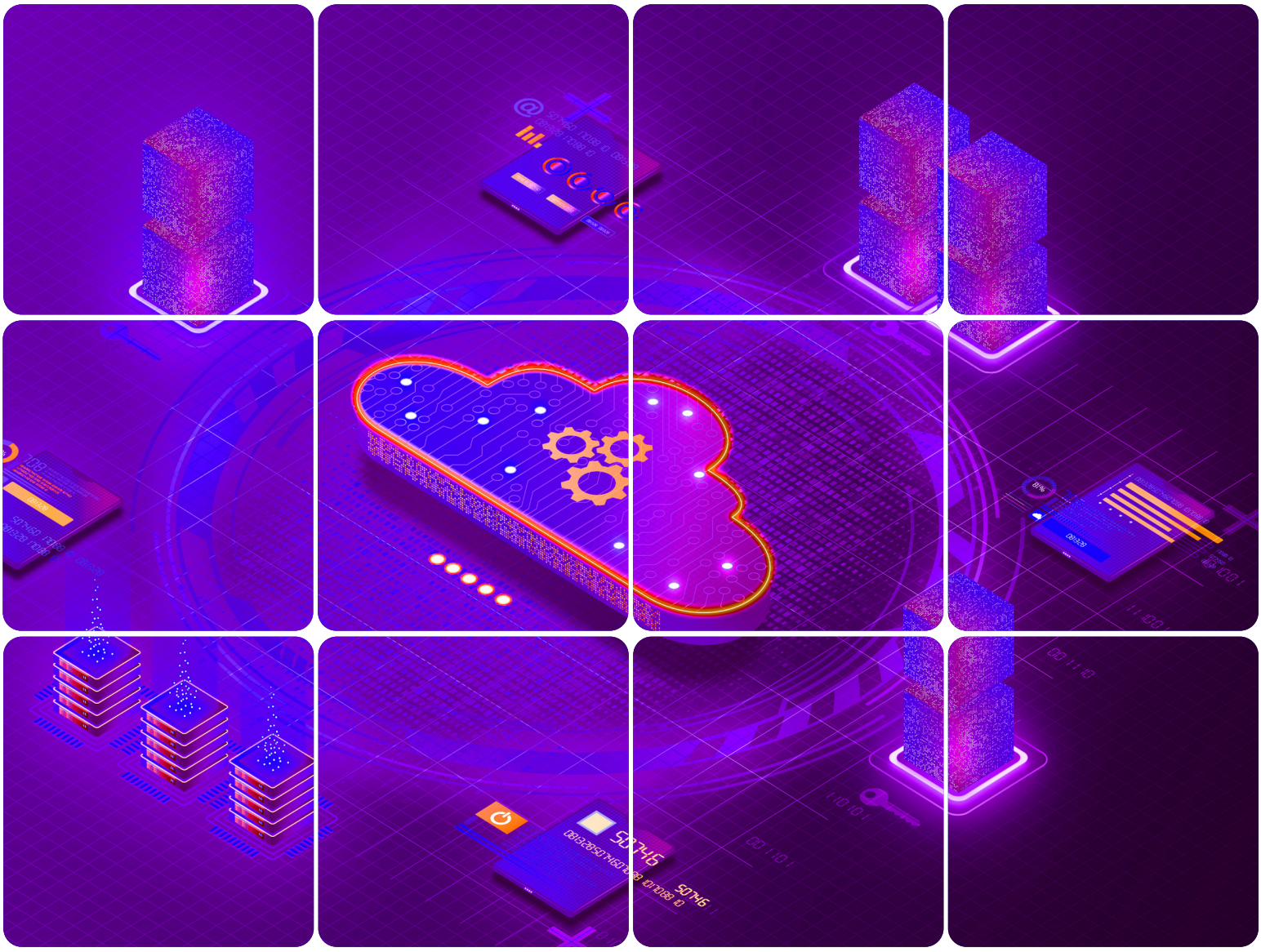

The Economic Benefits of Juniper Cloud-Native Router in Modern vRAN and O-RAN Networks

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Executive Summary

The telecommunications landscape is rapidly evolving with the disaggregation and virtualization of Radio Access Networks (RAN), driving significant advancements in both vRAN and O-RAN architectures. These advancements aim to reduce vendor lock-in, enhance network flexibility, and improve cost efficiency for operators. The Juniper Cloud-Native Router offers a highly integrated, cloud-native solution for vRAN deployments, addressing both current and future operational needs.

