resources they need to keep your applications performing well, day after day.

INTEGRATING FEATURES TO PREVENT PROBLEMS

vSphere and VMware vRealize Operations, when used together, provide the Predictive DRS capability. It integrates self-learning and predictive analytics from VMware vRealize Operations with the resource scheduling algorithm of vSphere DRS. Together, they deliver predictive workload balancing for certain VMs before resource demand spikes occur, eliminating resource contention before it occurs.

Here's how it works: vRealize Operations runs its dynamic thresholds algorithm nightly against the VMs on which it collects data. These dynamic thresholds create forecasted metrics for the future utilization of the VMs. The metrics are then passed to vSphere DRS to determine the best placement and balance of VMs before resource utilization spikes occur.

Presto! You've just helped prevent resource contention on hosts that run VMs with predictable utilization patterns.

To guide intelligent workload placement, the next-gen virtualization platform shows you how your workloads are utilized across your data centers, clusters, and hosts, and where you have resource contention. But it doesn't stop there. It also provides recommendations on cross-cluster placement opportunities, as well as the best destination within clusters.

Security

In an age of highly sophisticated attacks on corporate systems, security threats have emerged as a top IT and business priority. To ward off cybercrime and protect the business, security must be comprehensive and ingrained. It should be enabled at the foundation of the IT architecture and deployed across the entire IT environment, not just in one component or layer. Comprehensive built-in security should span and protect the data, infrastructure, and access layers.

In the following sections, I show you some of the ways that a modern virtualization platform enables comprehensive security for your IT environment.

Operationally simple, policy-driven security

Security is only good if you can use it. To that end, the process of applying and managing security settings needs to be operationally simple through a policy-driven approach. This makes securing your entire environment less tedious and more scalable. Furthermore, to improve operations, security hardening guidelines should be consistently and confidently enforced across the virtual infrastructure.

To enable this tighter level of security, and to help ensure that best practices are followed in a consistent manner, a complete virtualization platform needs to be able to identify when something is out of compliance with the policies and guidelines set by the security teams.

Secure data, infrastructure, and access

A next-gen virtualization platform natively provides secure data, infrastructure, and access at scale via an operationally simple, policy-driven model. Protecting all three areas is essential for digital transformation and the evolution of any given business.

For example, consider these features offered in vSphere:

- » **VM-level encryption to protect against unauthorized data access:** In addition, when used with VMware vSphere vMotion, the encryption safeguards both data at rest and data in motion.
- » **A secure boot model that protects both the hypervisor and the guest operating system:** This capability helps you prevent images from being tampered with and ward off the loading of unauthorized components.
- » **Multifactor authentication and audit-quality logging capabilities:** Audit-quality logging provides forensic information about user actions. In simple terms, audit-quality logging helps you better understand who did what, when, and where.

Compliance and security hardening

In a fully featured virtualization platform, detailed templates show you the security posture of your environment against hundreds of security hardening conditions, so you can quickly drill into noncompliant areas and take remedial actions.

In addition, the platform enables you to

- » Schedule compliance checking jobs to run automatically at any frequency you desire
- » Identify changes early on and automate remediation
- » Correlate change events to performance degradation occurring at any level of the environment

Enabling Multi-Cloud Environments

A next-gen virtualization platform also needs to support environments that are more complex. In this section, I cover some of the important features of this support.

Support for hybrid environments

A next-gen virtualization platform is designed from the ground up to support hybrid cloud environments. It allows you to run,

manage, connect, and secure your applications across multiple private and public clouds and devices — including apps running natively on leading public clouds.

With the right cross-cloud architecture in your hybrid environment, you can operate a robust private cloud in your data center and leverage services from multiple public clouds without creating cloud silos. This is a benefit of a virtualization platform that enables the seamless integration of private and public clouds.



REMEMBER

With a seamlessly integrated hybrid cloud environment, test and development teams can leverage public cloud capacity to meet spikes in demand during development and testing cycles. This capability allows them to get the resources they need when they need them, without adding costly infrastructure that sits idle much of the time.

Workload migration — to the cloud and back

A fully featured virtualization platform allows you to migrate live workloads not just across servers but also across clusters and clouds and over long distances. To handle spikes in demand, you can migrate workloads from your on-premises data center to the public cloud, and then migrate them back into your data center when demand subsides. This same hybrid approach can be used to enable cloud-based backup scenarios.

Throughout the migration, the virtual machine retains its network identity and connections, to help ensure a seamless migration process, whether the workload lands in the public cloud, in your on-premises data center, or in a distant data center. Want to move a live workload from your West Coast data center to your East Coast data center? No problem. Go for it.

Consistent management

Virtualization rises to a higher level with the addition of capabilities for simplified, consistent, and centralized operations management across the virtualized data center. To that end, a comprehensive virtualization platform embeds purpose-built management software that helps you improve the performance, availability, and efficiency of your infrastructure and applications. Features to look for include the following:

- » **A content library that provides a central repository for storing, managing, and sharing data center resources, such as VM templates:** Stored VMs templates can be deployed directly into production, increasing both the consistency and the efficiency of data center operations.
- » **Self-learning analytics that learn what is normal for an environment and issue an alert only when an anomaly is detected, significantly cutting down false alerts.**
- » **Storage policy-based management (SPBM) that allows consistent management across storage tiers and a dynamic storage class of service automation.**

Replacing Physical Infrastructure with Code

Developers want to manage and provision computing infrastructure and its configuration through code. They want to write scripts to remove the need for manual configuration of infrastructure. Given the rapid momentum of the ongoing digital transformation, this capability is no longer just a nice-to-have; it's becoming a requirement.

