

# O-RAN Sustainability: Benefiting from the Open Ecosystem of VMware RIC

RAN Intelligent Controller Partner xApps and rApps  
to Reduce Energy Usage in Radio Access Networks





## Table of contents

Strategies to Save Energy and Reduce Emissions in the RAN . . . . .	2
A Virtualized RAN Architecture for a Sustainable Future . . . . .	4
Energy Efficiency in Telecom. . . . .	5
RAN Energy Management with the Auptim rApp from AirHop. . . . .	6
Using Aira's xApp to Boost MU-MIMO Performance . . . . .	7
Saving Energy Dynamically with the HCLSoftware rApp. . . . .	8
Autoscaling Resources with the Net AI xUPscaler xApp . . . . .	9
Rimedo Labs xApp Steers Traffic to Optimize Utilization . . . . .	10
Telco Cloud Platform RAN. . . . .	11
VMware RIC. . . . .	12
Modernize the RAN to Save Energy . . . . .	13



## ADVANCING SUSTAINABILITY IN TELECOM NETWORKS

VMware is a certified carbon-neutral company, powered 100% by renewable energy. And we've set an ambitious agenda to advance sustainability, including radically decarbonizing our supply chain, improving the carbon efficiency of workloads, and fueling the transition to zero-carbon clouds. VMware is working with our partners and customers to [advance sustainability in telecommunications networks](#) across four key pillars of a zero-carbon strategy:

- Improving energy and resource efficiency
- Using renewable energy sources
- Reducing greenhouse gas emissions
- Overcoming institutional barriers

This paper demonstrates how the open RAN ecosystem fostered by the VMware Telco Cloud helps telecommunications companies advance toward a greener, more sustainable future. The use cases in this paper illuminate how the programmability of [VMware RAN Intelligence Controller](#) helps reduce energy consumption and carbon emissions in radio access networks.

# Strategies to Save Energy and Reduce Emissions in the RAN

Sustainability initiatives at telcos are driven by a myriad of factors, from regulatory requirements, to customer expectations and demands from investors. Perhaps the most compelling of all however are basic business imperatives – increasing costs, and the additional demands introduced by 5G, are forcing telcos to seek ways to reduce their energy consumption in order to increase their margins. Beyond cost, sustainability initiatives are creating new business opportunities. According to research group STL Partners, telcos see greater upside than downside in efforts to mitigate climate change, with total opportunities outweighing the costs by 1.8% of revenue.

More than 80% of a typical communications service provider's (CSP) energy consumption is in the radio access network (RAN), making this costly part of the network prime for innovation that heightens sustainability.

## VMware's Approach to Sustainability

VMware has identified 3 key strategies that will allow Telcos to increase their energy efficiency and reduce their carbon emissions.

- **Improve workload efficiencies:** Intelligent workload management using AI/ML-driven automation.
- **Optimize resource utilization:** Consolidate resources to reduce redundancy and waste.
- **Enable green energy:** Centralized power policies that manage energy sources.

Since the RAN typically consumes 73% of the total energy usage at telcos, VMware is developing technology and working with partners in its open ecosystem to reduce energy usage and carbon emissions.

Reducing RAN energy consumption requires a combination of more efficient architectures, smarter operations, and greater process automation – all of which can be enabled with the RAN Intelligent Controller, or RIC.



“[The RIC] validates the role that this powerful new platform plays in defining Open RAN as the future of networking. It boosts capacity for customers when they need it most, reduces the need for expensive hardware by a third and cuts down on energy consumption. These time and cost savings will ultimately encourage the introduction of new, innovative services.”

FRANCISCO MARTÍN,  
HEAD OF OPEN RAN,  
VODAFONE



## DECONSTRUCTING THE RIC

The O-RAN Alliance's architecture decouples the RIC: Non-real time (Non-RT) control functionality of greater than 1 second typically resides in the non-RT RIC, and the near-real time (near-RT) control functions of between 10 milliseconds and 1 second reside in the near-RT RIC.