This whitepaper provides a comprehensive analysis of how Cloud-Native Router optimizes cloud-native vRAN and O-RAN networks. By leveraging virtualized routing functions, the Cloud-Native Router solution eliminates the need for physical cell site routers, drastically reducing the capital and operational expenses associated with router hardware, power consumption, space requirements, and ongoing support costs. The Cloud-Native Router architecture, built on the proven Junos OS control plane and powered by the Data Plane Development Kit, enables agile scaling, automation, and real-time network management.

Our analysis, based on ACG's total cost of ownership model, demonstrates a cumulative TCO savings of 57%, cumulative CapEx savings of 49%, and cumulative OpEx savings of 65% over five years in a network with 30,000 cell sites deploying Juniper Cloud-Native Router. The combination of lower CapEx, through the elimination of physical router hardware, and lower OpEx, achieved by reducing power, space, and operational costs, makes Cloud-Native Router a future-proof solution for 5G networks and beyond.

vRAN/O-RAN Overview

The Radio Access Network (RAN) is undergoing significant transformation as the industry moves toward disaggregation and virtualization of network functions. Traditionally, the RAN comprised tightly integrated hardware and software, most notably the Baseband Unit (BBU), which processed baseband signals at the cell site. However, in the era of virtualized RAN (vRAN) and Open RAN (O-RAN), this monolithic hardware is being split into discrete software components known as the Central Unit (CU) and Distributed Unit (DU).

Both the CU and DU are now cloud-native software modules running on general-purpose servers. Typically, the DU remains on a hardened server at the cell site, close to the radio equipment, to minimize latency and ensure real-time processing. In contrast, the CU is often hosted in a centralized or edge data center, such as a central office, providing more efficient management of multiple DUs.

The distinction between vRAN and O-RAN lies in their architectural openness. vRAN solutions are generally proprietary, with a single vendor controlling both the hardware and software components. Conversely, O-RAN promotes interoperability and openness, adhering to specifications defined by the O-RAN Alliance, enabling operators to mix and match hardware and software vendors. This disaggregation allows operators to break free from vendor lock-in, improving flexibility and cost-efficiency.

At the heart of these virtualized architectures is the requirement for robust IP transport from the cell site to the centralized locations. This function is traditionally performed by a physical cell site router, responsible for carrying packets over the IP network. However, as vRAN and O-RAN mature, there is a growing emphasis on reducing the hardware footprint at the cell site, leading to solutions that combine both computing and routing capabilities into a single server.

Juniper Cloud-Native Router vRAN Solution

Juniper Cloud-Native Router represents a cutting-edge solution for vRAN deployments, particularly in the context of evolving operational modes. The Present Mode of Operation (PMO) typically includes a server hosting the DU, alongside a cell site router equipped with 10G uplinks to transport the IP traffic to a central location (Figure 1). This setup, while functional, retains the physical footprint and costs associated with maintaining separate routing hardware.

The Future Mode of Operation (FMO) offers a more integrated approach, with the server not only hosting the vDU but also running Juniper Cloud-Native Router on the same hardware (Figure 1). This server is enhanced with a Smart NIC card, designed to handle the stringent timing requirements for RAN processing, while the Cloud-Native Router software, requiring a minimum of three CPU cores, can forward traffic at speeds of 10Gbps or higher. In typical cell site configurations, the link speeds are 10G, ensuring the forwarding capacity far exceeds the requirements of the network, providing an optimal balance between performance and resource utilization.

