Inherent Value: The Benefits of Running CNFs on VMs

Optimizing Mixed Workloads on Shared Infrastructure with Kubernetes in VMware Telco Cloud Platform

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THE VMWARE TELCO CLOUD FOR 5G AT A GLANCE

VMware helps communications service providers build, operate, monetize, and protect their telco cloud. Our technology empowers CSPs to transform their networks into a 5G force, accelerate the delivery of innovative services, and compete in a multi-cloud world.

The VMware telco cloud creates a consistent foundation for operating all generations of cellular and fixed-line technology while leading the way to 5G adoption. Solutions for infrastructure, orchestration, automation, assurance, optimization, security, and the radio access network modernize your network from the core and edge to the RAN.

15-50%
Reduction in hardware costs (Source: Forrester, Understanding the Total Economic Impact Of A Common Platform Approach to NFV)

40-50%
Reduction in platform management effort through simplification (Source: Forrester, Understanding the Total Economic Impact Of A Common Platform Approach to NFV)

18%
Revenue increase from the ability to bring services to market faster (Source: ACG, Economic Benefits of VMware Telco Cloud Automation and Horizontal Infrastructure)

The Synergy of Containers and Virtual Machines on vSphere

The path to modernization is lit up by the transformational power of cloud-native principles. Kubernetes, containers, and microservices supply the tools for the kind of flexible, modern operations required to thrive in a 5G world. The automated operations and agile methods that accompany cloud-native technology streamline the deployment of containerized network functions and 5G services.

A container wraps a network function in a consistent, portable package that can be independently distributed and modified with little effort and few or no dependencies. Containers then run on a host operating system and share its kernel. The host operating system resides on either a virtual machine (VM) or a physical server.

Containers and a microservices architecture make it easier to independently deploy, modify, and maintain network functions. A container orchestration system— typically Kubernetes—automates the deployment and management of containerized functions and services at scale. Combining containers and VMs produces a powerful synergy that taps the benefits of both technologies.

- Virtual machines solve infrastructure-related problems by better utilizing servers, improving infrastructure management at scale, streamlining IT operations, and isolating resources for security. These are some of the reasons why the major public cloud providers use hypervisors and VMs to run containers.
- Containers solve application-related problems by, among other things, streamlining DevOps, fostering a microservices architecture, improving portability, and further improving resource utilization.

Cost-effectively putting containerized network functions (CNFs) into production hinges on your ability to secure, manage, and automate them at scale in an efficient and integral way. Running CNFs on virtual machines yields a range of benefits:

- Operating CNFs in production requires lifecycle management, high availability, resource management, data persistence, networking, and automation—all of which are an integral part of VMware vSphere and the VMware telco cloud.
- Optimizations in the vSphere CPU scheduler for NUMA architectures ensure that containers run on VMs with high performance.
- VMs isolate containers with strong security boundaries, and VMs let you impose security by using built-in mechanisms that can be managed at scale without silos.

VMware Telco Cloud Platform, which uses vSphere as its foundation, establishes the perfect catalyst for efficiently and securely operating CNFs at scale.

> “A well-built virtualised network can be more secure and resilient than an equivalent network built on dedicated hardware.”
>
> SECURITY ANALYSIS FOR THE UK TELECOM SECTOR: SUMMARY OF FINDINGS
> NATIONAL CYBER SECURITY CENTRE, JANUARY 2020

The Architecture of CNFs and Kubernetes on the Platform

VMware Telco Cloud Platform and its components radically simplify security, operations, and management of 5G networks by running CNFs on virtual machines. VMware Telco Cloud Platform includes compute, networking, and VMware Telco Cloud Automation.

Software-Defined Infrastructure

VMware Telco Cloud Platform supplies infrastructure as a service (IaaS) and containers as a service (CaaS) with the following virtualization technology:

- VMware vSphere®
- VMware NSX-T™ Data Center
- VMware vSAN™, an optional add-on.

