ABI RESEARCH COMPETITIVE RANKING

5G TELCO CLOUD-NATIVE PLATFORMS

vmware®

OVERALL: 81.7 | INNOVATION: 86.8 | IMPLEMENTATION: 76.3 | RANK: 1

vmware®

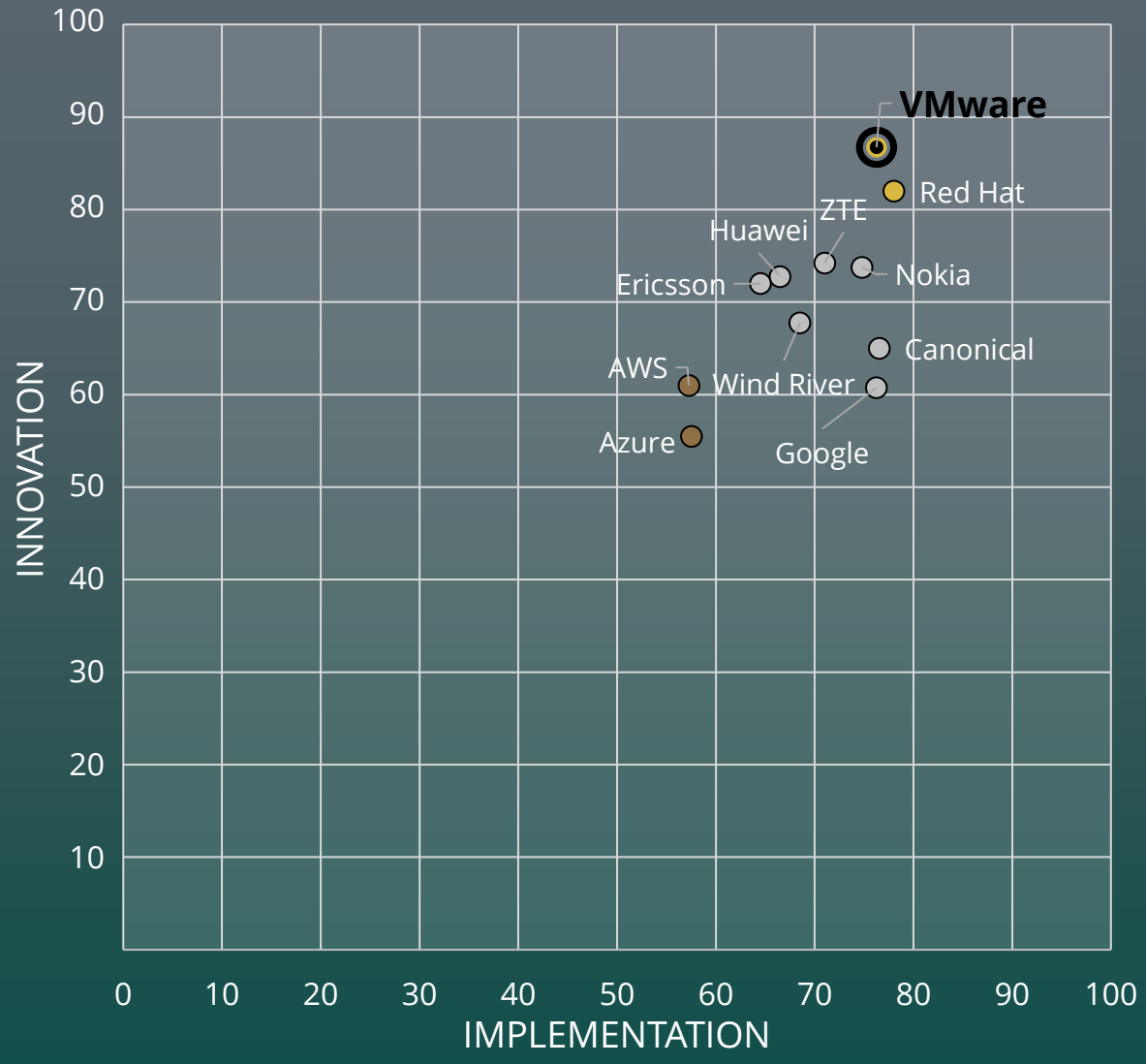
OVERALL LEADER
ABIresearch.

TOP INNOVATOR
ABIresearch.

TOP IMPLEMENTER
ABIresearch.