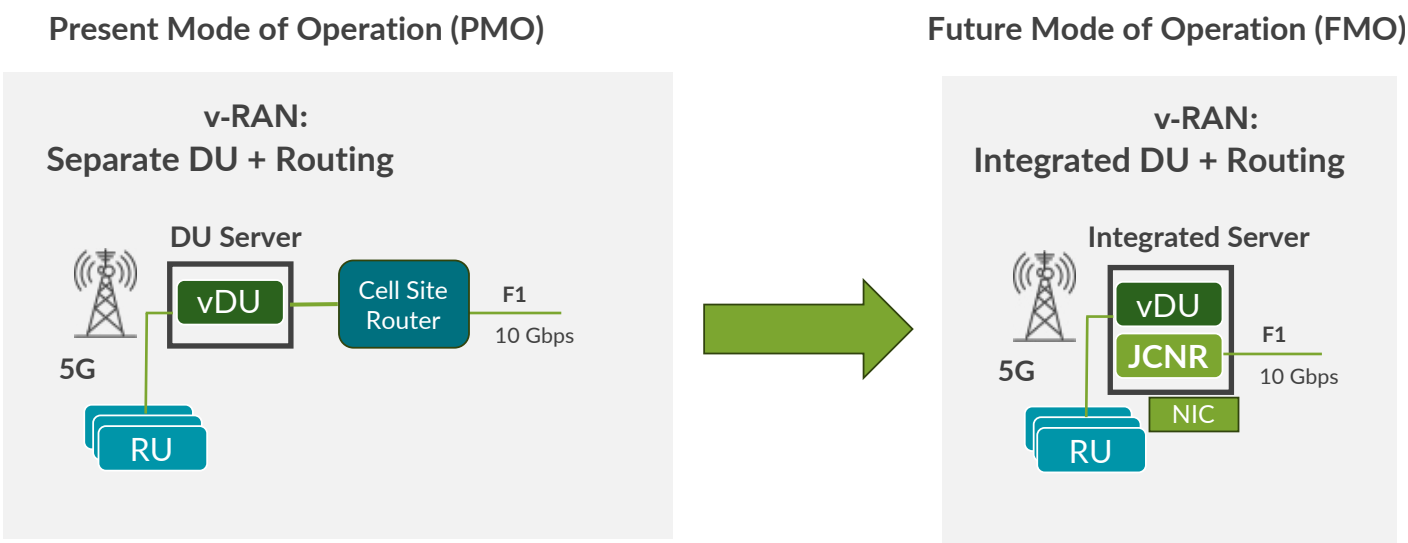

Figure 1. PMO with a Physical Cell Site Router vs FMO with Integrated Virtual Router

One of the key advantages of this integrated solution is the elimination of the physical router at the cell site, bringing with it significant reductions in capital expenditures (CapEx), power consumption, space requirements, and ongoing hardware maintenance costs. Additionally, by integrating the router within the DU server, operators benefit from improved automation and ease of maintenance across large-scale networks, often spanning thousands of routers. The ability to streamline operations through automation tools and reduce labor costs makes this a highly scalable and cost-effective solution for large deployments.

Juniper Cloud-Native Router Overview

The Cloud-Native Router is a virtual router, designed from the ground up to deliver carrier-grade routing in a virtualized environment. Built on Juniper's proven Junos OS control plane and powered by the Data Plane Development Kit (DPDK) for fast packet processing, Cloud-Native Router provides high-performance routing in a lightweight, agile package (Figure 2). As a fully cloud-native solution, it can be deployed in a Kubernetes environment, making it an ideal choice for modern network architectures where scalability and flexibility are paramount.

Cloud-Native Router offers multiple configuration options, catering to a wide range of operational requirements. Operators can configure it through the familiar Junos CLI, use Kubernetes custom resources for orchestration or take advantage of automation frameworks such as Netconf and Terraform to streamline the deployment and management of network services.

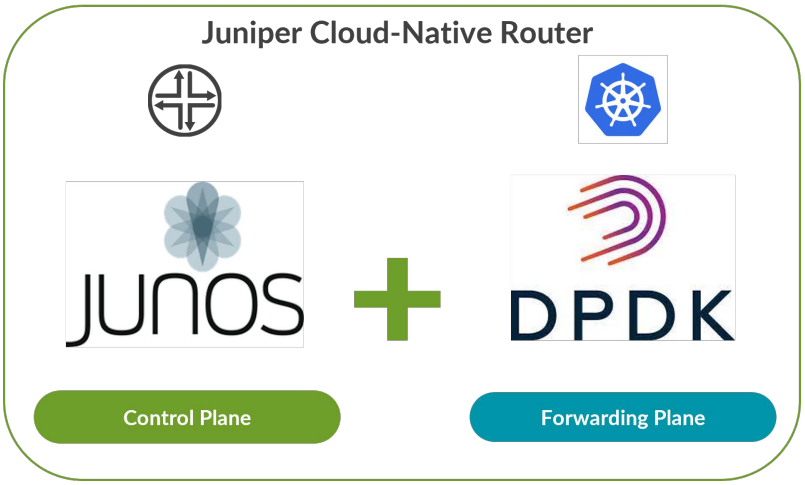

Figure 2. Juniper Cloud-Native Router

Juniper Cloud-Native Router Key Benefits

The key benefits of Cloud-Native Router extend beyond cost reduction, though that is a major focus of this whitepaper. It offers agility, scalability, and rapid provisioning capabilities, enabling operators to scale their networks on demand. It supports multi-environmental deployments, allowing seamless integration across public, private, and hybrid clouds. Enhanced routing and security features, including service chaining with Juniper's cSRX firewall, further simplify deployment and improve security postures.

