Digital Transformation in Action

Communications Service Providers Unleash 5G Innovation with VMware Telco Cloud

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Table of contents

Executive Summary

The world is changing, and communication services providers (CSPs) are fighting for a prominent role in the emerging digital services ecosystem. In the dawn of 5G, CSPs can draw on the unique capabilities of their 5G networks to deliver innovative new services that no one else can provide: custom cellular networks tailored to the services running on them, mass-scale Internet of Things (IoT) deployments, ultra-low-latency connectivity, and many others that haven't even been dreamed up yet.

To do any of this, though, CSPs need to fundamentally transform their networks and operations. And the to-do list is long:

• "Cloudify" the network to deliver the right resources, in the right place, at the right time to any device.

• Through automation, build the agility to roll out new services and respond to new opportunities more quickly.

• Get a handle on exponential operational complexity and data growth.

• Drive down operating costs.

• Ensure a consistently superior customer experience.

Consider the "how" side of the equation, and the task looks even more formidable. Somehow, CSPs need to replace the legacy, hardware-centric operating models they've used for years with agile software methodologies and DevOps ways of working. If they want to capitalize on the most exciting 5G opportunities—enterprise services including security on-demand, network slicing, private cellular networks, and multi-access edge computing (MEC)—they'll also need to tackle complex cloud-native technologies unlike anything they've dealt with before.

VMware is helping CSPs around the world overcome these challenges with the VMware® Telco Cloud portfolio. With VMware Telco Cloud, you can:

• Move from antiquated network models to cloud-native technology, cloud-first automation, and software-centric ways of working.

• Monetize your 5G network investments with a continuously expanding portfolio of next-generation enterprise and consumer mobile services.

• Reinvent your business around software-centric innovation, automated operations, and cloud speed and agility.

This paper details how VMware Telco Cloud solutions can help you capitalize on the 5G opportunity and transform your business. You'll learn how you can manage virtualized and cloud-native network functions with a consistent platform that extends across your distributed 4G and 5G network—vertically across multiple network layers and clouds, horizontally from core to edge to radio access network (RAN) to customer.

Meeting the 5G Challenge

By now, you likely know all about the promise of 5G architectures, especially for new enterprise services. And you know you can't get there with yesterday's network and operational models. You have to find a way to run your network like the hyperscale companies run their own infrastructures: as an agile, automated platform for dynamic cloud-based services.

You'll need to turn the page on operating models that treat your network as a collection of specialized physical network appliances. Instead, your network needs to become a dynamic pool of virtualized resources, all running on common off-the-shelf hardware, with the ability to distribute network functions wherever they're needed—quickly, with minimal human effort.

Time to Transform Your Network

The VMware Telco Cloud provides a platform to help you rapidly deploy and efficiently operate a cloud-native 5G network. Powered by field-proven telco infrastructure and cloud-first automation, it empowers you to deploy virtualized and containerized network functions (VNFs/CNFs) from multiple vendors with consistency, agility, and scalability. You can compose new services with best-of-breed capabilities from an open ecosystem of dozens of leading network vendors. And you can provision and manage these resources anywhere—from the core and edge to the RAN, from the public cloud to the customer premises—using common tools and processes.

VMware Telco Cloud solutions address the biggest problems plaguing today's CSP network architectures. They break down complex, monolithic software stacks, eliminating the need for siloed network layers and dedicated management tools that lock you into one network equipment vendor's products and pricing. Instead, you can launch a new generation of innovative services on a consistent, horizontal infrastructure. Your operations become simpler and more automated. You gain the ability to continually create innovative new services and quickly bring them to market.

- *Telco Cloud Automation*, a cloud-first, vendor-neutral framework to orchestrate infrastructure, containers as a service (CaaS), and telco network functions and services, and to automate their management across any network and cloud

- *Telco Cloud Infrastructure*, which enables you to consistently deploy and operate network functions across all networks and clouds, and deliver innovative new 5G services

- *Tanzu Standard for Telco*, which takes VMware's standards-compliant distribution of Kubernetes for container orchestration with telco enhanced features to deliver the scalability, performance, and availability needed in service provider networks

- "*Ready for Telco Cloud" Certification Program*, through which you can quickly onboard *more than 200 VNFs/CNFs*, including solutions from the world's leading network equipment providers (NEPs), that are pre-tested for interoperability with the VMware Telco Cloud Platform

VMware Telco Cloud Portfolio

The VMware Telco Cloud portfolio consists of all the important pieces required for an agile, software-driven network:

- **Telco Cloud Platform:** VMware Telco Cloud Platform provides a cloud-native framework to quickly, efficiently deploy and manage virtual and cloud-native network functions across distributed 5G networks. You can run VNFs and CNFs from dozens of vendors, on any cloud, with holistic visibility, orchestration, and operational consistency.

