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Hanish Rathod
Josh Townsend



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Virtualization
2.0
FOR
DUMMIES®

**By Hanish Rathod and
Josh Townsend**

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Introduction



Welcome to *Virtualization 2.0 For Dummies*, your guide to understanding and managing that big, borderless frontier known as the virtualized data center.

It's a world that knows no boundaries. A world where data, devices and user expectations are growing like mad. Where businesses are expected to operate 24x7 while running faster, leaner, more securely and more profitably each year.

If you're in IT, let's face it, you're an enabler. You're creating the virtualized environment that makes these outsized expectations possible. And, ultimately, you're responsible for controlling what you've created. In the words of Doctor Frankenstein, 'It is aliiive'. And that's a good thing, as long as it can be controlled and managed.

This book can help. It provides tips, insights and advice for gaining the upper hand on your virtualized data center. With a quick read, you can better understand how to manage the virtual environment you're responsible for, and begin using the technologies of Virtualization 2.0 to bring the full benefits and cost savings of virtualization to your organization.

About This Book

This book is packed with information for understanding and managing a virtualized data center, including how virtualization got here, why virtualization matters, and what you need to know before deploying or upgrading a virtualized environment.

Foolish Assumptions

In writing this book, we've made some assumptions about you. We assume that:

- ✔ You work in IT or within an IT organization.
- ✔ You understand the basics of virtualization and have already virtualized some aspects of your data center.
- ✔ You believe that virtualization is a good thing but you need ideas for how to make it better.

How This Book Is Organized

Virtualization 2.0 For Dummies is divided into eight chapters:

- ✔ **Chapter 1: The What and Why of Virtualization.** What it is, why it matters, and why virtualized data centers are all the rage in this ever-changing digital world.
- ✔ **Chapter 2: The Evolution of Virtualization.** How we got here, the challenges we face, and what the future holds.
- ✔ **Chapter 3: Virtualization 2.0 – Starting with Operations Management.** The key to seeing and

managing a sprawling mix of virtual machines and assets, and keeping your data center humming.

- ✔ **Chapter 4: Virtualization 2.0 Deep Dive.** Meet the four horsemen of Virtualization 2.0 – backup, storage, the network, and at the foundation, operations management – and see how they work to expand virtualization beyond the compute layer.
- ✔ **Chapter 5: Real-world Outcomes.** Learn how five IT outcomes can be achieved in the real world with Virtualization 2.0.
- ✔ **Chapter 6: Preflight.** Things to consider, roadblocks to avoid, and what to expect before you launch.
- ✔ **Chapter 7: Best Practices.** Wondering how others have gone about this? Check out these technical tips, techniques and insights.
- ✔ **Chapter 8: Useful Resources.** Ready to make the move to Virtualization 2.0? Here are our picks for the top resources as you expand virtualization beyond your servers.

Icons Used in This Book



The Dummies man spotlights real-life examples to illustrate a point.



The knotted string highlights important information to bear in mind.



Follow the target for tips and top-notch advice from the trenches.



Watch out for these potential pitfalls.

Where to Go from Here

You can take the traditional route and read this book straight through. Or you can skip between sections, using the section headings as your guide to pinpoint the information you need. Whichever way you choose, you can't go wrong. Both paths lead to the same outcome – a better understanding of Virtualization 2.0 and how it can make your data center even more efficient.

Chapter 1

The What and Why of Virtualization

In This Chapter

- ▶ Virtualization defined
 - ▶ How it all began
 - ▶ Drivers and trends
 - ▶ Why data centers go virtual
-

There's this scene in *Matrix Reloaded* where Neo is attacked by an endlessly propagating pack of Mr. Smith clones. Ten Smiths become hundreds, then thousands. They just keep coming, relentless and identical.

It's a cool CGI effect. And not a bad metaphor for virtualization. In fact, if you take away the sunglasses and slow-mo body slams, you've got the basic idea behind managing a virtual data center: Endless numbers of virtual machines, created in software, cloning fast, and coming at you from every direction.

If you manage a virtualized data center, you understand. According to *Strategic Benchmarks 2014: Server Virtualization*, a March 2014 Forrester Research, Inc. report, over 50 per cent of today's x86 workloads were virtualized in

2013. By 2015, respondents expect to virtualize more than 70 per cent of their x86 servers. Virtualization has clearly gone mainstream in the 21st Century, but why? How did we reach a point where virtual machines and resources are everywhere, propagating like mad?

In the Beginning: The Mighty Mainframe

The data center as we know it today evolved from the mainframes of the 1950s. Back then, mainframes were housed in large, climate-controlled, secure facilities with sophisticated power and cooling systems. Mainframes are complex, expensive and powerful, and after 50 years, they still play a role in today's computing hierarchy.

By the 1990s, many mainframes were being replaced by server rooms where banks of servers are connected, powered, cooled and maintained onsite. Server rooms brought improvements over mainframes, allowing a more modular approach to provisioning resources and handling increased data growth. Like mainframes, server rooms are complex and expensive, and can generate enough heat to warm an entire building.

In the 2000s, offsite colocation facilities entered the scene, allowing companies to house their servers and data in multiple locations. It was the beginning of the modern data center: Data started flowing to servers that may have been offsite or onsite, creating a level of abstraction between a company and its data. That trend continues today with cloud-connected, virtualized data centers.

Like the early mainframes, today's virtualized data center comes in all shapes and sizes. In fact, it's misleading to refer to 'the' data center as though a single blueprint exists. It doesn't.

Some are fully in-sourced, built from the ground up with onsite servers, applications, network infrastructure and IT teams to manage everything in-house. Others are fully outsourced, using a combination of cloud platforms to connect a business to its data located in distant facilities. Others fall somewhere in between, a hybrid combination of cloud-based services and on-premises infrastructure and servers. Regardless of the approach, the common ground is that a virtualized data center is designed to evolve with a business. It supports a level of growth and IT flexibility that used to be inconceivable.

Trend Spotting: Data, Data Everywhere

Businesses around the world are using that new-found flexibility to grow their data stores as never before. In its Global Cloud Index, Cisco predicts that the world's data centers will be handling 7.7 zettabytes of data per year by 2017, nearly double what they're handling today.

One zettabyte is *one billion* terabytes. Even if it's just a bunch of 1's and 0's, that's a boatload of data, and it's growing with no end in sight. Where's it coming from? And more importantly, where are the servers that will handle it?

Cisco divides all of that data center traffic into three classes: traffic that stays in the data center (76 per cent), traffic that flows between data centers (7 per cent), and traffic that flows from the data center to consumers over the internet or network (17 per cent). Here's a fact that hits home: Put all that data center traffic together, and in 2011, 70 per cent of it was handled in on-premises data centers. By 2017, only 31 per cent will be handled at an organization's physical site, leaving 69 per cent to be handled in the cloud.

There are quite a few factors driving this trend toward the cloud. Uptime Institute's 2012 Data Center Industry Study reports that 27 per cent of companies are looking for cost reductions, 23 per cent are motivated by an increase in scalability, 13 per cent cite pressure from customers or users to improve access to data, and 13 per cent are trying to build a more agile, responsive company around a cloud-based data center.

There's clearly some momentum here. Yet IT professionals are cautious by nature. Some look at cloud-based data center solutions and wonder about offsite security, deployment time, change management issues and other unknowns. Their default mindset is, 'We're getting by – why take a chance?'