Non-RT functions typically include service and policy management, RAN analytics, and training for machine-learning models.

Trained machine-learning models, artificial intelligence-enabled policies, and real-time control functions produced in the non-RT RIC are distributed to the near-RT RIC for runtime execution.

The O-RAN A1 interface connects the orchestration layer containing the non-RT RIC with the eNB containing the near-RT RIC.

As a result, you can modify the RAN and program your network according to models optimized to meet your network's unique policies and objectives.



[Demo Video: Activating Network Programmability with VMware RIC](#)

# A Virtualized RAN Architecture for a Sustainable Future

Energy consumption in the RAN is driven by the need to manage and power radio transmissions across wide geographic areas. Although each successive generation of mobile technology has introduced more effective algorithms to increase the bandwidth available to mobile users, the demands of capacity, coverage and quality have led to greater power requirements for radio access networks.

As a result, the RAN has become the key focus of industry attempts to reduce overall power consumption. The question is, how can power consumption be reduced without undermining service quality? It is essential to balance the need to reduce energy costs with the need to ensure that residential and enterprise consumers experience the benefits of enhanced 5G services.

Legacy RANs, built on proprietary physical hardware, are inherently inefficient, with dedicated capacity permanently allocated and powered on in silos. For optimization and operations, CSPs have been limited to whatever management capabilities are offered by their RAN vendors.

The O-RAN Alliance's architecture delivers a more efficient alternative:

- Virtualized components bring agility and scalability.
- Open APIs foster supply-chain diversity.
- Disaggregation paves the way to add the RIC and its power of programmability.

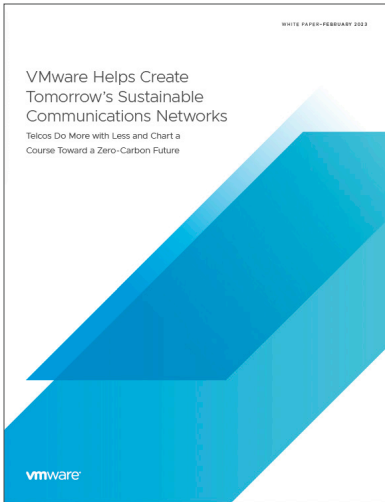
In the O-RAN architecture for an open RAN, third-party applications are hosted on the RAN Intelligent Controller, or RIC. The RIC brings software-defined programmability to the RAN by collecting information on performance and configuration management and exposing it to applications. These applications, which can exploit artificial intelligence and machine learning, can then determine how the RAN can be reconfigured to optimize the network to reduce energy consumption and carbon emissions. The RIC, then, is ideally positioned to host applications that can control all aspects of power consumption in the RAN, from the computing resources allocated to RAN control functions to the transmission power used by each cell site.

## VMware RIC Partners and Sustainability

According to Omdia, VMware has developed the most extensive partner ecosystem of any RAN vendor in the telecommunications industry. VMware is working with several partners from across its ecosystem to implement energy-savings applications.

This paper describes the different approaches taken by our partners to helping telcos reduce energy usage. Their innovative applications highlight how VMware RIC lets you program, manage, and optimize a radio access network. The partner applications can be used individually or in combination to meet your own unique requirements.

The next page addresses the RIC's role in improving energy efficiency. Then the spotlight shifts to five energy-savings applications from partners in the open RAN ecosystem powered by VMware RIC.



### BUILDING AND OPERATING SUSTAINABLE TELECOM NETWORKS

VMware is helping telcos do more with less so they can improve energy efficiency, maximize the use of renewable energy, and reduce carbon emissions. Find out how in our [white paper on sustainable telecommunications networks](#).



*Reducing RAN OpEx with an energy savings rApp from VMware*

## Energy Efficiency in Telecom

Telecommunications and IT together, known as ICT, consume 5-9% percent of the world's electricity supply, and the rapid growth in digitization could increase the information and communications technology industry's power consumption to 20 percent by 2030. This projected increase is driven not by losses in efficiency but by the ever-increasing demand for transmitting and consuming data at maximum speed.

