Brought to you by

vmware

Telco Cloud

for dummies

A Wiley Brand

VMware Special Edition

Become a digital service provider (DSP)

Future-ready your telco network

Compete in the new digital economy

Lawrence Miller
Stephanie Owyoung

About VMware

VMware software powers the world's complex digital infrastructure. The company's cloud, networking and security, and digital workspace offerings provide a dynamic and efficient digital foundation to customers globally, aided by an extensive ecosystem of partners. Headquartered in Palo Alto, California, VMware is committed to being a force for good, from its breakthrough innovations to its global impact.

For more information on its telco cloud solutions, please visit **https://telco.vmware.com.**

Telco Cloud

VMware Special Edition

by Lawrence Miller and Stephanie Owyoung

for dummies®
A Wiley Brand

Telco Cloud For Dummies®, VMware Special Edition

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

ISBN 978-1-119-66447-5 (pbk); ISBN 978-1-119-66451-2 (ebk)

Manufactured in the United States of America

10 9 8 7 6 5 4 3 2 1

For general information on our other products and services, or how to create a custom *For Dummies* book for your business or organization, please contact our Business Development Department in the U.S. at 877-409-4177, contact info@dummies.biz, or visit www.wiley.com/go/custompub. For information about licensing the *For Dummies* brand for products or services, contact BrandedRights&Licenses@Wiley.com.

Publisher's Acknowledgments

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

Project Editor: Elizabeth Kuball

Associate Publisher: Katie Mohr

Editorial Manager: Rev Mengle

Business Development Representative: Karen Hattan

Production Editor: Tamilmani Varadharaj

Special Help: Debbie Bradshaw, Karl Brown, Karina Dahlke, Jean-Philippe Goyet, Steve Hoenisch, Sachin Katti, Yusuke Kanamori, Anupama Mahabhashyam, Misbah Mahmoodi, Suzanne McCormac, Gabriele Di Piazza

Table of Contents

Foreword

Telcos missed the last cloud wave and lost the opportunity to hyperscalers, resulting in their getting relegated to just basic connectivity providers. With the emergence of 5G, telcos have a new opportunity to break out of that mold and reinvent themselves, develop new business models, and engage with the larger innovation ecosystem to deliver new services that are more germane in the digital world. This transformation requires a virtualized and containerized telco cloud architecture to modernize legacy networks. Telco clouds deliver the cost, agility, and scalability benefits of a cloud, tailored to communications service provider (CSP) needs. A telco cloud also gives CSPs the ability to become more agile and compete with hyperscalers and over-the-top providers.

Using a telco cloud foundation, CSPs can deploy their core, edge, radio access network (RAN), and private enterprise applications and network functions on a common foundation. Further, they can connect this foundation with private, public, and edge clouds, giving them a platform to build the next-generation applications and services that consumers and enterprises require today and for the future. VMware believes openness is a key to a healthy industry ecosystem, with open standards and open source playing important roles. Our commitment to openness is evidenced by our support for initiatives like Open RAN, the Open Radio Access Network (O-RAN) Alliance, Kubernetes, the Linux Foundation, and the Telecom Infra Project.

With the current state of complexity in telco networks plagued with legacy business and operational support systems, the transformation to future telco could seem daunting. VMware is working with carriers globally, delivering them a solution that enables them to provide for the demands of the day while laying the groundwork for tomorrow. This solution includes analytical capabilities to understand patterns, time sequencing of events, market trends, and customer behavior by embracing artificial

intelligence with deep neural techniques for machine learning and self-healing capabilities. Only VMware enables a uniform architecture for a multi-cloud world that enables CSPs to deliver any application, on any cloud, to any device.

Shekar Ayyar

Executive Vice President and General Manager, Telco and Edge Cloud, VMware

Introduction

Today, many communications service providers (CSPs) are becoming digital service providers (DSPs) to thrive in a shifting marketplace and participate in the new cloud economy. The key drivers of this digital transformation for CSPs include

- **The requirement to adapt to shifting market demands:** Service providers need to fulfill on-demand, customizable 5G services while keeping pace with the rapid growth of the Internet of Things (IoT) and steadily increasing data requirements.
- **The need for improved business and service agility:** Bringing new revenue-generating services to market faster requires automated and dynamic network operations.
- **The imperative to control rising network costs:** Vendor lock-in and monolithic operating models drive increasing capital expenses (CAPEX) and operating expenses (OPEX).
- **The desire to reimagine customer relationships:** New tooling and business models are required to compete in this dynamic marketplace and deliver superior customer experiences.

Digital transformation enables CSPs to meet the needs of these key drivers with software-driven, cloud-enabled network architectures, flexible DevOps-driven operations, and the ability to leverage new revenue-generating business models.

The foundation for CSP digital transformation is the telco cloud. The telco cloud lets you run your network like a cloud with software-driven telecom infrastructure built to run virtual and cloud network functions and enable agile operations. The telco cloud is an essential platform to build and deliver new consumer and enterprise applications and compete with agile over-the-top vendors who have been operating digital, cloud-enabled networks for years. In this book, you learn how the telco cloud can help you succeed on your digital transformation journey in the new cloud economy.

About This Book

Telco Cloud For Dummies consists of five chapters that explore

- What it takes to become a digital service provider in a multi-cloud world (Chapter 1)
- How to build a foundation for the telco cloud (Chapter 2)
- The requirements for the telco cloud (Chapter 3)
- Which VMware technologies power the telco cloud (Chapter 4)
- Key benefits of the telco cloud (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 (though we don't recommend upside down or backward).

Foolish Assumptions

It's been said that most assumptions have outlived their uselessness, but we assume a few things nonetheless:

- You work in the communications industry and are interested in developing multi-cloud and/or edge cloud services.
- You're a chief technology officer (CTO), chief technology information officer (CTIO), chief security officer (CSO), chief data officer (CDO), vice president of networking, network or cloud architect, or network operator, or you're leading a network transformation project.
- You have at least a basic understanding of technology concepts such as cloud computing, networking, and virtualization.

If these assumptions describe you, this is the book for you! If none of these assumptions describe you, keep reading anyway! It's a great book and when you finish reading it, you'll know quite a lot about the telco cloud!

Icons Used in This Book

Throughout this book, we 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

If you seek to attain the seventh level of NERD-vana, perk up! This icon explains the jargon beneath the jargon!

TIP

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

Beyond the Book

There's only so much we can cover in 48 short pages, so if you find yourself at the end of this book, thinking, "Gosh, this was an amazing book! Where can I learn more?," just go to `https://telco.vmware.com`.

IN THIS CHAPTER

- Becoming a digital service provider in a multi-cloud world
- Understanding the value of operational agility
- Competing effectively in the new cloud economy
- Looking at telco cloud capabilities

Chapter 1
Responding to Communications Industry Challenges and Opportunities

Communications service providers (CSPs) are in a race to become more agile and profitable by taking advantage of the digital era, including the promise of 5G, the Internet of Things (IoT), artificial intelligence (AI), and big data. The intersection of these new capabilities, along with technological advances in cloud and edge computing and the shifting competitive and customer landscapes, has led to new opportunities for CSPs globally. In order to succeed in the digital era, however, they need the agility of their web-scale competition — multi-cloud networks built to be automated, dynamic, and scalable.

CSPs that can undergo a profound transformation to capitalize on the promise of the digital era can move from disrupted to disruptor. Imperative to this transformation is the evolution toward a cloud model or "telco cloud." With a telco cloud, CSPs will have a modern platform to design, deploy, and manage new

digital services and applications with greater agility, security, and customization.

In this chapter, we explain what it takes for a CSP to become a digital service provider (DSP) in order to innovate more quickly and compete effectively in the new cloud economy. Every network, region, market, and operating model has its own nuances, but several challenges, conditions, and opportunities are common for most CSPs. The following sections review those generalized circumstances, with an appreciation for the differences that do exist.

Creating Operational Agility with a Telco Cloud

Under the influence of digital technologies, new competitive pressures, and cost-models that no longer facilitate success, yesterday's communications service provider business is rapidly becoming a commodity service and new customer demands and opportunities are afoot.

Current service provider networks were architected for a different kind of service (primarily voice), for a different kind of market (not always on), with an approach to network innovation that was measured in years or even decades (instead of days or months). Incremental innovation has enabled service providers to transition from voice to data to video service delivery, but the network tools and resources remain monolithic, manually controlled, and far too expensive to enable the next-generation services of 5G. The enhanced mobile broadband, massive machine-to-machine (M2M) communications, and ultra-reliable low latency required to fulfill the needs of 5G services will require architectures to be more agile and automated.

CSPs have traditionally built out extensive dedicated networks of vertically integrated, single-purpose, proprietary hardware from industry-focused providers. Buildings and racks full of expensive gear created vendor lock-in to network equipment manufacturers. This infrastructure was designed to provide carrier-grade quality and reliability and required the support of specialized telco engineering teams — "five nines" reliability requires full

operation 99.999 percent of the time. Launching a new service (which was rare because the needs of enterprise customers didn't change much) required new hardware for each application and truck deliveries to every location. This inevitably led to 12- to 18-month deployment times for new services.

This architecture, and the business model it supports, is approaching extinction. The reasons for its impending demise include the following:

- **Voice and data transport have largely become a commodity business.** Digital technologies have proliferated fierce competition from over-the-top (OTT) providers and greenfield service providers built on new, agile networks. Increasing network traffic without matched increased revenue has siphoned revenues from displaced services (for example, WhatsApp and others), and new business models that bring new price competition make competing with current capabilities challenging.
- **Customer needs are evolving rapidly.** The old, inflexible architecture of single-purpose hardware can't support quick creation and deployment of new services and can't fulfill service customization to meet those needs.
- **Legacy infrastructure can't keep pace with the demand for bandwidth.** Consider the rise of data-heavy analytics in the enterprise, OTT consumer content and service providers like Netflix and YouTube, and the millions of mobile apps in the consumer world. Video, virtual reality (VR), augmented reality (AR), and IoT usage are all rising.
- **Telcos are subject to ever-rising costs.** For example, servicing anticipated data growth with current hardware-driven, step-growth bandwidth expansion would be incredibly expensive. CSPs want to break vendor lock-in to have the flexibility to work with more ecosystem partners.