Seven Good Reasons to Virtualize

Virtualization is designed for this world of fast-growing data and cloud-connected businesses. Today, a majority of the world's data centers have at least some degree of virtualization in place, and for good reasons: It makes them more competitive and helps them manage their cloud-based workloads. Here are seven factors that together make a business case for virtualization.

- ✓ **Lower costs:** To run a lot of servers, you'll need to buy a lot of power and remove a lot of heat. Add to that the cost of buying, installing, upgrading and maintaining servers and the costs can quickly spiral out of control. Businesses that go virtual are responsible for less physical hardware and the expenses that go with it.

- ✔ **Faster provisioning:** Provisioning resources for a traditional data center can take some time and it's often a one-way street. Once resources are provisioned, it can be difficult to reprovision them. Often it's easier to just buy new servers, storage or other network assets. By comparison, virtualized environments can be reprovisioned with a few clicks. Does a workgroup need more storage? Does the lab need extra computing power for a few weeks? Fire up your virtualization dashboard and it's done.
- ✔ **Fewer business disruptions:** When a physical server fails, it can take days or weeks to replace it. Someone on the IT team needs to buy and reinstall new hardware. And if you don't have a current full-image backup of the server, you'll also need to reinstall the operating systems and applications, configure directories, restore settings, reconfigure databases, and restore as much of the data as you can find. In a virtual environment, failed servers are bypassed and data keeps flowing.
- ✔ **Easier backups:** In a virtualized environment, it's easy to have full backups or snapshots of your virtual servers, virtual machines, databases, files and settings. Virtual environments can be backed up from the system level to the object level as often as you want, and it's all transparent.
- ✔ **No vendor lock-in:** Virtualized data centers have a level of abstraction between hardware and software. That means a virtual machine doesn't know or care what server hardware it runs on. You're not tied to one vendor for your hardware, operating system or cloud platform.

- ✔ **Greater efficiency:** Data centers typically run 24/7 so servers are plugged in and using energy around the clock. However, according to a September 2013 Gartner report, *Maverick Research: Peer-to-Peer Sharing of Excess IT Resources Puts Money in the Bank*, 'Other IT infrastructure utilization rates can be quite low as well – for example, servers often have a utilization rate of less than 10%, while storage utilization is a bit higher but still below 50% in many cases'. Virtualization cuts this back with shared hardware, software and infrastructure.
- ✔ **Head-start to the cloud:** Virtualization is a strong step in the direction of the cloud – a step that most companies are already taking. In fact, 55 per cent of business-unit aligned developers in IT operations consider private cloud a top infrastructure priority, according to *Predictions For 2014: Cloud Computing*, a December 2013 report from Forrester Research, Inc. This is further proof that all the pieces of a modern data center are being influenced, at least in part, by the cloud. Companies that virtualize their servers and abstract their day-to-day operations from the underlying hardware are positioned to leverage cloud services if and when it make sense.

As with all change, there are growing pains as well as significant opportunities. One thing is certain. In looking at all the trends and statistics from industry watchers, it's clear that virtualization is here to stay, and that's a good thing – especially for those who help drive the evolution.

Chapter 2

The Evolution of Virtualization

In This Chapter

- ▶ Hypervisor 101
- ▶ Today's challenges
- ▶ Tomorrow's data center

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

Hypervisor 101: Sharing the Love

A hypervisor is software that is installed on a host computer. That computer and the resources it controls then become part of a larger pool of resources that can be shared by virtual machines (VMs) on the network. The hypervisor controls how those resources are accessed by the VMs. There are multiple types of hypervisors:

- ✓ **Bare metal hypervisors:** These are commonly called Type 1 hypervisors, and 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, disk storage, and the network.

Today's Challenges

Hypervisors brought the benefits of virtualization to the data center. But with progress came challenges that are familiar to most IT managers. A Forrester Research paper, 'Expand Your Virtual Infrastructure with Confidence and Control', identifies the following common challenges in today's first-generation virtualized data centers:

- ✔ **VM sprawl:** Creating new virtual machines is so easy that VM workloads tend to propagate quickly. The result is VM sprawl, where more and more VMs are added to a virtualized infrastructure, adding time and costs to manually monitor, manage and secure.
- ✔ **Over provisioning:** Around 44 per cent of small and midsized businesses surveyed by Forrester run six or fewer VMs per physical server. That number has the potential to be much higher, probably 25 or more depending on the workload and specifics of the hardware. But without capacity management tools, these businesses lack the visibility they need to

optimize the virtual environment. As a result, they're missing out on the efficiencies and cost savings of virtualization, and are limiting their return on investment.

- ✔ **Spotty visibility and monitoring:** Most first-generation virtualized data centers lack the tools or don't have policies in place to monitor their virtual infrastructure on a continuous basis. Virtual environments are monitored only when there's a problem or a capacity shortfall. Worse, the monitoring tool of choice is often a spreadsheet, which makes it difficult to draw insights into what's not working, and why. It's a reactive rather than proactive stance, and that's a hard way to run a competitive business these days.
- ✔ **Complex troubleshooting:** Two-thirds of today's businesses need from half a day to a full week to resolve IT performance issues. Only one-third are currently able to resolve most problems within an hour. For IT to keep up with a modern business, complex troubleshooting needs to happen faster and unplanned downtime needs to be avoided.

The Next Generation: Virtualization 2.0

The next generation of virtualization – referred to as Virtualization 2.0 – is making a big leap forward.

The evolution is similar in some ways to the dramatic transformation of mobile technology. (If you need a reminder, type 'cell phone 1980' into your favorite search engine and check out the images.) The first generation of mobility solutions, though primitive by today's standards,

introduced mind-blowing new functionality – the ability to make a phone call without a landline. The second generation, smart phones, upped the ante by literally putting a computer in every pocket, forever transforming how consumers use their phones.

The changes underway in virtualization are just as dramatic. Here's what the next-generation data center will look like with Virtualization 2.0.

- ✔ **Visible:** With integrated management capabilities, next-generation data centers will have the visibility they need to truly 'see' every layer, platform, app and device in their virtual environment. Virtualization will extend beyond the server to include storage, backup, and the entire network ecosystem, so IT teams will be able to see the entire ecosystem they're responsible for managing.
- ✔ **Optimized:** Over-provisioned capacity will be reclaimed and put to use, so available resources will see higher utilization rates and data centers will see lower costs for hardware, maintenance, power and cooling. Advanced capacity management will allow IT to play a crucial role in helping the business plan resources ahead of time and increase profits.
- ✔ **Predictive:** Data centers will proactively analyze performance data, help you spot trends, and identify the root cause of performance drift as it occurs within the data center. Some fixes will happen automatically, others will trigger *smart* alerts that provide actionable recommendations to fix problems fast. Smart alerts are selective – they 'learn' the typical behaviors of VMs, devices and users in your virtualized environment, and avoid sending false alarms that flood inboxes and eat up nights and

weekends. You'll get fewer, more meaningful notifications based on policies that you define, and can find and fix problems fast before they cause downtime.

- ✔ **Always on:** Automated, agentless failover/backup with built-in redundancies across a massive virtual landscape will eliminate the threat of downtime. If a bank of servers, an entire facility or even an entire region goes down, the data center will be unaffected.
- ✔ **Customized:** Custom dashboards, reports and views will allow stakeholders outside the data center to see – and understand – how the IT infrastructure is running, and how it can run even better. Virtualization management tools will monitor the whole environment, analyze workloads, detect anomalies and deliver insights via a custom dashboard.