With more telecom network functionality being moved to data centers or the edge, including virtualized RAN sites, the share of network energy consumption is projected to grow nearly five-fold. If the ICT industry can work smarter and manage workloads better, some sources estimate that the ICT industry can prevent emissions at a rate of 10 times its own footprint by 2030. In addition to using massive MIMO, which highly energy efficient, the following strategies could improve RAN energy efficiency:

- Making energy consumption visible and making workloads carbon-aware.
- Using renewable-energy-powered data centers.
- Placing and scheduling workloads with the explicit, measurable intention of minimizing energy consumption and reducing emissions.

If you could manage when and where workloads are running, you could take advantage of renewable energy. A prerequisite to doing so is integrating energy and carbon metrics with your workload management system. The development of carbon-aware software could integrate electricity carbon intensity as an optimization factor into workload management. Intelligent workload placement and optimization could improve the sustainability of 5G, and the RIC could help.

### Role of an rApp in the Non-RT RIC

- Reduce energy consumption of RAN components when they are not in use.
- Use machine learning models and intelligent workload placement to place workloads so they minimize the consumption of non-renewable energy.

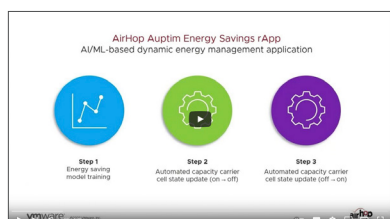
### Role of an xApp in the Near-RT RIC

- Collect data on the carbon intensity of RAN workloads as they run and send it to the non-RT RIC for use in machine learning models that seek to minimize emissions.





## VIDEO DEMONSTRATION OF THE USE CASE ON VMWARE RIC



*Managing RAN energy consumption with AirHop's Energy Savings rApp*

### BENEFITS OF USING AIRHOP'S AUPTIM RAPP

- Reduce energy consumption: a recent proof-of-concept trial at a CSP showed that the rApp reduced energy consumption by 15 percent.
- Ensure user quality of service and fulfill customer SLAs.
- Improve operational sustainability.

About AirHop Communications  
AirHop's solutions include the Auptim family of O-RAN standard-compliant xApps and rApps and the eSON and eSON360 platforms for pre-standard architecture deployments. See <https://www.airhopcomm.com>



# RAN Energy Management with the Auptim rApp from AirHop

As you expand your RAN footprint to enhance connectivity and services, a major challenge is finding the right balance between energy consumption and network performance.

In 5G networks, CSPs use carrier aggregation to furnish wide-area coverage and high-capacity throughput for data-heavy applications. You need to strike a balance between resources assigned to coverage and capacity. If insufficient resources are provided for capacity, user experience will suffer, but if full resources are permanently allocated for both coverage and capacity, energy consumption in the RAN will be higher than needed to meet end-user service expectations.

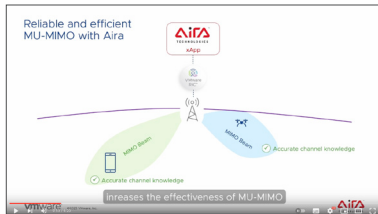
## Role of AirHop's Auptim rApp on VMware RIC

AirHop's Auptim AI/ML-based Energy Savings rApp intelligently manages energy consumption in multi-carrier cellular networks while maintaining high levels of end-user quality of service. The rApp optimizes network-wide energy usage by switching on and off capacity carriers in response to service demand levels. Using the Energy Savings rApp results in a reduction of operating expenses in the form of energy costs, assurance of quality of service, and a more sustainable network.

- Supported by the policy-based guidance, data analytics, and AI/ML model management provided by VMware Centralized RIC, the AirHop Communications Auptim rApp uses machine learning to predict energy savings actions in the network.
- The training process begins by ingesting historical RAN data composed of unique traffic profiles characterizing demand variations due to time windows and by types of customers, network configurations, and performance KPIs.
- Then the application establishes a single trained model deployed as distributed inferences across cells to optimize energy savings for each cell in the network. The deployed model is periodically updated based on various inputs.