- **Telco Cloud Operations:** Focusing on the health of the service versus individual components, Telco Cloud Operations streamlines 4G and 5G network operations by enabling operators to monitor the underlying network as well as the virtual network functions and services.
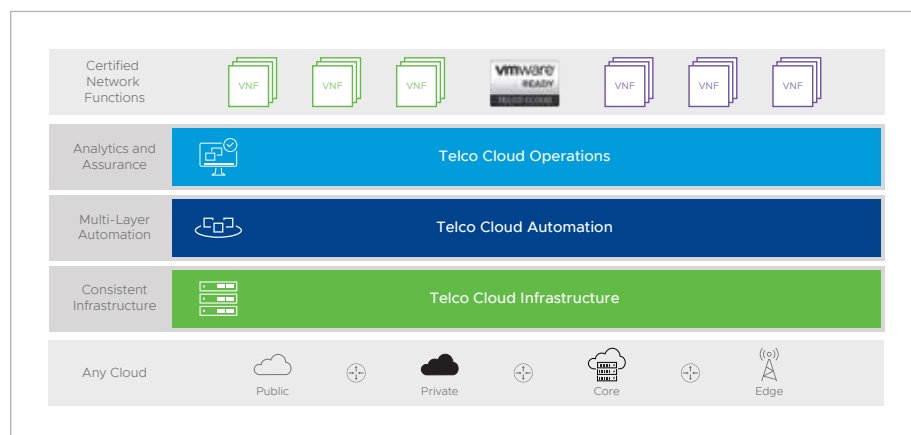

FIGURE 1. VMWARE TELCO CLOUD PORTFOLIO ARCHITECTURE OVERVIEW

VMware Telco Cloud in Action

The best way to understand what VMware Telco Cloud solutions can mean for your business is to see how they affect the real-world situations you face every day. In the following sections, we'll explore some of the most important ways VMware Telco Cloud can transform your business to enable 5G, including:

- Implementing extensible voice and data services

- Deploying cloud-native network functions

- Expanding the network with zero-touch provisioning (ZTP)

- Bringing modern software approaches and DevOps to network teams

- Assuring superior customer experiences

Transformation 1: Create More Innovative, Extensible Services

The world's telecommunications networks have come a long way in the last two decades. But despite ongoing evolution, they still fall well short of the agile, software-centric, automated infrastructures that the industry has sought to implement for years. Meanwhile, hyperscale cloud providers have moved in to set the standard for consumer and enterprise services, delivering a level of speed and innovation that most CSPs wish they could match.

Why does this capabilities gap persist? The problem is, even as individual network functions have been virtualized, the mindset behind them has mostly stayed the same. VNFs may run on commodity hardware, but they're still managed independently from one another. CSPs have no way to manage and automate multi-vendor network functions in a unified way, as a single, holistic platform. Instead, VNFs are still locked away in silos, requiring separate tools and processes for each different vendor and layer in the network.

Telco Cloud Transformation

Now, imagine if you could treat your network as a single, horizontal cloud-native platform. All the core tasks you perform to run your day-to-day business start to look very different. No longer do you need to treat your network as a collection of distinct physical resources, vendors and network layers, each managed as its own separate entity, with its own processes and tools. Instead, you're running a telco cloud, with all the benefits that come with it.

- **A single, consistent horizontal infrastructure:** Now, you have a common cloud-first infrastructure that extends everywhere—from core to RAN to edge to cloud to customer. It no longer matters where a network resource resides or which vendor or network layer it belongs to; you can visualize and manage all of your network functions in one place. When every component can exist as a VNF or CNF, controlled in the same way over the same commodity servers, you can easily plug in new network functions and compose new services using best-of-breed capabilities from dozens of vendors.

- **Centralized automation:** Forget about having to use dedicated tools for each vendor's equipment, or manually stitch together resources across network layers. You can manage the entire lifecycle of all network resources—both VNFs and CNFs, from the core to the distributed edge—in one place. Adding a new service? The network automatically deploys Kubernetes clusters to run the right cloud-native network resources, in the right place. For most aspects of network provisioning and lifecycle management—such as workload balancing, placement, and testing across clouds or edge clusters—the network just handles it, without human operators having to spell out how.