There is also a version of the platform tailored to support the radio access network (RAN). VMware Telco Cloud Platform RAN™ is a RAN-optimized platform that runs virtualized baseband functions, virtualized distributed units (vDUs), and virtualized central units (vCUs) in accordance with RAN performance and latency requirements.

Automation and Orchestration

VMware Telco Cloud Automation orchestrates network functions, services, and resources from a centralized location. The platform integrates with multiple virtual infrastructure managers (VIMs) and Kubernetes clusters to form a powerful multi-tenant environment to securely manage the service and application layer. VMware Telco Cloud Automation centralizes the provisioning and management of clusters.

Cloud-Native Principles and Automated Operations

The path to modernization is paved by the transformational power of cloud-native principles. Kubernetes, containers, and microservices supply tools for the kind of flexible, modern operations required to thrive with 5G. The automated operations and agile methods that come with cloud-native technology streamline the development, deployment, and management of new services.

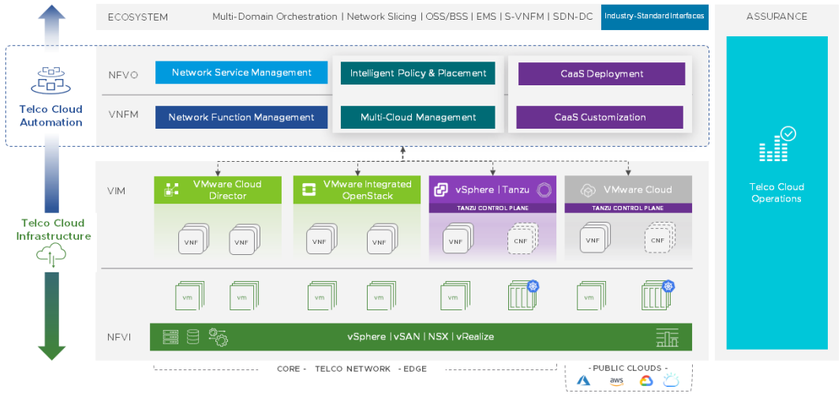
Consistent infrastructure plays a critical role in modernization by uniting clouds and multi-vendor networks in a single platform. With common infrastructure, service providers can avoid creating another network silo when they build out 5G. By simplifying complex heterogeneous environments, horizontal architectures deliver centralized management at scale. Ubiquitous automation ties all the moving parts together to reduce costs, promote on-demand delivery, and set the stage for innovation. The synergy of combining containers and VMs by running Kubernetes on vSphere is central to maximizing the benefits of cloud-native technology.

VMWARE TELCO CLOUD PLATFORM AT A GLANCE

VMware Telco Cloud Platform is powered by field-proven compute and networking combined with VMware Telco Cloud Automation™ and VMware Tanzu™ Standard for Telco, which is a telco-grade Kubernetes distribution. This combination empowers CSPs to rapidly deploy and efficiently operate multi-vendor CNFs and VNFs with agility and scalability.

KEY CAPABILITIES

- Deploy and manage VNFs and CNFs on consistent horizontal infrastructure
- Use microservices and optimize resources with a telco-grade Kubernetes distribution
- Manage CNFs at scale
- Automate lifecycle management of Kubernetes clusters, network functions, and 5G services
- Accelerate the deployment of network functions through the VMware Ready for Telco Cloud program
- Follow a reference architecture to implement a solution that works best for your requirements



VMware Telco Cloud Platform combines networking and compute with VMware Telco Cloud Automation to form a cloud-native platform that runs CNFs and VNFs on any cloud with visibility, orchestration, and operational consistency.

Telco-Grade Kubernetes

Tanzu Standard for Telco provides a carrier-grade Kubernetes distribution with telco-grade extensions to run and manage CNFs at scale. This CaaS functionality of VMware Telco Cloud Platform simplifies the operation of Kubernetes for multi-cloud deployments and centralizes management and governance for clusters. The platform provides telco-grade CaaS enhancements:

- Multus to attach multiple container networking interfaces to Kubernetes pods through its plugins
- Topology Manager to optimally allocate CPU memory and device resources on the same NUMA node to support performance-sensitive applications
- Kubernetes cluster automation to simplify the deployment and management of master and worker nodes

A telco-grade Kubernetes platform lets you address emerging use cases with agility and flexibility.