OVERALL: 81.7 | INNOVATION: 86.8 | IMPLEMENTATION: 76.3 | RANK: 1

VMWARE INNOVATION *VERSUS* IMPLEMENTATION MATRIX



INNOVATION

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INNOVATION SCORE: 86.8

VMware is a leading provider of multi-cloud services for apps, enabling digital innovation with telco control. Based in Palo Alto, California, VMware offers a broad portfolio of services and software spanning virtualization, networking, storage, cloud-native platforms, and security across multiple industries. For the telecommunications industry, it has worked with more than 140 CSPs in deploying NFVI and cloud-native networks. It offers a cloud-native platform called VMware Telco Cloud Platform for 5G networks, which supports more than 220 third-party VNFs/CNFs, including NFs from Nokia, Cisco, Ericsson, and Metaswitch. Recently, VMware Telco Cloud Platform was used in a 5G deployment with DISH, deploying multi-vendor NFs on top of a consistent horizontal platform, with the ability to dynamically move and scale workloads in the cloud. Telia has also selected VMware Telco Cloud Platform as the common network horizontal digital platform on top of which 4G and 5G CNFs—both virtualized and containerized—will run.

VMware Telco Cloud Platform is a hybrid IaaS and CaaS platform that can run both VNFs and CNFs from multiple vendors. VMware offers an interoperability certification program, VMware Ready for Telco Cloud, that enables CSPs to quickly validate multi-vendor VNFs and CNFs on VMware Telco Cloud Platform with a dedicated VMware team or through a self-certification process for a faster time-to-market. These certifications help ensure that VNFs/CNFs can interoperate at the core infrastructure layer of VMware Telco Cloud Platform, as well at the orchestration level. Furthermore, VMware vSphere Enterprise Plus, which is the cloud computing virtualization platform that is part of VMware Telco Cloud Platform, offers the abstraction and management layer that helps enable a multi-vendor ecosystem. VMware Telco Cloud Platform also supports a variety of Operating Systems (OSs), including CentOS, Ubuntu, Amazon Linux, Red Hat Enterprise Linux, and Photon OS. VMware thus scores a perfect 10 for their ability to orchestrate and support multi-vendor NFs.

In terms of open source, VMware is the number two contributor to Kubernetes and offers native Kubernetes access through command-line tools like kubectl. VMware also contributes to other open-source communities, such as ONAP, OPNFV, O-RAN, and OSM. VMware Telco Cloud Platform's CaaS engine, Tanzu, is an upstream Kubernetes project, and uses open-source projects, such as Harbor, Cluster API, Velero, and Sonobuoy, to deliver additional capabilities. VMware also provides a fully open-stack-compliant VIM, VMware Integrated OpenStack, as well as VMware Cloud Director, with a multi-tenant VIM.

Regarding container security, virtualization provided by VMware vSphere offers inherent security in the hypervisor, which separates the VM's OS from the underlying hardware's OS and isolates tenants. (Note that this level of segmentation cannot be achieved with bare metal deployments at the moment without using virtualization technology, such as KubeVirt.) Pod-level micro segmentation is also enabled through VMware NSX, which is VMware Telco Cloud Platform's networking and security solution. VMware scores very high in terms of container security due to the inherent security brought about by vSphere and NSX, which are based on virtualization technology, enabling isolation of tenants and hypervisor security for containers.

INNOVATION

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INNOVATION SCORE: 86.8

VMware Telco Cloud Platform is purpose-built for the telecommunications industry and offers telco-grade Kubernetes through Tanzu, which includes telecommunications-specific enhancements, such as Multus Container Network Interface (CNI), support for DPDK, SR-IOV, and automated cluster provisioning and configuration. VMware also offers a whole suite of networking capabilities for CSPs, such as:

- VMware NSX (included in VMware Telco Cloud Platform), which provides Software-Defined Networking (SDN) and network security
- VMware RIC, which abstracts the complexities inherent to the underlying RAN infrastructure and provides developer APIs for xApps and rApps to program the open RAN
- VMware Software-Defined Wide Area Network (SD-WAN), which delivers secure, reliable, and efficient access for users from any location to any cloud application
- VMware Telco Cloud Automation for orchestration
- VMware Telco Cloud Operations for service assurance

VMware Telco Cloud Platform also provides additional telco-specific features, such as a low latency data plane through Central Processing Unit (CPU) pinning, fine-grained Non-Uniform Memory Access (NUMA) placement, and vertical NUMA alignment. Carrier-grade reliability, High Availability (HA), and resiliency are also ensured through VMware ESXi, a type-1 hypervisor. Rollbacks and upgrades are also possible without the need to take assets offline and reroute traffic. Additional O&M solutions in the VMware portfolio include VMware vRealize, which provides carrier-grade cloud automation.

For container orchestration, VMware Telco Cloud Platform uses late binding, which automates workload instantiation and configures cloud environments based on VNF/CNF requirements. With late binding, VNF/CNF customization time is reduced by 75% compared to manual configuration methods. Late binding also optimizes performance by helping avoid over- and under-provisioning of infrastructure resources. VMware Telco Cloud Automation provides automatic deployment of the full telco stack with infrastructure provisioning, dynamic placement of workloads, and LCM of VNFs/CNFs and services. If a workload is not performing well, VMware Telco Cloud Automation applies the right operational procedure (*e.g.*, healing, termination, or custom operations). VMware also provides multi-cluster management and orchestration through VMware Telco Cloud Automation and VMware Tanzu Kubernetes Grid as a fundamental feature included in VMware Telco Cloud Platform. VMware's differentiating factor here is late binding, reducing NF customization time and, thus, overall time-to-market.