TIP

The flipside of disruption is opportunity. CSPs, which are able to quickly meet new market demands, will discover abundant opportunities and new sources of revenue as their enterprise customers undergo digital transformations. MarketWatch predicts that the global digital transformation market will exceed $462 billion by 2024. By providing new digital services that match the needs of their customers — for example, software-defined

wide area networks (SD-WANs) — CSPs can earn higher margins than they did with voice and data transport and generate new revenue streams.

Twenty years ago, before the introduction of the iPhone, communication devices had dedicated purposes. Customers didn't have the flexibility to leverage one device for multiple uses. The introduction of software onto the consumer mobile device is how this multi-use (think App Store) capability is enabled. The telco network must go through the same transformation.

Cloud computing has been proven to enable more agile operations, providing the capability to generate new revenue and decrease costs. Most enterprises are looking to cloud to increase business agility, efficiency, and speed while reducing costs, but these shifts for service provider networks carry exponential benefits simply because of the sheer size of their networks. With the right approach to cloud technology, service providers can meet growing demand for next-generation services by bringing the benefits of cloud to their enterprise and consumer customers.

The cloudification of communications networks is prompting organizational shifts within CSPs, bringing together enterprise-focused IT operations and core service delivery operations in a way the industry has never seen before. By aligning these operations with unifying resources to support such an alignment, service providers will recapture the innovation process by reallocating resources currently focused on manually controlling the network, to focus on creating value through service and network creation in a uniform manner. Many of these previously disparate organizations are striving to adopt a telco cloud strategy and cloud-first mindset to compete in the digital markets of the new cloud economy.

At its root, telco cloud is about structuring technology using software architectures to automate and unify resources to manage complexity and unlock velocity. By breaking down the network silos, CSPs enable cross-pollination throughout their organization to help make application development and operations teams more efficient and speed delivery of more reliable products and services. Some of the processes providing these efficiencies include DevOps-enabled continuous integration and continuous deployment (CI/CD), automation, assurance, and cross-network monitoring.

As operational structures shift to leverage the telco cloud transformation, culture must also be realigned. Cultural changes in large companies that have traditionally prioritized service reliability above innovation and in which network downtime can quickly become a "résumé-updating event" isn't easy. This traditional telco mentality is in stark contrast to the "fail fast" ethos of the many web companies today that pride themselves on the efficiency of their CI/CD pipelines. Not only do teams have to be trained with new software skills, but they also need to learn to think and operate in new ways, at mass scales.

Although these operational shifts are important parts of the digital transformation, they could fill a book of their own so we'll leave you with one important note on the influence of telco cloud for a cultural transformation. With the potential for CSPs to offer not only differentiated levels of network connectivity but also end-to-end solutions specific to industry verticals and customer segments, CSPs must take back control of their networks and teach their teams to innovate in order to thrive. The telco cloud provides the flexible foundations to do just that.

Responding to Unforeseen Market Shifts

A good example of why CSPs are looking to transform their networks is the recent pandemic, COVID-19. The CSP role in supporting the seismic shift in behaviors and demand to remote communications is critical. Amid already changing market demands, CSPs had to quickly calculate how to balance the upsurge in demand while simultaneously finding a sustainable way to assert their influence on the architecture of future communications systems. Fierce Telecom reported that for some CSPs, "the planned capacity increases for the entire year were reached during the height of the coronavirus pandemic" (`www.fiercetelecom.com/telecom/covid-19-s-impact-will-evolve-telecommunications-industry`). Delivering carrier-grade service in such a rapidly changing environment with current network architectures was a challenge for many CSPs. This is where the telco cloud can help.

Future-proof networks will be able to self-manage the adjustments needed to support rapid shifts in customer behavior. These

networks, empowered by the automated telco cloud, will have the flexibility to shift loads around the network and adjust bandwidth allocations. CSPs will also have the tools needed to quickly create new services to address shifting market needs.

Defining the Telco Cloud

Telco cloud lets service providers run their networks like a cloud. Supporting agile and efficient creation and deployment of services, telco cloud architectures connect public, private, and edge cloud infrastructure to enable seamless, DevOps-managed environments for digital service providers. The foundation for this agile environment starts with a network functions virtualization (NFV)–enabled platform, sometimes referred to as *telco cloud infrastructure.* Creating an abstraction layer for the telco network, this layer of the telco cloud includes modern hardware resources to support modular cloud-native network functions (CNFs), as well as virtualized network functions (VNFs). The telco cloud infrastructure establishes a software foundation for creating and delivering next-generation services.

In addition to this software foundation, telco cloud requires automated orchestration to manage CNFs and VNFs across all software-defined resources. Telco cloud automation will manage service life cycles throughout the network cloud, the hybrid cloud, the edge cloud, and the IT cloud (software-defined data center, or SDDC) in an integrated and consistent manner. Telco cloud automation is responsible for instantiating and delivering services to meet different quality of service (QoS) requirements seamlessly across network resources. With telco cloud automation, error-prone human activities like service provisioning are automated to remove complexity and optimize overall resource utilization.

With a flexible software foundation and automation platform in place, the last layer of a telco cloud is the intelligence layer. This layer is chartered with service assurance and root-cause analysis. By processing with streamed and normalized data from an end-to-end network, this layer creates dynamic network control as it continuously monitors and reacts to changing network conditions. Telco cloud intelligence makes real-time decisions about changes required to maintain performance and optimize utilization to close the automation loop and deliver improved customer experiences.

Participating in the New Cloud Economy

Cloud has fully arrived in the mainstream. A report published by the Internet Association estimates that "the cloud economy contributed approximately $214 billion (1.1 percent) to the U.S. Gross Domestic Product (GDP) and 2.15 million jobs in 2017." The *RightScale 2019 State of the Cloud Report* from Flexera found that enterprises run one-third of their workloads in public cloud and nearly half in private cloud. Thirteen percent of enterprises spend more than $12 million annually on public cloud and 50 percent spend more than $1.2 million and planned to increase their public cloud spending by 24 percent in 2019.

Cloud technologies are influencing network architectures for CSPs, but they also provide new service opportunities. From a service delivery perspective, CSPs come to the cloud services market with deep service delivery experience, strong customer relationships, and the right infrastructure components. Together, these advantages provide a competitive advantage to communications service providers looking to become cloud service providers.

Cloud offerings supplied by web-scale data center operators like Amazon Web Services (AWS), Google Cloud, and Microsoft Azure have major shortcomings, which CSPs are well positioned to fulfill for the market. For example, data center operators:

- **Can't guarantee end-to-end performance.** Their control over performance and quality of experience (QoE) ends at the doorsteps of their data centers (where the CSP networks pick up).
- **Don't own the network over which the cloud services travel.** That means bandwidth can be expensive.
- **Are limited by centralized architectures.** They don't have the flexibility to move services closer to customers to ensure low latency and lower cost to deliver.

Because no single network resource meets every need for every use case, service providers will need multi-cloud environments to be able to move apps, data, and workloads across different clouds. In fact, 84 percent of enterprises today have a multi-cloud strategy leveraging approximately five clouds, on average, according to the *RightScale 2019 State of the Cloud Report* from Flexera.

Other services that CSPs will be enabled to deliver with a telco cloud include consumption-based network as a service (NaaS), platform as a service (PaaS) for the IoT, enterprise videoconferencing platforms, and many more.

TECHNICAL STUFF

What's the difference between multi-cloud and hybrid cloud? *Multi-cloud* refers to the use of multiple, disparate cloud providers (such as AWS, Google Cloud, and Microsoft Azure), in addition to private clouds for separate workloads that don't necessarily interoperate with each other. Hybrid cloud leverages a common cloud stack inclusive of infrastructure and management functionality across private and public clouds to enable a fully compatible and operationally consistent environment. A hybrid cloud is always "multi-cloud" because multiple public and/or private clouds interoperate across the environment, whereas a multi-cloud is not always a "hybrid cloud" because the various public and/or private clouds may not necessarily interoperate across the environment.

CSPs worldwide have recognized the cloud's capabilities to generate new business models and promote sustainable competitive advantage. To win in this new cloud economy, CSPs must update their understanding of evolving ecosystems, partnerships, and business models. They must evaluate where they can operate most successfully, given their formidable strategic assets, and then consider how to partner with other players most effectively in order to build the best possible cloud offerings. CSPs can play a key role in value creation on the back of cloud technologies — and now is the time to expand and exploit these opportunities.

TIP

Digital transformation for CSPs is about changes to the architecture, the processes, and the business model for new service delivery. However, CSPs no longer need to own all the equipment in their network infrastructure to build the telco cloud — they can deliver services over the infrastructure of others. For most CSPs, this requires a shift in thinking and in business strategy, but they now have the opportunity to fully participate and compete in the cloud economy and offer network services and applications "as a service."

IN THIS CHAPTER

- Looking to the future with 5G while ensuring backward compatibility
- Supporting different 5G use cases with edge cloud
- Bringing together multi-vendor environments
- Deploying the telco cloud on a telco cloud infrastructure platform

Chapter 2
Building a Foundation for the Telco Cloud

In this chapter, we show you how the network has evolved to 5G, how edge cloud enables 5G use cases, how to enable multi-vendor environments, and how to deploy a telco cloud platform.

Evolving to 5G Telco Networks

For Apple iPhone and Google Android users, it may seem like 4G Long-Term Evolution (LTE) networks have been around forever, but the next generation of cellular technology, 5G, is arriving right on time — approximately ten years after the introduction of 4G (4G networks were commercially introduced in 2008, ten years after 3G networks were introduced). 5G will radically transform the customer experience and will enable

- **Higher speeds and more spectrum:** 5G networks will be able to achieve speeds of up to 20 gigabits per second (Gbps) using a combination of, among other innovations, carrier aggregation (CA), massive multiple-input and multiple-output (MIMO), and quadrature amplitude modulation (QAM) to

push the envelope on available spectrum. Unlicensed spectrum in the 2.4 and 5 gigahertz (GHz) frequency bands will be used to provide connectivity and offload traffic to relieve network congestion as needed.