- **Simplified operations:** Your network teams can now operate and manage all multi-vendor network resources and services from one place, with one common set of controls. Before, operations teams lived in a world of complex network resources and alarms, where it could take hours—sometimes days—to determine how a network issue was affecting services and which actual customers were impacted. Now, your operations are customer-centric, with holistic real-time visibility, monitoring, and troubleshooting. When the network detects a problem, your teams can see exactly which customers and service level agreements (SLAs) are affected and prioritize their response based on business impact. (For more details, see Transformation 5: Delivering Superior Customer Experiences.)

- **Carrier-grade, secure cloud infrastructure:** With a telco cloud, you gain the same flexibility, speed, and capacity for continuous software upgrades that hyperscale cloud companies use every day. But now, those capabilities come in a package optimized for service provider environments, tuned to the needs of vast distributed infrastructures serving millions of customers and huge volumes of data. Your carrier-grade cloud environment provides intrinsic security and data protection, including telco-grade hardening of your virtual infrastructure and Kubernetes clusters.

Enabling a New Breed of Enterprise Services

The biggest advantage of telco cloud is not just the ability to do the things you do now more efficiently. It's to deliver new kinds of enterprise services that weren't possible before. Because now, you can draw on your network to do things that no over-the-top (OTT) application provider or hyperscale cloud company can match.

- **Private networks with both shared and licensed wireless spectrum:** You can now offer enterprise customers secure, private cellular networks customized for the services running on them. That can include using both licensed and shared spectrum (via Citizens Broadband Radio Service, or OnGo technology) to suit different use cases and customers. You can offer intelligent local breakout of internet and software-as-a-service (SaaS) traffic, combining software-defined wide-area network (SD-WAN) intelligence with private wireless networks. And you can offer enterprise edge services with flexible data residency and security, so customers can benefit from modern cloud capabilities even as they keep their most sensitive data on-premises.

- **Interoperability between public and private networks:** With VMware Telco Cloud, you can combine public cloud and private cloud resources to improve capacity and coverage for mission-critical enterprise applications. You retain centralized multi-tenant control of all customers in one place. And you can integrate these services with *VMware SD-WAN* to optimize distributed networks, as a secure access service edge (SASE) offering, to help enterprise customers adapt to the huge numbers of remote and home-based workers they're now supporting in the wake of COVID-19.

- **Application-driven infrastructure:** With VMware Telco Cloud, your network teams now have across-the-board consistency in creating Kubernetes clusters to support cloud-native resources for enterprise tenants. Once you define the policy, your distributed cloud-native infrastructure will automatically optimize itself as needed to support different applications. The network only commits the actual resources needed for a given application at a given time, maximizing your capital investments and eliminating the need to overprovision resources that rarely get used.

- **Enhanced edge services:** Your telco cloud gives you open, standards-compliant MEC capabilities, the foundation for a wide range of revenue-generating edge applications. That can include content delivery network (CDN) services to efficiently deliver huge amounts of high-resolution video content, converged edge platforms for private networks and specialized third-party MEC services, and many others.

- **A large and growing ecosystem of third-party network functions with the VMware Ready for Telco Cloud program:** In the old days, your NEP controlled many aspects of the services you delivered. Integrating new vendors into your infrastructure and OSS was an arduous manual process, so most CSPs just relied on their primary vendors' solutions (and release timelines) to meet customer needs. With VMware Telco Cloud, you have the freedom to deploy innovative new services using best-of-breed components, all of which have been pre-tested for interoperability and easy deployment on the VMware Telco Cloud Platform.

VMware Telco Cloud: Under the Hood

At a technical level, VMware Telco Cloud delivers the key capabilities you need to transform for a 5G world.

- **Flexible, mobile core:** Your telco cloud abstracts and decomposes evolved packet core (EPC) functions into virtualized or containerized software instances running on common infrastructure. You can easily, continually assemble and reassemble these functions in unique ways to deliver new kinds of services. You gain new flexibility for core network functions with the ability to deploy them centrally or distribute them across the environment.

- **Control- and user-plane separation (CUPS):** You can now benefit from more modern and efficient network topologies, like standards-compliant CUPS. You can independently scale control-plane and user-plane functions to meet the most demanding end-user requirements at the edge, while minimizing the traffic you have to backhaul across the network.

- **Application-level visibility and optimization:** VMware Telco Cloud uses deep packet inspection (DPI) to provide a deeper level of subscriber analytics that powers superior customer experiences. Unlike traditional monitoring tools, VMware Telco Cloud can identify content and applications on a per-packet basis and associate them with specific enterprise customers or users. You can then use this information to optimize services in fine-grained ways and deliver consistently higher quality.

- **Maximum scalability for cloud-native resources:** In service provider environments, where network functions need to scale to support vast numbers of users and huge volumes of data, bare-metal deployments quickly break down. The VMware Telco Cloud provides the necessary virtualization layer to instantiate and scale cloud-native resources as needed. This virtualization layer also allows you to run highly diversified workload types supporting a wide range of enterprise services with different requirements on the same, shared physical infrastructure.