Chapter 3

Virtualization 2.0: Starting with Operations Management

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In This Chapter

- ▶ Capacity management
 - ▶ Performance monitoring
-

Whether you've already virtualized your data center or are just getting started, it's clear that the next generation of virtualization solutions need to address the issues of VM sprawl, over- or under-provisioning of resources, lack of insight into the IT environment, and the amount of time spent finding and fixing issues. The answer with Virtualization 2.0 is integrated operations management, which gives IT teams the power to improve application performance, reduce operating and capital expenses, and make sure businesses have what they need to be productive and responsive. Here's a high-level look at what integrated management brings to the table for today's virtualized data centers.

Capacity Management

Over-provisioning is expensive. It's common to see virtual machines with far more capacity than they need to support peak demand. As a result, server resources often sit idle, using electricity, generating heat, and adding time and cost for IT – but contributing very little to the operation of the business.

Under-provisioning can be risky with exposure to performance issues. If a mission-critical workload doesn't have the processing power, storage and other network resources it needs, VM performance suffers, and so does the business.

Capacity management: What is it?

Capacity management helps identify idle and over-provisioned VMs to reclaim excess capacity and increase VM density without impacting performance. The key is insight into the data center – knowing how much resource each VM really requires, amount of resources available and how much will be required in the future.

Companies that see the entire landscape have an advantage. They get historical as well as real-time insight into the IT environment, and can use operations management tools to spot underused resources and see the source of a problem – for example, idle, powered-off or super-sized VMs. Dashboards make it easy to see the resources that are available and make informed decisions about provisioning. And with predictive analytics, it's easier to anticipate future needs and provision the right amount of resources for future workloads.

A recent Management Insights study found that effective operations management can provide additional benefits on top of the gains that virtualized data centers have already achieved, including:

- ✓ 34% Increase in capacity utilization
- ✓ 36% Increase in consolidation ratios
- ✓ 30% Increase in hardware savings
- ✓ 26% Decrease in diagnostic & problem resolution time

How it's done: Millennium Pharmacy optimized IT resources with VMware

Like most healthcare organizations, Millennium Pharmacy Systems faced increasing economic pressures that were also felt by its client nursing care facilities. This drove Millennium to develop a lean IT service and infrastructure model that could better meet its own needs and pass on cost savings to customers.

To achieve this, Millennium sought a vendor that could deliver a more cohesive virtual environment managed with fewer resources and provide maximum insight into data center health and utilization. After having successfully virtualized three server farms containing 25 physical machines on VMware vSphere® software, VMware was the natural choice for these next steps in the company's virtualization journey.

After piloting **VMware vSphere® with Operations Management™** in a proof of concept deployment, Millennium realized the value of upgrading to a virtualization platform that provided insight into workload capacity and health, including opportunities to

optimize systems to cut costs and reclaim overprovisioned resources.



‘[It] was almost jaw dropping in terms of the memory and resources we would get back by using this product,’ said Leon Ravenna, Millennium’s Vice President of Infrastructure and Operations and Information Security Officer. ‘Some of the results were almost unbelievable in terms of what they recommended. It drove us to be more efficient than we had been, and it taught us how to look at VMs differently than physical hardware.’

Optimized resources

By using vSphere with Operations Management capacity planning tools, Millennium discovered that every virtual machine was oversized. It quickly improved the efficiency of the entire data center by resizing each VM.



‘Our entire data center is much more efficient, much more trimmed down and able to utilize more VMs on less hardware,’ said Millennium’s Lead System Engineer, Craig Clark. Now 94 per cent virtualized, Millennium has reduced the footprint in its customer-facing data center that runs its proprietary MPSRx medication fulfillment system from 25 physical machines down to just four.

Streamlined management

In addition to optimizing resources, Millennium streamlined its data center management by using the single-pane-of-glass view provided by vSphere with Operations Management.

‘Prior to vSphere with Operations Management,’ remembered Clark, ‘we had three different vCenter™ Servers that required me to constantly toggle among the three to see each environment.’ Now, Clark can see and keep track of his data centers through a single, unified console.



‘When I first start my day with vSphere with Operations Management, I go straight to the dashboard, which gives me a global view of the health, risk, and efficiency of my entire IT environment,’ said Clark. ‘From there, I’m able to drill down to see how each component of my data center is working, including the clusters, hosts, VMs, and the data stores, as well as any faults that happen to be occurring. I can then quickly double-click to get to the individual fault and determine exactly what it is and what action I need to take.’

Business Impact

- ✓ Higher levels of reliability
- ✓ Fast recognition and resolution of issues saves time and reduces end-user impact
- ✓ 25 per cent increase in efficiency allows fewer resources to deliver more value
- ✓ Ability to capacity plan reduces capital expenditures and ensures server optimization
- ✓ Increased VM density leads to lower capital and operational expenses

Performance Monitoring

IT lacks the tools to aggregate and analyze performance data quickly enough to take proactive action and reduce downtime. Legacy monitoring tools used by IT are based on low-level metrics and static thresholds. This leads to a lack of understanding on root cause, alert storms, and false positives.

It can be difficult in a virtualized data center – in any data center, for that matter – to get to the root cause of performance problems. Sometimes performance simply degrades slowly over time. And like the frog in the slowly heated pot of water, businesses may not notice a problem in the data center until it's too late.

Performance problems might be tracked to a change in virtualization policy, a network performance issue, a memory bottleneck, under-provisioning, power outages – countless culprits come to mind. Good luck finding the root cause in a hurry if you need to launch multiple management consoles and want to compare what you're seeing across server, storage and network environments. No wonder performance problems are so hard to fix.

Performance monitoring: What is it?

The advanced performance monitoring solutions of Virtualization 2.0 provide a 'world view' of the IT environment on one dashboard. Bottlenecks and performance issues can be traced to the source.

There are two key features of an effective solution:

- **Predictive Analytics** analyze server performance data, establishes dynamic thresholds that adapt to the environment, and provides Smart Alerts

about health degradations and performance bottlenecks to drive proactive action and policy-based automation

- **Operations Console** displays key performance indicators in easily identifiable colored badges and provides a comprehensive view into what is driving current and potential future performance and capacity management issues in one place

Troubleshooting gets faster, easier and cheaper with less time wasted searching for issues. The dashboard makes it easy to filter through VMs or server clusters where performance levels appear to be degrading, get a handle on what's happening, and make informed decisions on how to proceed.

Did the problem start within the last six hours or has it been a long, slow slide? Is there a bottleneck in the system? Is it related to the CPU, memory or I/O? Is the issue limited to a particular VM, its peers or the host? With the integrated management tools of Virtualization 2.0, IT has all the answers.

How it's done: Cornerstone optimized IT performance with VMware

Cornerstone Home Lending, Inc. required a reliable virtualization platform to support growth ambitions of up to USD \$10 billion in annual loans in the next few years. It found the ideal solution to fit its business needs in **VMware vSphere® with Operations Management™**.

With the help of partner Computex, Inc., Cornerstone was able to implement 45 hosts and close to 100 virtual machines within a very short timeframe. Today, the solution provides insight into past and present asset

health through a comprehensive, centralized console, and enables best-in-class platform-wide management.

