LEARNING MADE EASY

Broadcom Special Edition

Private Cloud Operations

for dummies®

A Wiley Brand

Streamline operations

Optimize compute, storage, and network resources

Simplify management

Brought to you by

BROADCOM®

Lawrence Miller

About Broadcom, Inc.

Broadcom, Inc., a Delaware corporation headquartered in Palo Alto, California, is a global infrastructure technology leader built on more than 60 years of innovation, collaboration, and engineering excellence.

With roots based in the rich technical heritage of AT&T/Bell Labs, Lucent, and Hewlett-Packard/Agilent, Broadcom focuses on technologies that connect our world. Through the combination of industry leaders Broadcom, LSI, Broadcom Corporation, Brocade, CA Technologies, Symantec's enterprise security business, and VMware, the company has the size, scope, and engineering talent to lead the industry into the future.

Broadcom is focused on technology leadership and category-leading semiconductor and infrastructure software solutions. The company is a global leader in numerous product segments serving the world's most successful companies.

Broadcom combines global scale, engineering depth, broad product portfolio diversity, superior execution, and operational focus to deliver category-leading semiconductor and infrastructure software solutions so its customers can build and grow successful businesses in a constantly changing environment.

Private Cloud Operations

Broadcom Special Edition

by Lawrence Miller

for dummies®
A Wiley Brand

Private Cloud Operations For Dummies®, Broadcom Special Edition

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

ISBN 978-1-394-30446-2 (pbk); ISBN 978-1-394-30447-9 (ebk); ISBN 978-1-394-30448-6 (ebk)

Publisher's Acknowledgments

Editor: Elizabeth Kuball

Acquisitions Editor: Traci Martin

Senior Managing Editor: Rev Mengle

Client Account Manager: Cynthia Tweed

Content Refinement Specialist: Bharaneedharan Murthy

Special Help: Sachin Alex, Puneet Chawla, Andrew Firth, Kyle Gleed, Eric Gray, Sehjung Hah, Matt Just, Kelcey Lemon, Dave Overbeek, Devyani Pisolkar, Himanshu Singh, Cameron Sturdevant, Abhijit Timble

Table of Contents

Introduction

Managing the hybrid IT landscape has never been more challenging. Organizations are rapidly modernizing their application portfolios to meet digital business needs, and IT leaders are rethinking IT infrastructure to support the full spectrum of application types and requirements across on-premises and cloud environments.

All this change creates massive operational complexity. How can IT keep pace with this complex, fast-moving environment — and even pull ahead?

To effectively and efficiently modernize both applications and underlying infrastructure without impacting operations, IT must adopt a single cloud operating model that delivers consistent IT services wherever workloads are deployed.

In the ever-evolving cloud landscape, Broadcom helps businesses with infrastructure, applications, and security modernization initiatives to address business issues with innovative solutions. VMware Cloud Foundation (VCF) integrates compute, storage, networking, and management into a unified software-defined data center platform, delivering the benefits of public cloud and the security and performance of an on-premises private cloud. This guide introduces VCF, a powerful platform that gives you the vast scale and flexibility of a public cloud, but with the strong security, reliability, and speed of your own private setup.

About This Book

Private Cloud Operations For Dummies, Broadcom Special Edition, consists of five chapters that explore the following:

- Private and hybrid cloud challenges, the cloud repatriation trend, and the basics of VCF (Chapter 1)
- Simplifying private cloud build and infrastructure management, improving performance and troubleshooting, and orchestrating your private cloud (Chapter 2)

- Optimizing infrastructure resources; enabling full-stack visibility across private data centers, edge, cloud service providers, and hyperscale cloud environments; and migrating workloads at scale with VCF (Chapter 3)
- Hardening your infrastructure, reducing risk, and ensuring compliance in a continually evolving threat and regulatory landscape (Chapter 4)
- Ten key business benefits of VCF (Chapter 5)

Each chapter is written to stand on its own, so if you see a topic that piques your interest feel free to jump ahead to that chapter. You can read this book in any order that suits you.

Foolish Assumptions

It has been said that most assumptions have outlived their uselessness, but I assume a few things nonetheless!

Mainly, I assume that you're an IT leader such as a chief information officer (CIO), vice president of infrastructure, or IT director, or that you're an IT administrator or engineer, such as a systems administrator, virtual infrastructure (VI) administrator, cloud administrator, or cloud architect. As such, I assume that you're somewhat technical and you have a strong understanding of cloud, virtualization technologies, networking, and security and compliance.

If any of these assumptions describes you, then this is the book for you! If none of these assumptions describes you, keep reading anyway — it's a great book, and after reading it, you'll be able to hold your own with all the cool people in IT!

Icons Used in This Book

Throughout this book, I occasionally use special icons to call attention to important information. Here's what to expect:

REMEMBER

This icon points out important information you should commit to your nonvolatile memory, your gray matter, or your noggin.

TECHNICAL STUFF

This icon explains the jargon beneath the jargon and is the stuff legends — well, legendary nerds — are made of.

TIP

Tips are appreciated, but never expected, and I sure hope you'll appreciate these useful nuggets of information.

WARNING

These alerts point out the stuff your mother warned you about. Well, probably not, but they do offer practical advice.

Beyond the Book

There's only so much I can cover in this short book, so if you find yourself at the end of it wondering, "Where can I learn more?" go to `www.vmware.com/products/cloud-infrastructure/vmware-cloud-foundation`.

IN THIS CHAPTER

- Addressing private and hybrid cloud challenges
- Migrating workloads from the public cloud
- Introducing VMware Cloud Foundation

Chapter 1
Navigating the Complex, Fast-Changing IT Landscape

This chapter explores private and hybrid cloud challenges, the cloud repatriation trend, and building, operating, and optimizing VMware Cloud Foundation (VCF).

Recognizing Private and Hybrid Cloud Challenges

Hybrid cloud refers to a cloud computing model that uses a combination of at least one private cloud and at least one public cloud, which work together to provide a flexible mix of cloud computing services.

According to the Private Cloud Outlook 2025 report (`www.vmware.com/docs/private-cloud-outlook-2025`), when organizations were asked to identify each of their top cloud priorities, the most cited three-year priority was to build new workloads in private cloud environments (53 percent) (see Figure 1-1).

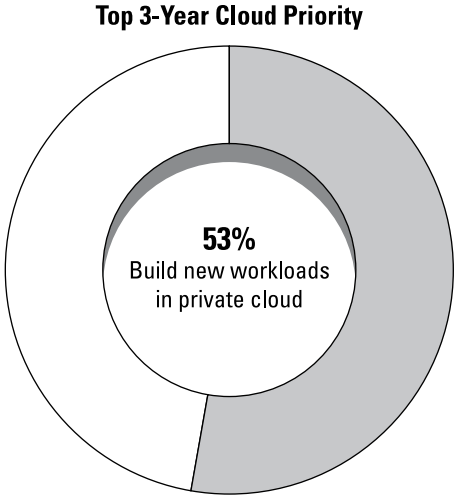
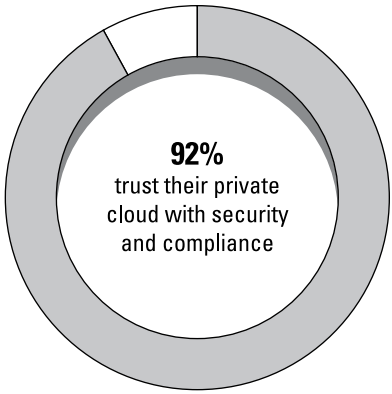


FIGURE 1-1: Three-year priority was to build new workloads in private cloud environments (53 percent).

Ninety-two percent of organizations say they trust their private cloud with security and compliance, according to the Private Cloud Outlook 2025 report (`www.vmware.com/docs/private-cloud-outlook-2025`). Security received the highest satisfaction rating for private cloud environments (see Figure 1-2).

Private cloud offers a single, seamless pool of resources that support modern application strategies and an organization's digital transformation efforts. Most organizations adopt a Private cloud strategy to:

- Reduce risk
- Minimize IT and cloud costs
- Support migrations without application refactoring
- Optimize data centers
- Meet seasonal peaks in demand for compute and storage resources by easily expanding to the cloud when needed



IT decision-makers that have high trust in private cloud; *n=1800*

FIGURE 1-2: Ninety-two percent of organizations say they trust their private cloud with security and compliance.

Private cloud extends infrastructure and operations consistently to provide a single operating model that manages application workloads across private and public clouds, edge, cloud service providers, and hyperscale cloud environments, allowing for seamless migration of workloads between these environments, as business needs dictate.

The challenge for organizations pursuing private cloud is to find an operating model that simplifies operations, reduces management complexity, allows interoperability to enhance flexibility, and addresses the requirements of a wide range of application architectures and digital business objectives.

TIP

A hybrid cloud solution works best when a single set of management tools, skills, and workflows can extend seamlessly across consistent infrastructure that is common to on-site, public cloud, and hosted environments.

A single operating model addresses challenges related to:

- **Migration without refactoring:** If applications are migrated from dissimilar environments, then applications need time-consuming and costly refactoring during migration. The consistent infrastructure in a hybrid cloud allows fast, low-cost migration to the cloud — and easy migration back on-site if needs change.

- **Virtual machine (VM) and container workloads:** IT organizations increasingly must support containerized cloud-native application architectures in addition to existing VMs. A hybrid cloud management foundation should enable integrated management of both existing and new applications.
- **Consistent security policies:** Many security policies are tied to the underlying infrastructure. With hybrid cloud, it's important to be able to tie security and compliance policies to the workload, so policies can be enforced consistently wherever workloads are deployed.
- **Siloed tools and processes:** If different tools and processes are used to manage applications and underlying infrastructure in various unique environments, then new functional silos and specialized skills can keep organizations from achieving their cloud goals. A hybrid cloud should extend existing IT tools and processes from the data center to cloud to optimize operational efficiency and avoid having to train or hire new capabilities.

Bringing Modern Workloads Back to the Data Center

In the early days of the public cloud, many organizations moved quickly to adopt a "cloud first" strategy, deploying new workloads to the public cloud and migrating their legacy data center workloads to the public cloud whenever practical. As cloud strategies have matured, many organizations are now moving certain workloads back from the public cloud and adopting a hybrid cloud strategy. Organizations adopt a hybrid cloud strategy for many reasons including performance, control and security, and cost, among others.