- **Security from the inside out:** With the proliferation of 5G comes an increase in connections and data. By extension, the security risk landscape is changing. The VMware Telco Cloud portfolio helps you implement security controls for the virtualization plane and its management and orchestration. The security is built into the infrastructure, so it's programmable, automated, adaptive, and context-aware. Intrinsic security improves visibility, reduces complexity, and focuses your defenses by enabling you to apply and automate adaptive security measures like micro-segmentation in the right place.

- **Best-of-breed, ready-to-deploy network functions:** In the past, integrating new network capabilities to create new services—sourcing, integrating, and testing multi-vendor NFs for your unique environment—could take months, even years. When you use VMware Telco Cloud, you can take advantage of the VMware Ready for Telco Cloud program and choose from hundreds of pre-validated third-party VNFs and CNFs. The program also helps accelerate deployment by ensuring generic VNF manager (gVNFM) interoperability and providing standards-based onboarding artifacts. The program also reduces costs by increasing vendor competition and promoting accelerated innovation.

Transformation 2: Capitalize on Cloud-Native Technology Without the Complexity

In the enterprise and hyperscale cloud world, IT leaders have been evangelizing cloud-native technologies for years. When you break down monolithic applications into their constituent microservices, each running in its own container, applications become much easier to create, deploy, manage, and update. You can also continually update and innovate individual pieces of an application without having to rewrite the whole thing.

Today, CSPs are applying cloud-native principles to the network infrastructure itself with CNFs. As they do, they can innovate network functions more easily, using continuous integration and continuous delivery (CI/CD) pipelines to quickly and continually implement software updates. Cloud-native technology also lets CSPs integrate new vendors and CNFs more quickly, short-cutting much of the complexity involved in testing, deploying, and scaling network functions today.

That is, in theory. Actually realizing these benefits will require you to adopt cloud tools and processes unlike anything most CSPs have dealt with before. Just navigating the basics of cloud-native architectures—integrating the different pieces, deploying Kubernetes clusters to orchestrate container placement, tuning clusters to the needs of specific applications, visualizing the real-time health and availability of containerized resources—gets immensely complicated.

Telco Cloud Transformation

VMware Telco Cloud streamlines your migration to cloud-native infrastructure, bringing you the flexibility and speed of modern software models without all the complexity. Designed specifically to insert cloud-native technology into CSP environments, it abstracts away the low-level details of CNF management. It provides a centralized CaaS layer to orchestrate all your telco cloud infrastructure and services across your environment and automates provisioning at each layer of the network.

VMware Telco Cloud Platform combines:

- **Telco-optimized CaaS:** Cloud-native technologies can do amazing things, but most of the tools used to run them were designed for enterprise data centers, managing Kubernetes clusters across a small number of sites. In a large-scale CSP network, you might need to manage hundreds, even thousands of distributed clusters. VMware Telco Cloud Platform adds multiple enhancements to enable carrier-grade CaaS, optimizing cluster management and networking performance for the unique requirements of CSP networks. That includes customization of the Kubernetes clusters to fit CNF/CSP needs, performance optimization without rebooting, OS installation, and security patch and upgrade. You gain a resource-optimized Kubernetes runtime for device attachment, NUMA alignment, resource reservation, and placement.

- **Cloud-first automation:** VMware Telco Cloud Platform automates the discovery, registration, and creation of Kubernetes clusters while enabling continuous synchronization between architectural layers. This synchronization enables the system to maintain constant awareness of Kubernetes cluster resources, centralize fault and performance monitoring, and dynamically optimize workload placements. For example, when instantiating a new network function or service, if no available Kubernetes cluster profiles is suitable, the system can automatically optimize an existing cluster to match the network function's requirements by adjusting OS, platform as a service (PaaS), and networking configurations.

- **Multi-cloud visibility and consistency:** Telco Cloud Platform normalizes the infrastructure as a service (IaaS), CaaS, and OS layers to create a common cloud-native orchestration capability across the entire 5G network. It provides native integrations at each layer of the network and continuously synchronizes the southbound infrastructure stack (VIM/CaaS/IaaS) with the upper management and orchestration stack. As a result of this single pane of glass for highly distributed clouds, your service and application layers become multi-cloud aware. You can treat CNF resources across your entire distributed network—every site, across domains—as a shared pool of resources.

