ESG Economic Validation

Analyzing the Economic Benefits of Wind River Studio for 5G Deployments

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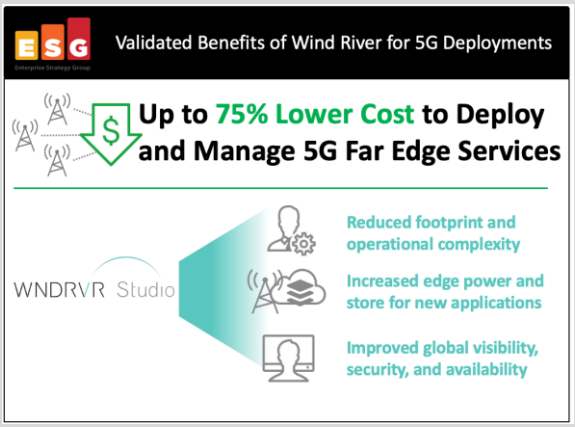
Executive Summary



Communication service providers (CSPs) are rapidly transitioning to 5G technologies. Indeed, most mobile operators are either in process with or planning their 5G deployments. This includes leveraging disaggregation technologies introduced with NFV to bring intelligence to the edge. While consumers will benefit from gigabit speeds and better experiences with video and AR/VR, the real prize is capturing new revenue sources to enable solutions, such as autonomous delivery by drone, automated manufacturing, and next generation transportation. The multifaceted needs of a 5G network create new requirements that legacy technology cannot meet. In order to enable these types of intelligence-driven use cases, a cloud-native, virtualized approach is required for deployment. However, there are many considerations communication service providers need to evaluate, such as capital costs, operating costs, high levels of availability and scale, and the ability to efficiently manage these large-scale, distributed 5G networks.

ESG validated Wind River Studio and its operator capabilities, which are designed to facilitate the rapid deployment of 5G technology across hundreds of thousands of far edge sites at a reduced cost compared with competitors, with more future-proof capabilities. Wind River Studio software is able to deploy in a single hyperconverged configuration (with an optional second server for high availability, as well as options for additional worker nodes where required) with StarlingX open source software founded by Wind River for far edge computing. ESG modeled the use of the Wind River solution and confirmed a 75% lower cost to deploy and manage 5G far edge services with additional cost benefits achieved through increased network visibility, real-time data intelligence, zero-touch provisioning, and remote lifecycle management. Wind River Studio empowers CSPs to rapidly introduce new enterprise and consumer services more economically and ensures mobile operators can create more value to their customers than ever before.

Introduction

This ESG Economic Validation quantifies the savings and benefits communication service providers (CSPs) can achieve when strategically partnering with Wind River to enable distributed 5G edge compute.

ESG audited Wind River Studio and created a cost model to compare Wind River to legacy telco system vendors and new competitors arriving from the enterprise space.

Background

CSPs understand transformation. In addition to the usual technology evolutions (2G, 3G, 4G, etc.), most mobile operators have an active digital transformation initiative. According to ESG's 2021 Technology Spending Intentions Survey, as shown in Figure 1, just over a quarter (26%) of CSPs report having a mature digital transformation initiative and almost two-thirds (65%) cite being in process with or beginning their digital transformation initiatives. When we asked these organizations what their most important digital transformation objectives were for these initiatives, we found that almost two thirds (62%) of CSPs desired to become more operationally efficient. While these transformations include people, process, and technology, it is important for the underlying technology to support the new processes. For most organizations, this includes leveraging new, innovative technology such as AI, orchestration, containers, and hyperconverged solutions as a way to both drive down the data center footprint and push technology to the edge. The other top goal for CSPs was to provide a better and differentiated customer experience, with 44% selecting that objective, something that is important to increase retention levels. Just behind that, 41% of CSPs reported the need to develop new, innovative products and services.[1] CSPs are looking to deliver additional value by deploying advanced services at the edge of the network to support the real-time requirements of many enterprise customers.

Figure 1. Digital Transformation

Source: Enterprise Strategy Group

A big part of the current evolution to 5G is the disaggregation of telecom infrastructure that has historically been delivered in purpose-built equipment and consolidated into regional data centers. Cloud technologies are being introduced by vendors such as Wind River to push efficient compute resources and applications right to the edge of the network with all distributed edge nodes supported by orchestration and management tools, allowing for rapid deployment and lower cost support through a single management console.