TIP

Cloud repatriation — moving applications, data, workloads, and other resources from the public cloud back to an on-premises data center or private cloud — is a growing trend. According to a June 2024 survey by IDC (`www.idc.com/getdoc.jsp?containerId=US50903124`), approximately 80 percent of respondents globally "expected to see some level of repatriation of compute and storage resources in the next 12 months."

In many cases, an application may not perform as expected in the cloud, particularly if the application was previously hosted in an on-premises data center, and then moved in a "lift-and-shift" migration to infrastructure as a service (IaaS) resources in the public cloud. Without refactoring, many such applications can't handle the inherent latency that exists between the public cloud and the corporate offices.

Certain applications and data may have regulatory and/or internal governance requirements for an organization to retain control of where and how its data is stored, as well as specific security controls that must be implemented for different workloads.

Finally, many organizations have been unable to fully realize the expected cost benefits of the public cloud. Although the shift from capital expenditures (CapEx) for infrastructure to a consumption-based operating expenditures (OpEx) model helps the bottom line, many organizations have been unable to effectively manage cloud sprawl and the associated costs — particularly if they didn't properly plan their original move to the cloud.

Getting Acquainted with VMware Cloud Foundation

Private cloud is an environment where agility and reliability are becoming increasingly important. Integrating advanced software-defined compute, storage, and networking with a full suite of automation and orchestration enables efficient, reliable, and agile digital operations. When deploying private cloud infrastructure, driving higher degrees of efficiency and flexibility are core to delivering the highest value at the lowest cost. This includes integrating key data center technologies — compute, storage, networking, and security — all managed through automation and orchestration deeply embedded in the platform to lower operational cost.

VMware Cloud Foundation (VCF) is a full-stack, private cloud solution that supports digital transformation initiatives by enabling organizations to accelerate developer productivity, embracing cloud for traditional and artificial intelligence (AI) workloads to deliver apps and services to market faster.

VCF is a robust and reliable solution for private cloud deployment that streamlines resource management and accelerates innovation, reducing technological debt and increasing operational efficiency.

Core platform components are shown in Figure 1-3.

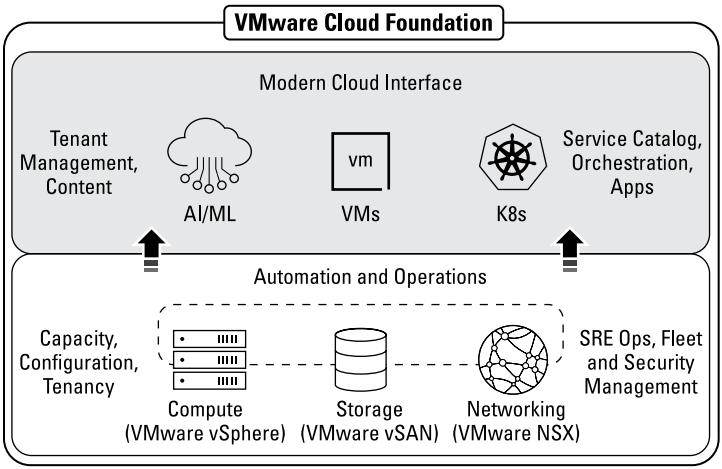


FIGURE 1-3: VCF core components.

VCF simplifies the deployment of a fully integrated IaaS stack with a unified and automated platform. Enabling consistent, secure, and agile operations across private and public clouds, VCF ensures that organizations can flexibly scale their infrastructure to meet evolving business needs by consolidating disparate functions into a single, integrated platform, significantly reducing the complexity and overhead typically associated with private cloud deployments.

Key capabilities in VCF include:

- **Compute virtualization:** VCF leverages vSphere to create and manage VMs and containers, providing a flexible, secure, and scalable compute platform.
- **Storage virtualization:** By integrating vSAN into the platform, VCF offers integrated, secure, scalable storage solutions that enhance resource efficiency and reduce operational complexity.

- **Network virtualization:** VCF leverages the capabilities of NSX to provide a secure, software-defined networking layer capable of handling the dynamic needs of modern cloud-based applications.
- **Automated provisioning and management:** Inbuilt workflows within VCF help to transform on-premises IT operations to a cloud operating model. This level of automation reduces the time and complexity associated with deploying, managing, and maintaining private cloud environments.

Some common VCF scenarios include:

- **Infrastructure modernization:** VCF plays a crucial role in transforming traditional IT infrastructures into a more agile and adaptable private cloud environment. This transformation is key to enabling organizations to deploy core private cloud use cases that deliver strategic outcomes, lower total cost of ownership (TCO), and increase productivity. VCF employs a build capability, fleet management to scale, operations, automation, and orchestration to standardize and simplify the entire infrastructure lifecycle, including Day 0 deployment, Day 1 provisioning, and Day 2 patching and updates:
  - *Modernize an on-premises private cloud:* Build private cloud infrastructure that modernizes existing data center deployments with a cloud operating model for standardization, consistency, and scale.
  - *Automation to provide IaaS via a self-service catalog:* Implement advanced automation and orchestration across the full-stack infrastructure to streamline cloud operations, while enabling developer self-service for frictionless access to abstracted infrastructure services.
  - *Hybrid cloud extension:* Utilize the platform architecture and cloud operating model to extend private cloud infrastructures into supported public and partner cloud environments utilizing workload mobility for maximum efficiency and scale.
- **Cloud efficiency for developers:** To keep continuous development pipelines running at peak efficiencies, it's critical to ensure that developers have frictionless access to application code, infrastructure services, runtime

environments, system tools, libraries, and registries. VCF services consist of an upstream-compliant Kubernetes runtime with a set of infrastructure and automation services, including infrastructure-as-code (IaC), software configuration management, and infrastructure pipelines:

- *Deliver IaC:* Automation capabilities allow developers to automate and manage infrastructure via code for more rapid and consistent deployments.
- *Implement private AI:* Design and implement a robust foundation for generative AI (GenAI) and large language model (LLM) workloads through integration with the leading AI platforms.
- *Run business-critical and modern workloads:* Facilitate production-scale infrastructure optimized across traditional and modern cloud-native applications.

- **Security and resilience:** The Advanced Services add-on VMware Advanced Cyber Compliance enables a comprehensive security posture, aligning with modern security requirements and providing a robust defense mechanism within the cloud environment. VCF provides a consistent, secure platform with the ability to extend the security architecture even further with advanced service add-ons for intrusion detection and recovery, addressing key challenges such as ransomware threats, disaster scenarios, and the need for advanced security architectures:
  - *Ransomware protection and recovery:* Implement robust security measures to safeguard against ransomware attacks, minimizing vulnerabilities and providing rapid recovery capabilities, enabling businesses to quickly restore operations and data integrity in the event of a ransomware attack.
  - *Implement disaster recovery:* Design and deploy a resilient disaster recovery framework, ensuring minimal service disruption and data loss during unforeseen events.
  - *Integrate security, compliance, and resilience:* Incorporate robust built-in security measures — such as microsegmentation, and more — to protect sensitive data, meet legal obligations, and maintain infrastructure uptime for business continuity.

TIP

The deployment of a full-stack private cloud platform such as VCF is enhanced by a suite of support programs, assessment, and professional services for ongoing operations. VCF support includes cloud maturity and adoption assessments coupled with digital learning, in addition to VCF Jumpstart Workshops (`www.vmware.com/resources/professional-services`) that help customers understand Broadcom's recommended best practices for cloud maturity. These services provide a tailored implementation and adoption plan to help customers achieve their business goals.

VCF Operations and management capabilities include the following:

- **Fleet management** automates the build installation, operations, and lifecycle management of the software-defined data center (SDDC) stack, streamlining deployment, configuration, and updating processes
- **Management and orchestration** deliver comprehensive build, operations, and analysis, across the full-stack infrastructure platform
- **Workload mobility** enables seamless migration, workload rebalancing, and disaster recovery across private and public clouds

MB LAYS FLEXIBLE, AUTOMATED FOUNDATION FOR GROWTH

MB aimed to be one of the top three banks in Vietnam, but its infrastructure wasn't flexible enough to cater to rapidly evolving customer demands. By deploying VCF, the bank transformed its on-premises data center infrastructure into an automated self-service private cloud. This has reduced the time for resource provisioning from days to hours, shortening time to market for new financial products. The bank plans to move more workloads into the private cloud and integrate with third-party technologies to deliver advanced services to internal users.

(continued)

(continued)

Becoming a digital-first financial giant

Headquartered in Hanoi, Vietnam, MB is one of the top five commercial joint stock banks in Vietnam. Winning both local and international awards for its innovative online financial products and digital transformation initiatives, MB has embarked on an ambitious goal to be not only among the top three banks in the country but also one of the best in the region by 2026.

Struggling to keep up with changing customer behavior

Vietnam has a young, tech-savvy population that drives the adoption of digital banking in the country. Of the more than 3.5 million banking transactions MB processes daily, 94 percent are carried out digitally, a big jump from just 65 percent from before.

Most MB customers are from the growing middle class, and they want to access financial services easily and quickly. Brand loyalty in these customers tends to be low, and they're highly likely to move to another bank if they're dissatisfied with the product or experience. To be their bank of choice, MB has to win customer trust by providing them with the best user experience.

The bank's infrastructure wasn't flexible enough to enable the team to respond quickly to changes, and keeping up with new technologies became a challenge for the IT team. As a result, MB couldn't deliver new financial products and services to the market, including updated features in its mobile app.

Putting in place a future-proof foundation

MB went through a rigorous selection process in its search for an automated infrastructure platform before deciding on VCF. The bank has been using VMware solutions for more than a decade, starting with the early days of the hypervisor, and it can leverage existing skill sets in setting up and managing a private cloud.

Delivering IT as a service

VCF has dramatically eased the burden on IT operations while improving cross-function collaboration. Previously, when the DevOps and application support teams required a new service environment, they would send a request ticket to the IT team, which might take a few days to provision resources. Every team had tight deadlines, so this sometimes resulted in friction between departments.

With VCF integrating Kubernetes and incorporating monitoring and management tools, users can go to a self-service catalog and rapidly provision VMs, databases, storage, and containers.

Because of the predesigned scripts and processes in the underlying environment, a service environment can be achieved with profiles and tools instead of compiling programs and tools from scratch. This led to a significant reduction in service deployment time from days to hours. And because manual approval is no longer required for resource applications, system tenants get direct access to resource allocation, further shortening resource allocation time for developers.