Operational simplicity is another major advantage of Cloud-Native Router. By leveraging Kubernetes for automated deployment, scaling, and configuration management, network operators can reduce the complexity of managing large-scale networks. The integration of real-time telemetry provides granular insights into network performance, allowing operators to proactively address issues before they impact service quality.

Cost Optimization and Reduced TCO

Juniper Cloud-Native Router has the potential for significant cost optimization. By consolidating the router function into the existing DU server, operators can realize substantial savings in capital and operational expenses. The virtual router eliminates the need for dedicated routing hardware at the cell site, reducing power consumption, cooling, space, and hardware support costs. Furthermore, automation tools help minimize the labor costs associated with deploying, configuring, and maintaining large-scale routing infrastructures. These savings, when multiplied across many cell sites, contribute to a reduced TCO, making Juniper Cloud-Native Router an attractive option for network operators looking to optimize their investments in vRAN and O-RAN architectures.

This efficient, scalable, and cloud-native approach ensures that operators are well-positioned to meet the demands of future 5G and beyond deployments. Cloud-Native Router provides the agility needed to adapt to rapidly evolving network requirements while reducing both initial capital outlays and ongoing operational costs.

TCO Model Assumptions

ACG has developed a TCO model using our unique Business Analytics Engine (BAE)[1] that simulates the CapEx and OpEx expenses in a service provider RAN over five years. In this analysis we compare two scenarios as depicted in Figure 1 in our TCO model:

- Present Mode of Operation:
  - DU server
  - Cell site router with 10G uplinks to transport IP traffic
- Future Mode of Operation
  - Server hosting both the vDU and JCNR virtual router
  - Server is equipped with a Smart NIC card for RAN timing
  - Cloud-Native Router requires two cores for the data plane and a shared core for the control plane and can forward traffic 10G and higher

We model a mobile network with 30,000 cell sites, which is like a large USA region or a western European country. We assume that the routers are rolled out over five years with one-third of the routers deployed in the first year.

The expenses considered for the PMO solution with a physical router are:

- Router hardware and software expenses
- Router installation
- Router HW support
- Router power
- Router space
- Labor expenses

[1] https://www.acgbae.com/

Costs considered for the FMO with the Juniper Cloud-Native Router are:

- Server expenses
  - Server acquisition
  - Server hardware support
  - Server timing NIC
- For the server expenses we assume there is a 32 core RAN optimized server and 3 cores that are used for Cloud-Native Router, which is 9.38% of the server expenses
- Power expenses (9.38% of server power)
- Cloud-Native Router software license
- No additional space required
- Labor expenses, which are reduced by Kubernetes automation

TCO Model Results

The five-year cumulative TCO comparison of the PMO and FMO in a network with 30,000 cell sites is presented in Table 1. The key results show a cumulative:

- TCO savings of 57% over 5 years
- CapEx savings of 49% over 5 years
- OpEx savings of 65% over 5 years

In a network of 30,000 cell sites this amounts to a total TCO savings of $93 million over 5 years.

Indicators	PMO: Cell Site Router	FMO: JNCR	Savings	% Savings
TCO	$217.45M	$93.07M	$124.38M	57.19%
CapEx	$105.0M	$53.53M	$51.47M	49.01%
OpEx	$112.45M	$39.54M	$72.91M	64.83%

Table 1. Five-Year Cumulative TCO Comparison of PMO and FMO in a Network with 30,000 Cell Sites

A breakdown of the five-year cumulative CapEx and OpEx is provided in Figure 3. The key areas of CapEx savings are:

- Elimination of physical router hardware
- Elimination of physical router installations in cell sites

The FMO CapEx is calculated as the cost of 3 cores in a 32 core server or 9.38% of the server expenses, which results in significantly lower CapEx than a physical router. The key areas of OpEx savings are:

- Elimination of physical router space expenses
- Reduction of hardware support expenses
- Reduction of power expenses
- Reduction of operations expenses

Space is eliminated because Juniper Cloud-Native Router is a virtual router requiring no physical space. Hardware support is reduced. Power expenses for Cloud-Native Router are assumed to be 9.38% of the server power as compared to the power required for a physical router. Router operations are reduced because of Kubernetes cloud-native network automation.