- **Multiple simultaneous connections:** 5G will allow multiple connection points for a single device. With previous cellular technology, a device made one connection to the closest tower, and that connection was handed off to each subsequent hop until arriving at the desired destination. With 5G, that device — a sensor in a car, for example — can connect to multiple towers at the same time. Multiple connection points provide a more reliable signal and more available bandwidth for passing data. In addition, this will provide the basis for all kinds of new and innovative location-based services.
- **Service customization:** With automated orchestration and a distributed multi-cloud environment, communications service providers (CSPs) will have the tools they need to enable service customization based on location, customer requests, and more.
- **Network slicing:** 5G bandwidth can be finely divided, with each slice having its own service-level requirements and virtual network functions (VNFs). Network slicing essentially provides enhanced quality of service (QoS) on a cellular network.
- **Support for cloud-native networks and applications:** Virtualization and container technologies enable support for cloud-native networks and applications that are built from the ground up to take advantage of programmable software-defined networks, a virtual evolved packet core (vEPC), and more.

Together, these technical advances mean 5G is architected with service delivery in mind. For example, autonomous vehicles will benefit from higher-speed and lower-latency 5G networks to sense and react to their surroundings in real time, as well as the high reliability that 5G can provide. These increased network capabilities will open the door to many new applications and capabilities that don't currently exist.

REMEMBER

Network virtualization, including network functions virtualization (NFV) adoption, is a key requisite for service providers to take full advantage of 5G as an engine for revenue. This transition helps enable efficient delivery of new services.

The following telco-cloud-enabled, 5G use cases provide new revenue streams for CSPs:

- **Healthcare:** Advanced network services could enable improved patient monitoring in both inpatient and outpatient scenarios, including telemedicine.
- **E-sports:** Telco cloud can help reduce latency, a key experience factor for the gaming community.
- **Securities trading:** Traders and custodian banks could benefit from secure, high-performance trading platforms.
- **Precision manufacturing:** Connected equipment and processes throughout the supply, manufacturing, and distribution chains can bolster efficiency and quality. Connecting these machines also enables big data analytics opportunities and cost-saving potential.
- **Live entertainment:** Venues could deliver new, real-time customizable experiences to sports fans and concertgoers.
- **Smart cities:** Enabling services based on technologies such as facial recognition, traffic management, and autonomous vehicles can improve quality of life for citizens.
- **Retail:** Physical stores can obtain the same types of real-time insights as their online counterparts.

5G requires cloudlike operations — more secure, agile, and automated environments. This transformation requires a modern telco cloud that leverages the cost, agility, and scalability advantages that are inherent in any cloud architecture. To bridge the two worlds, a robust telco cloud must fulfill the needs of 4G networks (and even some 3G networks) in addition to next-generation 5G technologies to provide a smooth migration for an agile future.

This 4G/5G interoperability is important because 4G resources and use cases will be around for quite some time. In fact, there are still more than three billion 3G mobile subscriptions globally, and 3G subscriptions represent as much as 48 percent of all mobile subscriptions in many regions such as the Middle East and Africa (46 percent), Southeast Asia and Oceania (48 percent), and Central and Eastern Europe (46 percent), according to the June 2019 Ericsson Mobility Report. A properly architected 5G strategy will enable CSPs to reuse existing spectrum in 3G and 4G networks, breathing new life (and use cases) into these networks,

and making interoperability between networks — enabled by a modern telco cloud — a critical capability and competitive differentiator.


TIP

The June 2019 Ericsson Mobility Report predicts that demand for 4G LTE service will continue in the near term, peaking at approximately 5.3 billion subscriptions worldwide by 2024, and that by the end of 2024 there will be 1.9 billion 5G subscriptions.

To fully grasp the opportunities at hand, CSPs need to apply 5G thinking to each phase of a range of business processes, from telco infrastructure on the back end to the delivery of customer support and enterprise services. This requires CSPs to organize differently and develop new skills. And it requires a focus on service delivery, as well as the network. Because of 5G and these many other market and technology forces, CSPs must begin their journey to modernize their networks and digitally transform their businesses now. With the right infrastructure in place, CSPs can build a modern telco cloud and realize these service possibilities and the new revenue streams they create.

Enabling 5G Use Cases with Edge Cloud

There is a unique opportunity for CSPs to connect different clouds across their networks to transform what is otherwise a rigid infrastructure to make it agile and multipurpose. As discussed in Chapter 1, the essential platform to enable this transformation is the telco cloud — a modern platform to design, deploy, and manage new digital services and applications with greater agility and customization.

Footprint is a huge natural advantage for service providers transforming to compete in the digital economy. With central and distributed resources that cover broad territories, CSPs can enable services leveraging resources in the location (edge, core, cloud, and so on) that offers the best performance for cost — a process called *application placement.* By adding network components to the edge, service providers can deliver services without having to use resources all the way back in the regional data centers. For example, during a live sports event where many subscribers are all streaming the same content, delivering that service using resources at the edge is likely more efficient than it would be to

send the same data multiple times from the core. With distributed resources and uniform control, CSPs can more intelligently manage traffic, drop latency, decrease bandwidth costs, and improve customer experience. Application placement can also be used to generate new revenue by intelligently aligning assets and costs with the CSP customers' demands and willingness to pay for guaranteed performance. Because they own the access network, service providers can guarantee service quality and performance from the virtual machine or container all the way to the customer premises.

Beyond application placement, distributed resources at the edge provide a dramatic increase of available computing power. This edge cloud will enable a new breed of 5G applications that require high bandwidth and low latency. For CSPs, the edge cloud enables improved performance in terms of latency, jitter, and bandwidth, ultimately delivering a superior quality of experience for their end customers.

With these conditions at the edge, CSPs are also uniquely positioned — literally at the "last mile" of the network — to deliver the edge cloud to their customers. To take advantage of this enormous opportunity, CSPs need a disaggregated and distributed virtual infrastructure that allows them to selectively place workloads closer to the subscriber. These distributed mini or micro data centers can be co-located in central office (CO) or cellular tower facilities and are broadly known as *telco edge sites.* The geography of a country coupled with its population density could lead a typical CSP to deploy thousands of these edge sites to cater to multiple use cases.

With high data throughput, low latency, and the massive number of devices that 5G networks will need to support, a distributed edge cloud will also let CSPs introduce new services to the marketplace. The ability to deploy new services quickly and at scale is a key requirement to monetize this market opportunity effectively. To be able to do this, CSPs need their distributed infrastructure to be scalable and automated.


TIP

Multi-access Edge Computing (MEC) is the edge computing architectural standard created by the European Telecommunications Standards Institute (ETSI) and widely accepted in the CSP industry.

THE THREE LAWS OF THE CLOUD

VMware CEO Pat Gelsinger has described "three laws of the cloud" that affect every platform choice and help to explain the need for an edge cloud:

- **The law of physics:** Networks have a physical speed limit. An application that demands ultrafast decisions simply can't wait for data to make a long-distance trip to and from a public cloud data center.
- **The law of economics:** Bandwidth still costs money, CSPs can't afford to move every bit of data to the cloud or backhaul all edge data to a private data center.
- **The law of the land:** Data stored in each country or region is subject to that area's specific laws, so public cloud can complicate customers' data governance rules and requirements.

Enabling Multi-Vendor Environments

One of the primary drivers for digital transformation is the desire to break vendor lock-in and enable interoperable networks. In order to create multi-vendor environments, increase vendor competition, and drive standardization, many CSPs look to open-source technologies as a part of their transformation.

Bringing the benefits of standardization to valuable technologies like NFV, software-defined networking (SDN), and cloud-native microservices, open-source technology empowers service providers in several ways.

Overcoming the limitations of proprietary vendor hardware, this community-based innovation approach provides CSPs with the tools to control their network architecture and have the ability to continuously innovate in and on top of their network. This flexibility changes their relationship with their vendors while driving competition and, in turn, decreasing costs.

CSPs reap secondary benefits from open source by providing a standardized foundation for hardened, differentiated vendor solutions. By leveraging open-source solutions, vendors can turn their research and development resources to adding value to openly accessible platforms.

Severing ties with legacy hardware solutions and turning to modern software-based technologies is strengthened with open source in the right places of a next-generation network architecture. Striking a balance between a foundation built on more modern, virtualized, and software-driven architectures with existing legacy resources (which are often still worth billions of dollars of investment) remains a challenging task. One tool that delivers value in open source throughout a telco network stack is Kubernetes.

Kubernetes is a lightweight container solution to run multiple applications on a single server with a shared operating system (OS). With its own file system, memory, central processing unit (CPU), and process space, Kubernetes is decoupled from the underlying infrastructure, which makes creating and deploying services across the data center, core, and edge easier. Kubernetes in an important tool to enable the cloud-native architectures (discussed in more detail in Chapter 3) that CSPs are building in their digital transformations. These microservices-based environments require containers to help them run more reliably, recover more easily, and use resources more efficiently.


TIP

Many enterprises today have built a robust on-premises, cloudlike infrastructure using open-source technologies such as Docker, Kubernetes, OpenStack, and OpenDaylight with OpenFlow, promising greater interoperability and flexibility across heterogenous hardware. In Chapter 4, we fill you in on carrier-grade, open-source technologies that are available from VMware to power your telco cloud.


REMEMBER

"Free" is not the reason CSPs should embrace open-source technology, because in reality, it isn't "free." The "off-the-rack" open-source code typically represents around 30 percent of what's needed to deploy the software technology. Additional work to customize, configure, patch, secure, and scale the technology takes considerable expertise. The primary drivers of innovation and agility are the main reasons to adopt open source.

In the past, CSPs didn't participate in open source because they'd downsized or eliminated their software departments and development teams. Today, however, amidst the digital transformation, everything on the network is getting virtualized and software is playing a key role. CSPs are looking to their software-seasoned vendor partners to help them change their operations and rebuild their software development capabilities and teams.

Many over-the-top (OTT) providers and successful startup enterprises have leveraged open-source technology extensively to overcome traditional barriers to entry, accelerate time to market, and rapidly build economies of scale. CSPs can take a page from this playbook and use open-source technology as a tool to drive innovation and transform their business models.