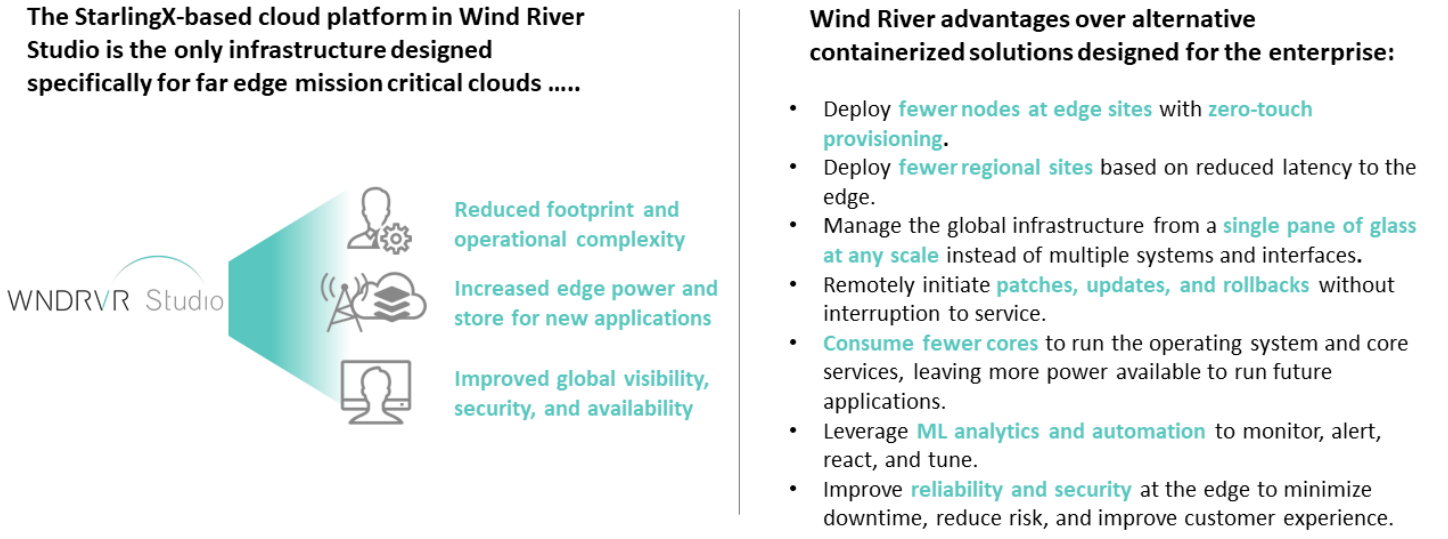
[1] Source: ESG Research Report, *2021 Technology Spending Intentions Survey*, January 2021.

Wind River Studio operator capabilities

Wind River has been an integral part of the existing CSP network fabric for forty years and its technology is used to support billions of devices as an integrated part of the equipment provided by all of the top TEMs worldwide, deployed in central offices. To address the demand of communication service providers for more performance and new revenue-generating services closer to their customers, Wind River Studio integrates a cloud infrastructure platform, orchestration, and analytics technologies to deliver a powerful solution for the intelligent 5G Edge.

Wind River Studio is designed so that operators can deploy and manage their globally distributed 5G edge networks from centralized locations. Each far edge location is its own sub-cloud and tied into a single management view. As Figure 2 highlights, this unified platform can provide CSPs with a number of benefits.

Figure 2. Managing the Far Edge



Source: Enterprise Strategy Group

To empower a 5G far edge location with a lower cost, smaller network footprint, very low latency, and the ability to drive innovative new services for customers, Wind River expanded upon the industry-standard open source OpenStack operating system and contributed to the creation of StarlingX. Wind River commercialized the platform and hardened it to support six nines of reliability to meet CSP standards. In addition, it added award-winning global support, 24/7/365 emergency recovery and service restoration, and professional services. Wind River Studio operator capabilities include these core features:

- Cloud Platform: A production-grade distributed Kubernetes cloud platform for managing edge cloud infrastructure based on the Open Source StarlingX project. Wind River Studio compiles best-in-class open source technology to deploy and manage single node, multi-node, and distributed cloud networks.
- Orchestration: One platform for complete end-to-end automation. Required applications are chosen from an app catalog and deployed to a carrier-grade cloud platform, and the resources that are needed are orchestrated for the applications. This solution scales to thousands of nodes in a geographically dispersed distributed environment.
- Analytics: Allows for effective management of a distributed cloud system by consuming and processing data through machine-learning algorithms to produce meaningful insights for decision making. With full stack monitoring of the

cloud infrastructure cluster and services, Wind River Studio collects, analyzes, and visualizes cloud behavioral data so operators can keep clouds up and optimized while reducing operational costs.