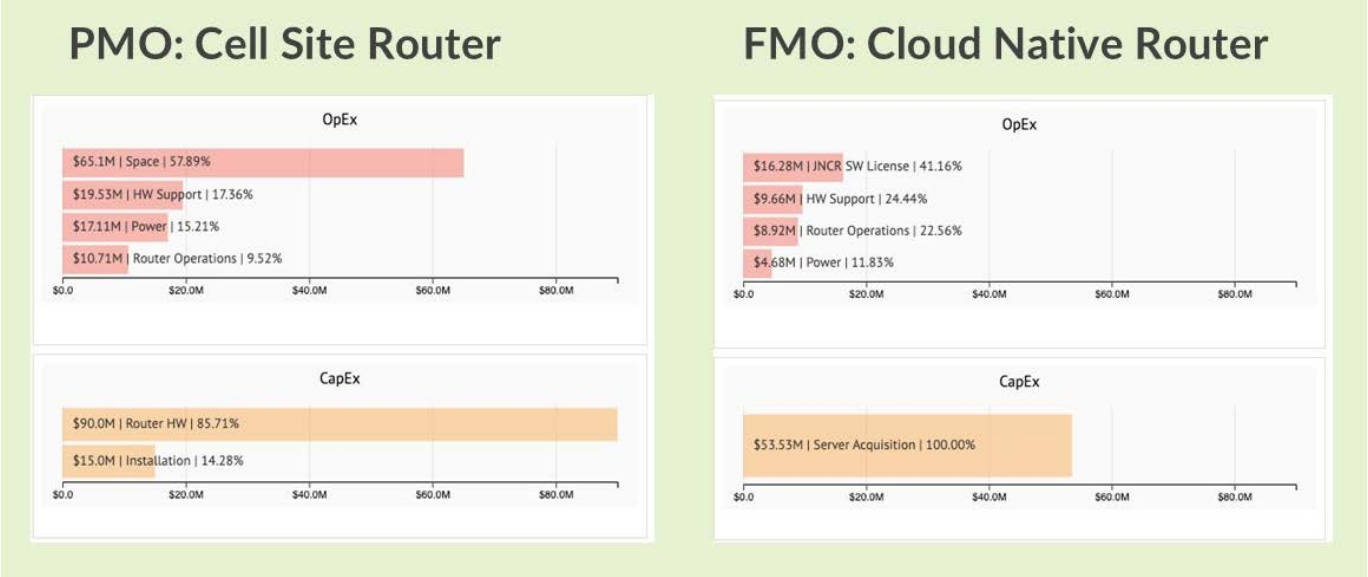

Figure 3. Five-Year Cumulative Breakdown of CapEx and OpEx for PMO and FMO

Conclusion

The transition to virtualized RAN, including both vRAN and O-RAN architectures, represents a critical evolution in the telecommunications industry. Juniper Cloud-Native Router exemplifies the benefits of this transition by offering a cloud-native, cost-effective solution that meets the stringent demands of modern RAN deployments. By integrating routing capabilities within existing DU servers, Cloud-Native Router minimizes the hardware footprint, simplifies network operations, and delivers substantial cost savings over time.

The findings from ACG's TCO model reveal that Juniper Cloud-Native Router significantly reduces both CapEx and OpEx in large-scale network deployments, making it an attractive option for operators seeking to streamline their infrastructure while maintaining high levels of performance and reliability. With a focus on automation, scalability, and operational simplicity, Juniper Cloud-Native Router empowers network operators to efficiently manage the complexity of large networks, positioning them for success in the 5G era and beyond.

By adopting the Juniper Cloud-Native Router solution, operators can unlock new efficiencies, reduce their total cost of ownership, and future-proof their networks for the next generation of wireless connectivity.

Peter Fetterolf, Ph. D. is an expert in network technology, architecture and economic analysis. He is responsible for financial modeling and whitepapers as well as software development of the ACG Research Business Analytics Engine. Dr. Fetterolf has a multidisciplinary background in the networking industry with over thirty years of experience as a management consultant, entrepreneur, executive manager, and academic. He is experienced in economic modeling, business case analysis, engineering management, product definition, market validation, network design, and enterprise, and service provider network strategy.