Finally, the rApp makes an intelligent decision about the on or off state of the capacity carrier in order to maximize energy savings. As a result, the energy consumption of the RAN fluctuates with traffic demand without affecting user quality of service.

## VIDEO DEMONSTRATION OF THE USE CASE ON VMWARE RIC



### *Boosting MU-MIMO Performance with Aira's xApp on VMware Distributed RIC*

#### **BENEFITS OF USING AIRA'S HIGH FIDELITY CHANNEL ESTIMATION AND PREDICTION xAPP**

- Increase the effectiveness of MU-MIMO compared to simple channel estimation.
- Obtain large SINR gains.
- Expand cell coverage.
- Reduce OpEx and CapEx.
- Reduce power consumption.

About Aira Technologies  
Aira Technologies is a pioneer in the application of machine learning to radically improve wireless telecommunications. See <https://www.aira-technology.com>



# Using Aira's xApp to Boost MU-MIMO Performance

MU-MIMO can improve RAN performance without changes to devices or radios. In order to beamform efficiently, however, MU-MIMO requires accurate knowledge of the channel between the user and the base station. Current channel estimation techniques fail to incorporate user mobility and evolution of the RF environment into their calculations, resulting in inaccurate estimates that eliminate the advantage of MU-MIMO.

Aira's High Fidelity Channel Estimation and Prediction xApp can allow operators with existing networks to achieve more than double the throughput and gain up to 3dB of Signal to Interference Noise Ratio (SINR).

This excess throughput can either service more subscribers or furnish existing ones with higher levels of data rates for high-fidelity applications like VR and gaming, helping operators improve revenue. With these gains in SINR, operators can extend cell ranges and plan new network deployments with fewer base stations, thereby reducing overall energy consumption.

Channel Estimation is a key processing block in the Distributed Unit (DU) of the radio access network (RAN) software stack. In traditional implementations, the algorithm used for channel estimation relies solely on the reference signals (such as SRS and DMRS) defined by 3GPP. Aira's more custom approach taps its machine learning module to use the reference signals to establish and continuously update a network profile and user profile.

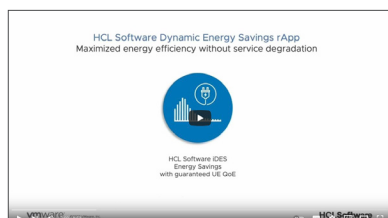
## Role of Aira's xApp on VMware RIC

- The characteristics of the serving network and user behavior are finger-printed by Aira using ML algorithms that can predict future changes in the channels between users and their serving networks.
- Aira's Channel Prediction xApp uses L1 reference signals (SRS, DMRS, etc.) to first estimate and classify the user status, including their speed and distance from the base station, and the network environment, including especially the most likely channel model and multipath delays. The xApp then uses this information with the reference signals to predict the evolution of the user channel.





## VIDEO DEMONSTRATION OF THE USE CASE ON VMWARE RIC



*Maximizing energy efficiency with HCLSoftware's iDES rApp*

### BENEFITS OF USING THE HCLSOFTWARE rAPP

- Save energy beyond the standard dSON energy-saving feature.
- Maximize customer experience.
- Fulfill SLAs while controlling energy costs.

**About HCLSoftware**  
HCLSoftware is a division of HCL Technologies (HCL). HCLSoftware develops, sells, and supports over 30 product families in the areas of customer experience, digital solutions, secure DevOps, security, and automation. See <https://www.hcl-software.com>

# HCLSoftware

## Saving Energy Dynamically with the HCLSoftware rApp

As you transform your networks to deliver innovative 5G services, it's important to find the right compromise between quality of experience for subscribers and reducing the energy needed to power your networks. Insufficient network resources can lower service quality; excessive network resources wastes energy and increases operating costs. A recent study by McKinsey showed that the RAN consumes about 60 percent of the total power consumed by a mobile network.