ESG Economic Validation

ESG completed a quantitative and qualitative economic analysis of Wind River Studio to determine its cost-effectiveness, operational efficiency, and ability to deliver innovation for 5G deployments. Testing focused on the economic benefits organizations can expect when leveraging Wind River for 5G far edge deployments compared with legacy telco systems and several competitors that are entering the market with corporate enterprise network designed solutions.

ESG's Economic Validation process is a proven method for understanding, validating, quantifying, and modeling the economic value propositions of a product or solution. The process leverages ESG's core competencies in market and industry analysis, forward-looking research, and technical/economic validation. ESG conducted in-depth interviews to better understand and quantify how Wind River Studio created value in 5G environments, in comparison with previously deployed solutions. The qualitative and quantitative findings were used as the basis for a simple economic model comparing the expected costs of operating without Wind River to the cost reductions and benefits of deploying Wind River in a 5G network.

Economic Value Overview

Any evolution to a new technology will be challenging and 5G is no different since it is designed to carry 100 times more data bits using the same energy as 4G, but there are many new aspects to be considered. In addition to power, latency, and enhanced security, the compute footprint at the far edge and centralized, intelligent management all play an important role. Many consider the far edge to be at the tower, but as demand for more innovative services increases, this is likely to extend even further into corporate sites, campuses, and communities. Providing the right foundation for 5G today will enable CSPs to better position themselves for future innovative services.

ESG's economic analysis revealed that an effective deployment of Wind River Studio can meet these challenges and provide significant cost, administration, and operational benefits in these areas:

- Lower cost to deploy and scale – ESG validated a significant cost reduction when Wind River Studio is deployed for 5G at the far edge. This includes far fewer servers, lower power and network requirements, and reduced latency, which increases performance and can lower the number of servers required at regional centers or even the number of regional locations to support edge locations.
- Simplified administration and enhanced intelligence – Managing thousands of nodes and ensuring six nines of uptime availability is accomplished through integrated analytics and centralized management to meet the stringent requirements and lifecycle management of communication service providers. Plus, a single resource can leverage the central management capabilities to manage thousands of distributed nodes.
- Business agility and faster time to deliver new services – Enabling private-cloud capabilities at the network edge allows for greater business agility to deploy new services faster and meet emerging market demands. 5G is opening a new world of service possibilities and communication service providers need to future-proof their infrastructure.

Lower Cost to Deploy and Scale

CSPs are looking to deploy closer to customers and enable personalized and adaptive services over the network.

For 5G edge networks to introduce new personalized and adaptive services driven by AI, they must first deliver the essential requirements of extremely low latency, high availability, security, and flexibility. Simultaneously, these networks must be robust, resilient, and flexible.

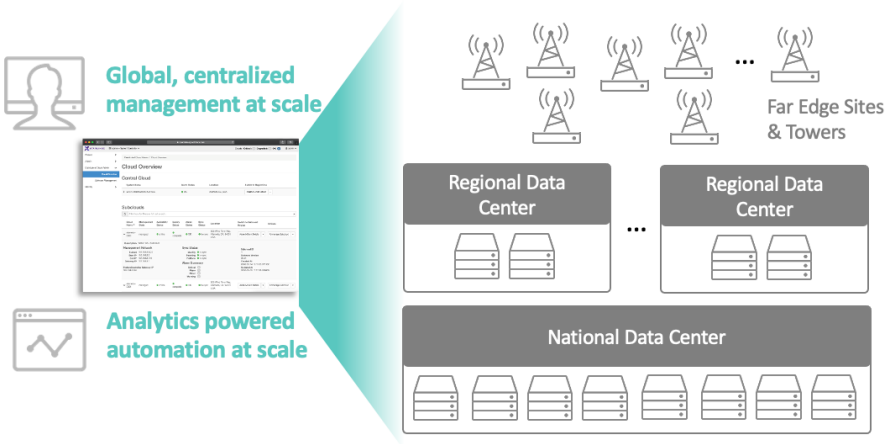
Edge computing supported by centralized control through Wind River Studio increases service capabilities by pushing the compute function closer to the user, reducing latency and backhaul traffic. The Wind River solution utilizes a single 24-core server with an optional second server for high availability. This hyperconverged virtual software solution includes Wind River software (StarlingX and Open Stack, with Kubernetes container orchestration), ready for virtualized CSP applications (vDU, vCU) and operating on COTS (commercial off-the-shelf) servers with compute, storage, and networking resources. Flexibility is provided with this open source design to work on all hardware platforms. When compared to legacy systems that require four proprietary servers to Wind River's single server and an additional two servers for high availability (total of six servers versus Wind River's two for HA), Wind River provides significant CapEx savings, especially when deploying hundreds or thousands of nodes.