Kubernetes on vSphere

In the architecture of VMware Telco Cloud Platform, Kubernetes runs on vSphere. Here are some of the distinguishing characteristics of how Kubernetes runs on vSphere:

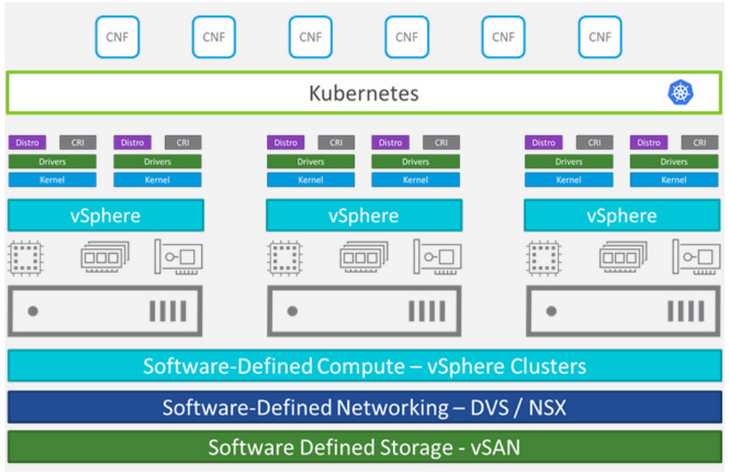
- The vSphere hypervisor runs on each physical host
- The hardware resources are shared among Kubernetes worker nodes running on VMs
- Each host can support from one-to-many worker nodes
- The overhead for the hypervisor layer is small: 2 cores and 1GB of memory

The Benefits of Shared Compute Resources

- Compute resources are aggregated and shared among workloads.
- Networking is software-defined using either Layer 2 (DVS) or full-stack (NSX-T) models.

“ A quintessential example of the use of virtualization and containers together is the public cloud, where nearly all containers run inside virtual machines (VMs). The primary reason for this is the need for secure multitenancy because the container boundary is not strong enough to isolate tenants and the boundaries between tenants must be enforced with VMs. Additionally, VMs partition and provision the underlying hardware for heterogeneous customer environments, while containers are then used to manage each customer’s apps within that VM slice. Consolidating heterogeneous workloads on the same infrastructure also maximizes utilization.”

IDC TECHNOLOGY SPOTLIGHT:
THE SYNERGIES BETWEEN CONTAINERS AND VIRTUAL MACHINES



The architecture of Kubernetes on vSphere in VMware Telco Cloud Platform. The architecture puts in place horizontal software-defined infrastructure for compute, networking, and (optionally) storage.

Innovation and Compatibility through Abstraction

- vSphere is the first compatibility target for hardware vendors and innovations.
- There are tens of thousands of compatible devices and device combinations.
- Hardware is abstracted to high-performance, universally supported virtual devices.
- With compatibility a given, developers can focus on innovation.

In this way, the developer-friendly architecture of VMware Telco Cloud Platform includes capabilities for resource optimization, migration, tenant and service isolation, and automation.