Delighting both customers and employees

MB needs to keep step with fast-evolving consumer demands, which goes beyond being able to roll out new products or services faster. More crucially, the bank is now agile enough to tweak these new offerings on the fly, based on customer feedback.

With a flexible and automated infrastructure, the IT team can now support continuous integration/continuous delivery (CI/CD). In the past, it handled about 200 requests a year. However, the number has more than doubled due to Kubernetes.

As a bank, security is paramount. VCF allows MB to deploy virtual desktops to more than 3,000 employees at the headquarters for secure access to corporate resources from any device. This quickens business decision-making because management can log in from anywhere at any time.

Plus, by automating the provisioning and management of virtual desktops and apps, the bank can cut down on time taken to service users and free up the IT team for more strategic and business-critical tasks. Meanwhile, new joiners are fully onboarded and productive, from Day 1.

Developing next-generation services

About 30 percent of MB workloads have been moved to the private cloud, and the plan is to continue to migrate more, including live and traditional workloads. The IT team also looks forward to integrating third-party technologies to enrich and develop advanced services such as AI or machine learning (ML) for users.

See the customer case study at `https://www.vmware.com/resources/customers/vmw-mb-lays-flexible-automated-foundation-for-growth`.

IN THIS CHAPTER

- Managing your private cloud from a single pane of glass
- Optimizing performance and increasing troubleshooting effectiveness
- Leveraging fleet management for orchestration and lifecycle management

Chapter 2
Managing Your Private Cloud

In this chapter, you discover how the management tools and capabilities in VMware Cloud Foundation (VCF) Operations, with VCF Operations fleet management, helps organizations streamline private cloud management.

Streamlining Cloud Infrastructure Management

To gain management control of your private cloud infrastructure, you need visibility across compute, storage, and network resources, maintaining accurate views of your continually evolving infrastructure. How else can your team plan initiatives, optimize processes, or secure systems — all at scale?

VCF is a full-stack private cloud solution that combines the scale and agility of the public cloud with the security and performance of the private cloud. With the visibility and near real-time insights provided by VCF Operations, IT team members have the data and tools they need to drive powerful outcomes.

Designed to simplify and streamline enterprise infrastructure management and operations, VCF focuses on streamlining operations management and leveraging artificial intelligence (AI) and detailed analytics to empower IT teams with agility and adaptability.

TIP

Key VCF capabilities for streamlining cloud infrastructure management include:

- Providing full-stack visibility from the physical, virtual, or cloud infrastructure to applications running on private cloud
- Enabling monitoring across operating systems and infrastructure modes
- Extending monitoring capabilities with out-of-the-box management packs, software development kits (SDKs), and a no-code builder to simplify the integration of third-party services
- Showing trends and incoming issues via dashboards, alerts, and reports
- Centralizing fleet management for licensing, identity management, certificates, tags, passwords, and lifecycle
- Using single sign-on (SSO) to manage access included in fleet management

Boosting Performance and Enhancing Troubleshooting

From high expectations around latency for digital experiences to the substantial compute requirements of next-generation applications like AI, demands around performance and uptime are only going to increase. How can your organization meet these skyrocketing needs?

The capabilities and actionable insights provided by VCF's unified platform deliver the tools to boost performance, accelerate issue response, and proactively address potential bottlenecks and gaps.

TIP

Key VCF capabilities for boosting performance and enhancing troubleshooting include:

- Centralizing logging data and comparing changes through logs across different time intervals
- Improving IT's ability to identify anomalies
- Highlighting notifications, events, property changes, and anomalous metrics in the troubleshooting workbench
- Easing monitoring of infrastructure health with simplified diagnostics
- Leveraging AI- and machine learning (ML)–based analytics to predict, prevent, and troubleshoot across applications and infrastructure

Optimal application performance hinges on apps being able to access the resources they need. VCF management capabilities provide the features you need to optimize performance and enhance troubleshooting, including:

- **Full-stack visibility:** Get a unified view of your entire infrastructure (both virtual and physical) and the applications running on it. Feature highlights include:
  - A single view of all important performance data from virtual and physical infrastructure to apps
  - Easily consumable dashboard alerts and reports
  - A rich set of management packs to extend monitoring, troubleshooting and remediation capabilities
- **Application monitoring:** Ensure that an application is running properly by monitoring its performance, availability, and end-user experience. Feature highlights include:
  - Telegraf agents and custom script execution
  - Service discovery (agentless), which shows performance, dependencies, and impacts to help with better visibility through in-built VMware tools
  - Management packs, which help extend visibility into applications and provide out-of-the-box dashboards and alerts to monitor applications
- **AI-driven troubleshooting and remediation:** Achieve faster time to resolution to meet your service-level

agreements (SLAs) and realize better performance at lower costs. Feature highlights include:

- Troubleshooting Workbench with AI-based analytics and metric correlation
- Highlighting notifications, events, property changes, and anomalous metrics
- Tie-in for logs for last-mile root-cause analysis

VCF Operations for networks (discussed in Chapter 3) helps IT teams identify bottlenecks, allocate workloads efficiently, identify and mitigate situations where inefficient network traffic patterns harm application performance, and improve migration planning with minimizing risks. VCF provides network visibility and troubleshooting capabilities across physical, virtual, and containerized infrastructure across compute, storage, and networks (see Figure 2-1).

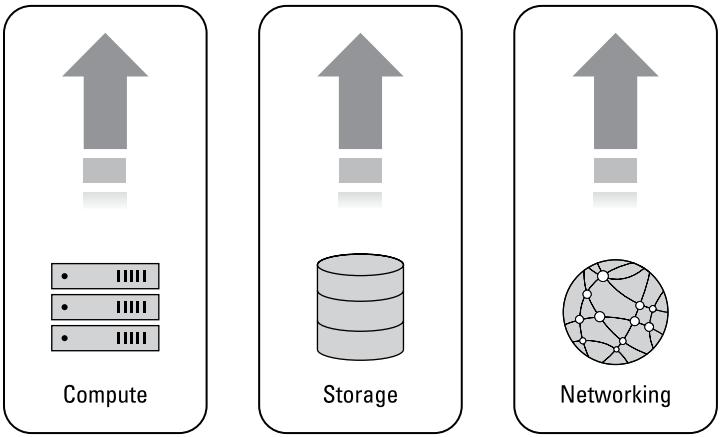


FIGURE 2-1: VCF extends network visibility and troubleshooting across physical, virtual, and containerized infrastructure for compute, storage, and networks.


TIP

Key VCF Operations for networks capabilities for boosting performance and enhancing troubleshooting include:

- Providing visibility across hybrid cloud infrastructure and traffic and path analytics
- Using network segmentation to prioritize critical traffic

» Mapping application dependencies to plan cloud migrations that increase agility

TIP

According to a Forrester Total Economic Impact study (www.vmware.com/docs/vmw-vcf-operations-forrester-tei), organizations using VCF Operations experienced a 20 percent reduction in mean time to resolution (MTTR), a 50 percent improvement in team coordination during incident investigations, and a 5x boost in uptime. Another Forrester Total Economic Impact study (www.vmware.com/docs/vmw-vcf-network-operations-forrester-tei) found that organizations using VCF Operations for networks experienced a 90 percent decrease in troubleshooting time, resulting in faster issue resolution, a 50 percent reduction in network outages, and 75 percent less time spent monitoring the network to optimize for performance.

MARY WASHINGTON HEALTHCARE USES PRIVATE CLOUD TO FOCUS ON PATIENT CARE

Mary Washington Healthcare (MWHC) is a regional healthcare provider in Fredericksburg, Virginia, spanning emergency rooms, wellness centers, and 570 hospital beds. As a nonprofit organization, income is invested back into MWHC through activities such as technology upgrades, developing new services, and hiring staff.

VMware Cloud Foundation is transforming how the healthcare organization's IT operations are managed, enabling impactful digital workflows and improving the experience for frontline medical teams. By accelerating the delivery of new digital projects, MWHC continues to improve patient care.

Strengthening a regional health network

MWHC has acquired more than 50 local healthcare practices in the last decade, resulting in many elements needing to be connected. Rapid growth left MWHC with an inefficient and fragmented IT infrastructure and no central visibility of IT operations.

(continued)

(continued)

To knit together its ecosystem of healthcare services in a single pane of glass, MWHC selected the EPIC electronic healthcare record system. This established a consistent system of patient records across the organization.

System downtime is costly in any organization. In healthcare, it can directly impact critical lifesaving systems and procedures. For the EPIC deployment to be successful, various improvements were needed, including ensuring that the IT infrastructure was modern, robust, and flexible enough to support it.

Creating an IT infrastructure for today and the future

There were numerous shortfalls in how the legacy server, computing, and storage resources were managed. The IT team was involved in too many manual tasks, it was impossible to accurately predict capacity requirements, there was no chargeback ability for IT resources, and issues could not be proactively addressed.

The new approach to the management of IT infrastructure for MWHC is built on VCF Operations. The organization has deployed a private cloud platform with a public-cloud-like consumption model. MWHC was already a VMware vSphere and vSAN customer, so its adoption of VCF Operations is confirmation of a deeper, more strategic engagement between MWHC and Broadcom.

Establishing visibility across IT operations

VCF Operations has provided MWHC with several breakthroughs in its IT infrastructure performance. MWHC now has the ability to microsegment its network and strengthen security with VMware vDefend.

VCF Operations also comes with its own distinct feature set. Today, MWHC relies on VCF Operations for operations management, network insight, and logs to create efficiencies and strengthen the resilience of its IT operations.

Reliable performance, robust security, and greater business resiliency

The impact of VCF is felt throughout the organization. The solutions provided help bring together server, network, and application developer teams that were previously siloed. Operational visibility allows MWHC to get ahead of IT issues before they impact staff and patients,

reducing the strain on the help desk and shifting teams out of fire-fighting mode.

Operations management has transformed capacity planning. Where previously the guiding concern was not to under-provision — inevitably leading to over-provisioning — today, MWHC can make accurate assessments of resource needs.

With VCF, MWHC has reduced unplanned downtime and improved application performance. Care teams trust the IT infrastructure to support the latest medical technology. Also, reducing or eliminating outages, where every minute lost costs US$30,000 and patient outcomes are put at risk, is absolutely essential.

Watch the customer video at `https://youtu.be/hZE_a41z9T8`.