A forward-looking virtualization platform enables this shift to infrastructure as code through support for DevOps (Development/Operations) processes, automation, APIs, containers, and more.

DevOps

As organizations move down the digital transformation path, momentum is growing for the use of DevOps processes, which orchestrate the work of developers and IT operations personnel. Even for back in 2018, IDC had forecasted that 45 percent of CIOs will focus on platformization, using DevOps for rapid development, cost reduction, and enterprise agility.

A next-gen virtualization platform facilitates DevOps processes to accelerate the development, testing, and release of software applications and updates.



When developers build scale-out applications, such as those used in data analytics, they require a lot of processing power. As more processing power is needed, the code in the software can automatically call APIs to spin up more VMs or nodes to help with the processing. When the processing is complete, the code once again terminates the VMs and reclaims the resources for other uses.

Automation and APIs

In a world where the infrastructure as code model is emerging as a new requirement in fast-moving DevOps environments, a programmable infrastructure layer is now essential. To that end, users now expect modern software products and frameworks to be accompanied by a well-defined and fully accessible set of programmable APIs.

To support this need, a modern virtualization platform provides sets of programmable REST-based (Representational State Transfer) APIs. These developer-friendly APIs vastly improve the user experience by enabling finer control of virtual infrastructure for apps. They're one of the keys to increasing the productivity of DevOps teams.

Support for containers

To further support the needs of developers, a next-gen virtualization platform offers integrated containers. Containers allow developers to write code once and deploy it anywhere in neat packages of micro-services. In addition, containers help increase the efficiency, speed, and flexibility of development processes.

Better still, the integrated approach — with support for containers built into the virtualization platform — allows IT teams to run both traditional and containerized applications side-by-side on the same infrastructure without the need for additional tooling or training. So, everybody wins. Developers gain the portability, agility, and speed of containers without disrupting existing workflows, while IT teams get the security, isolation, and management of VMs.

Chapter 4 looks at capabilities that go beyond server virtualization. For now, take note of the following key takeaway points. A robust next-gen virtualization platform

- » Serves as a universal application platform
- » Makes IT simple, intelligent, and secure
- » Supports multi-cloud environments
- » Delivers infrastructure as code



TIP

The VMware vSphere product suite meets all the requirements for a next-gen virtualization platform. It's designed to provide a flexible and secure foundation for business agility, one that accelerates the digital transformation to cloud computing and success in the digital economy. With vSphere, you can run, manage, connect, and secure your applications in a common operating environment, across different clouds and diverse devices.

- » Virtualizing storage, networking, and security
- » Moving to virtualized networking
- » Considering a software-defined data center and hybrid cloud

Chapter 4

Going Beyond Server Virtualization

After you've adopted a robust, next-gen virtualization platform, you're ready to take things to a higher level. You have the foundation for virtualized storage, virtualized networking, and a cloud management platform, all of which move you forward on the path to the software-defined data center (SDDC).

This chapter introduces virtualized storage, virtualized networking, and SDDCs.

Looking at Virtualized Storage

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

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 and 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. The conventional 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 pre-provisioned storage services, often leading to wasted resources (because of overprovisioning to provide for future growth).

How hyper-converged infrastructure works

HCI collapses compute, storage (including storage networking), and management onto virtualized, industry-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.



TECHNICAL
STUFF

In an HCI environment built on SDS, where an x86 Intel-based 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. So, 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.



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

Understanding Virtualized Networking

In this section, I dive into the concept of network virtualization — how it works, how it differs from other approaches to the network, and why the time is right for this new approach.

How network virtualization works

Network virtualization makes it possible to programmatically create, provision, and manage networks in software, using the underlying physical network as a simple packet-forwarding backplane. Here's how it works:

- » Network and security services in software are distributed to hypervisors and “attached” to individual virtual machines, based on networking and security policies defined for each connected application.
- » When a VM is moved to another host, its networking and security services move with it.
- » When new VMs are created to scale an application, the necessary policies are dynamically applied to those VMs as well.

Similar to the way a virtual machine is a software container that presents logical compute services to an application, a virtual network is a software container that presents logical network services — logical switching, logical routing, logical firewalls, logical load balancing, logical VPNs, and more — to connected workloads. These network and security services are delivered in software and require only IP packet forwarding from the underlying physical network. The workloads themselves are connected via a software representation of a physical network “wire.” This allows for the entire network to be created in software.



TIP

VMware NSX is designed to serve as a network virtualization and security platform for the SDDC. NSX reproduces the entire network model in software. This end-to-end model enables any network topology — from simple to complex multitier networks — to be created and provisioned in seconds.

Network virtualization versus software-defined networking

Network virtualization may sound a lot like software-defined networking (SDN), but there are actually major differences between these two concepts. Let's look at these differences.

Though the term *software-defined networking* means different things to different people, this much is clear: SDN allows software to control the network and its physical devices. SDN is all about software talking to hardware — you can essentially call it a next-generation network management solution. Though it centralizes management and allows you to control network switches and routers through software, SDN doesn't virtualize all networking functions and components.

In other words, SDN doesn't allow you to run the entire network in software. Hardware remains the driving force for the network. In contrast to SDN, network virtualization completely decouples network resources from the underlying hardware. All networking components and functions are faithfully replicated in software. Virtualization principles are applied to physical network infrastructure to create a flexible pool of transport capacity that can be allocated, used, and repurposed on demand.