Ricky Caldwell, Cornerstone's Director of Server Operations, Architecture and Infrastructure, sees the capacity planning and performance monitoring offered by vSphere with Operations Management as vital to his organization.



'I'm able to open up VMware vCenter™ and with everything in a common console, it gives me one full view to my entire environment,' Caldwell said. 'I'm not required to open up five different management consoles in order to see my server, my storage, my network. It's all in one location, which makes it very easy.'

Maximizing system performance

'With vSphere with Operations Management, we get a very in-depth view of what's happening on various levels, on a day-to-day basis, a weekly basis, or a monthly basis,' added Cornerstone's Server Operations Project Lead, Stan Thampi. 'Alerts tell me right away if I have any emerging performance issues that need to be looked at, before they impact the business.'

To maximize system performance, Cornerstone utilizes vSphere Distributed Resource Scheduler™ (DRS) provided within the vSphere with Operations Management platform. With DRS, Cornerstone can load balance resources to virtual machines by deploying new capacity to a cluster or automatically migrating virtual machines at any time without any service disruptions.

Leveraging a holistic view

vSphere with Operations Management collects the metrics from vCenter Server to provide a holistic view of

Cornerstone's IT infrastructure. The comprehensive dashboard includes health, risk, and efficiency scores, so managers quickly understand IT service levels and workload capacities.

Since implementing vSphere with Operations Management, Cornerstone can now better identify capacity shortfalls, stressed workloads, and over-provisioned servers. These insights allow the company to optimize the use of its existing resources and make IT investment decisions with certainty.

Reducing hardware costs



The switch from physical to virtual servers has resulted in hardware cost savings close to 70 per cent. 'We're no longer spending four or five thousand dollars per physical server. We can now leverage the virtual hardware we have in place for a third of the cost,' added Caldwell.

In addition, Cornerstone has reduced operating expenses since virtualized infrastructure require less power and cooling.

Business Impact

- ✓ Comprehensive insight into IT
- ✓ Improved resource planning to better inform IT investments and decision making
- ✓ 70 per cent reduction in hardware costs
- ✓ Ensured uptime with reliable virtualized infrastructure
- ✓ Reduced time spent on identifying and resolving system issues

Chapter 4

Virtualization 2.0: Deep Dive

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In This Chapter

- ▶ Virtualization 2.0 technologies beyond the server
 - ▶ Operations management for virtualized environments
 - ▶ Virtualized backup
 - ▶ Virtualized storage
 - ▶ Virtualized networking
-

If we've learned anything about data center virtualization over the past few years, it's that cloud-based data environments are a mosaic. Most businesses use a mix of private and hybrid cloud services to meet the needs of a bewildering number of devices, operating systems, applications, users and work groups.

Virtualization 2.0 fits this borderless world pretty well. In fact, 'borderless' is a good description for next-generation virtualization, which goes beyond servers and VMs to include operations management, backup, disaster recovery, storage, network operations and more.

It makes sense. A data center is the nerve center of a business. Virtualizing just part of it limits its benefits and reduces the return on investment. In this chapter, you'll meet the four horsemen of the virtualized data center:

operations management, backup, storage, and the network. You'll see how they work – and how they work together – to create a modern, fully optimized IT environment that's ready for whatever a cloud-based business can throw at it.

We'll reference specific VMware products from this point forward, so you get both a micro and macro view of Virtualization 2.0 and its role in a state-of-the-art data center.

Operations Management for Virtualized Environments

If your employees and customers are happy and productive, thank IT ops. IT operations management plays a central role in how – and how well – knowledge workers do their jobs.

It's no exaggeration to say that customers and employees rely on IT applications and infrastructure every minute of every day. Nothing has a greater impact on their ability to do their jobs. Yet many data centers lack the monitoring tools they need to keep the data center humming. Many use legacy monitoring tools – in some cases, spreadsheets – for troubleshooting and provisioning.



Most legacy monitoring tools were not designed to keep up with a modern, virtualized environment. They force businesses to be reactive instead of proactive: all too often, IT admins get hit with alert storms and false alarms – or worse, no warning at all – when the performance of the network or an application drifts out of spec or begins to bottle-neck. For IT, it often means fire drills and late nights.

Since most IT departments are stretched thin, they can't afford to spend more time, budget and resources manually

identifying and resolving performance and capacity issues. In many cases, a small IT team is supporting an organization that has significant competitive pressures; siloed management tools make their job harder than it needs to be.

The challenge: Improve efficiency, and fast

How efficiently can you deliver IT services, deploy IT resources, and enforce IT policies and compliance measures? The answer affects your profitability. With modern tools such as those found in the VMware vCenter™ Operations Management Suite™, data centers can improve efficiency and achieve three key benefits:

- ✔ **Faster service delivery:** With insight across the entire virtual environment, including applications, infrastructure, devices and VMs, it's easier to identify performance drift and fix performance, capacity and configuration issues before they cause downtime
- ✔ **Higher operational efficiency:** By optimizing how resources are used and managed, over-provisioning is avoided and unnecessary purchases are reduced. And it goes beyond cost efficiency. IT teams are also able to work more efficiently, reducing fire drills and late nights, and focusing their skills to help the business be more competitive.
- ✔ **Improved control and compliance:** By automating configuration and compliance policies and monitoring results, the burden on IT is reduced – and many of the costs of non-compliance are avoided.

How it works

vCenter™ Operations Management Suite™ delivers intelligent operations from applications to storage – managing the health, risk, efficiency and compliance of a dynamic environment from a single console.

Self-learning analytics, dynamic thresholds, and the ability to automatically correlate application and infrastructure performance help IT teams to proactively identify potential capacity and performance issues. Dynamic thresholds automatically adapt to the virtual environment, providing fewer and more specific alerts regarding health degradations, bottlenecks and capacity shortfalls. Smart Alerts combine multiple symptoms into a single alert that identifies the underlying issue and provides clear recommendations for remediation. Smart alerts, along with the software's ability to map application dependencies to the underlying infrastructure, make it easier to find and fix problems faster.

Operations teams can create custom workflows for common IT operations and processes, all of which can be automated based on policies they control. Common actions – such as defining specific capacity thresholds, alert types, notifications and configuration settings – can be prioritized around the needs of the business.

Storage analytics provide visibility into infrastructure topology, usage statistics and events across host bus adapters, fabric and arrays using standard protocols. Automated capacity optimization allows operations teams to reclaim over-provisioned capacity, increase resource utilization and eliminate the need for scripts and spreadsheets.

The Suite automatically detects, enforces and remediates security hardening guidelines, configuration standards and regulatory compliance requirements across the virtual environment. Change events can be visually correlated with performance data across physical and virtual infrastructure, operating systems and applications, providing visibility into performance degradation caused by configuration changes.

Custom dashboards, reports and views help operations teams visualize key performance indicators (KPIs), provide

role-based access and enable better collaboration across infrastructure, operations and applications teams.

Virtualized Backup

Protecting data in a virtualized environment can be tricky. Data is distributed across a lot of devices, platforms and facilities, making it hard to control. What's more, new virtual machines can be spun-up easily, often without the backup administrator knowing that the workload needs to be part of the backup routine. It's a recipe for trouble.

Virtual environments that use conventional software to back up their virtual machines are adding complexity to an environment that's already complicated enough.

Conventional backup software must be licensed, installed and maintained on every virtual machine, so that software competes for virtual machines resources and impacts server performance.