HCL's iDES rApp uses artificial intelligence and machine learning (AI/ML) to predict future traffic load and expected user quality-of-experience. iDES then determines which cells to turn off in order to save energy while meeting key quality indicators (KQIs). An example of such a KQI is the maximum percentage of UEs below an SLA at any given time. It can safely turn off cells to reduce power consumption without compromising on QoE. It can turn cells back on when the quality of experience is expected to degrade.

Field deployments of iDES show that by extending cell off-time (or sleep time) of under-utilized cells, an additional 7% reduction in energy savings can be achieved compared to traditional techniques.

### Role of the HCL iDES rApp on VMware RIC

- The HCLSoftware iDES rApp runs on VMware Centralized RIC and uses resources and services provided by the RIC's R1 interface, including network and UE data.
- The iDES rApp includes several decision-making modules that process input data to make network configuration decisions. iDES works with supporting rApps that use AI/ML to forecast changes in network load and the quality of user experience.
- iDES lets you set a target value for a key quality indicator (KQI) to determine the service quality that the network must deliver. For example, if you set a KQI mandating that up to 20 percent of users might experience throughput below 8Mbps, iDES will turn cells off only when the KQI can be guaranteed and turn cells back on when the algorithms predict the KQI would be breached. Cell on-off decisions are sent to VMware RIC over R1, which then sends them to the network, and then an iDES rApp module validates that changes deliver the intended result.

## VIDEO DEMONSTRATION OF THE USE CASE ON VMWARE RIC



*Forecasting RAN Traffic and Autoscaling Resources with a Net AI xApp on VMware RIC*

### BENEFITS OF USING THE NET AI xAPP

- Use near real-time RAN-resource auto-scaling to optimize QoS performance.
- Tap artificial intelligence to improve accuracy in traffic forecasts.
- Enhance quality of service for customers.
- Reduce energy costs and OpEx

#### About Net AI

Net AI is a pioneering network intelligence company whose mission is to develop a deep traffic analysis platform that helps mobile CSPs drastically reduce CapEx and OpEx.

<https://netai.tech>



# Autoscaling Resources with the Net AI xUPscaler xApp

Investment in network infrastructure is typically driven by traffic estimates obtained with the aid of deep packet-inspection tools. Provisioning of RAN Centralized Unit (CU) user plane capacity, for example, is largely performed to meet peak traffic demand and does not change in real-time to meet actual demand. Network resources are typically managed reactively, based on offline information that is usually too dated for effective decision making. Such an approach results in poor CapEx efficiency, modest user quality of experience, and high energy and engineering costs.

Real-time predictive information about service-level network usage is critical to the effective management and monetization of 5G networks.

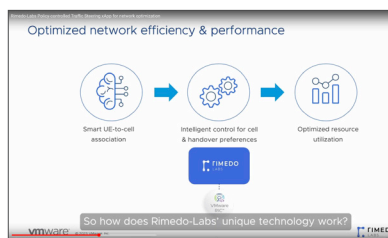
Net AI's xUPscaler xApp, which runs on VMware Distributed RIC, helps tackle the challenges of meeting increasing traffic demands in a cost-effective and energy-efficient way. The xApp embeds Net AI's artificial intelligence models and uses historic and real-time network traffic data to forecast traffic volumes at the level of base stations (or at higher geographic granularity) to furnish actionable analytics to the near-RT RIC through an O-RAN-compliant interface. The xApp sends comprehensive KPIs to a web service, which displays these values on a dashboard.

## The Role of the Net AI xApp on VMware RIC

- Net AI's xApp disentangles metadata that summarizes traffic consumption measured by the volume of uplink and downlink data into the demands of the individual services that make up these aggregates. It predicts future traffic consumption over configurable time horizons.
- Net AI's forecasting engine uses spatiotemporal correlations characteristic of mobile traffic along with AI-driven autoscaling logic to produce relative capacity values for gNB Centralized Unit User Plane (gNB-CU-UP) entities, which are used to load-balance traffic between gNB-CU-UPs.
- Forecasts are generated using traffic volume data from each antenna in the RAN relayed to the xApp by an E2 interface subscription to VMware Distributed RIC. The forecasts are saved to the VMware RIC shared data layer to avail them to other xApps registered with the RIC.