Deploying a Telco Cloud Platform

As the foundational component of a telco cloud, NFV is an architectural framework developed by the European Telecommunications Standards Institute (ETSI) Industry Specification Group (ISG). The framework provides a reference model where network functions are delivered through software virtualization with commercial off-the-shelf (COTS) hardware. In this way, NFV moves away from proprietary, purpose-built hardware dedicated to a single service that is common in legacy telco network infrastructures. The result is a transformed network that is agile, resilient, and equipped to deliver high-quality services. The NFV framework defines functional abstractions and interactions between the building blocks. Some of these abstractions are already present in current deployments, while others must be added to support the virtualization process and operation.

Figure 2-1 shows the VMware reference model for an NFV-enabled telco cloud infrastructure environment with clear functional abstractions and interactions in the following tiers:

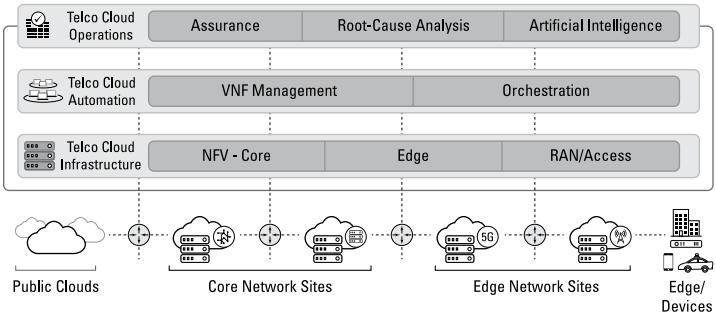

FIGURE 2-1: Layered abstractions of the NFV environment.

- **Physical infrastructure:** Represents compute hardware, storage, and physical networking as the underlying pool of shared resources. In addition, there are numerous other physical network devices such as switches, routers, element management system (EMS), and so on, making the execution ecosystem a hybrid virtual and physical topology.
- **NFVI:** The NFVI tier is delivered using the vCloud NFV platform. It delivers the virtualization runtime environment with network functions and resource isolation for virtual machine (VM) workloads. In NFVI, virtualized compute, storage, and networking are delivered as an integrated solution through vSphere, vSAN, and NSX-T Data Center. The NFVI is optimized for carrier-class workloads to enable the delivery of carrier-grade and resilient services. Infrastructure high availability, performance, and scale considerations are built into this tier for performance optimization.
- **Resource orchestration:** This tier provides resource management capabilities to the NFVI tier. In this way, the NFVI can deliver a flexible infrastructure for life-cycle management of workloads, network management, and resource management. The resource orchestration tier is responsible for controlling, managing, and monitoring the NFVI compute, storage, and network hardware, the software for the virtualization layer, and the virtualized resources. The Virtualized Infrastructure Manager (VIM) module manages the allocation and release of virtual resources, and the association of virtual to physical resources, including resource optimization. The VIM also maintains the inventory of NFVI, including the linkage and relationship between components as they relate to an instance of a VNF or cloud-native network function (CNF) workload. In this way, the VIM allows for monitoring in the context of a single VNF.
- **Cloud automation.** This tier provides the service management and control functions which bridge the virtual resource orchestration and physical functions to deliver services and service chains including operations support systems (OSS) and business support systems (BSS). It's typically a centralized control and management function, including embedded automation and optimization capabilities.
- **Solutions:** This tier is the multi-domain ecosystem that delivers software virtual functions as native VM functions. Such functions are composed in complex solutions to enable

service offers and business models that CSP customers consume. Solutions can range from small branch office functions including customer-premises equipment (CPE) to IP-based multimedia services (IMS), evolved packet core (EPC), multi-access edge computing (MEC), and more, delivered as tenant slices across multiple clouds.

- **Operations management:** This tier provides integrated operational intelligence for infrastructure Day 0, Day 1, and Day 2 operations that spans across all other tiers. The functional components within the operations management tier provide topology discovery, health monitoring, alerting, issue isolation, and closed-loop automation.

As shown in Figure 2-2, the telco cloud provides a common foundation for CSPs for their apps and VNFs.

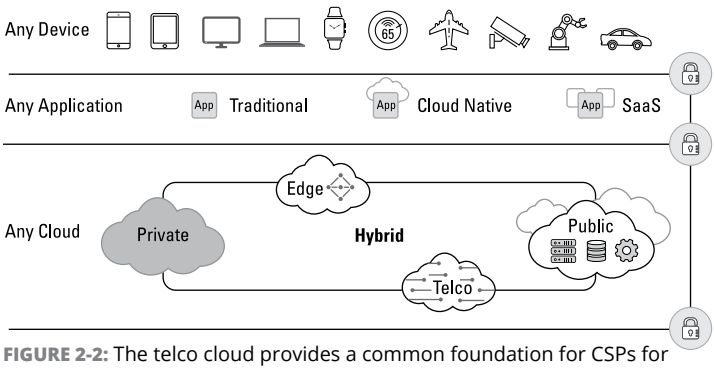

FIGURE 2-2: The telco cloud provides a common foundation for CSPs for their apps and VNFs.

Beyond the NFV-enabled telco cloud infrastructure, transforming to enable the other components of a telco cloud (including automation and intelligence tools) is a process CSPs have been working on for the last several years. Every transformation is different, but there are several "steps" every project undergoes to achieve better agility:

1. **Virtualization.** By separating network functions from their legacy hardware, greater flexibility is gained with lower operating expenses (OPEX) and capital expenses (CAPEX).

2. **Programmability.** Removing human processes and enabling real-time control of network services provides agility, speed to market, and faster fixes.
3. **Orchestration.** Full automation requires cooperation between the telco cloud infrastucture and the telco cloud automation to create efficiencies and provide on-demand differentiated services.
4. **Closed-loop feedback.** Real-time monitoring and assurance of end-to-end services across a multi-cloud environment creates an intelligent, self-organizing network.
5. **Predictability.** Applying artificial intelligence and machine learning can help future-proof a modern network while continually reducing costs and improving customer experiences.

IN THIS CHAPTER

- Looking at telco cloud opportunities
- Starting your cloud-native journey
- Adopting a DevOps mindset
- Reducing operating cost and complexity with automation and orchestration
- Delivering end-to-end service assurance
- Leveraging artificial intelligence and machine learning in operations
- Addressing security and privacy in the telco cloud
- Saving energy and the planet

Chapter 3
Building the Core Capabilities of the Telco Cloud

In this chapter, you learn how to transform your business and operations and address operations and analytics, automation and orchestration, service assurance, security and data privacy, and energy efficiency in the telco cloud.

Enabling Digital Service Delivery

Service providers building a telco cloud are building a single cloud environment that supports the creation and delivery of next-gen services with guaranteed performance and availability. With a focus on automation, this telco cloud joins the service provider's

network with other cloud entities: data centers, the public cloud, edge clouds, and private enterprise clouds. The telco cloud federates these cloud entities, providing visibility, orchestration, and management across the combined entities. The value is in the flexibility and agility of the telco cloud — it adapts to service providers' business needs as they evolve their operations and their businesses. With a single abstraction layer across multiple cloud environments, a telco cloud provides scalability, efficiency, reduction in complexity, and reduction in costs to allow service providers to do many things, including the following:

- Start with Infrastructure as a Service (IaaS) offerings; then add Platform as a Service (PaaS), Software as a Service (SaaS), and Containers as a Service (CaaS) offerings when it makes sense for their business.
- Securely host their own and third-party services in a multi-tenant environment.
- Quickly scale their resource pools up and down to meet new demands.
- Easily move workloads among data centers to ensure performance, improve resource utilization, and recover from faults.
- Tie customers into their data center resources.
- Support real-time, latency-sensitive applications and services, as well as non-latency-sensitive offerings.
- Support next-generation services, such as immersive video communications services that require real-time video processing in the cloud and real-time communications applications that are hosted in the data center.
- Support service automation through one or more types of cloud stacks.
- Support scalable cloud management for more dynamic service provisioning and growth of industry services.

Service providers have many years of experience meeting service-level agreements (SLAs) for business-critical services. In a telco cloud environment, service providers can offer end-to-end SLAs. These SLAs can cover

- Performance requirements and benchmarks
- Actions in case of failure
- Data security
- Data privacy
- Compliance with industry accountability and accounting practices and policies
- Audits and real-time analytics to monitor compliance
- Insurance that covers incidents such as data center security breaches
- Technical support
- Acceptance period
- Termination clauses, risk management, and assistance
- End-to-end SLA integrity and accountability

All these SLA opportunities aside, SLAs in a software-driven network are very different from their hardware-driven counterparts. In a software-driven network, SLAs are met from a platform level, not a resource level (as they are in a hardware-driven network). The platform works in real time to manage the assurance of performance, leveraging all available resources — not by guaranteeing individual performance resource by resource.

This means, the ways in which communications service providers (CSPs) scope projects and build requests for proposal (RFPs) need to change. Among many processes and procedures that need to be changed to support a more software-centric operating model, CSPs need to amend the way they engage their vendor partners.

Preparing for Cloud-Native Architectures

Virtualization is table stakes in a telco cloud. Building upon the momentum virtualization has provided, cloud-native approaches fully exploit cloud computing technology with a microservices architecture, leveraging containers to enable continuous delivery and dynamic management in a multi-cloud environment.

Cloud-native apps are designed, built, and implemented differently from traditional applications. Cloud-native apps leverage standardized events, logging, and services catalogs to streamline

service creation and deployment. By standardizing service elements and running these elements in modular, containerized environments that are geographically distributed and centrally orchestrated, cloud-native provides innovation agility.

Cloud-native network functions (CNFs) are the next generation in the evolution of network functions. They extend the common approach of virtualized network functions (VNFs) to include cloud-native principles: containers, microservices, and orchestration. CNFs are typically built by using a microservices architecture, deployed in portable, predictable containers, and orchestrated with Kubernetes. The result is functions that can be easily integrated with a continuous integration/continuous deployment (CI/CD) pipeline, rapidly onboarded and deployed, consistently managed with automation, and dynamically scaled to meet changes in demand.