With your networking resources decoupled from the physical infrastructure, you basically don't have to touch the underlying hardware. Virtual machines can move from one logical domain to another without anyone having to reconfigure the network or wire up domain connections. You implement network virtualization in the hypervisor layer on x86 servers rather than on network switches. The physical network serves as a packet-forwarding backplane controlled from a higher level.



REMEMBER

SDN allows you to control network switches and routers through software. It doesn't virtualize all networking functions and components. Network virtualization replicates all networking components and functions in software and allows you to run the entire network in software.

Cloud management platform

The modern chief information officer (CIO) knows there are conflicting priorities for the IT organization. For every priority, there is a *but* attached:

- » Quickly adopt new technology, but minimize technical debt.
- » Be strategic and focus on business objectives, but maintain operational excellence.
- » Encourage innovation, but stay secure and maintain compliance.
- » Support the business need for speed and agility, but maintain control and reduce IT costs.

Looking forward, most IT environments will be hybrid. Workloads will be a mix of traditional and modern application architectures. They'll be provisioned in an increasingly virtualized mix of physical and virtual environments managed both on-premises and in public clouds.

The concept of a cloud management platform has evolved as a response to this complex set of management requirements. Cloud management platforms deliver the management capabilities that allow you to effectively manage the complete life cycle of services delivered in a hybrid IT environment.

The VMware Cloud Management Platform delivers a complete solution for managing a heterogeneous, hybrid cloud. The platform comprehensively addresses management requirements related to day-one and day-two IT operations for compute, storage, network, and application-level resources across a hybrid and heterogeneous IT environment. These capabilities include the following:

- » **Day-one capabilities:** Allow your IT team to rapidly provision a complete services stack that includes application components along with compute, storage, and network infrastructure.
- » **Day-two capabilities:** Give you the ability to fully manage changes to the service stack, including everything from right-sizing to retirement along with the ability to fully address quality-of-service requirements associated with the running service.

Both day-one and day-two capabilities help your IT teams manage services across a hybrid IT landscape. In addition, core capabilities address requirements associated with automation, operations, and business management.

Considering Software-Defined Data Centers

Public cloud services can be a good fit for many applications, but company-owned data centers continue to play a critical role in enterprise IT, especially for those mission-critical applications that require greater control and security. As a result, many organizations are looking to shift to a more agile, service-oriented IT model that leverages both private and public clouds. The SDDC lays the foundation for this hybrid approach to IT.

SDDC in a box

In an SDDC, compute, storage, and networking services are decoupled from underlying hardware infrastructure and abstracted into logical pools of resources that can be more flexibly provisioned and managed. That's all good, of course, but it's not a simple undertaking to build an SDDC. This is where the concept of the "SDDC in a box" enters the picture.

Okay, maybe it's a stretch to say "SDDC in a box," but that's essentially the idea behind solutions that bring together the key components of a software-defined data center — including virtualized compute, virtualized storage, and virtualized networking and security — into a natively integrated stack. The result is a ready-to-roll enterprise-class cloud infrastructure.

This "SDDC in a box" approach can help your organization greatly simplify the path to the hybrid cloud, while increasing the productivity of your IT administrators and reducing your overall total cost of ownership (TCO) for your cloud environment. This is truly a fast route to the business agility, scalability, and operational efficiency of web-scale cloud service providers.



TIP

VMware Cloud Foundation provides a unified SDDC platform for the hybrid cloud. Based on VMware compute, storage, and network virtualization software, VMware Cloud Foundation delivers a natively integrated software stack that can be used on-premises for private cloud deployment or run as a service from the public cloud with consistent and simple operations.

SDDC as a Service

SDDC as a Service takes things a step further. This approach offers a fully integrated SDDC software stack via a public cloud, such as Amazon Web Services (AWS) and IBM Cloud. Basically, SDDC as a Service takes the fully virtualized cloud foundation from a private cloud and makes it available via a public cloud.

SDDC as a Service can be adopted as part of a hybrid cloud solution, in which a company pairs the capabilities of an on-premises private cloud with those of a public cloud. In these cases, use of a common virtualization platform enables the seamless integration of the private and public cloud environments. IT administrators can use a common set of software tools to manage both their on-premises and public-cloud resources in a consistent hybrid cloud environment.



TIP

VMware offers SDDC as a Service in partnership with Amazon Web Services. This offering, VMware Cloud on AWS, enables organizations to rapidly deploy AWS cloud-based resources that are enterprise-grade, secure, and operationally consistent with VMware vSphere-based private clouds. The solution empowers IT teams to deliver the richness of VMware and AWS compute, storage, networking, and security capabilities unified into an easy-to-use, flexible, cloud-based service. This service is sold, operated, and supported by VMware.

- » Getting started with your modern virtualization platform
- » Adding operations management

Chapter 5

Next-Gen Virtualization Preflight

When a virtual environment is firing on all cylinders, it drives down costs and minimizes downtime while increasing productivity. Unfortunately, many businesses undercut those gains before deployment by incurring costs and causing downtime in the earliest stages of the shift from physical to virtual.

This is a case where a little planning goes a long way. This chapter discusses some things to consider before you begin your migration. Know what to expect and you can plan accordingly.

Preparing to Move from Physical to Virtual

Preparation is key in ensuring the success of an important project like implementing next-gen virtualization. Let's have a look at how you can make sure you've covered all the bases.