The goal: Simplify, simplify

In a virtual world, new virtual machines need to be detected as soon as they're created and they need to be protected when they move. Setup routines need to be fast and easy; if there's a steep learning curve or if a backup solution is overly complicated, chances are good that newer workloads and devices will go unprotected until the IT team can find time to address the gap.

Virtualized backup solutions are designed to integrate with a virtualized data center, providing backup scheduling and management from a unified console. This improves control over all assets – virtual and physical – while optimizing how storage is consumed during virtual machine backups, reducing backup costs.

VMware vSphere Data Protection Advanced provides a good example of how a fully virtualized backup strategy can simplify life for IT admins, and make sure the virtualized environment is ready for fast disaster recovery. With virtualized backup integrated into the virtualized data center, IT can:

- ✓ Manage backup operations across all virtual machines from a unified UI
- ✓ Perform agentless virtual machine backup and recovery
- ✓ Back up application data on virtual and physical servers
- ✓ Replicate virtual machine and application backups for disaster recovery
- ✓ Reduce backup storage footprint through advanced data deduplication
- ✓ Recover from data disasters quickly with Changed Block Tracking technology
- ✓ Meet infrastructure SLAs
- ✓ Reduce total cost of ownership through simple per-CPU licensing and support

How it works

VMware vSphere® Data Protection™ Advanced is a disk-based backup solution, deployed as a pre-built, Linux-based virtual appliance. During a backup, the software creates a full-image snapshot of the virtual machine. Data deduplication is performed with every backup operation to optimize storage space. The vSphere® Hypervisor web UI is used to select, schedule, configure and manage backups. Specific virtual machines or virtual machine disk (.vmdk) files can

be selected for backup. Containers of virtual machines such as data centers, clusters and resource pools can also be selected for backup. When a virtual machine is added to the protected container, it is automatically backed up.

The first time a virtual machine is backed up, all data blocks are imaged; from that point until the next full backup, only unique data segments are backed up, thereby ensuring that redundant data is not backed up, saving backup storage resources. Since VMware vSphere Data Protection is primarily agentless, it eliminates the overhead of installing an agent in every virtual machine. However, through the use of light-weight application agents it allows granular, object-level backup of mission-critical applications like Microsoft® Exchange Server, SQL Server and SharePoint on both virtualized and physical servers. This is the recommended way to backup these mission-critical applications, since the agents utilize the application's backup APIs to perform backups in a transaction-consistent manner.

vSphere Data Protection Advanced can replicate backup data to another vSphere Data Protection Advanced appliance (or to EMC Avamar servers). Backup data can be replicated to offsite or disaster recovery locations in an encrypted, WAN-optimized manner; i.e. only unique data segments are compressed, deduplicated, encrypted and replicated minimizing network bandwidth consumption and helping make the data in-flight secure.

Virtualized Storage

Virtual machines require storage. Lots of it. The world's stored data doubles nearly every 24 months. This creates constant pressure in the data center where, all too often, legacy storage solutions pre-date the shift to virtual infrastructure. It creates a functional gap – and no small amount of stress – since the needs of the business are being met in many areas, but rarely in the area of storage.

It used to be easier. In the days before VMs, traditional storage solutions such as storage-area networks (SANs) provided a centralized approach to storage, so multiple machines, workgroups or departments could share storage resources. VMs added a layer of complexity to the storage picture. IT managers suddenly were expected to provide the same level of service to a virtual environment that was available with a SAN.

The answer: Virtual storage-area networks

A virtual storage-area network is created by software that can pool storage components in standard x86 servers and present them as a shared datastore through the hypervisor to virtual machines. VMware Virtual SAN™ pools the solid-state drives (SSDs) and hard-disk drives (HDDs) that are inside physical servers, and make them appear as a single, shared storage resource. They're designed for today's virtualized, software-defined data centers, removing the complexity of deploying and managing storage for virtual environments. That means IT managers can set and change application service levels on the fly, in software, and control storage that's as fluid and dynamic as the virtual data center it serves.

Modern tools, like Virtual SAN, address three big requirements for virtualized data centers:

- ✔ **Simpler storage:** Policy-driven storage simplifies and streamlines provisioning and management for software-defined data centers. VM-level storage policies automatically match requirements with underlying storage resources. Many manual storage tasks are automated, improving efficiency while reducing costs.
- ✔ **Higher performance:** When read/write caching uses server-side flash, storage commands are executed fast. A virtual SAN solution actually delivers better performance than most virtual appliances or external arrays.
- ✔ **Lower cost:** When storage can be scaled as needed, a storage environment can grow incrementally, in small batches. No more over-provisioning or buying forward. Leveraging server-side economics allows you to enjoy savings from reduced markups on all storage components. Hardware-agnostic design means you can leverage your existing infrastructure, and have the flexibility to design the solution for a wide range of performance and capacity requirements. In addition, UI familiarity means a short learning curve so operational productivity is improved, saving time and money.

How it works

Virtual SAN™ creates a shared datastore for virtual machines by pooling the SSDs and HDDs inside servers and making the resources available to VMs. Once a Virtual SAN is set up, storage can be provisioned to new VMs and existing VMs can be moved from another datastore into the Virtual SAN. The Virtual SAN interface is integrated into a

console with the vSphere hypervisor web client, allowing it to work seamlessly with virtualized applications for backup, data replication, cloning, snapshotting and more. Different storage policies can be identified for each VM – a key consideration for virtual environments. This allows IT administrators to do things like:

- ✔ Specify the number of hardware failures a VM can tolerate.
- ✔ Dedicate a specific percentage of flash storage to a VM.
- ✔ Identify the number of hard disks that should be provisioned for a VM's objects.
- ✔ Specify the overall percentage of capacity that should be reserved for each VM.
- ✔ Change policies on the fly from the vSphere web client.

Virtualized Networking

Server and storage virtualization solutions have transformed the data center. Network virtualization is doing the same. The automation, the cost savings, the benefits of consolidation and on-the-fly provisioning and software-based control – all are coming to a network near you. Good thing, too, because without network virtualization, the full potential of data center virtualization is not being realized.

Traditional networks and network services simply can't keep up with the rapid-fire pace of a virtualized data center. Manual provisioning, vendor-specific hardware and rigid network topologies all affect how traditional networks operate – and how the IT team spends its time.

On a daily basis, IT teams with traditional networks struggle with time consuming and error prone manual provisioning,

which is not only slow but also error prone. Since workloads are restricted by physical topologies, network operators spend a lot of time performing manual box-by-box configuration of VLANs, ACLs, firewalls and more. IT administrators are often forced to over-provision the network due to VM sprawl. Add over-subscription, security blind spots and siloed management and it's easy to see why most IT teams have their hands full.

The mission: Make life easier

Virtualized networks are designed to address these issues by aligning with the underlying design philosophy of a virtualized data center. The VMware NSX™ network virtualization platform shows how the software-defined data center approach turns into actual advantages for IT teams. For example, a fully virtualized network means:

- ✔ **Streamlined operations:** Network engineers dramatically reduce or even eliminate manual network and security configuration changes. They can now programmatically create, provision, snapshot, move, delete and restore complex network environments – all in software.
- ✔ **Greater flexibility:** Traditional networks are rigid, and their functionality is slow to evolve. Network virtualization transforms the underlying physical network into a pool of network capacity that can be provisioned and repurposed on demand.
- ✔ **Unrestricted workload mobility and placement:** Workloads can be placed or moved freely through the physical data center environment while remaining connected to any virtual network. This ability allows any available compute capacity to be utilized at any time, dramatically reducing the need to over-provision

servers to compensate for physical topology restrictions.