Regarding AI and ML capabilities for network operations, VMware vSphere Bitfusion virtualizes Graphics Processing Units (GPUs) to support AI and ML, and VMware vRealize AI Cloud uses ML to optimize VMware vSAN performance at the infrastructure layer. VMware Telco Cloud Operations also uses ML and analytics for monitoring, business intelligence, and proactive assurance.

IMPLEMENTATION

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IMPLEMENTATION SCORE: 76.3

VMware Telco Cloud Platform enables multi-cloud capabilities from the core, edge, and RAN to the public cloud, with the virtualization layer in VMware Telco Cloud Infrastructure enabling the building and management of the same workloads across public, private, and edge clouds with consistent management tools and orchestration. With VMware Telco Cloud Automation and late binding, workloads can be placed across multiple clouds and a cloud-smart approach eases workload instantiation and increases mobility from the network core to edge. VMware has recently introduced VMware Telco Cloud Platform – Public Cloud, which will be generally available in 4Q 2022, but can already support CSPs deploying their NFs on VMware Cloud on AWS environments.

VMware Telco Cloud Platform – RAN gives CSPs a platform to modernize their RAN architecture by enabling multi-vendor virtualized Distributed Units (DUs) and virtualized Central Units (CUs) to run on top of a common horizontal infrastructure with consistent operations and automation, providing a cloud-native platform for RAN. VMware has also partnered with Intel to optimize vRAN infrastructure. VMware has partnerships with Altiostar and Mavenir to certify their RAN solution on VMware Telco Cloud Platform – RAN. VMware's telco domain range thus extends from the core to RAN and edge, and its VMware Telco Cloud Platform – RA gives it an edge over most other cloud infrastructure providers for the RAN domain.

In terms of cloud-native capabilities, VMware supports CI/CD with VMware Telco Cloud Automation SDK and API-based integrations to major third-party CI/CD toolchains, such as Jenkins and GitLab. Container orchestration and LCM is done through Tanzu Standard for Telco, which provisions and manages the life cycle of Tanzu Kubernetes clusters. Both VNFs and CNFs run in VMs as part of VMware's value proposition, which provides operational flexibilities and innate security through the separation of the Guest and Host OS. This flexibility gives CSPs a consistent singular horizontal platform across the core, edge, RAN, and public cloud to run legacy VNFs and future CNFs as CSPs transition into a cloud-native environment and way of working.

VMware Telco Cloud Platform consists of three main layers: a consistent horizontal infrastructure layer responsible for hosting multi-vendor VNFs, a CaaS layer with Tanzu Standard for Telco responsible for hosting and operating multi-vendor CNFs, and a cloud-smart automation layer with VMware Telco Cloud Automation responsible for providing a centralized management plane, enabling service, NF, CaaS, and infrastructure automated operations across domains and clouds. VMware Telco Cloud Operations, which offers real-time assurance with monitoring and root-cause analysis, can be added to the VMware Telco Cloud Platform stack. Furthermore, Tanzu itself is modular, and CSPs can choose different components for logging, monitoring, backup, observability, registry, *etc*.

CRITERIA AND METHODOLOGY

VENDOR MATRIX

Methodology: After individual scores are established for innovation and implementation, an overall company score is established using the Root Mean Square (RMS) method:

$$Score = \sqrt{\frac{innovation^2 + implementation^2}{2}}$$

The resulting overall scores are then ranked and used for percentile comparisons.

The RMS method, in comparison with a straight summation or average of individual innovation and implementation values, rewards companies for standout performances.

For example, using this method, a company with an innovation score of nine and an implementation score of one would score considerably higher than a company with a score of five in both areas, despite the mean score being the same. ABI Research believes that this is appropriate as the goal of these matrices is to highlight those companies that stand out from the others.

RANKING CRITERIA

Leader: A company that receives a score of **75 or above** for their overall ranking

Mainstream: A company that receives scores **between 60 and 75** for their overall ranking

Follower: A company that receives a score of **60 or below** for their overall ranking

Innovation Leader: A company that receives a score of **75 or above** for their innovation ranking.

Implementation Leader: A company that receives a score of **75 or above** for their implementation ranking.