- **Pre-integrated CI/CD capabilities:** Telco Cloud Platform uses industry best practices for CI/CD to automate most aspects of deploying and continually updating network services, infrastructure software, clusters, and PaaS tools. (For details, see Transformation 4: Unlock Innovation with Modern Software Approaches.)

- **Standardized reference architecture:** VMware provides a reference architecture for the assembly and configuration of all Telco Cloud Platform components. This allows for simpler, more consistent implementation, as well as providing a standard model for network function providers to validate the interoperability and compliance of their CNFs for use in your telco cloud.

Telco Cloud in Action: Deploying

Cloud-Native ResourcesCloud-native resources can get so complicated in CSP-scale networks, they're basically impossible to use without the automation and abstraction capabilities of a telco cloud platform. When you have those capabilities though, you can:

- **Accelerate cloud-native deployments:** Your telco cloud abstracts VNF and CNF resources across any hardware underlay and any site or cloud, so you can deploy cloud-native network resources in the same way across your end-to-end horizontal infrastructure. Using automated CaaS capabilities, you can centrally create and manage Kubernetes clusters (worker/management) based on templates across your telco cloud. You gain immediate visibility into each deployed Kubernetes cluster, with the ability to bootstrap new ones over the infrastructure using predefined templates. Your platform also integrates Day 0 to Day 2 workflows and policies for deployment and in-deployment customization of individual vendor functions, automating the many complex steps in these processes.

- **Automate multi-cloud orchestration:** Instead of treating each vendor and network layer as its own siloed entity, your telco cloud unites multi-cloud resources in a centralized orchestration system. Then, it employs intent-based placement to optimize cloud-native infrastructure and services utilization. The platform continuously synchronizes with all registered clouds and collects context-aware information across all your diverse sites: the state of those sites, the applications running there, the embedded technologies available to foster service delivery, and the cloud resources available for allocation. With access to this real-time information, your telco cloud orchestrator can automatically place network services and functions in the optimal location to enable the best-performing, most resource-efficient implementation.

- **Automatically optimize cloud-native resources:** When instantiating new network functions or services, your telco cloud can automatically optimize Kubernetes clusters to support their unique requirements, using a process called "late binding." By waiting to apply these optimizations until the cluster is actually ready to be used, the platform makes the most efficient use of available cluster and infrastructure resources, while maintaining more consistency across clusters.

Together, these capabilities give you a framework to implement and automate CaaS at CSP-scale. And they give you the toolset to continually innovate your services, while maintaining carrier-grade performance, resilience, and quality.

Transformation 3: Expand Your Network With Zero-Touch

Network expansion is a good thing—it means you're moving into new markets, delivering new services, peeling away customers from the competition. But historically, it's also been an expensive, heavily manual, and painfully slow undertaking often taking months—even years—to expand the network and roll out new services. If you're going to compete for next-generation enterprise services, especially against nimble hyperscale players, you need to be able to move quickly. Keep in mind, those long timelines apply to today's CSP networks, where you're deploying at a relatively small number of regional sites. In a 5G and MEC world, the process needs to be repeated across thousands—even tens of thousands—of locations.

Telco Cloud Transformation

Any time you're deploying new physical equipment, truck rolls will be part of the equation—even the most advanced automation can't change that. But for every other step in the process, telco cloud makes network expansion much faster, simpler, and less expensive. Apart from physically deploying equipment, all the other parts of the process—deploying the software stack, updating workflows and provisioning paths, ensuring the appropriate resources are in place, and provisioning the new service—either disappear or happen automatically.

Instead of endless, cumbersome, and error-prone manual software installations and configurations, you can use:

- **Predefined templates:** Define configurations once for all central, core, and edge sites across your environment. Whenever you need to expand, the network automatically deploys a software-defined data center (SDDC) stack based on the template optimized for that site, without a human operator having to be dispatched.

- **Zero-touch provisioning:** When you're ready to deploy, the system uses ZTP to implement the complete virtual infrastructure, create the Kubernetes clusters, and instantiate the needed network functions for that site and the services it will support.

Transformation 4: Unlock Innovation with Modern Software Approaches

The biggest, most persistent gap between CSPs and their hyperscale competitors is not technology. It's the knowledge, processes, and tools involved in modern software development. Hyperscalers were early pioneers in using new software methodologies—agile development, cloud-native application principles, CI/CD pipelines—to transform the marketplace. CSPs are still playing catch-up.

Many CSP network organizations have made major strides in recent years in bringing new software and DevOps ways of working to their teams developing new products and applications. But for network teams, major barriers remain—especially when it comes to deploying, configuring, and updating network software across distributed CSP environments.