Assembling your team

Before you move your physical server workloads into virtual machines, enlist a cross-discipline team that includes IT admins, application owners, finance personnel, and other stakeholders. It's important to have a range of perspectives to make sure your virtualization strategy aligns with business priorities. As you move forward, this team will also help you demonstrate how cost savings and improved service levels in the data center affect the rest of the organization.

Assemble a detailed plan that outlines the full scope of the project and its phases. Work with your finance team members to determine total cost of ownership (TCO) and your projected return on investment (ROI). If you need new hardware such as servers, storage arrays, or networking gear, put it in the budget.



REMEMBER

The cost of new hardware might be offset by savings in other areas, such as maintenance or operating expenses.

Next, decide which workloads will be your highest priority for the physical-to-virtual (P2V) migration. For example, you might start with test and development workloads; then virtualize your Tier 2 applications; and finally virtualize your Tier 1, mission-critical applications.



TIP

Before you roll out the new virtual environment, allow time to test it thoroughly. Record baseline performance on your current servers and applications. It's important to have this data before migration begins so you can benchmark VM performance gains against native performance levels. This helps justify the project for management buy-in.



WARNING

Be sure to carefully schedule the migration and expected downtime for the workloads you're migrating. Using a proven P2V conversion tool such as VMware vCenter Converter can help you minimize downtime and maximize automation during your migration process. vCenter Converter converts both Windows and Linux physical machines to a VMware virtual machine format and brings them into your VMware environment, automating the migration process semi-transparently for your users.

Using traditional versus virtual storage

Shared storage improves availability and allows hypervisors to leverage capabilities (such as VMware vMotion) to migrate running VMs across hosts for zero-downtime maintenance. Today, there are multiple options for shared storage:

- » **Traditional external storage-area network (SAN) or network-attached storage (NAS) array:** Compared to virtual storage, a SAN or NAS solution can be more expensive and require more technical expertise because it needs specialized hardware and IT staff. For organizations with available capital and larger IT environments, traditional arrays provide deduplication, array-based replication, and unified storage offerings (for example, NFS, iSCSI, Fiber Channel).
- » **Virtual storage:** This option is simpler than SAN and NAS because you don't need to purchase, configure, or maintain an external hardware array. For businesses that need shared storage but do not need all the features of an enterprise storage solution, a solution such as VMware vSAN can save capital expenses and ongoing management costs.

Sizing and managing shared storage

Virtualization allows you to pool your storage infrastructure, which gives you flexibility for optimal workload placement. You can place high I/O-intensive workloads such as Tier 1, mission-critical database applications on Tier 1 back-end storage, which might be on high-speed SSDs or enterprise-grade SAS disks. At the same time, you can move test and development environments or rarely accessed data to slower and lower-cost storage to reduce expenses over the long run.

When sizing and managing your shared storage, you should

- » **Monitor how much space is used on your existing physical volumes, and also the number of I/O operations per second (IOPS) your workloads use.** This information can help you choose the right type and size of disks for your new environment.

- » **Calculate your storage needs, in both raw capacity and IOPS, on current and future workloads.** What's the best way to meet those needs? Do you need the array-based replication or extreme amounts of capacity that a traditional storage array can provide? Or could your needs be met by a more cost-effective vSAN solution that allows you to scale storage capacity and performance as you add physical host servers?
- » **Take advantage of the storage efficiencies of virtualization.** For example, on a traditional physical server, adding or reconfiguring disk drives is difficult, time consuming, constrained by available drive bays, and can sometimes result in downtime or data loss. In a virtual environment, physical storage devices are abstracted — separated — from the virtual machine, so storage capacity can be added without affecting the VM in any way. Virtual disks, by the same token, can be easily expanded without requiring complex reconfiguration of physical storage devices.
- » **Choose thin or thick provisioning of virtual disks for individual VMs.** *Thick provisioning* allocates all the space for a virtual disk the moment you create it; *thin provisioning* allocates space as necessary throughout the virtual disk's life. If you have a dedicated storage solution from a third party, thin provisioning may be available at the array hardware level as well.



TIP

Using VMware vSphere, you can configure Storage I/O Controls to guarantee a certain amount of I/O resources for each virtual disk, or enable Storage I/O Controls to provide equitable access to storage resources for all VMs. This ensures that no particular workload will dominate the resources of any physical array.



REMEMBER

Addressing security and compliance

Just like physical servers, VMs need to have appropriate security and compliance policies in place. Remember the following:

- » **If your business must comply with any government regulations, consider any audit rules that apply.** For example, will it be acceptable for each workload to share physical networks or virtual switches? Must the data itself be on separate physical storage?

- » **As you set up policies and provisioning, keep in mind the challenge of managing sensitive data from different applications.** Do the rules allow that data to reside with the data from other applications at the compute, networking, and storage layers?
- » **Make sure you have a working management network with all management interfaces of physical hosts, switches, and other data center infrastructure in the environment.** Isolated management networks provide higher security while preventing VM traffic from interfering with management traffic.
- » **You need to balance VM protection with performance by scheduling security scans and other checks for off hours.** Also, consider using features built into vSphere, such as VMware vShield Endpoint, which offloads antivirus and antimalware processes. This approach can also lower the risk of antivirus “storms” by centralizing those functions.