Here's the path to using cloud-native approaches:

- **Integrate** any CNF while normalizing the containers as a service (CaaS) and infrastructure as a service (IaaS) layers with consistent telco cloud infrastructure:
  - Workload vendor agnostic
  - Standards compliant
  - Unified design and onboarding
- **Automate** complete CNF life-cycle management (LCM) over any cloud and any hardware underlay:
  - CaaS deployment
  - CaaS customization
  - CNF LCM and configuration
- **Optimize** telco cloud resources for the most demanding cloud-native workloads (for example, virtualized radio access network, or vRAN):
  - Real-time operating system
  - Optimized Kubernetes networking
  - Burst to public cloud
- **Consolidate and integrate** 5G services network functions for given markets across vendors and across sites:

- Service and slice design
- Multi-cloud smart placement
- Key performance indicator (KPI)–driven LCM automation

» **Operationalize** lean and agile DevOps practices across operational functions:

- Built-in CI/CD
- Closed-loop assurance (machine learning and artificial intelligence)
- Vendor and site reliability engineer (SRE) dashboards

Enabling a New DevOps Mentality

In the end, digital transformation is meant to drive new service models. CSPs will have to become service innovators instead of relying on their vendor relationships to supply service innovation. Based on the current model of tying the service to the resources they require, the vendor innovation process is far too slow for the digital era. With DevOps methodologies, CSPs will be able to fail fast and create more opportunities more easily.

While over-the-top (OTT) vendors have been succeeding with DevOps practices for years now, CSPs have been watching from a distance. With the telco cloud, CSPs now have a platform to leverage DevOps methodologies on the service network and are staffing up with their software teams to create value through new services, as well as continually improve the scalable, programmable infrastructure.

DevOps tools in the automation layer of the network are used to abstract service models — creating templates for service elements and their parameters. This portable way of describing services provides building blocks of technology-agnostic service component information, policies, and associated contracts. Common among CSPs, the models leverage industry standards like Yet Another Next Generation (YANG) and Topology and Orchestration Specification for Cloud Applications (TOSCA) to ease deployment across varying technologies. By creating the service model, the automation layer can better maintain consistent outcomes.

Automating and Orchestrating Next-Generation Networks

Automation is pivotal to business success and the operationalization of emerging 5G network technology. Meeting the needs of new technology requires different approaches to basic problems that now stem from increased levels of complexity associated with the joint management of new and existing network infrastructure. Automated, intelligent operations become business imperatives in bridging the gap between new and existing infrastructure and in managing 5G networks at scale.

CSPs must embrace operations automation and look at every opportunity to reduce human intervention, reduce operating expenses (OPEX), and increase service agility. A shared infrastructure layer, dynamic resizing and movement of workloads, distributed topologies, and owned and leased cloud environments will drive the need for self-correcting and self-adjusting automation. In a cloud-native network made up of microservices and shared resources, the operational intelligence that CSPs need to manage such dynamic environments must feature just-in-time analytics to trigger components, and must offer a single line of sight for monitoring and resolution. With the shift to microservices and multi-cloud environments, the manual operation processes of the current networks will no longer be feasible.

Telco cloud automation tools include orchestration software engineered to accelerate the time to market of modern network functions — virtual network functions (VNFs) and cloud-native network functions (CNFs) — and physical network functions (PNFs) while igniting operational agility through life-cycle management automation.

TIP

VMware Telco Cloud Automation provides management across any network and any cloud, across multiple virtualized infrastructure managers (VIMs), including VMware vCloud Director, VMware Integrated OpenStack, Kubernetes, VMware vCenter, and VMware Cloud on AWS. This orchestration solution streamlines service management with native integration into VMware Telco Cloud Infrastructure and other products to enhance customer experience, minimize costs, and optimize resource utilization. VMware Telco Cloud Automation and VMware Telco Cloud Infrastructure

unite in a single solution called VMware Telco Cloud Platform. It enables multi-cloud placement and eases worload portability across the network core, the edge, and private and public clouds.

Key workflows for Telco Cloud Automation include

- Predictive analytics for issue avoidance
- Automated remediation and workload optimization
- Accelerated VNF onboarding and service delivery
- Machine learning with prescriptive alerting
- Dynamic service chaining
- Programmable networks

Assuring Services

The telco cloud introduces new levels of complexity and a further distribution of resources. For these reasons, service assurance must evolve to address the changing nature of the network infrastructure, as well as the new imperatives around the ultra-low-latency requirements of 5G, the emergence of customizable services, and the new paradigm of network slicing.

Accuracy, speed, low latency, and error-free operations of the telco cloud are critical to the success of a service provider's digital business. To compete and innovate successfully, CSPs need a real-time, unified view of their infrastructure and network topology.

Network operators need top-level visibility — across all domains — to be able to monitor end-to-end network performance and customer quality of service (QoS). They also need to be able to drill down into their networks to get more granular insight into the causes of degraded performance or into possible ways to optimize the allocation of network resources. This calls for a more proactive approach to service assurance, which, with the emergence of artificial intelligence and machine learning, will evolve into predictive service assurance aimed at identifying network anomalies early, before they negatively impact the network and the user experience.

The characteristics of a modern service assurance strategy include the following:

- **Advanced analytics** driven by machine learning for behavioral and reinforced learning
- **Distributed, graph-based topologies** with hierarchical analytics
- **Real-time intelligence** for dynamic optimizations and problem avoidance
- **Intent-driven capabilities** replacing static rules with dynamic policies and operational intent
- **Extensible, model driven, and open source** to cater to declarative constructs and enable ease of integration

REMEMBER

As CSPs prepare for the rollout of 5G networks, new tailored services, and continued network functions virtualization (NFV) deployments, the ability to monitor and immediately manage both the traditional physical infrastructure and the new virtual networks that overlay them, as one seamless entity, becomes mission-critical. CSPs must evolve beyond reactive approaches with human intervention at each layer if they want to keep pace with the avalanche of new services, tighter cross-domain dependencies, and virtualized networks.

Key service assurance requirements include the abilities to

- **Holistically monitor and manage** networks at the service, virtual, physical, and transport layers
- **Automate root cause analysis** of issues across all layers, including NFV and software-defined wide area network (SD-WAN) environments
- **Trigger closed-loop actions** and remediation of problems via application programming interface (API) integration with orchestration and operations support systems (OSS) tools
- **Prioritize issues** based on correlation of service and tenant impact
- **Manage multiple tenants** with multi-vendor solutions in a unified view
- **Drive SLA management** with historical and real-time views, trending, forecasting, and adaptive alerting

TIP

VMware Telco Cloud Operations is purpose-built to meet service assurance challenges in 5G distributed cloud environments composed of hybrid physical and virtual infrastructure. By providing complete visibility into the telco cloud network and reducing mean time to repair/resolve (MTTR), Telco Cloud Operations helps CSPs accelerate innovation and maintain competitive advantage through simplified management and cost control. Find out more in Chapter 4.

Employing Intelligent Operations and Analytics

Similar to the change drivers for assurance, more intelligent analytics capabilities are required to combat rising complexity in cloud-native-ready, hybrid networks; enormous network traffic growth; ballooning operational costs; and the creation of massive amounts of data. Complexity continues to increase because of the rollout of 5G technology and use cases that take advantage of the potential that this new wave of network capability offers. Existing systems and processes fall considerably short in meeting business expectations that come from such a radical technology refresh and strategy change.

CSPs understand the importance of managing Day 0, Day 1, and Day 2 requirements with operational intelligence that can address the following:

- Single-pane-of-glass visibility across hybrid cloud environments
- Dynamic discovery, cross-tier correlation, and huge multitenancy
- Performance monitoring with predictive intelligence
- Causality analysis with prescriptive recommendations
- Embedded demand forecasting and cost analysis
- Closed-loop automation for dynamic optimization

A telco cloud requires a robust solution to manage CSP operational processes across a hybrid virtual and physical environment. Traditional approaches to integrating operational intelligence across the ecosystem with hardware-based vertical solutions are neither sustainable nor viable.


TIP

The operations management solution from VMware is fully integrated into the platform so you can monitor and analyze operations with a 360-degree view from a single pane. At the core, VMware vRealize Operations Manager, and VMware Smart Assurance (all discussed in Chapter 4) provide monitoring, alerting, proactive avoidance, issue isolation, and remediation.

Streaming analytics is another important telco cloud capability that allows users to continuously query a stream of data and perform statistical analysis on this data stream as it's moving through the system. Conditions and patterns can be detected very quickly, and multiple streams of data can be correlated for new insights. Streaming analytics provides time-sensitive processing and is suited for the rapid analysis of time-series data streaming from devices, Internet of Things (IoT) sensors, transactions, applications, and web sessions. Key streaming analytics use cases include the following:

- **Customer experience:** Delivering superior customer experiences is a key driver for competing in the cloud economy. CSPs can use streaming analytics to understand their subscribers' experiences. By cross-correlating various metrics such as voice and data performance, time of day, services used, cell site association, and applications used, CSPs can more readily determine the quality of experience (QoE) of their customers. Network errors and call quality can be compared to customer survey data such as Net Promoter Score (NPS) to better understand any relevant correlation between them.
- **Marketing:** Mobile network operators (MNOs) can use the real-time intelligence provided by streaming analytics to run location-based mobile marketing campaigns, giving them the ability to target advertisements to an anonymized set of subscribers when they enter specific geographic areas. MNOs can also offer proactive roaming incentives based on subscribers' real-time roaming statuses. Anonymized information on density and frequency of subscribers in a

particular location can be offered to content providers and advertisers.

- **Operations:** Using streaming analytics, MNOs can measure real-time data quality of service (QoS) to improve network operations and customer experience. They can correlate the quality of the Long-Term Evolution (LTE) and Voice over LTE (VoLTE) network — how many calls or messages are succeeding, failing, or degrading — within a certain cell site with the specific models of phone, operating system, time of day, and so on. By understanding real-time cell site traffic usage (such as volume, density, and errors) and attach success rates, MNOs can better optimize their radio access networks (RAN) and core networks.


TIP

Artificial intelligence and machine learning technologies can be a true force multiplier for CSPs in the telco cloud, ingesting and analyzing massive datasets and surfacing deep operational and business insights. These insights can drive actions that can be automated, when appropriate, to enable fast and efficient operations and maximize human productivity by letting operators to focus on other value-added activities.