CSPs would like to shift to a full "NetOps" model for network operations—one that marries DevOps tools and continuous updates to network infrastructure software. But there's a hard limit to what you can do when your network is still split up into siloed network layers and clouds that all work differently. If CSPs want to deliver the 5G and edge services that will redefine their relationship with customers, they need to flexibly, continually innovate and update network software and the applications and services running on it.

Telco Cloud Transformation

A telco cloud bridges the gap between yesterday's rigid, siloed software processes and today's dynamic, cloud-first models. With a single, horizontal platform that encompasses your entire network, you gain end-to-end visibility into and control over the software running both network functions and services. Network teams no longer have to worry about manual resource provisioning or using specialized tools for different network layers and clouds. Instead, they have a flexible, end-to-end foundation for simplified NF and service creation, testing, delivery, and updates.

With these state-of-the art software capabilities extending across every part of your business, you can continually update your multi-vendor NF software to bring new capabilities to customers. You can create and customize new 5G and edge services more easily. You can also deploy them more quickly and efficiently.

VMware Telco Cloud: Under the Hood

At a technical level, VMware Telco Cloud provides all the key capabilities you need to transform your approach to infrastructure and service software.

- **Simple, intuitive NF designer:** Included telco cloud tools make it easy to create, customize, and update NF data models. You can drag and drop virtual deployment units (VDU) or Helm charts and virtual links and simplify configurations of VDUs and connectivity. You can customize NF design with the included visual composer and scripts. And you can import and build custom workflows with VMware vRealize® Orchestrator™ (vRO).

- **Cloud-native service creation tools:** VMware Telco Cloud enables a microservices-based approach to service creation. By breaking up services into independently scalable, repeatable components, you can accelerate innovation and more easily and continually refine services.

- **Automated CI/CD:** VMware Telco Cloud integrates with your existing CI/CD pipeline, so you can more quickly and easily update NF software whenever your vendors release new versions. Whenever a vendor changes NF code, packages, or artifacts, the update is automatically pushed to (and recertified via) the VMware Ready for Telco Cloud program. Once the new software version passes through your organization's own testing requirements—also part of the automated CI/CD process—it appears in the Telco Cloud repository, available to implement as a registered software upgrade. This continuous, largely automated process makes developing, validating, and deploying new software versions much simpler.

- **Flexible foundation for network slicing:** The most innovative (and lucrative) 5G and edge services will use network slicing to tailor the virtual infrastructure for diverse applications and services. Which means you can expect those network resources to be far more dynamic, as the infrastructure continually adapts to changing application requirements. VMware Telco Cloud enables automated mobility of workloads across the registered cloud to any location that meets the requirements of that workload and service. You can implement your telco cloud so that human operators manually trigger this mobility, or it can happen dynamically through custom workflows. In this way, your telco cloud brings you closer to a fully automated, self-organizing network.

Transformation 5: Consistently Deliver Superior Customer Services

Adopting new cloud models, cloud-native applications, and software-defined infrastructure gives CSPs amazing agility to deliver innovative digital services. But these innovations also make CSP networks much more complex. In these dynamic, distributed, cloud-native environments, just recognizing when a service is having issues—much less doing something about it—becomes much harder.

If you can't detect service degradations and quickly zero in on their root causes, you can't monetize new 5G investments. After all, the truly transformational 5G and edge enterprise services—the ones that create new revenue streams and redefine a CSP's role in the digital ecosystem—require you to meet more stringent SLAs.

Services such as augmented reality and virtual reality experiences, autonomous vehicles leveraging vehicle-to-vehicle (V2V) communication, and industrial automation require latencies and synchronization on a completely different level than previous-generation services. Without the ability to recognize when a service is missing (or about to miss) an SLA target, those services—and the customer relationships they represent—quickly break down.

Telco Cloud Transformation

As part of your telco cloud, VMware Telco Cloud Operations gives you the end-to-end visibility, control, and automation to assure consistently excellent customer experiences, even for the most demanding 5G and edge services. It proactively monitors your entire network, detecting problems and correlating alarms across previously siloed domains and network layers—including across multiple tenants' SD-WANs and the underlying infrastructure. You can quickly find the root cause of any service degradation, immediately see which actual customers and SLAs are affected, and prioritize your response.

With Telco Cloud, you can now:

• **Automate root cause analysis:** Legacy network management systems (NMS) bury operations teams in information. They provide huge amounts of data about the "symptoms" of an issue but leave it to human operators to translate thousands of alerts. Now, your assurance platform automatically correlates all active, inactive, and unknown alarm statuses together with the network topology to quickly uncover the root cause of a problem. Your human operators receive only the details that matter, and more than 95% of typical network alarms—hundreds of thousands in typical CSP networks—fade into the background.