- ✔ **Bulletproof security:** Rather than being tied to IP addresses, network policies can be based on virtual containers, applications and Active Directory identities. Security policies are automatically attached to VMs as they're created, policies move with VMs and are deleted when VMs are deleted, all with no human intervention.
- ✔ **Disaster-proof operation:** A virtual network makes it easy to get a full-image backup of the 'application architecture' and have it available for push-button recovery – in minutes, on any replacement hardware, with no compromise in functionality.
- ✔ **Lower cost:** Network provisioning and configuration are automated. Administration, monitoring and troubleshooting are faster and easier. Network visibility and control spans both physical and virtual infrastructure. Hardware independence allows operators to build their physical infrastructure with the best price/performance solution from any vendor.

How it works

VMware NSX is based on a distributed system controller with traditional hypervisor and vSwitch. The entire virtual network is created in software, and is independent of the existing physical infrastructure, so NSX works with any application, hypervisor, network infrastructure or cloud service, and can be deployed on any IP network, including current or next-generation fabric architectures from any vendor.

Just as a VM is a software container that presents logical compute services to an application, VMware NSX is a software container that presents logical network services – logical switching, routing, firewalling, load balancing, and more – to connected workloads. To VMs, the NSX virtual network looks and acts like a traditional physical network. Workloads ‘see’ the same Layer 2 to 7 network services that they would see in a physical network – it’s just that these services are instantiated in software running in the hypervisors throughout the data center. Distributing network and security services, such as routing and firewalling into the hypervisor virtual switch, eliminates *hair-pinning* – the need for traffic to traverse the network to reach these traditionally hardware-based services.

Combining the automated operational model and distributed services capabilities of the VMware NSX platform provides IT organizations with never before possible agility and service delivery speed. Enterprises around the world are transforming data center operations and economics by implementing a software-defined data center approach. This new approach is allowing IT organizations to deliver:

- ✔ Unparalleled security inside the data center perimeter by delivering operationally feasible micro-segmentation
- ✔ Dramatically reduced time-to-market by delivering self-service R&D clouds
- ✔ Significantly reduced operational costs of and extend current investments in existing physical infrastructure.

Chapter 5

Real-world Outcomes of Virtualization 2.0

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In This Chapter

- ▶ Data center virtualization and standardization
 - ▶ Streamlined and automated data center operations
 - ▶ Security controls native to infrastructure
 - ▶ High availability and resilient infrastructure
 - ▶ App and infrastructure delivery automation
-

IT departments are responsible for solving some pretty big issues, and it goes beyond technology. Is it secure? Is it in compliance? Can it recover from a disaster? How fast? How *well*? Does every department, team and employee have what's needed to help the company compete and be profitable?

IT has a hand in all of it.

Clearly, IT teams focus not just on the *fire drill du jour* but also on big-picture, macro outcomes that make their company more successful. Here are the top-five IT outcomes that most data centers strive for. Virtualization 2.0 is the foundation that makes each one possible...

IT Outcome: Data Center Virtualization and Standardization

Complexity is a productivity killer. Overly complex data centers bleed time and energy from IT teams, and often result in unnecessary capital expenses, error-prone manual processes, disorganized topologies, siloed infrastructure and general lack of interoperability across the data environment. The end result is unplanned downtime – the ultimate complication for any competitive business.

Virtualization 2.0 helps by simplifying the data center. The entire environment – compute, storage, backup, network – is created and managed in software, so the underlying complexities are masked. These software-defined data centers improve efficiency through hardware consolidation – a bottom-line priority for most companies. With fewer machines to buy, configure, install, maintain, troubleshoot and support, IT can help the business run leaner and more profitably.

Data center consolidation and standardization can be addressed in three stages of maturity with Virtualization 2.0 solutions:

Stage 1: Compute virtualization

Get more mileage from your existing assets and the savings add up. This is the starting point for most businesses that are looking to reduce costs.

- ✔ **Required capabilities (what you need to be able to do):**
Compute virtualization. Business-critical application virtualization. Big Data app support.
- ✔ **Business outcome (how your business benefits):**
Dramatic CapEx and OpEx reduction result in a data center with better-than-public-cloud unit costs.

Stage 2: Network virtualization and software-defined storage

Once the hardware environment is simplified, software and networking are next. Streamline here for additional savings.

- ✔ **Required capabilities:** Run-book automation to support data center migrations, software-defined storage, and network virtualization
- ✔ **Business outcomes:** Extend CapEx and OpEx reductions across the entire data center infrastructure to maximize the return on your investments

Stage 3: Hybrid cloud

Big efficiencies can be gained by selectively deploying multiple aspects of a business in the cloud.

- ✔ **Required capabilities:** Ability to extend compute, storage, network, backup and disaster recovery resources to any cloud platform.
- ✔ **Business outcomes:** Expand capacity and service when you need them most without having to invest in new infrastructure.

IT Outcome: Streamlined and Automated Data Center Operations

Service-level agreements need to be met. To get there, data centers either over-provision the network so they're ready for peak flows, or under-provision the network and risk sluggish application performance, capacity shortfalls and lack of availability when it's needed most. The end result is a business disruption that's unplanned, unwelcome – and unnecessary.

Virtualization 2.0 provides intelligent operations management across physical, virtual and cloud infrastructures, from the hypervisor to web services to physical hardware. It correlates data from application to storage in a unified management environment that provides control over performance, capacity and configuration, with predictive analytics and smart alerts driving proactive action and policy-based automation.

Capacity optimization and performance monitoring can be addressed in three stages of maturity with Virtualization 2.0 solutions:

Stage 1: Performance and capacity management

Virtualization is about efficiency and optimization. Start by focusing on performance and capacity.

- ✓ **Required capabilities:** Maintain universal view of virtual environment. Monitor performance. Optimize resource utilization.
- ✓ **Business outcomes:** Reduce IT costs and sprawl by increasing capacity utilization and consolidation. Reduce costs to purchase, install and maintain hardware. Reduce IT time spent on troubleshooting.

Stage 2: Physical infrastructure health monitoring and 3rd party data integration

Third-party apps and integrated dashboards make the virtualized environment easier to manage – a key consideration as more VMs are added.

- ✓ **Required capabilities:** Support third-party management packs for Microsoft, SAP and more. Provide role-based access to customizable dashboards.
- ✓ **Business outcomes:** Faster diagnosis and troubleshooting. Fewer alerts, reducing fire drills for IT. Shorter mean-time-to-identification, improving service delivery to better meet service-level agreements.

Stage 3: App health monitoring, quality-of-service management

Are your business-critical apps running as well as they should? Managing this part of your business can bring serious gains.

- ✓ **Required capabilities:** Manage business-critical applications from any vendor (Microsoft, Oracle, SAP). Enforce regulatory compliance standards. Provide single-console visibility across applications, storage and network devices.
- ✓ **Business outcomes:** Dramatic improvements in service quality. Fewer manual errors in configuration. Improved uptime on tier 1 applications.

IT Outcome: Security Controls Native to Infrastructure

Few things keep an IT administrator up at night like security and compliance concerns. With workloads, files and users spread far and wide across the virtualized data center, it's hard to be confident that every single data door is locked, that every single compliance regulation is being met for every user on every device.