Orchestrating Your Private Cloud with Fleet Management

Traditional infrastructure deployment often involves manual configuration and numerous steps, which can take weeks or even months to complete, depending on the environment's size and complexity. Each manual step introduces the possibility of human error. Additionally, cloud administrators who manage private cloud infrastructure with numerous Kubernetes containers and virtual machine (VM) hosts can find it challenging to maintain consistent operations and administration, including lifecycle, licensing, and other aspects of managing a vast host infrastructure over workload domains. There are two kinds of workload domains: management and virtual infrastructure. Workload domains are composed of compute, storage, and network infrastructure.

For many cloud administrators, multiple different user interfaces and screens are needed to manage their private cloud infrastructure. Also, as part of lifecycle management, coordinating downtime to upgrade infrastructure when applications are live and running without disruptions is a business challenge. Scaling this infrastructure consistently across limited resources such as compute, memory, and storage capacity is also a challenge.

VCF Operations fleet management streamlines these processes, leveraging orchestrated operations to eliminate manual errors and ensure consistent, repeatable infrastructure deployments. This consistency accelerates time to value by reducing the need for staff retraining and specialized skill sets. VCF provides a simplified and central interface to better build, run, and scale flexible private cloud infrastructure, including workload domains, which are composed of VM hosts and clusters, instead of separately managing compute, storage, and network silos.

VCF Operations provides comprehensive capabilities for managing and scaling VCF deployments, offering centralized control over various aspects of the infrastructure. These capabilities include streamlined management of licenses, ensuring compliance, and cost optimization; standardized configurations to maintain consistency and reduce errors; integrated identity management for user authentication and access control; and automated certificate lifecycle management for enhanced security (see Figure 2-2).

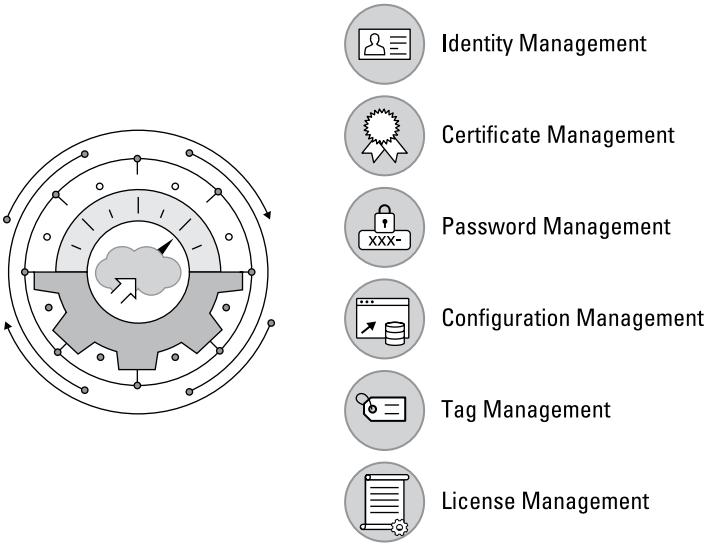


FIGURE 2-2: Key capabilities in VCF Operations fleet management.

Together, these features enable better consistency, resource management, and operational efficiency across VCF environments, whether you're running a single private cloud or multiple deployments across different locations. By streamlining these

critical management functions, VCF Operations empowers organizations to optimize their private cloud deployments, reduce administrative overhead, and ensure consistent security and compliance across their entire infrastructure.

The application programming interfaces (APIs) provided by VCF Operations allow for the automation of numerous tasks across storage, compute, and networking resources. Organizations can, thus, deploy and manage their environment more efficiently, resulting in a faster time to market for their services.

For example, you can use APIs to programmatically provision new infrastructure or additional resources, configure network policies, or adjust storage capacity based on application demands. VCF Operations is built with API-first automation in mind. It offers a comprehensive and standardized set of APIs essential for organizations that want to integrate their existing toolsets and automate infrastructure tasks. This API support helps accelerate private cloud adoption by simplifying the integration of third-party business systems into VCF.


TIP

Organizations can protect their investments in existing IT systems by programmatically integrating them to manage and provision software-defined data center (SDDC) infrastructure as code. This gives them the power and flexibility of cloud computing within their private data centers.

VCF leverages automation, API integration, and other capabilities to increase scale across the infrastructure. There are capabilities for easier patching to keep the software lifecycle updated, such as a flexible bill of materials so the administrator can orchestrate infrastructure upgrades and apply component patches to infrastructure as needed.

Beyond simplifying architecture and deployment, VCF Operations also provides unified lifecycle management for the core SDDC stack. This includes automating routine but critical tasks, such as patching and upgrading, ensuring that all components — vSphere (vCenter, ESX), vSAN, and, VCF Networking — are consistently maintained and up to date. This automation significantly reduces the risk of errors associated with manual processes and helps maintain a healthy, secure, and compliant infrastructure.

WARNING

Manually patching and upgrading an entire data center infrastructure stack is a complex endeavor, fraught with potential pitfalls. Administrators must meticulously consider component interdependencies, because an incorrect patching or upgrading order can lead to compatibility issues and system instability. Ensuring version compatibility across all components is crucial for maintaining a stable and supported environment. Minimizing downtime during these processes is essential for business continuity, while the prompt application of security patches is critical for protecting the infrastructure from vulnerabilities. These challenges highlight the need for a more streamlined and automated approach to lifecycle management.

VCF Operations streamlines and automates the entire lifecycle management process, effectively addressing the challenges of manual patching and upgrading. It orchestrates updates in a prescribed order, ensuring compatibility and minimizing downtime while automatically handling component dependencies. A centralized interface simplifies update management, making scheduling, initiating, and monitoring a breeze. By automating these tasks, VCF reduces the risk of human error, leading to a more stable and reliable infrastructure. This increased efficiency frees administrators from tedious manual tasks, allowing them to focus on strategic initiatives. Ultimately, VCF empowers organizations to maintain a healthy, secure, and up-to-date private cloud infrastructure with minimal effort and reduced risk.

REMEMBER

VCF Operations allows better consistency and resource management across your private cloud infrastructure. As organizations increase the scale of their VCF deployment, fleet management will allow them to be consistent and optimize their infrastructure. Keeping your private cloud infrastructure up to date improves the performance and security of business applications running on VCF.

NATIONAL ITMX ACCELERATES CASHLESS PAYMENTS WITH HYBRID CLOUD PLATFORM

National ITMX (NITMX) is the backbone of Thailand's national payment infrastructure and digital financial platform, facilitating seamless and secure electronic transactions nationwide for more than 70 million

users on its PromptPay platform. Established by the Thai Bankers' Association and governed by the Bank of Thailand, NITMX is a leading developer and service provider of Thailand's electronic payment infrastructure. NITMX supports various electronic payments and fund transfers across diverse channels, including automated teller machines (ATMs), cards, internet, and mobile.

To meet growing demand, NITMX partnered with Datapro Computer Systems (DCS) to deploy VCF Operations, providing scalability and operations. This move allows NITMX to handle 2,600 transactions per second, with room for growth without compromising performance. The company has also reaped significant cost savings by optimizing resource utilization and reducing infrastructure requirements.

Outdated infrastructure hampers move toward digital economy

Banking on the success of PromptPay, NITMX branched into PromptBiz, a digital payment infrastructure system for the business sector that makes it easier for small and medium-size enterprises to access financial sources. And as banks increasingly adopt digital systems to manage their banking structures, NITMX recently developed an open API infrastructure project to connect new systems and the banks' existing core banking systems, enabling it to provide its customers with faster and more convenient online banking services via mobile banking.

In 2021, PromptPay was linked with Singapore's PayNow system, making it a world-first for cross-border fast payments. NITMX was also chosen by the Asian Payment Network to be the hub for connecting payment and transfer systems in the region, establishing cross-border, real-time quick-response (QR) payments with six countries — Cambodia, Indonesia, Japan, Malaysia, Singapore, and Vietnam.

Because of these initiatives and more, NITMX is processing more transactions than it has ever done before. Last year, the company processed more than 14 billion transactions.

Migrating to a hybrid cloud platform

VCF Operations provides NITMX with integrated cloud infrastructure (compute, storage, networking, and security) and cloud management services to run enterprise applications anywhere.

(continued)

(continued)

Partnering with VMware to design and deploy a tailored solution that aligns with the company's unique requirements, DCS supported NITMX in migrating the nationally important PromptPay system to VCF.

Simplifying management and operations

VCF has brought true cloud agility to NITMX on-premises enterprise applications, significantly simplifying management and freeing resources for new projects.

The IT team now relies on lifecycle management services for Day 0 to Day 2 operations, such as deploying VMs, configuring storage, or creating management clusters. Additionally, VCF helps simplify patching, upgrade operations, and on-demand provisioning of isolated clusters.

NITMX has also benefitted greatly from VM rightsizing recommendations by VCF Operations. NITMX has achieved significant cost savings by optimizing resource utilization and reducing infrastructure requirements.

Ready for future growth and technological advancements

One of the biggest pain points that the IT team faced in the past was capacity planning, because it couldn't scale the capacity of its on-premises SDDC as flexibly as it could in the cloud. With VCF analyzing resource consumption trends in its environments and predicting where it's going, NITMX can confidently account for future growth.

As NITMX moves toward a hybrid cloud, VCF simplifies the process by delivering a common platform for private and public clouds, enabling the company to quickly and easily move workloads at scale across clouds without re-architecting applications.

With VCF, NITMX gained a future-ready platform that allows the team to seamlessly manage diverse workloads, maintain high levels of security, and achieve operational efficiency, enabling the company to transcend traditional boundaries and play an even bigger role in Thailand's financial ecosystem.

See the customer story at `www.vmware.com/resources/customers/national-itmx-accelerates-cashless-payments-with-hybrid-cloud-platform`.

IN THIS CHAPTER

- Maximizing resource utilization
- Managing costs and capacity
- Migrating workloads with VMware Operations workload mobility
- Automating workflows with VCF Operations orchestrator

Chapter 3
Operating Your Private Cloud

In this chapter, you discover key features and capabilities in VMware Cloud Foundation (VCF) Operations for operating your private cloud, including optimizing resource utilization, managing costs and capacity planning, migrating workloads to and from the public cloud, automating workflows, and monitoring and troubleshooting your environment.

Optimizing Compute, Storage, and Network Infrastructure Resources

A modern private cloud is more than just a virtualized infrastructure. It represents a holistic approach to IT service delivery, encompassing several key aspects. It requires a robust and agile foundation, which involves carefully selecting compute, storage, and networking technologies to ensure optimal performance, scalability, and resource utilization. Decisions around virtualization platforms, server hardware, containerization, software-defined networking, and storage solutions are critical to building this solid foundation.