• **Adapt to changes dynamically:** Traditionally, CSPs used rule-based engines to try to shortcut troubleshooting and event correlation. But human operators still had to spend a large portion of their time updating the engine as the network topology and configurations changed. With Telco Cloud Operations, your assurance platform continually monitors every part of your environment and updates itself automatically.

• **Address the most important problems first:** Conventional NMS and assurance solutions are designed to solve technical problems, not business ones. If there's a problem affecting multiple services and customers, for example, it's still up to human beings to figure out how to triage the response. Now, your telco cloud can automate this process with embedded business impact analysis tools. By assigning business impact scores to your various tenants and services, you can automatically prioritize incidents affecting your most important services, your highest-profile customers, and the problems most likely to lead to costly SLA violations.

• **Use automation to resolve issues faster:** Telco Cloud Operations monitors the complete service, from the underlying servers to the virtual machines (VMs) and VNFs themselves. You can integrate the platform with IT service management (ITSM) systems to trigger workflows for remediation or ticket generation. It can also interlock with orchestrators to take automated actions and achieve resolution. For example, if an alarm is raised for a VoLTE vIMS service, such as a high session count (which may result in dropped calls), Telco Cloud Operations will immediately correlate the alarm to the related vIMS service. A workflow in the related orchestrator can be automatically triggered to scale up the capacity of the vIMS service, without human intervention.
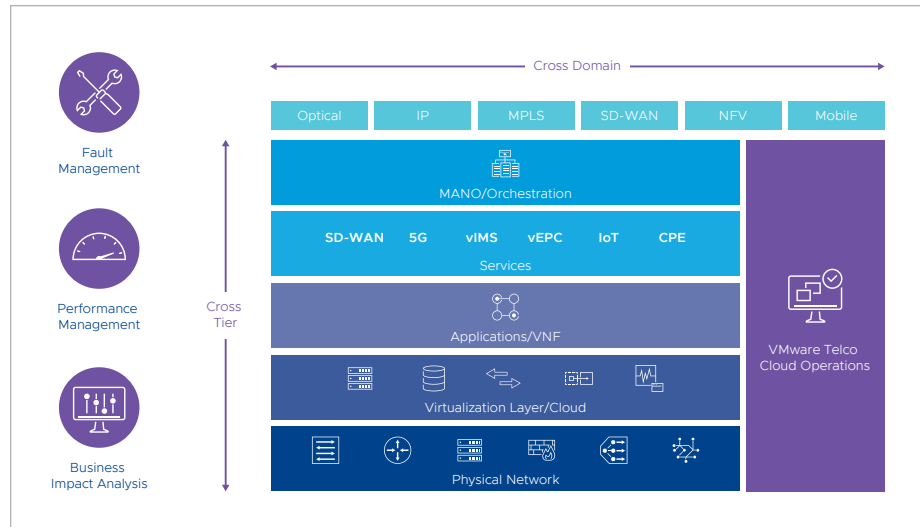
FIGURE 2. TELCO CLOUD OPERATIONS ARCHITECTURE

The benefits of this holistic approach to service assurance are far-reaching. Some CSPs using these tools have seen Telco Cloud Operations automatically triage more than 92% of network issues, freeing up operations experts to focus on higher-value activities.

VMware Telco Cloud Operations: Under the Hood

At a technical level, VMware Telco Cloud Operations provides all the capabilities needed to assure superior quality for tomorrow's dynamic CSP networks and services. These capabilities include:

- **End-to-end, multi-layer visibility:** Telco Cloud Operations gives your teams holistic visibility, including into virtualized network overlays and service layers for SD-WAN, NFV, and IoT. They can comprehensively monitor and manage all customer network environments—IP LAN/WAN, MPLS and SD-WAN—through a single pane of glass. With the platform's native ability to read TOSCA blueprints, your teams gain deep visibility into (and assurance for) a wide range of VNFs, including vIMS, vEPC, SDN, and SD-WAN. They can work with a comprehensive logical representation of the entire environment, including both physical and virtual network elements.

- **Dynamic discovery:** Telco Cloud automatically discovers the topology of the network and interlocks with orchestrators through API integrations. It determines the relationship between all the devices and services in the network, associates them with specific customers/tenants, and automatically updates this information as changes occur. This all happens automatically—with no need to manually reprogram rules or scripts.

- **Integrated multi-vendor SD-WAN monitoring and analytics:** Many conventional assurance systems still focus on the infrastructure underlay—leaving human operators to determine how issues are affecting actual services and customers on the software-defined overlay. With Telco Cloud, you can use an assurance platform designed from the ground up around customer-facing services, not network devices or virtualized functions. Telco Cloud Operations uses a common information model as the basis of support for all types of SD-WAN offerings, allowing operations teams to immediately identify specific SD-WAN tenants affected by a service degradation. Today, that includes built-in support for VMware SD-WAN and Cisco Viptela.