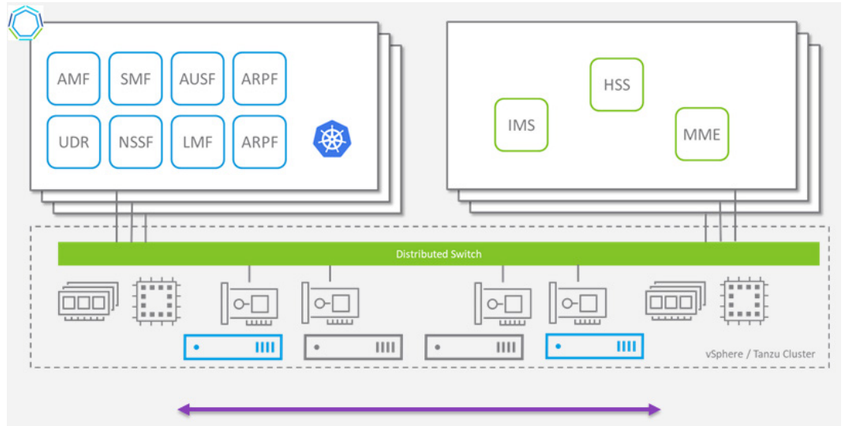
Elasticity of Scale to Balance Performance and Cost

VMware Telco Cloud Platform can migrate workloads to maximize performance or consolidate workloads to minimize resource costs.

- Workloads can be migrated to maximize performance.
- Workloads can be consolidated to minimize resource costs.

Kubernetes Worker Node Flexibility

With the flexibility to choose among Linux distributions, Linux kernels, and container runtimes, Kubernetes worker nodes can be tailored to your workload requirements.



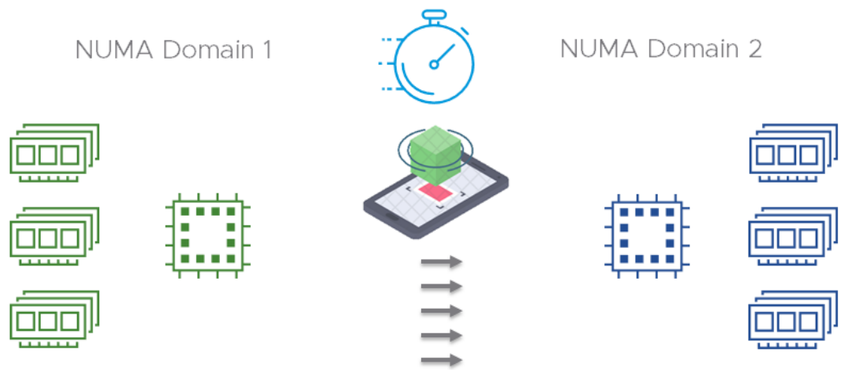
VMware Telco Cloud Platform can migrate workloads to maximize performance or consolidate workloads to minimize resource costs.

Tenant and Service Isolation for Secure Multi-Tenancy

Worker nodes for multiple tenants or services can share a common host with strong isolation and protections. For CNFs, isolation also minimizes the attack surface and the blast radius.

Optimized Scheduling for High-Performance Workloads

vSphere optimizes high-performance workloads by always scheduling processes into the same NUMA domain. To ensure high performance, there is no cross-domain context switching or memory access.



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CLOUD-NATIVE TECH AND CLOUD-FIRST AUTOMATION

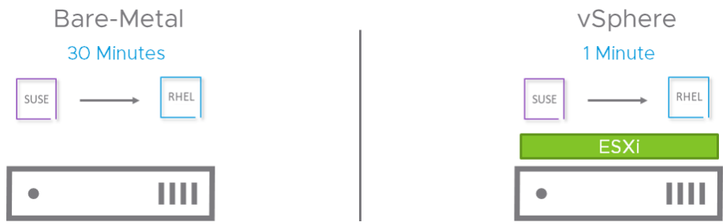
Capitalizing on the opportunities of 5G in a multi-cloud world hinges on two keys ingredients: cloud-native technology and cloud-first automation.

Cloud-native technology decouples containerized functions from the infrastructure so they can be deployed quickly, shared among services, updated easily, and managed independently. Orchestration and automation dynamically scale network functions to meet changes in demand. With containers as a service (CaaS), CSPs can use the same technology to meet different requirements and design more efficient 5G networks.

Cloud-first automation unites multi-cloud resources in a centralized orchestration system and then uses intent-based placement to automatically align the requirements of network functions and 5G services with resources and capabilities.