## VIDEO DEMONSTRATION OF THE USE CASE ON VMWARE RIC



### Steering traffic with the Rimedo Labs xApp for network optimization

#### BENEFITS OF THE POLICY-CONTROLLED xAPP FROM RIMEDO LABS ON VMWARE RIC

- Optimize network efficiency and performance.
- Avoid congestion at cell sites.
- Distribute load and demand evenly across the RAN.
- Gain greater energy efficiency.

**About Rimedo Labs**  
Rimedo Labs specializes in providing high-quality consulting, implementation and R&D services for modern wireless systems, focusing on Open RAN, 5G, and beyond. Rimedo Labs delivers customized xApps and rApps for RAN intelligent controllers.  
<https://rimedolabs.com>



# Rimedo Labs xApp Steers Traffic to Optimize Utilization

Current Traffic steering mechanisms primarily use radio conditions of the cell to determine where to steer traffic. These types of steering mechanism offer few steering options, mostly limited to cell reselection, modification of handover parameters, and cell priorities. After adopting these types of traffic steering methods, CSPs often discover that their networks are either underutilized in some areas or severely overloaded in others.

Rimedo Labs policy-controlled xApp, powered by VMware Distributed RIC, helps CSPs by providing service-based and load-balancing-focused traffic steering. Using internal intelligence and following the policies specified via the A1 interface, the Rimedo Labs policy-controlled xApp can simultaneously distribute the load between network nodes and offload specific traffic to dedicated cells (e.g., some cells may have caching enabled for video services, or lower latency or larger buffers).

By integrating Rimedo Labs policy-controlled xApp with Rimedo's Energy Savings rApp, which runs on VMware Centralized RIC, the solution is enhanced to support optimal resource allocation for more balanced, resilient and energy-efficient networks while ensuring a high-quality customer experience.

## Roles of the Rimedo Labs xApp and rApp

- The combination of VMware Distributed RIC and the Rimedo Labs xApp lets operators specify different objectives for traffic management by optimizing the network and UE performance to achieve a more balanced cell load.
- Operators can flexibly configure desired optimization policies, utilize the right performance criteria, and use machine learning to enable intelligent and proactive traffic steering.
- To reduce energy usage in the RAN, VMware and Rimedo have worked together to develop a solution that integrates Rimedo's Energy Savings rApp, hosted on VMware Centralized RIC, with Rimedo's Traffic Steering xApp, hosted on VMware Distributed RIC. The solution incorporates mobility and service load balancing with energy savings policies to improve user experience while reducing RAN energy usage.

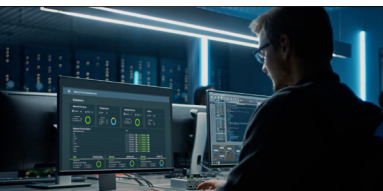


## AT A GLANCE

VMware Telco Cloud Platform RAN™ is powered by field-proven virtualized compute coupled with VMware Telco Cloud Automation™ and VMware Tanzu™ for Telco RAN, a telco-grade Kubernetes distribution.

### KEY BENEFITS AND CAPABILITIES

- Run virtualized baseband functions, virtualized distributed units (vDUs), and virtualized central units (vCUs) in accordance with stringent RAN performance and latency requirements
- Optimize the placement of DUs and CUs through programmable resource provisioning
- Use the same common platform to virtualize the RAN and migrate to O-RAN
- Deploy and operate both RAN and non-RAN workloads on a horizontal platform
- Use a security-hardened Linux host called Photon OS that is optimized for running containers on VMware vSphere®
- Isolate containerized network functions (CNFs) on virtual machines and the VMware hypervisor, VMware ESXi™, to establish a strong security boundary
- Automate lifecycle management of infrastructure, Kubernetes clusters, vRAN functions, and 5G services



[Video demo: Modernize the RAN to scale 5G RAN networks with ease](#)

# Telco Cloud Platform RAN

VMware Telco Cloud Platform RAN is powered by field-proven virtualized compute solution coupled with Tanzu for Telco RAN, a telco-grade Kubernetes distribution, and VMware Telco Cloud Automation. The platform paves a clear RAN modernization path: CSPs can move from their traditional RAN to vRAN now and start to move in the direction of the O-RAN Alliance's architecture.