VCF is built on best-in-breed technology spanning compute, network, storage, automation, and operations. This software-defined approach allows organizations to leverage commodity hardware, decoupling the software from the underlying physical infrastructure. This provides flexibility and cost efficiency, because resources can be dynamically reallocated as needed. With the comprehensive operations and management capabilities of VCF Operations, VCF delivers an actual private cloud experience without compromise. VMware Cloud Foundation Operations offers capabilities for various personas and roles who need to view applications and infrastructure environments when operating, troubleshooting, planning, and provisioning resources using integrated workflows to accelerate business agility and optimize cost, performance, and governance. This complete platform provides the following:

- **Simplified operations:** Automated deployment, lifecycle management, and patching streamline administrative tasks, reducing operational overhead.
- **Scalability and performance:** VCF can scale to support thousands of virtual machines (VMs) and containers, delivering high performance for demanding business-critical workloads.
- **Enhanced availability:** Built-in features like vSphere High Availability (HA) and Distributed Resource Scheduler (DRS) ensure continuous availability and resilience in the face of hardware or software failures.

TIP

Key capabilities for optimizing compute, storage, and network infrastructure resources in VCF Operations include:

- Providing end-to-end infrastructure capacity management tools
- Enabling IT to plan, justify, deploy, and scale capacity to support global business operations

VCF Operations for networks delivers additional capabilities including:

- Improving resource optimization and network capacity by automating the discovery and dependency mapping of all devices, applications, and services
- Using the dashboard to improve network capacity and review east–west traffic, resource-intensive hairpinned traffic, and other expensive, inefficient traffic profiles


TIP

According to a Forrester Total Economic Impact study (www.vmware.com/docs/vmw-vcf-operations-forrester-tei), organizations leveraging VCF Operations experienced a 5x reduction in relative downtime by applying what-if scenarios and optimizing capacity.

VCF Operations for networks is a component of VCF that delivers intelligent network operations for private cloud. VCF helps organizations build an optimized, highly available, and secure network infrastructure by accelerating application discovery, migration, network segmentation planning, and deployment. These capabilities enable visibility across virtual and physical networks and provide operational views to manage and scale VCF network infrastructure.


TIP

Key VCF Operations for networks capabilities for streamlining cloud infrastructure management include:

- Enabling network flow mappings
- Validating and verifying network health for applications, VMs, and containers on VMware Cloud Foundation
- Analyzing traffic flow and creating affinity diagrams
- Mapping application boundaries and dependencies and streamlining migrations
- Identifying and remediating gaps and bottlenecks


TIP

According to a Forrester Total Economic Impact study (www.vmware.com/docs/vmw-vcf-network-operations-forrester-tei), network mapping efficiency increased by 80 percent for organizations using VCF Operations and VCF Operations for networks.

Reducing Costs and Optimizing Capacity

No matter the focus of your business, it's vital to have enough capacity to support your applications and services while avoiding overprovisioning, which increases costs for little to no value. This balancing act is not simple, especially considering how quickly things change and how far infrastructure can sprawl.

VCF Operations provides a holistic view of the total cost of ownership (TCO) for your private cloud resources. It identifies unused resources and runs reclamation workflows to optimize costs, including showback and chargeback, which helps organizations understand the cost of running their private cloud and enabling data-driven decisions on infrastructure purchases.

Cost and capacity capabilities in VCF Operations include:

- **Assessing capacity and addressing shortfalls**
  - Capacity assessments leveraging artificial intelligence (AI)–driven predictive analytics
  - Capacity visibility across environments
  - Capacity projections using demand and allocation models
- **Reclaiming capacity and automating cost savings**
  - Identifying unused resources like powered-off VMs, idle VMs, old snapshots, and orphaned disks
  - Measuring cost savings based on capacity wastage
  - Running reclamation workflows to optimize cost and reclaim unused capacity
- **Infrastructure and workload planning**
  - "What-if" scenario planning for future capacity requirements
  - Highlighting cost implications and potential savings
  - Combining multiple capacity plans to meet real-world scenarios
- **Total cost of ownership (TCO) with showback and chargeback**
  - A holistic view of TCO
  - Customizable cost drivers that align with business expenses
  - Mapping line-of-business (LOB) applications to cloud resources and costs

TIP

According to a Forrester Total Economic Impact study (www.vmware.com/docs/vmw-vcf-operations-forrester-tei), VCF Operations helped organizations realize a 100 percent cost savings in last-minute hardware costs by being proactive, so last-minute purchases don't need to happen.

Workload Migration Using VCF Operations Workload Mobility

VCF Operations workload mobility, an application mobility platform, simplifies application migration, workload rebalancing, and business continuity across data centers and clouds.

VCF Operations workload mobility enables high-performance, large-scale app mobility across VMware vSphere and non-vSphere cloud and on-premises environments to accelerate data center modernization and cloud transformation (see Figure 3-1).

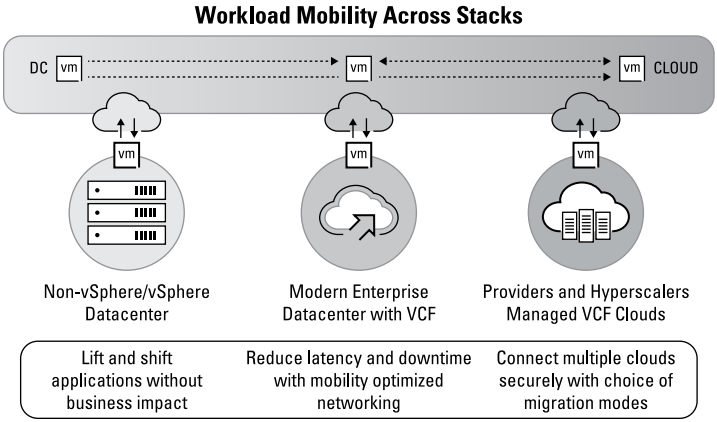


FIGURE 3-1: Accelerating the VCF journey with VCF Operations workload mobility.

VMware Operations workload mobility automates the creation of an optimized network interconnect and extension, and facilitates interoperability. This delivers live and bulk migration capabilities without redesigning the application or re-architecting networks.

Although VCF Operations workload mobility provides a number of technical features, its core function is its ability to migrate workloads between vSphere environments transparently. Migration types include:

- **Cold Migration:** This technique is used for VMs that are in a powered-off state. Workloads that may typically be cold migrated are testing and development VMs, or templates.
- **Bulk Migration:** The vast majority of workloads will use this technique. Bulk migration is also commonly referred to as "reboot to the cloud" because workloads are first replicated and at a predefined time are "hot swapped," meaning that the original workload is powered off and archived simultaneously to its replica in the cloud that is powered on.
- **Replication-Assisted vMotion (RAV):** This technique uses VCF Operations workload mobility along with vSphere Replication and vMotion technologies to provide large-scale, parallel migrations with zero downtime.

Key networking and migration capabilities are shown in Figure 3-2.

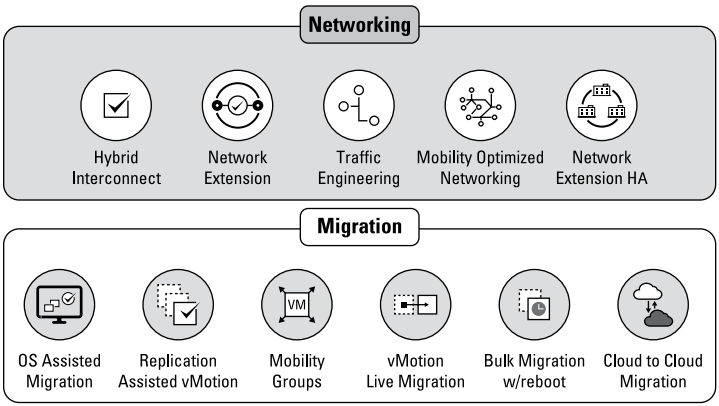


FIGURE 3-2: VCF Operations workload mobility capabilities in VCF.

VCF Operations workload mobility abstracts on-premises and cloud resources based on VMware vSphere and presents them to applications as one continuous resource. An encrypted, high-throughput, wide area network (WAN)–optimized, load-balanced, traffic-engineered hybrid interconnect automates the creation of a network extension. This allows support for hybrid services, such

as application migration, workload rebalancing, and optimized disaster recovery. With a VMware hybrid interconnect in place, applications can reside anywhere, independent of the hardware and software underneath.

REMEMBER

Common VCF Operations workload mobility use cases include:

- **Application migration:** Accelerate data center modernization with VCF Operations workload mobility. Automatically create a hybrid interconnect to easily migrate thousands of vSphere and non-vSphere VMs within and across data centers and clouds without requiring reboot. After they're migrated, swing networks without any retrofit/redesign.
- **Workload rebalancing:** Move workloads at any time to meet scale, cost management, compliance, and vendor neutrality goals. Actively rebalance your cloud and on-premises application footprint with VCF Operations workload mobility as an always-on, secure, high-throughput, WAN-optimized, hybrid interconnect that tethers cloud to on-premises estates for on-demand migration, data center extension, and cloud bursting.
- **Business continuity and disaster protection:** Leverage the VCF Operations workload mobility hybrid interconnect and rapid migration capabilities to protect workloads by replicating data across common VMware infrastructure in two or more places. Back up critical workloads on demand, or schedule for disaster recovery planning seamlessly and securely with no reconfiguration of Internet Protocol (IP) addresses. VCF Operations workload mobility integrates with VMware Live Recovery for advanced use cases.

VCF Operations Orchestrator

VCF Operations orchestrator is a workflow automation solution designed to simplify the automation of complex IT tasks. It helps improve service delivery efficiency, operational management, and IT agility. VCF Operations orchestrator is built with an open and flexible architecture that system administrators and IT operations staff can use to streamline tasks and integrate functions with third-party software through workflows.

The VCF Operations orchestrator workflow designer is an easy-to-use, drag-and-drop workflow creator that enables users to produce simple to complex workflows. With an intuitive interface, building complex automation routines can be accomplished quickly. The workflow engine allows users to create workflows by using either custom building blocks initiated by the user or third-party from the VCF Solutions Catalog (`https://vcf.broadcom.com/vsc`).