Deploying systems at scale is also made easy with zero-touch provisioning (ZTP) and single pane of glass host-level management. Servers can be shipped to their locations and then enabled remotely. Each node is constructed as a private sub-cloud, allowing for a high level of security and remote management, including the ability to eliminate the traditional truck-roll and all the costs associated with it.

With 5G, CSP networks will be hybrid environments, with newly introduced virtual applications along with legacy equipment in the same network. With this new architecture, service rollout is something that can, and will, happen in minutes rather than days or months and has the potential to automate the introduction of new revenue-generating services while maintaining six nines of reliability.

Simplified Administration and Enhanced Intelligence

In the constantly changing digital world that we live in, telecommunications leaders depend on real-time insights and action. As CSPs rapidly scale the number of 5G endpoints, the new imperative will include distributed computing, single pane of glass management, orchestration of network tasks, and the analytic tools necessary to constantly monitor and manage service delivery and availability. Networks must be dynamic and flexible to adapt to the needs of both enterprise and consumer. This new reality is driving cloud-native application development that enables services to run where and when needed on a distributed edge cloud.



Wind River Studio offers single pane of glass management with automated and hitless software updates and upgrades. The new disaggregated private cloud network of far edge nodes becomes manageable without any need to disproportionately scale up staff or take down the network for software updates or patches. Integrated end-to-end security also helps to mitigate risk. The single pane of glass and centralized orchestration of lifecycle management solve the large-scale

distributed management challenges associated with ensuring hundreds or thousands of edge locations provide a consistent, secure experience to millions of edge devices.

Real-time information from each intelligent node is collected and leveraged in decision making so operators can derive operational efficiencies in these highly distributed edge environments while still maintaining six-nines uptime. With full stack monitoring of the cloud infrastructure cluster and services, Wind River Studio collects, analyzes, and visualizes cloud behavioral data to help keep all the nodes up and optimized. This knowledge is further used for business decisions and contributes to efficient capacity planning for the organization. Some of the most notable analytics features include:

Collection	Host metrics, cluster metrics, network metrics, log events, integrity monitoring
Distribution	Data enrichment, data transformation, data pre-processing
Processing	Storage, replication, indexing, aggregation, resampling, lifecycle
Analysis	Visualizations, trend analysis, anomaly detection, security analysis, machine learning, alerting
Alerts	Proactive alerts, comprehensive, reports

Business Agility and Faster Time to Deliver New Services

Wind River Studio sets the foundation for software-driven service delivery that enables provisioning in minutes rather than days or months, leading to faster time to revenue. With data as the competitive differentiator, CSPs will access new revenue streams and use AI to provide the means for their customers to thrive in the new digital economy. The introduction of new services can be automated due to the infrastructure, remote management, and provision capabilities of Wind River Studio. The physical systems in each far edge node are optimized for low latency, and only use 2 of 24 cores, leaving the remaining 22 cores for the delivery of applications, which in many cases have not yet been defined for 5G and will develop once the infrastructure and capabilities are in place.

With Wind River Studio, CSPs can deploy new 5G services in minutes rather than months and address new market demands.

CSPs can connect the unconnected, attract new categories of customers, and drive value from those connections. As mobile phone subscriptions reach saturation, there is tremendous potential to monetize 5G environments with enterprise customers. 5G will provide better connectivity with more ultra-low latency to support emerging real-time applications at the edge. 5G will add new enterprise services through connections to machines, robots, appliances, tools, and more. Wind River Studio delivers the needed cost-effective infrastructure and will enable centrally managed services for all these connections.