Using Operations Management to Meet Business Objectives

Server virtualization allows physical resources to be shared among many virtual servers, improving resource utilization. But this isn't just about utilization. It's also about performance and security. It's important to make sure your mission-critical applications have the resources they need to perform well while ensuring they meet your company's compliance and security policies. Here are some things to consider:

- » **Define affinity rules for your VMs.** For example, you can define host affinity rules to keep VMs together, so a web server VM and its associated app and database VM are kept on the same physical server for high-speed virtual network connectivity. You can also define anti-affinity rules. For example, you can keep multiple database servers on separate hosts so if a physical host fails, other database VMs will keep running.

- » **Determine whether your applications must reside on specific hardware for compliance or process reasons.**
- » **Make sure you determine the recovery time objective (RTO) and recovery point objective (RPO) for each workload.** That way, when you're creating your business continuity and disaster recovery plans, your backup and recovery policies are aligned with your business priorities.

As the saying goes, those who ignore history are doomed to repeat it. By monitoring performance issues, resource shortfalls, and other historical data on your VMs, you can anticipate future spikes in memory and CPU usage, and plan accordingly so critical applications do not hit capacity limits. The tools of a modern virtualization platform make it easy to monitor and analyze workloads and diagnose problems, so you can keep your business-critical applications and VMs operating at peak performance.

Before you deploy, there are several things you need to know:

- » **Prepare carefully to optimize resource utilization.** Early planning will help improve consolidation and ROI down the road. So before you install, find the guardrails with vRealize Operations. How many hosts, VMs, storage systems, and clusters will you be monitoring? You'll need this baseline information before you start.
- » **Consider the appropriate permissions for different user types.** Using vSphere and vRealize Operations, you can configure permissions and security, and then assign privileges so authorized users have access to the right assets in the management console. For example, admins should be able to touch everything. Help desk staff should have the permissions they need to fix day-to-day problems without inadvertently changing policies or settings. Consider the best way to set up multiple user permission levels in order to maintain the security of the environment while giving all staff members the ability to fix day-to-day problems as they arise, so your business keeps moving.
- » **Model your virtual environment on your business structure.** Structure your operations views with intelligent groups that make sense for your business. Group objects based on specific business needs, departments, locations, and more to create a simplified view of your environment

from the vRealize Operations dashboard. Tailoring groups to your specific business needs helps simplify IT tasks, so IT staff is better equipped to manage more systems, lowering administrator overhead and freeing up staff for innovation elsewhere.

» **Create policies for efficient resource management.**

Use vRealize Operations to assign policies to certain groups of resources, geographic locations, or business units to customize badge thresholds (see the next bullet), alerts, and capacity management settings. Take advantage of the out-of-the-box policies included in vRealize Operations that will meet most of your business needs (for example, production or test environments, batch or interactive workloads) or create your own personalized policies.

» **Configure badges for quick health checks.** Badges are a visual representation of infrastructure assets, providing scores and metrics that show the health, risk, and efficiency of the virtual environment and monitored objects. Badge thresholds should be customized based on your environment's size and unique requirements. Badges are assigned a numerical value ranging from 0 to 100 and are color-coded depending on the thresholds defined. It's a single, integrated, real-time status indicator for all virtual infrastructure resources, allowing IT admins to more easily monitor the virtual environment.

» **Identify the needs of workgroups to configure capacity settings.** Every workgroup has different needs at different times. A production team working on a product launch might need to be over-provisioned for a few months with extra CPU and storage. A development and test environment might be fine with high-density, over-committed VMs and resources. With accurate capacity analysis, you can account for varying business needs and tap your massive pool of resources so every workgroup has what it needs.

» **Choose how you want to be alerted.** Smart alerts let you choose how you want to be notified by your management platform when a problem is developing. vRealize Operations learns typical behavior in your environment, so it provides fewer, more meaningful alerts that let you know when there really is a problem — for example, when a dynamic threshold is exceeded or an anomaly is detected. Similar to capacity settings, alerts are configured based on policies that

you define. Alerts also provide actionable recommendations so you can find and fix problems fast, before they cause downtime.

- » **Set up email notifications for administrative alerts.** To monitor data center health and capacity from anywhere, configure an optional SMTP server to activate email service for notification messages when problems occur. You can set email notifications for all types of alerts, so you can address problems as they happen in real time, minimizing downtime. For administrators, it's especially important to set up email notifications for administrative alerts to ensure vRealize Operations is always running properly.
- » **Schedule reports to help address bottlenecks before they occur.** Use reports in vRealize Operations to monitor capacity and performance in the vSphere environment and to help avoid bottlenecks. It's a good idea to schedule reports for regular intervals — weekly, monthly, quarterly, whatever makes sense for your business. You can also pull reports on demand for a real-time snapshot of the IT environment, and use historical reports to track growth patterns and anticipate future capacity needs. Detailed reporting is one of the most under-appreciated aspects of a virtual environment, and one of the best tools to continuously improve performance and efficiency.
- » **Unify your view of the virtual environment.** Use the dashboard super metrics to quickly recognize areas that need attention and look deeper into individual components of the environment when necessary. The consolidated dashboard helps you ensure that resources are being used efficiently and that all systems are performing and available, all from a single view that allows you to spend less time monitoring and more time optimizing. With this dashboard, you get a holistic view and deep insights into the health, risk, and efficiency of infrastructure and applications to help ensure quality of service and early detection of performance, capacity, and configuration issues.

- » Highlighting tips, techniques, and insights
- » Getting the best from your virtualization platform
- » Understanding the correct order for deployment

Chapter 6

Ten Best Practices for Your Next-Gen Virtualization Platform

Whether you're planning to virtualize your data center for the first time or optimize what's already in place, these tips, techniques, and insights from the trenches can improve performance, as well as increase your return on investment.