With VCF Operations orchestrator workflows and built-in plug-ins, users can easily perform tasks, such as:

- Assigning an IP address from an IP address management tool
- Generating a work order ticket
- Updating a configuration management database
- Configuring a load balancer
- Initiating a system backup
- Auto-remediate issues reported by VCF Operations


TECHNICAL STUFF

VCF Operations orchestrator enables you to create new building blocks with a built-in scripting engine. The scripting engine is enhanced with basic version control, variable type checking, namespace management, and exception handling. It can be used with customer building blocks for actions, workflows and policies. VCF Operations orchestrator supports multiple scripting languages, including PowerShell, Node.js, and Python.

All VCF Operations orchestrator workflows have version history, packaging, and rollback capabilities, which allows for basic change management capabilities during the distribution of processes to different project stages and locations.

Every step in the workflow is saved in a content database, which enables server restarts without losing the state and context perimeters. This feature is especially useful for processes that take a long time to execute.

Centralized management provides a central way to manage processes and ensure that administrators use up-to-date, version-controlled scripts. This provides proper change control across the environment.

The VCF Operations orchestrator plug-in software development kit (SDK) jump-starts users who are new to the VCF Operations orchestrator plug-in development community. It also enables advanced developers to integrate key SDK features into their existing development environments. The SDK provides an Eclipse add-on for plug-in development.

CHARLOTTE PIPE AND FOUNDRY SHARPENS ITS COMPETITIVE EDGE

Founded in 1901, Charlotte Pipe and Foundry manufactures premium cast iron and PVC pipe products for industrial, commercial, and residential plumbing applications. The company supplies its products to a global market and operates seven manufacturing facilities across the United States. The family-owned company, with its workforce of 1,500 employees, produces all products in the United States. Over its century-plus history, Charlotte Pipe has built a market-leading business by delivering premium-quality products and services.

In the face of rising costs, stiff competition, and the need for innovation, Charlotte Pipe used VCF Operations to secure cost reductions, improve operational efficiency, and bolster network security. By optimizing technology and data analytics, the company enhanced manufacturing processes and decision-making to increase its competitive edge. Through its partnership with Broadcom, Charlotte Pipe streamlined its cloud migration, fortified its cybersecurity, and developed a strategic industry partnership to drive innovation, growth, and sustainability.

Meeting challenging market conditions

Maintaining leadership in a global, commoditized market is no easy task. Domestic cast iron and PVC pipe manufacturers face competition from cheaper foreign imports, soaring domestic production costs, and variable demand driven by economic shifts and housing starts. The market is dispersed, demanding robust contractor and wholesaler relationships. These challenges are further amplified by constant changes in building codes and construction standards, mandating ongoing research and development investment and new certifications. Compliance with rigorous sustainability

(continued)

(continued)

benchmarks set by governments and consumers demands the creation of more eco-friendly products.

In an environment in which business interactions increasingly occur online, a strategic focus on enhancing business-to-business (B2B) e-commerce and digital sales capabilities is essential, necessitating further investment. To remain competitive, domestic manufacturers must aim for operational efficiency, product distinction, exemplary customer service, cost reduction, and swift adaptation to rapid market fluctuations. The primary challenge resides in widening profit margins in the face of commoditization and escalating costs.

Embracing a hybrid cloud strategy to drive innovation

Charlotte Pipe recognizes that surviving — and thriving — in the midst of these challenges demands a robust and flexible digital infrastructure. The company needed to better support B2B ecommerce capabilities, manage and analyze large volumes of data for strategic decision-making, uphold sustainability standards via sophisticated IT systems, and ensure robust cybersecurity protocols in the face of increased digitization.

The company's ultimate goals were to improve operational efficiency, create distinctive product offerings, and reduce costs to meet the demands of a rapidly changing market. Charlotte Pipe enlisted VMware to develop a hybrid cloud platform to leverage and integrate the most effective features of on-premises and cloud infrastructures, including the capability to integrate AI and machine learning (ML) into its business and manufacturing processes.

The platform is built on VCF, a unified software-defined data center (SDDC) solution that integrates VMware vSphere, vSAN, and VCF Networking into one integrated stack to deliver the enterprise-ready cloud infrastructure for private and public clouds that Charlotte Pipe needs. This simplifies deployment and operations by delivering cloud infrastructure with consistent operations, developer-ready infrastructure, and intrinsic security.

Using this comprehensive suite of software-defined services, Charlotte Pipe enhanced agility, simplified operations, and reduced costs. These services — encompassing areas such as computing, storage, networking, and security — support both traditional and containerized applications in various environments.

Preparing for AI and ML

Charlotte Pipe is boosting operational efficiency with infrastructure modernization, data management, and cybersecurity. Utilizing VCF Operations, Charlotte Pipe can optimize processes, improve network performance, and enhance stability. Moving forward, the company plans to integrate AI and ML to augment operational capabilities. The company also implemented microsegmentation for increased security and used VCF Operations for troubleshooting.

Laying the groundwork for the future

Charlotte Pipe is using microsegmentation, integrated into VCF, to strengthen its cybersecurity in various ways. The company can break down the network into isolated segments at the individual workload level, enabling the company to apply specific security policies to each segment and minimize the potential attack surface.

This strategy is especially useful in securing ecommerce operations, where protecting sensitive customer data is paramount. The company can employ microsegmentation to effectively secure, monitor, and manage data flows in vast data repositories.

Watch the customer video at `www.vmware.com/resources/customers/charlotte-pipe-and-foundry-harnesses-multi-cloud-tech-to-sharpen-edge`.

IN THIS CHAPTER

- Implementing security best practices
- Addressing issues and vulnerabilities
- Maintaining regulatory compliance
- Improving security and compliance posture

Chapter 4
Securing Your Private Cloud

This chapter explains how you can secure your VMware Cloud Foundation (VCF) private cloud infrastructure with best-practice hardening guidelines, diagnostics for VCF, and security and governance capabilities in VCF Operations.

Hardening Your Infrastructure

Most organizations are bound by requirements on how data is collected, used, stored, and transmitted, and how systems are secured. IT teams can only meet these ever-evolving requirements if they have visibility into where data, applications, and workloads live and the tools to define and enforce policies and automate remediation. With these insights, IT can enforce data controls, segment networks, and rapidly address anomalies.

VMware Cloud Foundation enhances the security of your private cloud with the following capabilities:

- Enabling infrastructure hardening based on VMware best practices

- Detecting infrastructure deviations from regulatory guidelines, industry benchmarks, and best-practice standards with the VCF Advanced Cyber Compliance add-on

Additionally, VCF Operations for networks works with VMware vDefend Firewall to implement automated firewall policies and harness network segmentation, adhering to compliance requirements.

For flawless and nondisruptive operations — such as password management, backup and restore, certificate management, and license management — and for optimal performance of your VCF environment, you can follow certain best practices based on industry expertise and previous successful experiences.

Monitoring and alerting

Monitoring the underlying physical infrastructure and the management and customer workloads in VCF in real time helps you prevent outages and plan future hardware needs. Table 4-1 describes monitoring and alerting solutions in VCF Operations.

TABLE 4-1 VCF Operations Monitoring and Alerting Solutions

Solution	Description
Intelligent Operations Management for VCF	Use VCF Operations for proactive management of system failures by reviewing and acting on events and alerts. Information is collected in the form of structured data (metrics).
PowerShell Module for VCF Reporting	Use the cmdlets in the VMware.CloudFoundation.Reporting PowerShell module to generate insights to the operational state of VCF. You can quickly access information from the PowerShell console and generate several types of reports in HTML format.
Health Reporting and Monitoring for VCF	Generate reports in HTML format, and use custom dashboards, alerts, and notifications in VCF Operations to monitor the health of your environment.
Intelligent Network Visibility for VCF	Use VCF Operations for networks for network visibility and analytics to improve microsegmentation security, minimize risk during application migration, optimize network performance, and manage and scale NSX and Kubernetes deployments.

Password operations

Certain measures enhance the security setup of your VCF environment, including:

- Monitoring passwords to ensure compliance, access control, and risk mitigation in your VCF environment
- Enforcing password policies, including complexity, expiration, and account lockout
- Implementing password complexity requirements to enhance password strength, expiration prompts for regular updates, and account lockouts to prevent unauthorized access attempts

Table 4-2 summarizes best-practice recommendations for password operations in VCF.

TABLE 4-2 Best Practices for Password Operations in VCF

Password Steps	Description
Set or update password policies	Configure password policies of the management components of VCF.
Monitor account password expiration	VCF shows a notification for account passwords that are expiring. VCF Operations can monitor account passwords at a VCF fleet level using custom dashboards, alerts, and notifications. To generate a point-in-time health report for your VCF environment.
Enable account password auto-rotation (schedule rotation)	Enable password auto-rotation for a VCF management component from VCF Operations. Enable auto-rotation of a password for a management component from SDDC Manager. Integrate a third-party or custom utility that uses the VCF API for password rotation.

License operations

VMware Cloud Foundation (VCF) requires access to a secure license file to deploy VCF components. In previous releases, VCF components were licensed using license keys. Licensing VCF is now easier and is managed using the VCF Operations console. VCF Operations is registered to the Broadcom support portal and uses a single license file for components across your VCF fleet. Prior versions of VCF used individual license keys for each VCF component. The license usage file needs to be shared with Broadcom every 180 days. When the licenses are assigned to a vCenter, all the ESX hosts associated with it will automatically fetch the appropriate entitlement based on the license file information assigned to the vCenter.

Table 4-3 describes best-practice recommendations for license operations in VCF.

TABLE 4-3 Best Practices for License Operations in VCF

Licensing	Description
License file instead of previous license keys	A single license file managed from VCF Operations covers the VCF environment across multiple VCF instances.
License usage	Licensing consumption data is required to be shared with Broadcom within every 180 days.
License file support	1. VMware Cloud Foundation Cores 2. vSAN TiBs 3. Private AI Foundation 4. VMware vSphere Foundation Cores 5. VMware Cloud Foundation Edge Cores
Software version	No version specific licensing. No license key upgrade required from version 8.x to version 9.0.
Broadcom support portal	Licensing with the Business Services console is found at the Broadcom Support Portal or via the direct link `vcf.broadcom.com`.

Certificate operations

By actively managing certificates in VCF, organizations can maintain secure communication, establish trust, protect sensitive data, meet compliance requirements, and respond effectively to certificate-related incidents or vulnerabilities.