MODERNIZE THE RAN TO MONETIZE THE EDGE

With VMware Telco Cloud RAN, virtualization and cloud-native technology can be extended to the radio access network, bringing efficiency, flexibility, and automation. The platform transforms the RAN into a 5G multi-services hub that lets you deploy non-RAN CNFs alongside vRAN functions. As a result, you can monetize 5G by quickly introducing new edge services while streamlining operations.



With vSphere and virtual machines, there are no long, tedious reboot cycles---hardware is repurposed or refreshed in seconds or minutes, and the operating system and workload images can be easily maintained, deleted, or reverted.

Go Fast, Change in a Flash

VMware ESXi™ is the hypervisor in vSphere. After it is set up, workload and server provisioning and reprovisioning takes place in a flash.

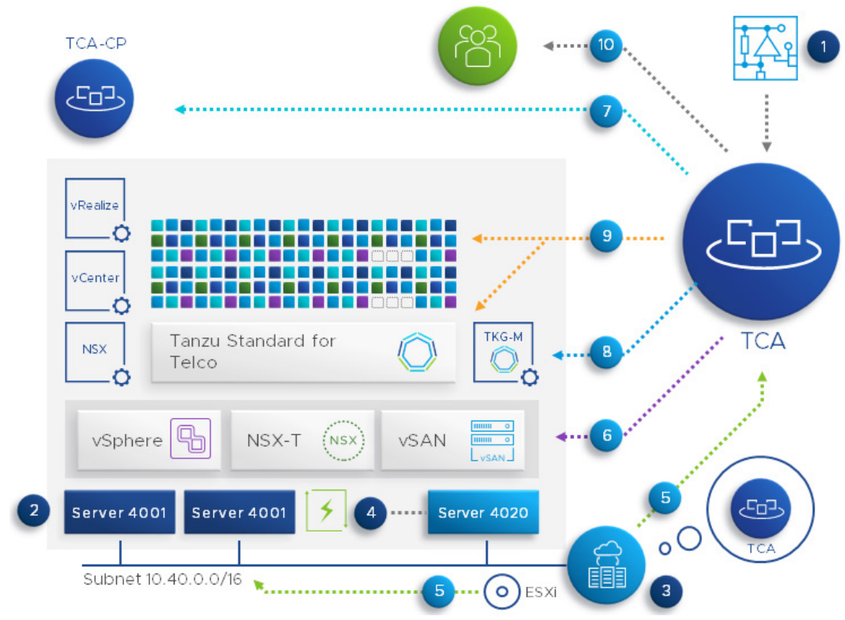
- The high-function orchestration interface of vSphere centralizes management.
- There are no long, tedious reboot cycles; hardware is repurposed or refreshed in seconds or minutes.
- Operating system and workload images can be easily maintained, deleted, or reverted.
- Bypass difficult boot device configuration and ordering.
- No need to provision and maintain a PXE server.
- No need to secure-erase disks.
- No need to manage Layer 2 networking or native VLANs.

Less Disruptive Upgrades with Worker Node Swaps

- The CNFs are recreated on other Kubernetes worker nodes on vSphere, and then the original worker nodes are updated.
- The updated worker node is returned to service.
- The CNFs are redistributed to the updated worker node.

Maintenance and Operations from Core to the RAN

When it comes to operating all the infrastructure that goes into building a non-standalone 5G network as well as managing both VNFs and CNFs, virtual machines offer a huge advantage. Operations teams can use the same sets of tools that they have learned to use for the 4G core. The common management of resources across 4G and 5G stacks unlocks for the full benefits of cloud-native technology, including flexibility and automation. With VMware Telco Cloud RAN, these common tools now extend to the radio access network.



VMware Telco Cloud Automation, which is included with VMware Telco Cloud Platform, automates site deployment.

Automated Site Deployment

The diagram above demonstrates how automation deploys a site.