The RIC helps transform the RAN into a 5G multi-services hub that enables you to develop and deploy custom 5G applications alongside vRAN functions while delivering superior quality 5G services and customer experiences. As a result, you can deploy applications to save energy and reduce emissions in the RAN.

VMware Telco Cloud Platform RAN helps you virtualize RAN functions on a horizontal platform, which becomes the foundation for moving to O-RAN by giving you the flexibility to evolve toward the future without disrupting your operations or overhauling your network design.

Furthermore, VMware Telco Cloud Platform RAN simplifies operations with consistency across distributed RAN sites, regardless of the vRAN functions each site hosts. Centralized automation simplifies operations and reduces OpEx.

VMware RIC can run on VMware Telco Cloud Platform RAN or on another platform.

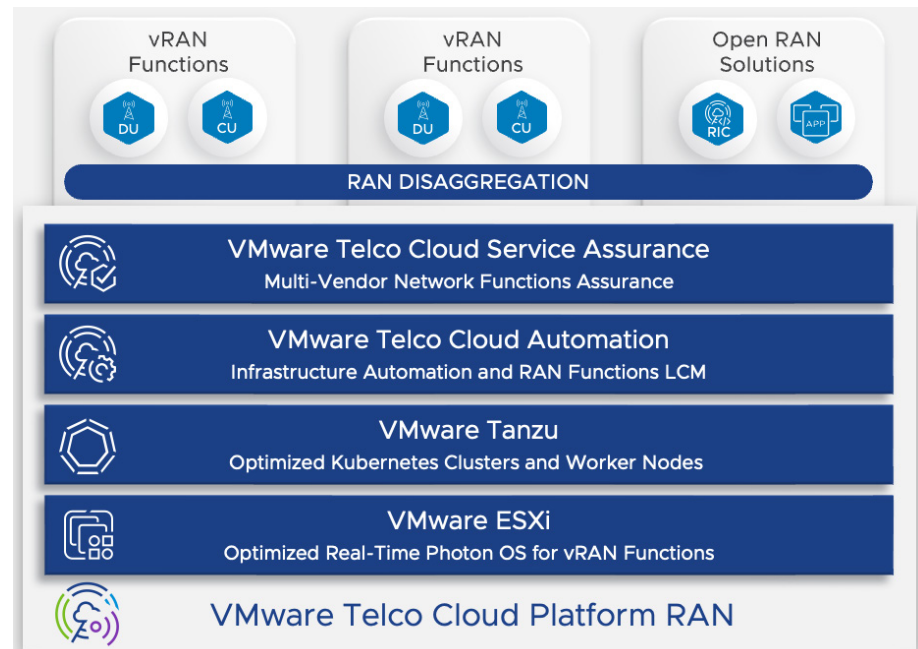


FIGURE 1: The architecture of VMware Telco Cloud Platform RAN enables you to fulfill various 5G use cases with ease and consistency.



## RAN PROGRAMMABILITY

The RIC disaggregates the RAN control, management, and data planes to enable applications from different vendors to access control and management plane functions. The result radically improves RAN programmability.



*Demo Video: Activating Network Programmability with VMware RIC*

## LEARN MORE

For more information about VMware RIC, call 1-877VMWARE (outside North America, dial +1-650-427-5000) or visit <https://telco.vmware.com/>

# VMware RIC

VMware RIC is a multi-RAN, multi-cloud platform that abstracts the underlying RAN infrastructure to host the xApps and rApps that drive the O-RAN RIC use cases highlighted in this paper. These apps spark innovation by introducing automation, optimization, and service customization.