- **Proactive performance analytics:** Telco Cloud enables unified performance management across all layers of your next-generation infrastructure. With support for NetFlow, SNMP, IP SLA, sFlow, VNFs, and SD-WAN performance metrics, your team can track network and service health across your entire environment in one place, and even combine metrics to create custom KPIs. Using machine learning, the platform analyzes historical metrics and establishes dynamic baselines and trends, so it can detect anomalies. This means operations teams can not only respond to problems more quickly. They can also detect and address many service quality issues—such as jitter, latency, packet loss, and congestion—before they affect customers and harm SLAs.

Transform Your Business
with VMware Telco Cloud

The evolution to full-fledged 5G networks opens up amazing business opportunities for service providers, but also brings new challenges. We've explored the most common network transformations CSPs will undertake with 5G networks, so it should be clear that yesterday's network and operational models will quickly fall apart in this more complex, highly dynamic services landscape. The ability to visualize, provision, and manage all resources across your network as a single, horizontal platform becomes essential to CSP success. Which means telco cloud capabilities are no longer an interesting possibility for the future. They're a core business requirement.

With VMware Telco Cloud, you can:

• Modernize your network and services with web-scale speed and agility while maintaining carrier-grade performance, resilience and quality.

• Increase business agility with the ability to quickly deploy NFs and services everywhere—from core to edge.

• Reduce complexity by deploying and managing VNFs and CNFs side by side on a consistent horizontal infrastructure.

• Accelerate deployment timelines and time to revenue with automated provisioning of cloud-native network resources, NFs and services.

• Deliver superior customer experiences with the ability to maintain holistic visibility—horizontally from core to edge to customer, and vertically across multiple layers of the network—using a single tool.

• Support higher SLAs with the ability to identify service degradations more quickly, associate them with specific customers and services, and prioritize your response.

• Continually update and expand your network capabilities more easily with less risk, using hundreds of multi-vendor CNFs and VNFs that are pre-validated and certified for VMware Telco Cloud Platform.

• Innovate your network and services to become a full-fledged digital service provider, and unlock a world of new use cases, revenue models, partnerships, and service offerings.

VMware: the Right Partner for Your Telco Cloud Journey

More than any other vendor in the marketplace, VMware is the ideal partner to help you implement and capitalize on a telco cloud. Consider the alternatives:

• **Network equipment providers (NEPs)** can bring you some telco cloud capabilities, but not end-to-end, from core to cloud to customer. These vendors still build capabilities around siloed domains and network layers. They love to lock you in and prefer to sell traditional physical network elements with fixed software release schedules versus flexible virtual resources.

• **Hyperscale cloud providers** would be happy to help you deliver new cloud infrastructure and services to enterprise customers. But choosing this path means locking yourself—and your customers—into one vendor's cloud and services. Worse, it means that cloud provider's brand, not yours, will be top-of-mind for your customers, and they will own the biggest part of those relationships. Not a promising approach if your goal is to move up the value chain and play a larger role in the marketplace for next-generation digital enterprise services.

• **Open-source platforms** can give you the flexibility and control to create and deliver your own cloud-first services—provided you have the in-house expertise to assemble and use complex open-source tools and processes. That entails identifying and patching together multiple open-source solutions, adapting them to support the requirements of large-scale distributed CSP networks, integrating and testing everything as a single architecture, and supporting and maintaining each piece of the open-source puzzle on an ongoing basis. Most CSPs are just beginning to get their feet wet with agile software development, CI/CD, and cloud-native applications. Adding open-source technology into the mix takes that complexity to another level entirely, and few CSPs are equipped to successfully implement that approach.

VMware comes from a different part of the technology world, and we bring a very different perspective and approach to CSP transformation. We've been at the cutting edge of new cloud software models, cloud-native infrastructure, and cloud-first automation. And we've played a central role in the digital transformation of thousands of service providers around the globe.

Unlike other vendors in this space, we have no incentive to lock you into one vendor's product portfolio or cloud. Instead, we've spent years delivering flexible technology platforms that make it easy to work with the vendors and cloud providers you prefer, and that make the most sense for each offering and market you plan to target. Use any vendor's southbound infrastructure and NFs, and whichever northbound orchestration and management applications work best for your business.

Whichever path you take to transform your business, VMware can help you get there. To learn more, contact your VMware account representative or visit *https://telco.vmware.com/*.

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