Preparing Your Physical Servers

Implementing server virtualization begins with the physical servers that become your hypervisor hosts. Configure the physical servers for virtualization before you install the hypervisor:

- » Prepare the physical servers you want to use as hypervisor hosts — you've already verified that they're on the hardware compatibility list (HCL), right? — by updating firmware, and keeping racks and cabling tidy.

- » Make sure your BIOS settings are configured correctly for the hypervisor software. First, make sure you're running the latest version of the BIOS and that it's set to enable all populated processor sockets and all cores in each socket. Enable turbo boost, hyper-threading, and any hardware-assisted virtualization features that are available. Disable any devices you won't be using, such as serial, USB, or network ports. If the BIOS allows memory scrubbing to be configured, leave it at the manufacturer's default setting.
- » Verify that you have the latest recommended drivers from your server vendor. Many server manufacturers provide OEM customized installer CDs for VMware ESXi that include recommended drivers for VMware ESXi.

Installing Your Hypervisor

Now that your physical servers are configured, you can begin installing your hypervisor (VMware ESXi). Here are a few things to pay attention to during the install:

- » Install your hypervisor following the vendor's published guidance, documenting your configuration as you go (record host names, IP addresses, NTP server configuration, passwords, and so on). Maintain consistency as you install the hypervisor across all your servers.
- » Launch your administrative platform (such as VMware vCenter Server) and configure it to manage your physical hosts.
- » Complete your configuration by adjusting permissions, the hypervisor's firewall, and other advanced settings to meet your organization's requirements.
- » Complete any zoning or host-access configuration in your storage solution so that your hypervisor hosts can connect to the presented storage. Configure your hosts to access the storage so that all hosts in a cluster access the same pool of shared storage. If you're using a vSAN solution, enable it through your virtualization management console now.

Configuring Back-End Storage Devices Correctly

Back-end storage affects front-end performance. Many workloads are very sensitive to I/O throughput, so if performance problems crop up, the culprit is often storage configuration. The right configuration for your environment will depend on workloads, hardware, vendors, RAID level, cache size, stripe size, and more. Consult your hypervisor and storage documentation for details, but in general:

- » Plan your deployment around storage capacity, throughput, and IOPS, using metrics gathered from the systems you'll virtualize.
- » Consider using flash-based storage to complement slower hard drives as a caching tier or as primary storage for high-IO workloads. VMware vSAN automatically leverages flash-based storage to accelerate all reads and writes to the vSAN datastore.
- » Choose storage hardware that is scalable and virtualization-aware (that is, supporting VAAI, VASA, and VMware vSphere Virtual Volumes). This improves scalability and performance by offloading some operations to the storage hardware.
- » Make sure end-to-end Fiber Channel speeds are consistent to avoid I/O speed bumps.
- » Configure maximum queue depth if needed for Fiber Channel HBA cards.
- » Create dedicated connections to storage devices for data acquisition, transaction logging, and other applications that write large amounts of data to storage. Note that with newer high-speed connections (16 Gb Fiber Channel, 10/40/100 Gb Ethernet) and converged fabrics, this step may not be necessary.
- » Design network topology to avoid Ethernet bottlenecks caused by oversubscribed iSCSI and NFS links.
- » Make sure you have an adequate amount of read/write cache throughout your storage environment to reduce the load on storage arrays and improve workload performance.
- » Make sure storage adapter cards are installed in slots that have adequate bandwidth for the I/O traffic they'll be carrying.

Evaluating and Redesigning the Network before Virtualizing

A virtualized server won't do much good if it can't communicate with the rest of your network. Prepare your physical network to complement your virtual networking:

- » Consider using server-class network interface cards (NICs). Make sure the rest of the network infrastructure between the source and destination NICs is compatible. For example, if NICs are rated for 10 Gigabit, all cables and switches need to be rated for 10 Gb speed, and switch settings need to be set for 10 Gb.
- » Use network adapters that support checksum offload, TCP segmentation offload (TSO), high-memory 64-bit DMA addresses, multiple Scatter Gather elements per Tx frame, jumbo frames (JF), and large receive offload (LRO).
- » Use network adapters that support NetQueue, if possible. NetQueue significantly boosts performance of 10 Gb adapters in virtualized environments.
- » Make sure network cards are installed in slots with enough bandwidth to support maximum throughput.
- » Consider installing multiple physical network adapters between a single virtual switch and the network. This provides passive failover in the event of a hardware failure, and can increase throughput (in some configurations) by distributing traffic across the adapters.
- » Configure the appropriate VLANs and subnets on your physical switches, trunking any VLANs to your hypervisor hosts' uplink ports. Verify that you have a secure management network for your hypervisors and other infrastructure management traffic.
- » Configure your virtual switches to match settings on your physical switches, including MTU Size (Jumbo Frames), and speed.
- » Finally, connect your hypervisor hosts to the physical network and test end-to-end connectivity.

Securing Your Environment

Securing your IT environment is mandatory, and a virtualized environment is no different. In addition to securing the OS and apps running in your virtual servers, you also need to secure the components of your virtual infrastructure:

- » Make sure you have a working management network with all management interfaces of physical hosts, switches, and other data center infrastructure in the environment. Isolated management networks provide higher security while preventing VM traffic from interfering with management traffic.
- » Configure single sign-on to sync with a trusted identity source such as Microsoft Active Directory. Grant permissions to users and groups using the principle of least privilege, giving only those roles and rights needed to perform required work.
- » Request and configure SSL certificates from a valid internal certificate authority or purchase certificates from a trusted security authority for vCenter and ESXi hosts to ensure confidentiality, data integrity, and authenticity of ESXi and vCenter Server traffic.
- » Perform hardening of your environment to meet your security and regulatory requirements. The vSphere Hardening Guide provides suggested configurations to enhance the security posture of your environment. VMware vRealize Operations can continuously check for compliance against the vSphere Hardening Guide, alert you when something is noncompliant, and help you remediate quickly.