VMware RIC modernizes the RAN to be programmable so you can build an open RAN with solutions from a vibrant ecosystem of partners. Here are some key capabilities and benefits of VMware RIC and its SDKs:

- Flexibility – VMware RIC can run on VMware Telco Cloud Platform RAN or on other vendors' RAN platforms, including traditional and virtualized RAN environments from third parties, so you can build a future-proof RAN with multi-vendor solutions while protecting your investments.
- Simplicity – Centralized RAN intelligence helps simplify RAN operations and optimizes network utilization.
- Programmability – Reduces operational complexity by running RAN control and management functions with open standards.
- Monetization – The VMware RIC SDKs empower developers and vendors to create innovative services that maximize business growth.
- Ecosystem – The ecosystem partners of VMware spark innovation.

By working with both traditional RAN and virtualized RAN environments, VMware Centralized RIC empowers you to run rApps and xApps without making significant changes to your existing RAN architecture — you can take the first step toward a disaggregated RAN now and set the stage for a smooth transition to open RAN.

### xApp and rApp Partner Ecosystem

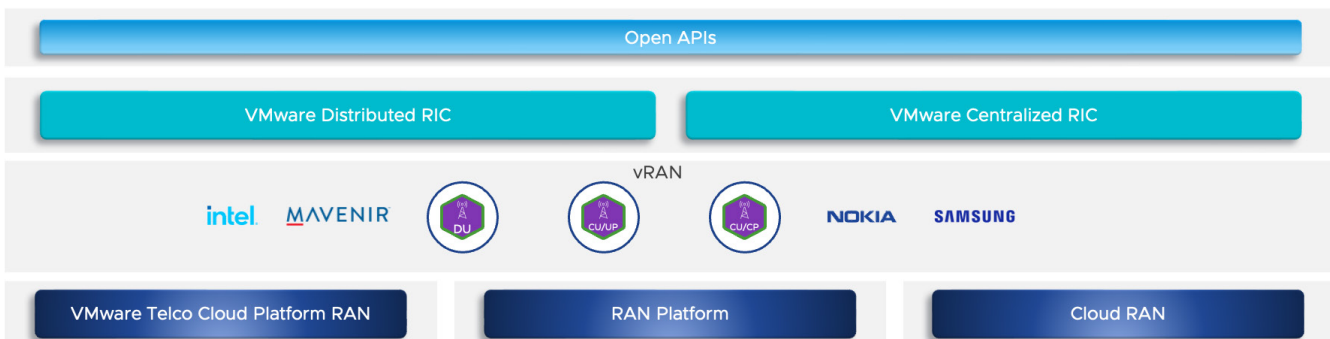


FIGURE 2: Solutions from a vibrant ecosystem of partners put open RAN use cases into action so you can optimize and monetize 5G.

# Modernize the RAN to Save Energy

The use cases covered in this paper demonstrate the potential value that RAN intelligent controllers can drive. By identifying target RIC use cases for sustainability early, you can work with application developers and independent software vendors to devise a strategy for reducing energy consumption and carbon emissions.

VMware Telco Cloud Platform RAN modernizes your radio access networks so that you can rapidly develop and deploy innovative 5G services at scale. The energy-saving xApps and rApps in this paper can be deployed on VMware RIC.

## THE VMWARE TELCO CLOUD FOR 5G

VMware helps communications service providers build, operate, protect, and monetize their telco cloud. Our technology empowers you to transform your 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. Solutions for infrastructure, orchestration, automation, assurance, optimization, and security modernize your network from the core to the RAN.

## TELCO CLOUD PORTFOLIO

- VMware Telco Cloud Platform
- VMware Telco Cloud Automation
- VMware Telco Cloud Service Assurance
- VMware Telco Cloud Platform Public Cloud
- VMware Telco Cloud Platform RAN
- VMware RIC





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