1. Site blueprints are defined.
2. Racks, switches and servers are installed.
3. A bare-metal provisioning system is installed and linked with VMware Telco Cloud Automation.
4. Servers are powered on.
5. ESXi is deployed to each host and VMware Telco Cloud Automation is notified their availability.
6. VMware Telco Cloud Automation bootstraps the telco cloud infrastructure.
7. VMware Telco Cloud Automation deploys its control plane.
8. VMware Telco Cloud Automation deploys Tanzu Standard for Telco to run Kubernetes workloads.
9. VMware Telco Cloud Automation deploys network services and optimizes the infrastructure.
10. OSS/BSS systems orchestrate operations infrastructure and service management.

Dynamic Resource Allocation and Late Binding

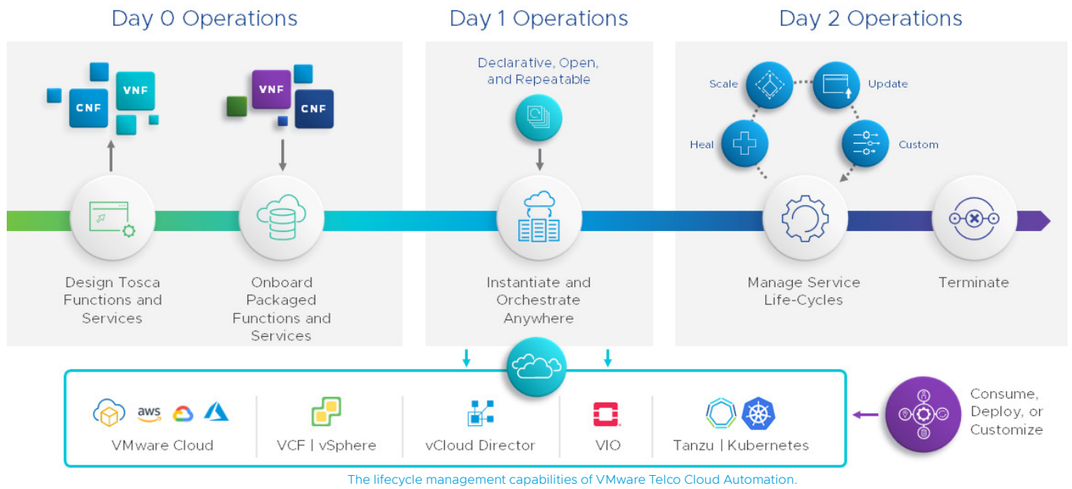
VMware Telco Cloud Platform automates the discovery, registration, and creation of Kubernetes clusters while continuously synchronizing between the CaaS layer and VMware Telco Cloud Automation. This synchronization creates Kubernetes cluster resource awareness, centralizes fault and performance monitoring, and optimizes workload placements. When the system instantiates a workload, it optimizes a cluster or creates a new one to match the CNF requirements through late binding. Here are some of the things late binding does to optimize worker nodes and their resources:

- Enable Huge-Pages
- Install R/T Kernel
- Isolate Cores
- Configure TuneD
- Allocate vGPU