INNOVATION CRITERIA

Multi-Vendor Network Functions Orchestration: Companies that enable integration and orchestration of third-party Virtual Network Functions (VNFs)/Cloud-Native Network Functions (CNFs) through certification programs, open interfaces, and multi-vendor orchestrators. As CSPs increasingly want choice and flexibility in building a "best-of-breed" telco stack, a multi-vendor platform becomes an increasingly attractive option. VNFs are included in this assessment as 5G CNF design and deployment has not yet seen mass deployment for many CSPs. **This criterion takes up 25% of the innovation scoring.**

Telco Grade Supporting Features: 5G is a performance technology and telco cloud-native platforms will have to provide features such as Single Root I/O Virtualization (SR-IOV), Data Plane Development Kit (DPDK), Non-Uniform Memory Access (NUMA), and dual stack IPv4 and IPv6 capabilities, among many others. **This is also a high-priority criterion and takes up 25% of the innovation score.**

Container Orchestration and Management: 5G Service-Based Architecture (SBA) will require the orchestration and management of containers to deliver cloud-native capabilities. Platforms are evaluated on their ability to auto-scale clusters and enable Life Cycle Management (LCM) and Zero-Touch Provisioning (ZTP) of containers. **This criterion is also high priority and takes up 20% of the innovation score.**

Artificial Intelligence (AI) and Machine Learning (ML) Capabilities for Network Operations: AI and ML capabilities for network operations is another important criterion that enables automation, ensures that Service-Level Agreements (SLAs) are kept, and improves customer experience. As microservices come into play for 5G, automation is key to ensuring the efficiency of the network. Companies are evaluated based on the degree of AI/ML used for troubleshooting, predictive network maintenance, and network analytics. AI/ML capabilities for 5G cloud-native platforms is a rapidly developing area, with some companies being further ahead due to pre-existing AI/ML capabilities, while others are working to implement it. **This criterion gets a 15% for its innovation scoring.**

INNOVATION CRITERIA

Open Standards and Open Source: Open standards and open source enables portability across multiple clouds and helps avoid software or cloud "lock-ins." It also supports innovation and allows CSPs and app developers to improve their offerings based on changing demand and market trends, as opposed to relying on a proprietary solution where it is up to the platform provider to provide updates. Companies that support interoperability with third-party components through open standards and enable innovation through the utilization of open-source projects will rank highly on this criterion. **This criterion takes a lower priority at 10% of the innovation score.**

Container Security: While Kubernetes and cloud Operating Systems (OSs) themselves have built-in security features, container security is still an important feature, albeit one of lower priority in the scope of this CA. This criterion is measured by implementation of security features, effectiveness of ensuring tenant isolation, and measures to ensure rollbacks. **It gets a 5% cut of the innovation score.**

IMPLEMENTATION CRITERIA

Cloud-Native Capabilities: This is a key criterion for CSPs, as moving forward, 5G will require CSPs to design services and work in a cloud-native way. Platform providers are evaluated on their support for cloud-native capabilities, such as CI/CD pipelines, DevOps processes, microservices, service mesh, container orchestration, cluster management, *etc*. **This criterion has the highest weighting of 30% for implementation.**

Extent of Modularity: Beyond incorporating multi-vendor Network Functions (NFs), CSPs are also looking for service continuity and protection of existing investments in the form of modularity for cloud-native platforms. Third-party components should be able to interoperate with these platforms, and CSPs are looking to avoid platform "lock-ins" as well. The ability to swap out components, the level of interoperability with CSPs' existing assets and components, and the extent of ecosystem support are evaluated for this criterion. **This is the second most prioritized criterion, with a weighting of 25% for implementation.**

Multi Cloud and Hybrid Cloud Support: The introduction of hyperscalers into the telco domain is an emerging trend that will drive innovation and transform the way CSPs deploy their networks. Being able to go multi cloud or hybrid cloud is an increasing area of interest for CSPs, and platform providers are looking to increase their support to manage cloud-native workloads across multi-cloud deployments and enable advanced capabilities, such as "burst-to-cloud" with hybrid cloud deployments. Becoming cloud agnostic is also an increasingly important feature for CSPs to deploy their Information Technology (IT) and telco workloads. This is an emerging trend for telcos that will increase in importance in the long term and **gets a 20% scoring for implementation.**

Telco Domain Range: Companies are evaluated based on the ease and extent of deploying the platform across the telco domains (*i.e*., core, edge, far edge, and RAN). CSPs ideally want to have a single unified platform that cuts across all telco domains, but the market is very heterogenous in this regard; therefore, this **gets a lower scoring of 15% for implementation.**

Deployment Model: This criterion refers to whether the platform supports bare metal deployments and Virtual Machine (VM) deployments. As CSPs transition from VMs on NFVI to containers on bare metal, the platform will need to provide CSPs with an evolutionary path that does not alienate brownfield deployments of VNFs on NFVI. **This has an implementation weighting of 10%.**

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New York, NY 11771 USA
Tel: +1 516-624-2500
www.abiresearch.com

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