Virtualization 2.0 helps by enhancing the software-defined network with policy-based security and compliance technologies, thus allowing workloads to be configured and monitored according to precise rules. These control measures remain in place regardless of where workloads are deployed in a private or hybrid cloud.

Security and compliance can be addressed in three stages of maturity with Virtualization 2.0 solutions:

Stage 1: Network security tied to workloads

Security and compliance policies need to be automated across the network. Every virtualized data center needs to address this baseline functionality.

- ✓ **Required capabilities:** Layer 2 to layer 7 network virtualization and security. Security and network services follow workloads. Ability to introduce network services on the host (VM) level. Hardware-independent network and security services. Automated network infrastructure.
- ✓ **Business outcomes:** Faster deployment of network and security resources. Increased hardware efficiency through multi-tenancy. Next-generation network security. Increased VM security.

Stage 2: Advanced 3rd party security services integrated into network platform

As a virtualized network matures, additional refinements help address compliance and monitoring across the virtual infrastructure.

- ✔ **Required capabilities:** Integration with 3rd party security service providers, providing multi-level security to the infrastructure, including advanced firewall services, intrusion prevention systems and network antivirus capabilities, personalized and configured via policies on the VM level.
- ✔ **Business outcomes:** Better multi-layer security with low administration overhead.

Stage 3: Extension of network and security services to hybrid cloud

The final stage of network maturity brings the network and all security and compliance services into the cloud.

- ✔ **Required capabilities:** Streamline and secure the extension of network to hybrid clouds. Move infrastructure to any cloud platform without having to change network and security configuration.
- ✔ **Business outcomes:** Easier workload migration across the virtualized environment, with security baked in.

IT Outcome: High Availability and Resilient Infrastructure

Stuff happens. Power grids go down, storms hit, viruses spread. The threats never stop. Nor does the need for network access. Data centers are expected to operate 24x7, be fully secure, protect sensitive data and meet every compliance requirement. After a disaster passes and there's still an inch of water in the conference room, workers expect to be back online with no interruption, with every workload, app, file and setting right where they left it.

That's the expectation for a modern data center. Virtualization 2.0 can help by simplifying how routine backups and disaster recovery processes are managed. With higher levels of automation, non-disruptive testing and high-performance data protection, Virtualization 2.0 provides expanding degrees of protection to cover VMs, clusters and the entire data center. Operations management tools, snapshots, live migration tools and other capabilities help reduce or even avoid business impacts before they cause a disruption. The net effect is less risk of business downtime and continuous, seamless data center operation across private and hybrid clouds.

Business continuity can be addressed in three stages of maturity with Virtualization 2.0 solutions:

Stage 1: High availability, data protection, and disaster recovery-as-a-service

Where's your next data disaster coming from? Even if you had a crystal ball and could see the future, you would need to address these baseline items.

- ✔ **Required capabilities:** Back up hundreds of VMs per virtual appliance, Provide agentless, image-level backups to disk for any virtualized app. Conduct data deduplication with each backup. Use across sites and to hybrid cloud.
- ✔ **Business outcomes:** Zero service disruption when disaster strikes. Guaranteed resource availability across the business, so outages are avoided. Full data protection for all workloads for fast recovery from data disasters.

Stage 2: Automated disaster recovery for vSphere environments

With automated workload recovery across sites, the disaster recovery solution brings cost-effective data protection and reduced downtime for apps and services.

- ✔ **Required capabilities:** Non-disruptive DR testing for virtualized environments. Recovery setup in minutes. Support for all applications. One-click failover initiation.
- ✔ **Business outcomes:** Comprehensive, low-cost disaster recovery with failback – prior settings and data are resynchronized to pre-disaster locations to greatly reduce business disruptions.

Stage 3: Self-service, policy-based DR protection for apps

Advanced DR policies for failback create an ultra-resilient data environment – one that can recover quickly from almost any disaster.

- ✔ **Required capabilities:** Define and provision DR protection tiers to virtual machines. Self-service, policy-based provisioning of predefined DR tiers.
- ✔ **Business outcomes:** Reduced admin time to provision DR-protected workloads. Quicker time to market for DR-protected workloads.

IT Outcome: App and Infrastructure Delivery Automation

Businesses move fast. Data centers need to do the same. Data center infrastructure needs to be up to the challenge of helping businesses acquire new customers, capture new revenue streams, enter new markets or shift business models on the fly.

Virtualization 2.0 can help by automating service delivery across hybrid environments. That means apps – and the people who rely on them – have access to the right tools at the right time, governed by policies that control security, compliance, provisioning, backup and more.

Infrastructure and app automation can be addressed in three stages of maturity with Virtualization 2.0 solutions:

Stage 1: Infrastructure-as-a-Service

Setting up automated, self-service provisioning is the first step in getting a virtualized data center up to speed.

- ✔ **Required capabilities:** Automated provisioning of VMs and related services through self-service portal. Infrastructure costing.
- ✔ **Business outcomes:** Accelerated time-to-value and more IT control. Much faster provisioning (weeks to minutes). Greater IT efficiency, reducing IT time, costs and headaches for provisioning. Faster ramp times for workgroups, improving the business' competitive profile.

Stage 2: Application and middleware delivery automation

Automating how middleware and apps are provisioned can further accelerate virtualized operations, especially as some services move to the cloud.

- ✔ **Required capabilities:** Automated middleware and apps provisioning. Policy-based network and storage services. Service costing.
- ✔ **Business outcomes:** Improved agility. Less time to provision and deploy complex applications. Easy to increase capacity on demand – extend workloads to the hybrid cloud as needed.

Stage 3: Heterogeneous and hybrid cloud

Fully optimized environments transparently support any workloads across a combination of hypervisors and hardware in private and hybrid clouds.

- ✔ **Required capabilities:** Application release automation. XaaS. Provisioning and migration of workloads for multi-hardware and multi-hypervisor across private and hybrid clouds including vCloud Air™, AWS, and those based on OpenStack.
- ✔ **Business outcomes:** Less IT time and cost to provision fully loaded VMs. Lower CapEx thanks to optimized, consolidated storage and networking infrastructure.

Chapter 6

Virtualization 2.0 Preflight

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In This Chapter

- ▶ Getting started with Virtualization 2.0
 - ▶ Adding operations management
-

When a virtual environment is firing on all cylinders, it drives down costs and reduces unplanned downtime. 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. Here are 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

Before you move your physical server workloads into virtual machines, enlist a cross-discipline team that includes application owners, finance and facilities. 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.

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.
- ✔ Make sure your infrastructure is ready to provide the high levels of service your business demands. Build redundancy into the physical plant (especially power and cooling), build redundant network and storage fabrics, and use quality gear throughout. The business is betting on IT to get this done right, so build it right and build it from the bottom up.



As always with such efforts, 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 vs. 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 SAN or NAS array:**

Compared to virtual storage, a storage-area network (SAN) or network-attached storage (NAS) solution can be more expensive and require more technical expertise because they need 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, Fibre 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 Virtual SAN™ 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 highly volatile I/O workloads such as Tier 1, mission-critical database applications on Tier 1 backend storage, such as 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 IOPS (I/Os per second) 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 Virtual SAN 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, there may also be thin provisioning available at the array hardware level as well.
- ✔ Using VMware vSphere® with Operations Management™, you can configure Storage I/O control to guarantee a certain amount of I/O resources for each virtual disk, or enable Storage I/O Control to provide equitable access to storage resources for all VMs. This ensures that no particular workload will dominate the resources of any physical array.