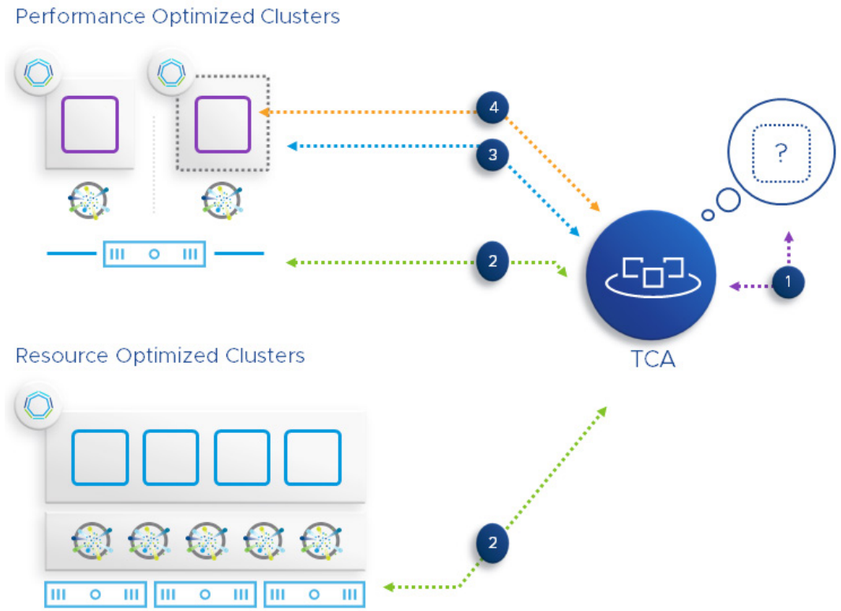
Lifecycle Management

VMware Telco Cloud Platform includes multi-layer lifecycle management to automate the provisioning and operations of all the layers of the telco cloud, including virtual machines and Linux container hosts.

- Onboard network functions using standards-based templates and model network services based on multi-vendor network functions.
- Centralize the creation, optimization, and management of Kubernetes clusters with CaaS automation.



The lifecycle management capabilities of VMware Telco Cloud Automation.



VMware Telco Cloud Automation optimizes the placement of services and containerized network functions (CNFs).

Optimizing Service Placement on Kubernetes

VMware Telco Cloud Automation follows these steps to optimize service placement:

1. Assess the service's requirements.
2. Gauge the resources of Kubernetes and the hardware and infrastructure.
3. Deploy a performance-optimized Kubernetes cluster.
4. Place service on the cluster.

Optimizing the Placement of DUs and CUs for the RAN

As for the radio access network, VMware Telco Cloud Platform RAN extends the capabilities of VMware Telco Cloud Automation from the 5G core to the RAN. Programmable resource provisioning optimizes where to locate DUs and CUs. When you onboard a virtualized RAN function, you can programmatically adjust the underpinning availability and resource configuration based on the function's requirements.

To meet high-performance, low-latency requirements, DUs can be placed at the far edge near users. CUs, meanwhile, can be automatically placed or dynamically moved closer to the core to maximize resource utilization. These late-binding capabilities let you dynamically move DU and CU resources on demand to improve resource utilization or to add more resources when necessary.

> “Containers and Kubernetes were developed to be better application deployment and management solutions and do not address management of the underlying infrastructure. Kubernetes does not address the underlying virtual or physical infrastructure but expects the user to present a robust infrastructure on which it can operate. Faster and more agile provisioning is a strength of virtualization, as well as one of the primary reasons why customers moved from physical to virtual, and this benefit still applies to containers.”
>
> IDC TECHNOLOGY SPOTLIGHT:
> *THE SYNERGIES BETWEEN CONTAINERS AND VIRTUAL MACHINES*

Conclusion: Management, Security, Performance, and Automation

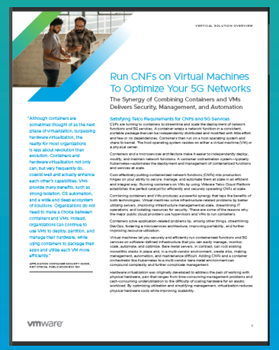
Using VMware Telco Cloud Platform to run, manage, and automate CNFs on vSphere yields a range of benefits:

- It secures containers and the orchestration system with isolation, strong security boundaries, authentication, access control, micro-segmentation, and other measures.
- It optimizes the performance of large clusters and mixed workloads.
- It scales containerized functions without the pain of adding, configuring, and managing physical hardware.
- It streamlines network management and improves network security.
- It minimizes operational complexity and simplifies management while maximizing hardware utilization and economies of scale.
- It automates the deployment and management of CNFs across clouds.

Running CNFs on virtual machines fuses the benefits of proven virtualization technology with the power of cloud-native technology so you can deploy, manage, automate, and protect innovative 5G services and network functions at scale.

Learn More

To find out more about the benefits of running CNFs on virtual machines, click below to download a technical white paper or a solution overview.



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