Table 4-4 describes best-practice recommendations for certificate operations in VCF.

TABLE 4-4 Best Practices for Certificate Operations in VCF

Operation	When or How Often	Description
Replace self-signed certificates	After management domain deployment After virtual infrastructure (VI) workload domain deployment using VCF Operations	To manage custom certificates for most management components, leverage the fleet management capabilities within the VCF Operations console. You can also use APIs or PowerShell for certificate management.
Replace signed certificates from a trusted certificate authority	After management domain deployment After VI workload domain deployment The key length must be modified A certificate has expired, or its expiration date is close The certificate authority or the private key has been compromised A certificate has been revoked by the issuing certificate authority	Follow the same guidelines as when replacing self-signed certificates.

(continued)

TABLE 4-4 *(continued)*

Operation	When or How Often	Description
Identify expiring certificates	At least once a month	VCF Operations fleet management shows an alert if a certificate is expiring. To monitor expiring certificates managed by VCF Operations fleet management using custom dashboards, alerts, and notifications in VCF Operations, use the open-source Python module for VCF health monitoring. To generate a point-in-time health report for your VCF environment, use the PowerShell module for VCF health reporting.
Replace expired certificates	When the certificate of a management component that is managed by VCF Operations fleet management has expired	If the certificates of multiple management components have expired, replace them in the following order: 1. Replace the certificates of the NSX Manager cluster and nodes. 2. Replace the vCenter Server certificate with a VMware Certificate Authority (VMCA)–signed one. 3. If you're replacing expired certificates in the management domain, replace the VCF Operations fleet management certificate. 4. You can use VCF Operations to replace temporary certifications for NSX and vCenters with self-signed or Certificate Authority (CA) certificates.

RETAIL GIANT UNIFIES IT OPERATIONS AND ACCELERATES DIGITAL TRANSFORMATION

Seven & i Holdings Co., Ltd. is the parent company of various businesses, including the convenience-store chain 7-Eleven and the supermarket Ito-Yokado. It operates a total of 74,000 stores in 17 countries and regions around the world. In addition, it has expanded its business into other sectors, ranging from financial services to general merchandise stores. The group's stores cater to a wide range of customers and strive to meet the needs of people of all ages.

To accelerate digital transformation (DX) in the group, Seven & i formulated its Group DX Strategy Map. This strategy is divided into two major areas: defensive DX, focusing on security and efficiency, and offensive DX, focusing on creating new customer value through various innovations including artificial intelligence (AI) and in-house development.

Eliminating siloed IT infrastructure with defensive DX

Consumer needs have become far more diverse because of the maturity of the Japanese market and lifestyle changes over recent years. Seven & i decided to build a new logistics platform called "Last Mile DX Platform." In addition to improving customer convenience, the platform will optimize logistics through AI-enabled delivery control, helping the group to deliver products more efficiently to consumers of its e-commerce and online supermarket services.

However, the scale of the group and the IT silos of the companies within the group became hurdles as Seven & i proceeded with this offensive DX strategy. The size and quality of its systems varied from company to company because each one deployed different IT infrastructures. Furthermore, the lack of consistency made it difficult for the group to take advantage of its scale. To address this challenge, it was necessary to launch a defensive DX strategy that could bring about flexible IT infrastructure development and better security.

(continued)

(continued)

Supporting operating companies through integration and cloud solutions

Seven & i's defensive DX strategy started with the construction of a common platform. The objective was to standardize IT resources by integrating IT infrastructure, making the impact of investments tangible while standardizing security system quality. To meet the requirements of various systems, which differed in nature and size between companies, the group turned its attention to private cloud solutions.

Even though they're on-premises, the group's private clouds needed to be simplified so that multiple systems of different sizes and system requirements could be easily managed. Furthermore, the group hoped to reduce its dependence on system integrators by reducing its reliance on hardware and virtualizing as much as possible.

Aggregating siloed systems isn't enough to ensure security or to satisfy the requirements of individual systems. Therefore, to prevent information leaks from operations and development staff, it was necessary for Seven & i Holdings to build an architecture that covered communication control, encryption, and authority management.

Seven & i adopted VMware Cloud Foundation as the core technology for its new infrastructure and used it to integrate the group's siloed IT environments. In addition, VMware Cloud Foundation's centralized hybrid cloud platform integrated all the different systems, improved security, and met the group's IT requirements. These benefits supported the rationale for the adoption, together with VMware vSphere vMotion, which is indispensable for operations.

Today, Seven & i has deployed approximately 2,000 virtual machines (VMs), and 22 systems are already operating. In addition, eight large-scale systems are now hosted on a private cloud.

Advancing defensive DX and delivering more customer value

Seven & i will continue to collaborate with VMware to conduct semiannual IT environment assessments. The group also plans to strengthen its infrastructure with further improvements in security and cost-efficiency as the key priority.

Advancing the defensive DX will create an environment where the offensive DX can be scaled securely and quickly as the group continues to innovate and deliver new value to customers.

See the customer case study at `www.vmware.com/docs/vmw-seven-holdings-case-study`.

Leveraging Diagnostics for Security Advisories and More

Diagnostics for VCF is integrated and monitors the overall operational status of the VCF software stack. It's a self-service platform that helps you analyze and troubleshoot the components of VCF, including vCenter, ESX, and vSAN; capabilities such as vSphere vMotion, snapshots, and VM provisioning; and other issues including security advisories and certificates. Diagnostics validates if your environment is up-to-date with important VMware Cloud Foundation Security Advisories.

TIP

You can monitor the operational state of your environment using diagnostics findings and custom dashboards. The built-in dashboards are an extension to native VCF Operations dashboards.

With diagnostics, you can address issues or vulnerabilities related to certificates such as expired Secure Sockets Layer (SSL) certificates.

Diagnostics also provides relevant information in self-help flows for vCenter capabilities such as vSphere vMotion to help you diagnose migration issues.

Key benefits of diagnostics for VCF include:

- Ensuring platform availability by proactively identifying and diagnosing operational issues
- Preserving the security posture of your environment
- Providing built-in known issue detection with remediation guidance and links to supporting knowledge base articles
- With self-service, improving the time to understand the cause of an issue and determining the next steps for your VMware software environment

- Quickly identifying the cause and remediation options, which helps your business run with less disruption


TECHNICAL STUFF

VCF monitors the operational state of the following components, which also reports findings indicating the occurrence of a known issue and provides recommendations:

- **vCenter:** vCenter Operational State: Ping reachability
- **ESX operational state:** Connectivity from vCenter
- **VMware vSAN operational state:** Disk group status, physical disks status

VCF includes the following set of capabilities that help understand the operational state of the VCF stack:

- **Workload provisioning (VMs):** VM provisioning requests and failures, provisioning findings and recommendations, and general troubleshooting
- **vSphere vMotion:** Successful and failed vMotion, findings and recommendations, and general troubleshooting
- **Snapshots:** Snapshot failures, findings, and recommendations, and general troubleshooting

Ensuring Compliance with Data Privacy Regulations

Effective governance and compliance are critical aspects of running any infrastructure, requiring compliance with regulatory standards and hardening guidelines while reducing overall complexity and helping ensure security. VCF Operations helps provide a better overall security posture for your private cloud infrastructure and ensures that posture is maintained. Cloud admins are quickly made aware of any changes to the VCF infrastructure, reducing the time to take action to remediate, if required.


TIP

Network Operations Center (NOC) teams, site reliability engineers (SREs), and IT administrators can quickly become aware of what's going on and what changes are happening in your environments with:

- Improved visibility into platform interaction changes across the VCF infrastructure
- Visibility into suspicious access events and policy violations
- Increased user accountability as each action is getting registered in these events
- Infrastructure security state reporting encryption status for ESX host, VMs, and vSAN clusters

VCF Operations also provides a streamlined event auditing process across all VCF resources. Audit records are generated for various platform interactions, including searches, logins, logouts, capability checks, and configuration modifications. These records are easily searchable and viewable within the VCF Operations console, ensuring that cloud administrators are quickly aware of any VCF infrastructure changes. This real-time visibility helps reduce the time to take remedial action, if required, and provides insights into suspicious access events and policy violations. Additionally, it increases user accountability because each action is registered and associated with the user who performed it.

VCF Operations empowers organizations to strengthen their security posture and maintain a consistent and secure VCF environment.


TIP

With VCF Operations, you can gain an understanding of your compliance posture and improve it, reducing organizational and business risk.

Improving Security Management with Event Auditing

VCF Operations provides a streamlined event auditing process across all VCF resources. Audit records are generated for various platform interactions, including searches, logins, logouts, capability checks, and configuration modifications. These records are easily searchable and viewable within the VCF Operations console, ensuring that cloud administrators are aware of any platform changes. This real-time visibility helps reduce the time to take remedial action, if required, and provides insights into suspicious access events and policy violations. Additionally, it increases user

accountability because each action is registered and associated with the user who performed it.

DTU SUPERCHARGES LIFE SCIENCE RESEARCH WITH VMWARE CLOUD FOUNDATION

The Technical University of Denmark (DTU) is home to Computerome, the Danish national life science supercomputing center. One of the largest high-performance computers (HPCs) in Scandinavia, Computerome supports collaboration between researchers, healthcare professionals, and industry, and it can process sensitive data in a highly secure environment. To create a more powerful, flexible system, DTU engaged VMware to engineer the HPC as a virtual private cloud hosting smaller clouds in a secure, segmented network.

A supercomputer for life science research

Computerome consists of 50,000 central processing unit (CPU) cores, 20 petabytes of storage, and 220 terabytes of memory, providing an aggregate peak performance exceeding 1,000 teraflops (floating point operations per second, used to measure calculations for computing). The system maintains an extensive and continually growing library of more than 4,000 software and scientific tools available to its users.

Virtualization creates a flexible HPC

Computerome built the first iteration of the HPC on a conventional, bare-metal infrastructure. The system served multiple, concurrent workloads, demanding the reprovisioning of physical hardware nodes before each run. This time-consuming process required expert IT management, wasting hours of potential compute time. As research activity intensified, the labor of maintaining the system led to delays, slowing innovation. Resource-intensive application management generated higher costs and contributed to siloed operations, with 80 percent of project budgets spent on infrastructure management.