Offering Intrinsic Security and Data Privacy

Security and data privacy issues are of paramount concern for CSPs and their enterprise customers and end consumers. To effectively address these issues, the telco cloud must be designed with security and data privacy built in, rather than as bolted-on products or services. This approach is necessary due to the highly dynamic nature of cloud and virtualized environments. VM workloads, VNFs, CNFs, and containerized services are rapidly and frequently provisioned, deprovisioned, and moved in a cloud environment.

Security and privacy must, therefore, not be tied to a physical location or logical construct (such as an IP address), but instead must be an intrinsic part of the resource to be protected. Data should always be encrypted, whether in transit or at rest. Technologies such as micro-segmentation can be employed to effectively create

a perimeter around individual resources in the telco cloud, each with its own granular policy defined and enforced, as needed, to ensure the security of the resource. And individual security elements can be deployed as VNFs themselves, as part of a larger security apparatus within the telco cloud.

Going Energy Efficient and "Green"

Being environmentally friendly and socially responsible is a critical imperative for the telco industry. According to a study by McMaster University, the information and communications technology industry alone accounts for 1.5 percent of total global emissions. More ominously, this trend is projected to worsen and rise to 14 percent by 2040. Approximately 80 percent of the energy consumption and greenhouse gas emissions of mobile operators is from their networks and the move toward 5G is expected to increase total network energy consumption globally by 150 percent to 170 percent by 2026.

Working together with numerous standards bodies including the Global e-Sustainability Initiative (GeSI), the Global System for Mobile Communications Association's (GSMA) Better Future Initiative, the Institute of Electrical and Electronics Engineers (IEEE) Sustainable ICT Initiative, and the United Nations Sustainable Development Goals (SDG), the telecom industry is diligently working to reduce its adverse impacts on the environment.

As CSPs digitally transform their network architectures and operations to become digital service providers, they have an excellent opportunity to modernize their networks and build a "green" telco cloud to support 5G networks, edge clouds, and the Internet of Things (IoT).

Specifically, the use of virtualization technology has led to the avoidance of 340 million metric tons of carbon dioxide (CO_2) and a reduction of 603 million megawatts of power consumption. VMware technology also helps maximize the utilization of existing physical assets — you can consolidate servers and repurpose hardware to support NFV, software-defined networking, and edge computing. The result reduces replacement, operating, power, and cooling costs.

TIP

VMware's Carbon Calculator allows you to determine the environmental benefit of virtualizing your servers. Go to `www.vmware.com/company/sustainability/carbon-calculator.html` to use the calculator.

REMEMBER

VMware demonstrates its commitment to the environment not only in its products and solutions, but also in its own operations. VMware has been ranked as the 90th most sustainable company by Forbes, consistently ahead of many of its industry peers. VMware has also achieved carbon neutrality in its global operations two years ahead of its own internal target and now powers 100 percent of its operations with renewable energy.

IN THIS CHAPTER

- Laying the foundation with telco cloud infrastructure
- Automating the telco cloud
- Taking an intelligent and integrated approach to service assurance
- Redefining enterprise networks with VMware SD-WAN by VeloCloud
- Unlocking the potential of Kubernetes
- Securing the telco cloud
- Ensuring interoperability and readiness in the telco cloud partner ecosystem

Chapter 4
VMware Technologies Powering the Telco Cloud

To make the most of the telco cloud landscape, communications service providers (CSPs) need tools and systems that tightly link clouds, services, applications and networks. Most importantly, they need a multi-cloud platform that tightly integrates compute, networking, and storage with customer requirements, additional resources, and network intelligence. Service providers are in a strong position to lead in cloud services, and they're already considered trusted by their customers.

With the right strategy and the right portfolio of telco cloud products and services, service providers can finally move beyond their traditional business model. They can transform their own operations, cut costs, and stake their claim in the new cloud economy.

In this chapter, you learn about the many VMware solutions, including VMware Telco Cloud Infrastructure, VMware Integrated OpenStack, VMware SD-WAN by VeloCloud, Kubernetes solutions from VMware, VMware Telco Cloud Operations, Uhana by VMware, VMware Telco Cloud Automation, and the VMware Ready for Telco Cloud program. These solutions work collectively to build a modern telco cloud.

VMware Telco Cloud Platform

VMware Telco Cloud Platform modernizes clouds to deliver web-scale speed and agility, enabling CSPs to innovate fast. With the platform's cloud-native support, the time to market of new software and vertical services is no longer measured in months and years. It is now measured in days and weeks, accelerating CSPs' time to revenue. By bringing innovative applications and services to the market faster, CSPs can now gain competitive advantages and win market share while increasing average revenue per unit (ARPU).

The platform also reduces operational complexity by automating operations with end-to-end life-cycle management that enables rapid onboarding, instantiation, and provisioning of cloud-native network functions (CNFs) and virtual network functions (VNFs), which can run side by side across 5G networks, from the core to the far edge.

Unlike siloed and monolithic solutions often used to build existing clouds, the platform encompasses a cloud-first and vendor-neutral approach, as showcased by the VMware Ready for Telco Cloud program, which provides numerous network functions from ecosystem partners.

By using the platform's multi-layer automation capabilities, CSPs can deploy any network function, anytime, in their 5G networks without disruption, providing telco-grade resiliency and service availability with a consistent experience.

The following sections cover the components of VMware Telco Cloud Platform.

VMware Telco Cloud Infrastructure

VMware Telco Cloud Infrastructure is a fully integrated, modular, multi-tenant, cloud-native, and network functions virtualization (NFV) platform that hundreds of the world's leading CSPs rely on to develop modern cloud computing stacks to support new revenue streams while lowering costs. It provides compute, storage, networking, management, and operational capabilities to help simplify, scale, and protect production cloud-native and NFV services. The transformative platform empowers CSPs to accelerate time to market, increase revenue, streamline operations, reduce network infrastructure costs, and deploy elastic business models for telecommunication workloads. Its flexible platform architecture allows CSPs to deploy applications and services across any networks from core to edge and seamlessly migrate from 4G to 5G networks.

VMware Telco Cloud Infrastructure consists of the following:

- **Full stack virtualization solutions:** Fully integrated virtualized compute, storage, and networking solutions, including the following:
  - **VMware vSphere:** Provides carrier-grade virtual compute designed to run modern and traditional applications side by side for optimized performance, high availability, fault tolerance, and workload optimization.
  - **VMware vSAN:** Offers simple hypervisor-converged storage embedded in the hypervisor that can be co-located with the VNF workloads to minimize jitter and latency.
  - **VMware NSX:** Delivers granular overlay networking and security at the hypervisor level, providing distributed network services for VNFs, including granular network isolation using NSX micro-segmentation and simplified operations.
- **A choice of virtualized infrastructure managers (VIMs):** VMware Integrated OpenStack and VMware vCloud Director provide life-cycle management of NFV infrastructure (NFVI) compute, storage, and networking for both virtual machine (VM) and container-based workloads.

- **Robust NFV operations management capabilities:** VMware vRealize Operations Manager, vRealize Log Insight, and vRealize Network Insight are fully integrated and provide real-time NFV operations monitoring, analytics, and optimization.

VMware Telco Cloud Automation

VMware Telco Cloud Automation is an orchestrator that accelerates time to market for network functions and services while igniting operational agility through simplified automation — across any network and any cloud. It applies an automated, cloud-first approach that streamlines the CSP's orchestration journey with native integration into VMware Telco Cloud Infrastructure products.

VMware Telco Cloud Automation enables multi-cloud application placement, easing workload instantiation and mobility from the network core to edge, and from private to public clouds. It also offers standards-driven modular components to integrate any multi-vendor management and orchestration (MANO) architecture. VMware further enhances interoperability by expanding partner network VNF certification via the VMware Ready for Telco Cloud program (more about this program later in the chapter). With simplified and certified interoperability, CSPs can leverage best-of-breed solutions and reduce their risks.

The core capabilities for VMware Telco Cloud Automation can be grouped into four areas:

- **Generic VNF Management (G-VNFM)** unifies and standardizes network function management across physical network function (PNF), VNF, and CNF infrastructures.
- **NFV/Domain Orchestration (NFVO)** simplifies the design and management of centralized and distributed multi-vendor network services (chaining PNF/CNF/VNF).
- **Multi-Cloud Infrastructure Management** abstracts cloud complexity, eases virtualized infrastructure manager (VIM) registration, enables container as a service (CaaS) management, synchronizes inventories/resources, and collects faults and performance from infrastructure to network functions.

- **Policy and Placement engine** enables intent-based and multi-cloud workload/policy placements from the network core to edge, and from private to public clouds.

VMware Integrated OpenStack

OpenStack is playing an important role in CSP business transformation as carriers look for a reliable, open NFV platform to manage their cloud infrastructure and drive revenue through new business models and communication services. However, as CSPs strive to make speed and scale of deployment their key differentiators, they're often exposed to the complexity, hidden costs, inconsistent tooling, and lack of carrier-grade support characteristic of several OpenStack implementations.

VMware Integrated OpenStack introduces several features to help CSPs simplify, scale, and secure production OpenStack environments. Through open, vendor-neutral application programming interface (API) access to VMware's virtualized infrastructure, CSPs have a proven, high-performance platform based on an open architecture to accelerate production NFV workload deployment and service innovation.

The latest version of VMware Integrated OpenStack is delivered as a completely containerized control plane powered by a dedicated VMware Tanzu Kubernetes Grid cluster.

VMware Integrated OpenStack enables easy deployment, upgrades, and operation of an OpenStack cloud on a robust VMware NFVI platform while utilizing open-source software and standard APIs, offering capabilities such as the following:

- **Simplified OpenStack installation and deployment:** VMware Integrated OpenStack provides the fastest path to a fully operational OpenStack environment. Using templated install and deployment as a downloaded application within the VMware vSphere web client, a production-grade OpenStack infrastructure can be easily deployed.
- **Seamless and hitless OpenStack upgrades:** The separation of control plane and data plane in VMware Integrated OpenStack offers hitless upgrades and patch updates, with

VMware vCenter maintenance mode providing network service continuity during maintenance cycles.