Performance-Tuning for Latency-Sensitive Workloads

Virtualized environments can be configured to improve performance of applications that are highly sensitive to latency. To accommodate those workloads:

- » Designate specific VMs as highly latency-sensitive, and use single root I/O virtualization (SR-IOV) or direct path I/O for latency-sensitive traffic on those VMs.

- » Evaluate power management features on the hypervisor host, and make sure the settings aren't slowing things down.
- » The virtual network adapter can also affect performance, so try disabling or enabling interrupt coalescing on NICs and see how performance is affected.

Enabling Advanced Features for Performance and Availability

After migration is complete, verify that all your virtual machines are powered on and connected to the network, and that you've distributed virtual machines to optimize the use of your server hardware.

With your virtualization platform deployed, it's time to leverage the power of advanced management tools. Here's where you should start:

- » Configure advanced features of your virtualization platform, including tools for high availability, load balancing, live migration of VMs, and advanced virtual networking options, such as a distributed virtual switch. These features can greatly simplify administration, reduce planned and unplanned downtime, and lay the groundwork for your virtualization platform to begin intelligently managing itself.
- » Enable your virtualization management platform, ensuring that your monitoring and capacity planning capabilities are collecting data. A next-gen virtualization platform uses complex learning algorithms to "learn" your environment, so it may take some time for those algorithms to accurately differentiate normal behavior from anomalies and send smart alerts only for real problems.
- » Adjust thresholds for your management platform to match your organization's requirements, service-level agreements (SLAs), and performance expectations. Build dashboards to show your business groups how you're providing greater uptime and performance while improving the bottom line by managing capacity and efficiency in your virtual data center.

Optimizing Virtual Machines So They're Stable and Efficient



TIP

With your virtualization infrastructure and management platform ready to run your workloads, it's time to start deploying VMs. Here are some tips to help you get started with building efficient, stable VMs:

- » Choose which VMs will be directly converted from physical servers (a physical-to-virtual migration, or P2V). Many servers can be directly converted, but this may also be a good time to consider a clean install of the operating system and application, so only your data is migrated.
- » Develop template VMs that include your most common OS, security settings, patches, and applications. By using a template to deploy new VMs, you ensure that all your new VMs conform to a standardized, known-good configuration.
- » Optimize how CPU and memory resources are allocated for VMs. Use resource settings (reservations, shares, and limits) only if needed.
- » Optimize your guest operating systems.
- » Use only the guest operating systems that are supported by your hypervisor.
- » Disable screen savers and animations on Windows and disable X Servers on Linux if they're not being used.
- » Schedule backups and virus scanning programs to run at off-peak hours.
- » Consider configuring your guest OS to use NTP, Windows Time Service, the VMware Tools time-synchronization option, or other time-keeping utility.
- » Configure virtualization-aware backups that enable you to complete full-image backups that include the running state of the VM at the time the backup was taken. Determine which VMs will use your virtualization platform's object-level backup and restore capabilities to achieve greater granularity for data protection. Implement a backup schedule using

your newfound backup powers to deliver the RTOs, RPOs, and SLAs that your business needs instead of just offering whatever your old backup solution was able to provide.

Monitoring and Optimizing Continuously

With your virtualization platform humming along and your management tools continuously monitoring your virtual data center's health, risk factors, and efficiency, you should start using the tools unique to modern virtualization to deliver the greatest possible business value to your organization. Here are some ideas to get you started:

- » Regularly meet with line-of-business stakeholders, application owners, and business leaders to understand how things are changing for your organization. Adapt your virtual infrastructure and management tools to meet these requirements by enabling advanced high-availability, replication, or fault tolerance solutions. Also, adjust monitoring thresholds so you receive smart alerts for any abnormalities that might jeopardize your ability to meet SLAs.
- » Verify your backups on a regular basis. Testing your VM backups can be much simpler than testing backups in physical environments (so there's no excuse for not testing!).
- » Perform regular security reviews to ensure that management traffic is protected, that permissions are in line with compliance requirements and best practices, and that you've performed hardening tasks as required by your organization.
- » Model the impact of adding additional workloads to your environment using capacity planning tools. This process will help you determine your risk of running out of physical resources and proactively identify the right amount of physical resources to add to your environment for planned expansions.
- » Use your operations management tools to run efficiency reports that identify opportunities to reclaim waste. An efficient data center has less risk. Less risk means better health and performance.

Spreading the Word

If it's true, it's not bragging, right? Don't be afraid to tell your organization about your successes and the value that IT is delivering. By leveraging the management capabilities of a next-gen virtualization platform within your data center infrastructure, you're now able to deliver higher quality of service, with less risk, at a much lower cost. IT is providing a valuable, profit-generating service for the organization. Let others know what you're doing and the impact IT is having. You never know . . . some of the efficiency gains in the data center might inspire improvements in other areas of your organization as well.