Addressing Security and Compliance

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

Remember:

- ✔ 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 with Operations Management, such as VMware vShield Endpoint™, which offloads anti-virus and anti-malware 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 system consolidation. 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. 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, so when you're creating your business continuity and disaster recovery plans, your backup and recovery policies are aligned with your business priorities.

Adding Operations Management

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 Virtualization 2.0 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, here are ten things you need to know. These tips will help you get the most from vSphere with Operations Management, our core virtualization product, vSphere, with the addition of performance monitoring and capacity management capabilities through the vCenter Operations Management Suite. This combination creates the operations management platform for Virtualization 2.0.

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 vCenter Operations Manager. 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

With vSphere with Operations Management, 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 vCenter 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 vCenter Operations Manager to assign policies to certain groups of resources, geographic locations, or business units to customize badge thresholds (see next step), alerts and capacity management settings. Take advantage of the out-of-the-box policies included with vSphere with Operations Management that will meet most of your business needs (e.g., 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. vCenter Operations Manager 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 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 vCenter Operations Manager is always running properly.

Schedule Reports to Help Address Bottlenecks Before They Occur

Use reports in vCenter Operations Manager 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 will 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.

Chapter 7

Ten Best Practices for Virtualization 2.0

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In This Chapter

- ▶ Tips, techniques and insights into Virtualization 2.0
 - ▶ Getting the best from Virtualization 2.0
 - ▶ Understand the correct order for deployment
-

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.

Prepare 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.

Install 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.
- ✔ Implement your administrative platform (vCenter Server™) and configure vCenter Server 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 Virtual SAN solution, enable it through your virtualization management console now.

Configure 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 will 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 (i.e. supporting VAAI and VASA). This improves scalability and performance by offloading some operations to the storage hardware.
- ✔ Make sure end-to-end Fibre Channel speeds are consistent to avoid I/O speed bumps.

- ✔ Configure maximum queue depth if needed for Fibre 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 Fibre Channel, 10/40/100 Gb Ethernet) and converged fabrics, this step may not be unnecessary.
- ✔ 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.

Evaluate and Redesign 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

Secure 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 do 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.

Performance-tune 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.

Enable Advanced Features for Performance and Availability

Once migration is complete, verify that all of your virtual machines are powered on and connected to the network, and that you've distributed virtual machines to optimize your use of your server hardware. With your virtualization platform deployed, it's time to leverage the power of Virtualization 2.0 management tools. Here's where you should start:

- ✔ Configure advanced features of your virtualization platform, including High Availability, Distributed Resource Scheduler, vMotion, and advanced virtual networking options such as a distributed virtual switch. These software-defined availability 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 good Virtualization 2.0 management 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, 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.

Optimize VMs So They're Stable and Efficient

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). While many servers can be directly converted, 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 of 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, 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 new-found 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.

Monitor and Optimize 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 Virtualization 2.0 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 have performed hardening tasks as required by your organization.
- ✔ Model the impact of adding additional workloads to your environment using vCenter™ Operations™ capacity planning tools. This will help you to determine your risk of running out of physical resources or proactively identify the right amount of physical resources to add to your environment for planned expansions.
- ✔ Run efficiency reports in vCenter™ Operations™ to identify opportunities to reclaim waste. An efficient data center has less risk. Less risk means better health and performance.

Spread 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 IT is delivering. By leveraging the management capabilities of Virtualization 2.0 within your virtualized infrastructure, you are 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.

Chapter 8

Ten Useful Resources for Virtualization 2.0

In This Chapter

- ▶ Bedtime reading with whitepapers
 - ▶ What the analysts are saying
 - ▶ See Virtualization 2.0 in action
-

Ready to make the move to Virtualization 2.0? Here are our picks for the top resources to review as you expand virtualization beyond your servers.

- ✔ Strategic Benchmarks 2014: Server Virtualization (Forrester Research, Inc., March 2014) – Access Requires Subscription.

<http://www.forrester.com/Strategic+Benchmarks+2014+Server+Virtualization/fulltext/-/E-RES110021>

- ✔ Cisco Global Cloud Index: http://www.cisco.com/c/en/us/solutions/collateral/service-provider/global-cloud-index-gci/Cloud_Index_White_Paper.html

- ✓ Gartner Maverick* Research: Peer-to-Peer Sharing of Excess IT Resources Puts Money in the Bank, Federico De Silva, September 23, 2013

<http://www.gartner.com/document/2594717>

- ✓ Predictions for 2014: Private Cloud Management and Infrastructure (Forrester Research, Inc., December 2013) – Access Requires Subscription

<http://www.forrester.com/Predictions+For+2014+Private+Cloud+Management+And+Infrastructure/quickscan/-/E-RES112121>

- ✓ Uptime Institute 2012 Data Center Industry Survey:

http://uptimeinstitute.com/images/stories/Uptime_Institute_2012_Data_Industry_Survey.pdf

- ✓ Expand Your Virtual Infrastructure with Confidence and Control (A February 2014 Commissioned Study Conducted by Forrester Consulting on behalf of VMware):

<http://www.vmware.com/files/pdf/smb/Expand-Your-Virtual-Infrastructure-With-Confidence-And-Control.pdf>

- ✓ Management Insights Study: Businesses Experience Operational and Business Benefits from vCenter Operations Management:

http://www.vmware.com/files/pdf/vcenter/Management_Insight_Study_Shows_Businesses_Benefits.pdf

- ✓ How To Troubleshoot vSphere 5.x Performance Issues Using vCenter Operations:

<https://www.vmware.com/resources/techresources/10370>

- ✓ vSphere with Operations Management Product Page:
<http://www.vmware.com/products/vsphere-operations-management/>
- ✓ VMware Product Walkthroughs (including vSphere with Operations Management):
<http://featurewalkthrough.vmware.com/>
- ✓ VMware Hands-on Labs – Try Products, No Installation Required:
vmware.com/go/Dummies-Labs

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If you work in IT, you know this already: data center virtualization has gone mainstream. But why? How did we reach a point where nearly every organization has at least some reliance on virtual machines? And more importantly, what should you do about it? It's not an idle question. IT teams are expected to address competitive business priorities while meeting the needs of every stakeholder, every minute of every day. It's your job to manage this vast, borderless, virtualized world that we all inhabit, and make sure it's secure and operational around the clock.

This book spells out the what, why and how of data center virtualization, and explains how the technologies of Virtualization 2.0 can bring a vast and sprawling virtualized world into focus.

- **See the big picture**—Learn where we are, how we got here, and why virtualization matters now more than ever to today's businesses. And tomorrow's.
- **Understand the dependencies**—Learn about the four cornerstones of a fully virtualized IT environment to grasp how they work—and how they work together.
- **Plan for the future**—Read tips, advice and best practices from virtualization experts who have been in the trenches, and can tell you what to expect before you start making changes.

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Open the book and find:

- What Virtualization 2.0 technology is and what it can do for your data center
- How to achieve real-world outcomes with Virtualization 2.0 for new business benefits
- What to do before you deploy Virtualization 2.0
- How to optimize Virtualization 2.0 performance in your IT environment

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