- **Simplified operations:** vCloud NFV delivers unique NFVI operational automation with 360-degree visibility, proactive and predictive analytics, issue isolation, root cause analysis, and fast remediation. VMware vRealize Operations Manager, vRealize Log Insight, and vRealize Network Insight are fully integrated within vCloud NFV and provide real-time operations monitoring, analytics, and remediation from a single pane of glass, further reducing operational costs.

VMware Telco Cloud Operations

As CSPs roll out 5G networks, new tailored services, and continued NFV deployments across multiple clouds, the ability to monitor and manage both the traditional physical infrastructure and the new virtual overlay networks as one seamless entity is a business imperative. It's no longer scalable to rely on simplistic, heterogeneous management tools. An intelligent and integrated approach to service assurance is needed. VMware Telco Cloud Operations addresses this need with capabilities and features that include the following:

- **Real-time actionable insights:** Provides an automated approach to operational intelligence to reduce service impact and operational expenses. Its automation maintains a stable configuration to prevent network incidents, proactively detect abnormal patterns, identify the root cause of problems, generate alerts, and trigger remediation workflows for detected problems.
- **Auto-discovery:** Automatically discovers the topology of an entire multivendor network — including the transport, physical, virtual, and services layers — and presents a comprehensive, graphical topology view.
- **Automated root cause analysis with service impact correlation:** Provides operators with the ability to immediately identify real problems for rapid remediation. Instead of presenting operators with thousands of separate alarms and alerts from a multitude of tools, VMware Telco Cloud Operations correlates all the active, inactive, and unknown

alarm statuses with the network topology to rapidly identify the root cause of the problem.

- **Self-adapting engine:** Instead of using a rules-based engine that needs to be continuously updated, VMware Telco Cloud Operations uses an advanced multidimensional deterministic model-based engine, known as Codebook, which collects millions of events and alarms per minute, correlates these signals with auto-generated computer signatures, and identifies the root cause of the problem.
- **Prioritized multi-tenant support for managed services:** Provides CSPs with the automated management capabilities needed to monitor and maximize service availability and efficiency for their managed services customers. With multi-tenant support, CSPs gain comprehensive insights across network environments and can address issues proactively before services are affected, and prioritize issues based on customer impact, locations, and business service-level agreements (SLAs).
- **NFV assurance:** Integrates with VMware's extensive telco and cloud portfolio for an intelligent, comprehensive approach to NFV assurance, providing real-time root cause analysis of issues across virtualized and legacy environments.
- **Virtual IP Multimedia Subsystem (IMS) assurance:** Extends a new common information model for vIMS service for voice over Long-Term Evolution (VoLTE), correlated across several layers such as VNF components, VIM tenancy, cloud infrastructure, and physical network, providing effective performance monitoring, root cause analysis, and issue isolation. Through API integration with vIMS orchestrators, workflows to remediate the service impacts can be automatically triggered without the need for human intervention.
- **Multi-vendor SD-WAN assurance and SD services:** Supports monitoring of multi-vendor SD-WAN enterprise services and is fully integrated with VMware SD-WAN for multi-tenant support and fault management, providing auto-discovery of tenants and services along with issue isolation and impact assessment across central and branch sites, gateways, and networks.

- **Integrated analytics and performance management with vRealize Operations:** Provides single-pane-of-glass visibility across service, virtual, and physical domains and includes powerful features such as capacity planning, performance monitoring, cost analysis, and compliance monitoring.

AI-Based Analytics: Uhana by VMware

CSP networks are on the cusp of two major shifts: the transition to programmable 4G and 5G networks and the rise of low-latency applications, which are placing new demands on the network. 5G as a technology offers ten times more control variables than LTE and manual configuration and management of all these variables quickly becomes less than optimal. To deliver a consistent, high-quality user experience with competitive economics, CSPs need to look to advanced technologies such as machine learning and artificial intelligence (AI) to help automate network operations, reduce complexity, and optimize the network in support of new applications.

AI and machine learning technologies are critical to the success and profitability of 5G networks and services for multiple reasons. Here are a few of the key ones:

- **Cell site densification:** 5G will require mobile network operators to dramatically increase the number of cell sites they have today, rolling out small cells versus centralized ones. Deploying, configuring, and managing all these small cells would be an overwhelming task without AI and automation.
- **Complexity:** The volume of configuration and ongoing management options increases dramatically with 5G. In addition, most 5G networks will be deployed in a non-standalone architecture, relying on a 4G core. The two networks must interact seamlessly and operators must be able correlate events between the two networks. This situation further increases the number of variables. AI can be leveraged to manage and adapt to continuously changing networks.

- **Need to reduce operating expenses (OPEX):** CSPs are continuously being asked to do more with less. As the complexity of the network and the volume of devices supported increases, so does OPEX. Yet the average revenue per user is stagnant or even decreasing. Disruptive players with low-cost, flat-rate plans drive prices down and squeeze operating margins. AI powers a new level of automation for operations and optimization drives up efficiency.
- **Introducing new service capabilities:** New premium offerings and service qualities are key to 5G having a positive return on investment (ROI). In order to support these high-value services — such as predictive quality of service (QoS) for enterprise applications like Internet of Things (IoT)–driven factories or dynamic radio access network (RAN) slicing for low-latency applications including self-driving cars — stringent SLAs will need to be met. It's very difficult to imagine meeting these requirements without data-driven AI.

Uhana by VMware is an AI-driven platform designed to help CSPs improve customer experience, optimize network operations, automate processes, and enable enhanced cellular services in their 4G and 5G networks. Uhana by VMware ingests millions of events per second of streaming data from cellular networks to provide actionable insights in real time. It leverages deep learning neural networks to understand the network performance — combining both 4G and 5G session information — to detect anomalies in network behavior, automatically determine the root cause of problems, predict future problems, and use reinforcement learning to determine recommendations for resolution. Through API integration with self-optimizing network (SON) platforms, Uhana by VMware provides the granular visibility and control needed to enable automated actions, remediating network conditions and taking proactive steps to avoid future issues.

The product's core technology is a highly scalable, low-latency, real-time stream processing and AI platform, deployable in the operator's private or public cloud infrastructure. It includes a high-performance stream processing engine that ingests subscriber-level network telemetry directly from the RAN to provide real-time, per-subscriber visibility. Uhana's AI engine analyzes the correlated data in real time, detects anomalies and/or degradation in the network and network services, and prioritizes them by their impact on the customers and network. Leveraging deep learning neural networks, Uhana automatically infers their

likely root causes based on all the data available and recommends optimization strategies for the best subscriber experience. This enables operators to rapidly detect technical issues and improve the efficiency of their operations while providing deep insights into the end users' quality of experience (QoE).

REMEMBER

Uhana by VMware applies deep learning techniques to deliver real-time subscriber-level network visibility, anomaly detection, automated root cause analysis, and RAN control guidance to provide a superior customer experience and enable new 5G applications.

Robust Enterprise Services: VMware SD-WAN by VeloCloud

A private multiprotocol label switching (MPLS)–based wide area network (WAN) connecting corporate data centers to headquarters and branch locations has been the cornerstone network offering that service providers have delivered to enterprises for more than a decade. However, the networking landscape has changed with the ubiquitous availability of Internet broadband and widespread enterprise adoption of cloud services. Cloud-based applications drive enterprises to rely more heavily on Internet connectivity as network traffic has predominantly shifted from a branch–to–data center pattern to a branch-to-cloud pattern.

The hub-and-spoke design of traditional MPLS networks causes inefficiencies that negatively impact the performance of cloud applications while driving up cost and complexity in enterprise networks. Hybrid WAN architectures that combine MPLS and Internet transport have gained popularity in the last few years, but it can be challenging for both enterprises and service providers to configure, operate, manage, and troubleshoot due to the complexity of managing two disparate and disjointed networks built on MPLS and the Internet.

VMware SD-WAN by VeloCloud enables service providers to deliver advanced services to increase revenue and acquire and retain customers. With VMware SD-WAN, service providers can deliver managed WAN services, improve performance for cloud-hosted applications, and integrate advanced services using intelligent edge devices and a cloud-delivered management model.

VMware SD-WAN is a branch networking solution that combines the economics and flexibility of multiple WAN transports with the deployment and agility of a cloud-based service. VMware SD-WAN provides a managed, cloud-ready solution for service providers looking to deliver a managed hybrid WAN leveraging their existing MPLS platform. With VMware SD-WAN, policies can be defined in the VMware SD-WAN Orchestrator to provide application access and delivery according to business requirements, WAN performance, and governance. By combining Internet links with MPLS, coupled with a centralized policy controller, service providers can meet enterprise customer demands for a unified, elastic bandwidth service. In addition to higher reliability, increased available bandwidth, and improved application performance for their end customers, service providers can easily operate and integrate this new architecture into their existing MPLS networks.

VMware SD-WAN consists of the following key components:

- **VMware SD-WAN Orchestrator** provides centralized policy management, monitoring, and troubleshooting, as well as a scalable control plane.
- **VMware SD-WAN Edge** is an easy-to-deploy Customer-Premises Equipment (CPE) or virtual CPE (vCPE) device that uses a call-home feature to get its configuration from the Orchestrator. Once enabled, it automatically detects the circuit characteristics (bandwidth, latency, and so on), builds a secure overlay network with the SD-WAN gateways across all available links, and starts steering applications per the configured policy.
- **VMware SD-WAN Gateway** is a multi-tenant virtual appliance that can be installed in the service provider core network or accessed from VMware-hosted points of presence (PoPs). The SD-WAN Gateway terminates the overlay tunnels from the VMware SD-WAN Edge, coming over private (MPLS) and public (Internet) links.

REMEMBER

The branch office WAN is in transition as applications move to the cloud/software as a service (SaaS) and SD-WAN improves the economics and quality of WAN connections and makes access to the cloud easier and better performing. VMware SD-WAN offers enterprise-grade performance, security, visibility, and control over both Internet and private networks, combining the reliability of MPLS private networks with the flexibility and cost savings of the Internet.

Service Creation and Delivery Streamlined with Containers

The digital era calls for continuous innovation at an accelerated pace and the kind of modernized data centers and software development technologies that make it possible.