- » Highlighting resources
- » Linking to research reports, blogs, and product information

Appendix

Resources

Ready for a deeper dive into the concepts and technologies embodied in a modern virtualization platform? Immerse yourself in my recommendations for resources that will enrich your understanding of the concepts, technologies, and tools for taking virtualization to a new level.

Watch Videos

Sometimes a picture is worth a thousand words, so I've found several videos that will help explain next-gen virtualization and save you from having to read a bunch of boring technical papers:

- » **vSphere overview:** Check out a brief video to get informed about what vSphere offers, and how it can help you:
<https://www.youtube.com/watch?v=DtCG8rU0F7g>.
- » **vSphere Use Cases:** These three short videos will help you understand the core use cases supported by vSphere:
 - **Data Center Consolidation and Business Continuity:**
<https://youtu.be/bcJuwX21wQI>
 - **Enhanced Application Performance and Availability:**
<https://youtu.be/1XmdTX3UpmE>
 - **Infrastructure and Application Security:** https://www.youtube.com/watch?v=AD_f3U01mek

» **vSphere Fast Facts:** This series of bite-size videos covers some key capabilities delivered by vSphere:

- **Ensure Performance with Predictive Load Balancing:**
<https://youtu.be/3f9BNAiNmaI>
- **Eliminate Downtime for Mission Critical Applications:**
<https://youtu.be/xPwylWoXaSM>
- **Simplify with Centralized Network Management:**
<https://youtu.be/Ss8UpDcVFQg>
- **Get Comprehensive Built-In Security That Is Operationally Simple:** <https://youtu.be/mF6e7pwKqyQ>
- **Run Any App, Anywhere, with the Universal Application Platform:** <https://youtu.be/P3rvTeMXCY4>
- **Save Time and Effort with Rapid Deployment and Provisioning:** <https://youtu.be/Z8aQgz2jT38>
- **Easily Manage Containerized Workloads:** <https://youtu.be/ybDpKLcaqWk>

» **vSphere Capabilities:** Learn how the capabilities of vSphere come together to provide an ideal foundation for your applications, your cloud, and your business: www.vmware.com/products/vsphere.html#resources.

» **vSphere YouTube Channel:** Get a close-up look at the vSphere platform to learn about the latest and listen to testimonials from customers: <http://vmw.re/vsphereonyoutube>.

» **vSphere Customer Stories:** Hear the inside stories from IT professionals and business leaders talking about why they chose the vSphere platform and the benefits they're realizing: www.vmware.com/products/vsphere.html#resources.

Join the Online Discussion

One of the great things about the Internet is that it provides the opportunity to connect with people who are experts or who have encountered the same problems you may be facing. Here are some places where you can connect with other next-gen virtualization users:

- » **vSphere Blog:** Get fresh insights into the latest with the platform, its capabilities, and its ongoing enhancements from people who work with the software every day: <https://blogs.vmware.com/vsphere>.
- » **vSphere Community:** Tap into the vast vSphere ecosystem. Access how-to documents, ask technical questions, and get direct insights from the user community: <https://communities.vmware.com/community/vmtn/vsphere>.
- » **vSphere Upgrade and Install Community:** Access technical resources and join the discussion on the details of vSphere upgrade and installation processes: <https://communities.vmware.com/community/vmtn/vsphere/upgradecenter>.
- » **VROOM! Performance Blog:** Rev up your virtualization engine with these insights from VMware's performance team: <https://blogs.vmware.com/performance>.

Dive into the Product Details

Here are some resources I've found that can help you get the information you need to make your next-gen virtualization project a great success:

- » **vSphere website:** Get key details on vSphere, including information on use cases, pricing, and the features in different product editions: www.vmware.com/products/vsphere.html.
- » **Power Your Hybrid Cloud with VMware vSphere:** As your business embraces digital transformation, look at how VMware vSphere keeps you competitive in the digital economy: www.vmware.com/content/dam/digitalmarketing/vmware/en/images/products/vsphere/vmware-vsphere-6-7-infographic.gif.
- » **Hands-on labs:** Test-drive the full technical capabilities of VMware products in these free evaluations that are up and running on your browser in minutes — with no requirement for installation: <https://www.vmware.com/products/vsphere/vsphere-hol.html>.

- » **vSphere Evaluation:** Start your 60-day trial of vSphere. Evaluate the software in your own environment: www.vmware.com/go/evaluate-vsphere-en.
- » **Product Walkthrough:** Click your way through the vSphere platform, from host life-cycle management capabilities to security enhancements and other new features: <https://vspherecentral.vmware.com>.

About the Author

Himanshu Singh is Group Manager of Product Marketing for VMware's Cloud Platform business, and runs the core product marketing team for VMware vSphere. His extensive experience in the technology industry includes driving cloud management solutions at VMware, growing the public cloud business at Microsoft Azure, as well as delivering and managing private clouds at IBM. He holds a B.Eng. (Hons.) degree from Nanyang Technological University, Singapore, and an MBA from Tuck School of Business at Dartmouth College. Follow him on Twitter at @himanshuks.

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You need a modern virtualization platform

To stay competitive in the new digital economy, your business needs a scalable, available, and secure modern data center. One that gives you the ability to not just run all apps — new and existing — but also securely connect apps across clouds and devices, with a next-gen platform that provides enhanced app performance and availability, and comprehensive built-in security.

Inside...

- What next-gen virtualization can do for your data center
- How storage and network virtualization fit
- A path to seamless adoption of hybrid cloud
- Guidance on deploying and optimizing next-gen virtualization
- How next-gen virtualization makes system administration easier

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