Computerome needed a more flexible HPC capable of running more workloads with less direct intervention by IT staff. The institution needed to fully exploit the potential of the existing compute infrastructure without incurring exponentially higher costs. Engineers

determined that virtualization of the HPC — a highly unusual move in the supercomputing sector — would enable Computerome to operate the HPC as a virtual private cloud running many smaller clouds in a secure, segmented network.

Using virtualization to create an HPC cloud

DTU partnered with Broadcom to engineer a virtualized iteration of the HPC, expanding the Computerome product portfolio, to offer a computing system designed to operate as a virtual private cloud while still delivering traditional HPC capabilities. Virtualizing the HPC using VMware Cloud Foundation allows Computerome to scale its operations to onboard, configure, and commission new scientific projects in hours, rather than days. The goal is for researchers to self-provision isolated virtual clouds in 10 to 15 minutes to enable more compute research, supporting projects that can generate lifesaving healthcare breakthroughs. VMware Cloud Foundation provides Computerome staff a single pane of glass for management and security, helping reduce costs for day-to-day operations, patching, and maintenance.

Analysis of personal data predicts the risks and benefits of cancer treatment

The solution runs many virtual instances on the HPC, allowing Computerome to perform different tasks and disparate setups, simultaneously — operations that were impossible on the previous system. VMware Cloud Foundation helps Computerome users utilize data and combinations of patterns in a variety of different areas and applications, including helping make cancer treatment and surgery more predictable.

For example, Professor Ismail Gögenur and his research group from Zealand University Hospital use Computerome to develop new tailored therapy approaches for cancer patients after surgery. Researchers now have access to a secure private cloud environment where specially developed algorithms can process millions of data points from electronic patient records and relevant medical studies. The algorithms running on the supercomputer predict the risks and benefits of cancer treatment, functioning as a decision support tool to help healthcare professionals choose the best treatment for each patient.

(continued)

(continued)

Securing sensitive scientific data in a virtualized HPC environment

Computerome now includes secure remote access for thousands of users and hosts more than 4,000 different tools for researchers, students, and medical personnel. Among the primary concerns for the new Computerome system, security ranked high, especially for GDPR and encryption. Computerome hosts personally sensitive health data for precision medicine and research, requiring strict auditable compliance processes.

With a 150 million Danish krone (DKK) investment in supercomputing resources expected to span a four-year period, the institution must be able to deliver more research results. Computerome can isolate research projects in a secure environment, utilizing VMware NSX network virtualization. Microsegmentation of data networks provides Computerome with completely separated research tasks in production, independent of a physical network provider.

A secure private cloud helps predict, prevent, and find cures

Computerome is a future-ready solution with enough compute power to facilitate giant steps in human genome research for years to come. Computerome can store massive quantities of data from millions of patient records, giving university researchers more accurate assessments of the causes and conditions associated with these diseases.

With solutions from Broadcom, Computerome has launched a secure private cloud to support global collaboration in life science research to help predict, prevent, and find cures for diseases. Computerome and DTU can now offer the life science sector the security and speed needed for research projects, which may lead to improvements in life science and healthcare.

See the customer story at `www.vmware.com/resources/customers/dtu-supercharges-life-science-research-with-vmware-cloud-technology`.

IN THIS CHAPTER

- Enabling full-stack visibility
- Delivering better efficiency and performance
- Taking the complexity out of lifecycle management
- Ensuring operational resilience
- Improving security
- Ensuring compliance
- Leveraging out-of-the-box and custom integrations
- Reducing costs
- Migrating workloads
- Promoting energy efficiency

Chapter 5
Ten Benefits of VMware Cloud Foundation Operations

You know it, you love it — it's the Part of Tens! Here are ten great benefits your organization can realize with VMware Cloud Foundation (VCF) Operations.

Empowering IT with Full-Stack Visibility

You can't effectively manage your environment if you don't have full-stack visibility across cloud, virtual, and physical resources whether in the public cloud, a private cloud, or an on-premises data center.

VCF enables full-stack visibility to help IT teams:

- Deliver on service-level agreements (SLAs) using advanced monitoring techniques
- Get full visibility of your global inventory from apps to infrastructure using out-of-the-box dashboards and reports
- Reduce dependency on multiple tools
- Drive better collaboration between teams, instead of working in silos
- Analyze logs, metrics, and flows within the same VCF Operations view

Improving Efficiency and Performance

VCF helps organizations improve the efficiency and performance of their private cloud infrastructure, thereby reducing costs and improving capacity planning by:

- Enabling data-driven decisions on infrastructure purchases
- Identifying unused capacity that can be shifted to where it's needed, workloads that can be virtualized to improve efficiency and performance, and unneeded resources that can be decommissioned
- Helping you understand the costs of running your cloud
- Enabling deeper analysis of traffic flows
- Delivering insights for effective network and service planning
- Providing chargeback capabilities for cloud resources associated with line-of-business (LOB) applications and workloads
- Improving agility and scale with seamless management of multi-region private cloud environments supporting rapid scale across data centers and cloud providers
- Proactive monitoring and resolving to root cause through a centralized dashboard for monitoring across the fleet, enabling proactive issue resolution and resulting in improved uptime and resilience with faster response to potential issues

Simplifying Fleet Management

VCF Operations fleet management delivers the following capabilities and benefits:

- **Operational efficiency:** Centralized management reduces time and complexity across compute, storage, and networking.
- **Unified lifecycle management:** Ensure patching and upgrade operations are delivered consistently across your VCF instances.
- **Centralized licensing:** Manage licensing across VCF instances with in-depth visibility and insights into consumption and usage trends.
- **Certificate management:** Maintain visibility and non-disruptively renew certificates across private cloud infrastructure and management components.
- **Password management:** Monitor, update, remediate, and auto-rotate key break-glass passwords for VCF components.
- **Identity management:** Provide secure access and authentication services across VCF components. Single sign-on (SSO) and identity access can be configured at a fleet level using modern or directory-bases identity solutions.

Increasing Operational Resilience

Key benefits of Health and Diagnostics for VCF include:

- Ensuring platform availability by proactively identifying and diagnosing operational issues
- Preserving the security posture of your environment
- Providing built-in known issue detection with remediation guidance and links to supporting knowledge base articles
- Improving the time to understand the cause of an issue and determining the next steps for your VMware software environment with self-service capabilities

- Enabling quick identification of the cause and remediation options and helping your business run with less disruption

Reducing Complexity and Enhancing Security

Infrastructure and cloud admins have traditionally had to work with the separate management and operational capabilities of the various components within the VCF stack, a less-than-ideal user experience. VCF introduces a new console experience that unifies these capabilities, providing admins with the ability to configure, manage, and operate their VCF stack as a single, fully integrated solution.

Diagnostics for VCF helps admins more easily and quickly:

- Curate findings and recommendations for faster remediation of issues
- Deliver security findings based on VMware Security Advisories (VMSAs)
- Provide insights into key operational actions like workload provisioning, vMotion, and snapshots
- Upload log bundles for faster support engagement

Addressing Compliance Requirements

Effective governance and compliance are critical aspects of running any infrastructure; they require compliance with regulatory and corporate standards, and VMware hardening guidelines while reducing overall complexity and helping ensure security. VCF Operations with the VMware Advanced Cyber Compliance add-on helps provide a better overall compliance posture for your infrastructure and ensures that posture is maintained. Cloud admins are quickly made aware of any changes to the VCF infrastructure, reducing the time to take remedial action, if required.

Extending Your Ecosystem

The VCF application programming interface (API) enables custom integrations with third-party vendors and VMware partners, in addition to the out-of-the-box integrations available in VCF.

Reducing Infrastructure and Operations Costs

VCF helps organizations modernize their infrastructure with the best possible total cost of ownership (TCO), enabling a cloud operating model that provides the benefit of public cloud with the security and performance of on-premises private clouds.

Managing Migrations and Workload Mobility

VCF Operations workload mobility simplifies application migration, workload rebalancing, and business continuity across data centers and clouds.

Key capabilities include:

- **Performing a bulk migration of live virtual machines (VMs):** Simply schedule the movement of hundreds of VMs in parallel.
- **Utilizing simple migration planning tools:** Easily identify application and workload relationships, and logically group VMs for efficient migration.
- **Enabling mobility across data centers and clouds:** Move VMs within your data center — from your local data center to the cloud, or across cloud regions or providers — to optimize resource utilization.
- **Migrating with zero downtime:** Perform live migrations with zero downtime by stretching Layer 2 networks, ensuring that workloads can retain their Internet Protocol (IP) addresses during the move.

Improving Energy Efficiency

Energy cost is an essential priority for every organization around the globe today. Every CxO is looking at reducing energy costs in every operation and identifying processes to achieve their energy savings goals.

Broadcom helps customers significantly reduce energy costs associated with a robust digital infrastructure. Broadcom has identified the following three components of energy for data center operations:

- The data center hardware and software infrastructure that is optimized
- Actual demand for resources, as required by either business or IT
- Running your operations with minimal overhead and buffers

You can use energy efficiency to track progress over time. Energy efficiency is based on five components with different weights:

- **Workload efficiency:** Measures the data center's waste resources and calculates a score based on various waste sources.
- **Resource utilization:** Based on hardware utilization from the absolute capacity without considering buffers and high availability (HA). This component is intended to drive leaner operations without impacting SLAs for operations.
- **Virtualization rate:** Virtualization drives consolidation, thus reducing power consumption.
- **Power source:** Measures the energy impact of different electric power sources.
- **Hardware efficiency:** Newer, next-generation hardware is generally more efficient than older hardware.

Accelerate digital transformation

IT leaders, it's time to simplify. Modernize and adopt a unified cloud operating model that guarantees consistent service delivery across all workloads for cost and performance optimization. This book reveals how VMware Cloud Foundation (VCF) gives you the power to build, operate, manage, and secure your modern, efficient private cloud.

Inside...

- Address private and hybrid cloud challenges
- Improve application performance
- Accelerate troubleshooting
- Reduce costs and increase capacity
- Enhance security and ensure compliance

BROADCOM®

Lawrence Miller served as a Chief Petty Officer in the U.S. Navy and has worked in information technology in various industries for more than 25 years. He is the co-author of *CISSP For Dummies* and has written more than 300 *For Dummies* books on numerous technology and security topics.

Go to Dummies.com™
for videos, step-by-step photos, how-to articles, or to shop!

ISBN: 978-1-394-30446-2
Not For Resale

for dummies®
A Wiley Brand

WILEY END USER LICENSE AGREEMENT

Go to www.wiley.com/go/eula to access Wiley’s ebook EULA.