Container technology can help transform CSPs into digital service providers focused on delivering innovations at the speed of business. Containers package applications and their dependencies into a distributable image that can run almost anywhere, streamlining the development and deployment of software. By adopting containers, CSPs can take a vital step toward remaking themselves into flexible, agile digital service providers capable of accelerating the delivery of innovative products, services, and customer experiences. CSPs can become the disrupters instead of the disrupted.

Container technology is a key contributing factor to achieving digital transformation. Containers provide the basis for a new application architecture that supports digital transformation and lays the foundation for innovation. CSPs that are adopting containers see them as a fast track to building and deploying cloud-native applications and cloud-native network functions.

Kubernetes-based container solutions typically include advanced networking, a private container registry, and full life-cycle management. Kubernetes solutions from VMware radically simplify the deployment and operation of Kubernetes clusters so CSPs can run and manage containers at scale on private and public clouds. The VMware Tanzu suite of products provides the following capabilities and benefits:

- **True application portability:** Get up and running on the latest version of pure, upstream Kubernetes, so you're never locked into a vendor-specific distribution.
- **Kubernetes and complementary open-source tools:** Empower your teams to choose the right tools and clouds to rapidly create new service offerings.
- **Open-source community connection:** VMware will help you capture the energy and innovation of the open-source community. VMware actively contributes to multiple open-source special interest groups (SIGs) and projects that

harden key technologies and fill gaps in the Kubernetes ecosystem.

- **Cloud-native ecosystem support and guidance:** Access support for Kubernetes and key open-source tooling. VMware experts can partner with you on architecture design reviews and help you evaluate networking, monitoring, backup, and other solutions.

Some of these capabilities are integrated with VMware Telco Cloud Automation and other VMware telco cloud solutions to help you deploy and manage services with Kubernetes. In addition, some of these benefits can be obtained by engaging with VMware professional services and other VMware teams that specialize in Kubernetes.

REMEMBER

VMware Tanzu helps you build a modern telco cloud that leverages Kubernetes and open-source technology, giving you a flexible solution to select the right tools and the right clouds for your workloads.

Intrinsic Security

VMware transforms networking and security with Carbon Black, NSX, AppDefense, and vRealize Network Insight.

Every organization is figuring out how to propel its business forward in a hyper-connected world. With VMware solutions, CSPs can protect their application infrastructure wherever applications reside, fully embrace connections to the cloud, and unify their branch and edge environments across the business.

Key security capabilities embedded in the VMware telco cloud include the following:

- **Secure application infrastructure:** In order to keep up with the increasingly dynamic, distributed nature of modern applications, security needs to be an intrinsic component of the infrastructure that applications and data live on, rather than bolted on as an afterthought. VMware delivers intrinsic security by architecting security controls directly into the hypervisor to protect the network and data center endpoints that comprise applications, as well as the data itself. With

VMware NSX and micro-segmentation, organizations can prevent the lateral spread of threats across their network. VMware AppDefense and Carbon Black detect and respond to threats on data center endpoints. VMware vSAN encrypts data at rest.

- **Cloud networking:** VMware brings networking and security consistency across heterogeneous sites by automating networking and security services.
- **Network edge:** VMware delivers visibility and control, assured application performance, and integrated security from data center to branch to the cloud. VMware SD-WAN lets you improve real-time app performance over standard Internet connections, simplify policy management with cloud-based configurations, provide optimized and secure SaaS or infrastructure as a service (IaaS) access, and support zero-touch deployment to bring up branches in days, not months.
- **Endpoint security:** Carbon Black delivers multiple endpoint security capabilities through a cloud-delivered platform that shares one console and one lightweight agent. Key capabilities of this solution include the following:
  - *Preventing known and new attacks as they evolve:* Carbon Black analyzes attackers' behavior patterns over time to detect and stop never-before-seen attacks, whether they're malware based or fileless.
  - *Investigating threats and closing gaps in real time:* Get the insight you need quickly and easily. Visualize attack chains, identify root causes, and respond immediately to threats.
  - *Improving IT hygiene and asset management:* Easily audit and change system state to track and improve your security posture.
  - *Hunting for and remediating threats:* Proactively hunt for abnormal activity by using cloud-delivered threat intelligence and custom watchlists to automate repetitive hunts.
  - *Securing virtual data centers:* Achieve superior protection from advanced threats without compromising availability and performance through embedded security in the hypervisor.

Ready for Telco Cloud Certification Program

The VMware Ready for Telco Cloud certification program enables CSP partners to test the interoperability and readiness of their VNFs and CNFs with VMware Telco Cloud Platform.

With more than 35 partners having received more than 165 certifications, the program offers two certification options:

- **VMware Ready for Telco Cloud Infrastructure** identifies network functions that interoperate with the core infrastructure layers of the VMware telco cloud, as referenced by the European Telecommunications Standards Institute (ETSI)–compliant VMware vCloud NFV Reference Architecture. The focus of this certification level is on compatibility with the VIM and the platform's core components:
  - VMware vSphere for virtualized compute
  - VMware NSX for virtualized networking
  - VMware vSAN for virtualized storage

  The program is available at no cost to VMware partners, and testing can be completed either in the VMware on-premises certification lab or in the cloud as a self-service model.
- **VMware Ready for Telco Cloud** certifies network functions for deployment and life-cycle operations through VMware Telco Cloud Automation, a multi-cloud orchestration and automation platform. As part of this certification program, VMware collaborates with partners to create an ETSI-compliant descriptor, as well as workflow, resource, and artifacts for a validated and tested Cloud Service Archive (CSAR). This level requires the partner to complete the VMware Ready for Telco Cloud Infrastructure certification as a prerequisite.

The program gives VMware partners the added advantage of accelerating the onboarding of their services on the VMware Telco Cloud Platform, thereby reducing CSPs' time to revenue. In addition, the VMware Ready for Telco Cloud program can help partners increase market reach by gaining access to global CSPs that have been deploying VMware technologies. CSPs, in turn, get access to the most advanced 5G core network functions and services that can run on VMware Telco Cloud Platform.


TIP

Learn more about the VMware Ready for Telco Cloud program and the VMware partner ecosystem and solutions at `www.vmware.com/solutions/industry/telco-technology-partners.html`.

IN THIS CHAPTER

- Virtualizing, getting ready for 5G, simplifying, and automating
- Adopting open-source technology
- Leveraging data and integrating security
- Collaborating with partners and expanding your service portfolio
- Transforming your organization and culture

Chapter 5
Ten Ways to Build a Differentiable Telco Cloud

With disruptive and digital players eating away at their core markets, communications service providers (CSPs) must adopt digital transformation strategies that streamline their operations, improve customer experience, and generate new revenue opportunities. This process requires new, lean operational and network architectures with the flexibility to support multiple business models at scale without significantly increasing operational complexity and cost.


TIP

The network industry faces a large learning curve over the coming years. And with the number of new components needed to run network functions in the cloud, no single vendor or communications service provider can tackle the challenges alone. Service providers will need to lean on external partners to realize the full benefits of 5G.

Here are ten ways to accelerate your journey to the telco cloud:

- **Virtualize.** In the digital transformation journey, virtualization is the key to network modernization and driving operational efficiency, agility, and service innovation. Virtualization also reduces the need for servers which, in turn, reduces electricity consumption and your carbon footprint, so you can save money while protecting the environment.
- **Think software.** 5G requires a shift from a hardware-focused network operation to a software focus. Tools like network function virtualization (NFV) and software-defined networking (SDN) present a generation shift in technology that can drive transformational benefits of revenue acceleration with innovative use cases such as fixed wireless, augmented reality (AR), virtual reality (VR), mobile edge computing, and streaming video.

  
  TIP

  Ensure 4G to 5G handoffs are smooth to future-proof your network.
- **Prepare for cloud-native technology.** Migrate from legacy network architectures to software-driven, microservices-based architectures to simplify business processes, improve network performance and omnichannel service management, and ensure faster service delivery.
- **Automate.** Drive efficiencies through aggressive automation of complete business processes with new tools and technology that capitalize on artificial intelligence and machine learning.
- **Open up.** Telcos must evolve from a closed silo architecture that only delivers their own services to their own customers to an open platform architecture accessed through standardized and openly available application programming interfaces (APIs).
- **Exploit data.** New forms of information architecture and predictive analytics present an entirely new way of understanding and using data for internal business operations and external monetization.
- **Make security intrinsic.** The telco cloud demands consistent security that is built into networks, applications, services, and operations from the data center to the cloud and out to the edge.

- **Engage with ecosystem partners.** Fostering innovation and collaboration while enabling faster time to market with the larger innovation ecosystem will be key to driving new revenue in the digital world.
- **Adopt a new customer-centric operations model.** Reimagine your customer relationships and build differentiated products to help your organization thrive. Offer new suites of digital services, address new vertical markets with strong revenue growth potential, and run your network with the customer experience at the core of your operations.
- **Modernize your organization and culture.** Telcos need to rewire themselves to work in agile ways and keep up with customers' increasing demands for digital-first experiences. The culture of traditional, infrastructure-centric organizations offering a limited portfolio of traditional services in competition with other telcos will be very different from the organization needed to offer a wide variety of digital services in competition with Internet and over-the-top (OTT) players.

Adopt a cloud-native mind-set and transform your network

The telco cloud lets service providers run their networks like a cloud. Supporting agile and efficient creation and deployment of services, telco cloud architectures connect public, private, and edge cloud infrastructure to enable seamless, DevOps-enabled environments for digital service providers. With a software-driven foundation, the telco cloud automates and simplifies complex telco networks to provide the flexibility and resiliency required for service providers to thrive in a digital economy.

Inside...

- Discover the benefits of the telco cloud
- Bridge your 4G and 5G networks
- Understand the transformation to become a digital service provider
- Address network complexity with next-generation service assurance
- Explore VMware solutions powering the telco cloud

vmware®

Lawrence Miller is the co-author of *CISSP For Dummies* and has written more than 150 *For Dummies* books on numerous technology and security topics. **Stephanie Owyoung** is a senior marketing manager for VMware's Telco & Edge Cloud business unit with nearly 20 years of telecom industry experience.

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

ISBN: 978-1-119-66447-5
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.