As connected communities continue to grow, 5G will bring three primary benefits to consumers: faster data speeds, lower latency, and increased connectivity. The greater capacity offered by 5G will allow networks to support more devices and enable more data-intensive tasks. For enterprises, 5G enables new innovations, including the support of autonomous cars, real-time quality control, video-enabled applications, advanced analytics, and big data management at faster speeds, as a few examples.

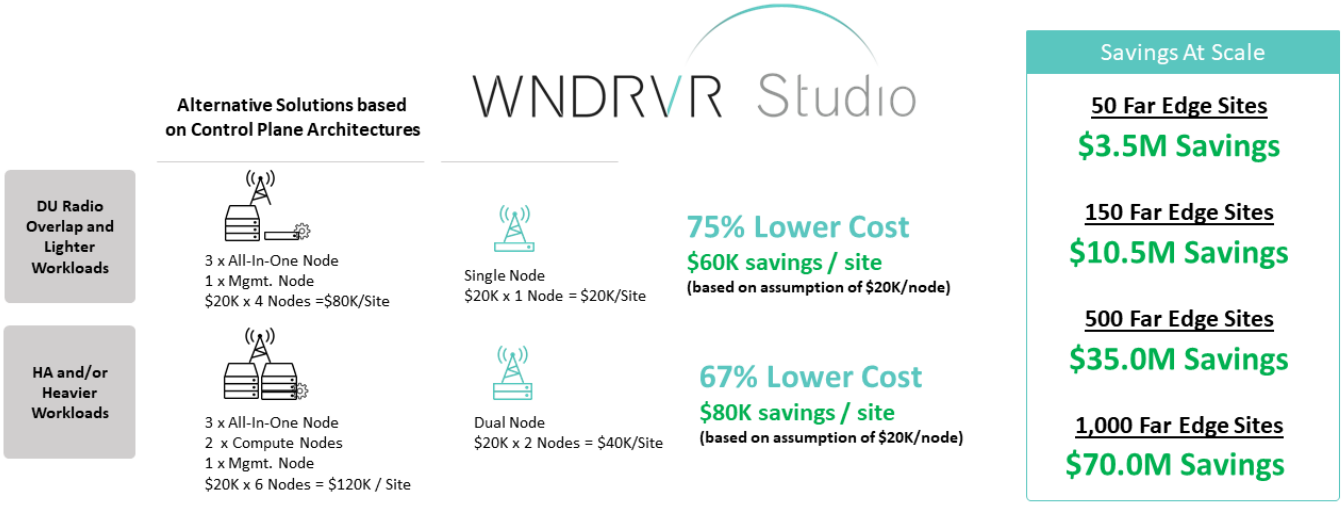
ESG Economic Analysis

To understand the cost savings that can be provided by Wind River Studio, ESG created an economic modeled scenario of Wind River Studio for 5G deployments. In the modeled scenario, ESG compared the deployment of Wind River Studio to 5G edge nodes with competitive options and considered the challenges faced at the far edge. These included a smaller footprint for systems, the need for lower latency, and the new requirement to enable advanced 5G-related applications. The promise of 5G is faster connectivity for consumers and higher bandwidth to enable new media-driven applications. Video is one such application, along with autonomous drones, self-driving vehicles, gaming at the edge, and more. But a

key question in everyone's mind is what new and exciting applications will be created once 5G is a reality. CSPs need to be prepared to deliver applications faster than ever before to meet market demands and create competitive differentiation. Getting the infrastructure and operational efficiencies right is the first step in the new and exciting journey.

ESG built a modeled scenario to consider quantitative and qualitative challenges. Wind River looks at each edge location as a sub-cloud of a regional cloud. For example, if this were New England and there were 10,000 towers, each would be a sub-cloud. Using Wind River Studio, a single manager could manage this cloud. Wind River is a hyperconverged virtual software solution, which includes Wind River software (StarlingX and Open Stack, with Kubernetes container orchestration), virtualized telecom application (vDU, vCU…), and COTS (commercial off-the-shelf) servers with compute, storage, and networking resources. Of the 24 cores in a server, only 2 cores are used for all controls, storage, and management, with the remaining 22 cores available for VNFs or potentially other innovative, value-add applications. As seen in Figure 3, when compared to competitive systems deployed at every edge location, ESG found that Wind River can operate on a single server (when leveraging densely populated towers for failover) or can be deployed with a second server if high availability is required. This is in comparison to competitive systems that require 4 equivalent cost servers and 6 to run in high availability mode. This immediately provides a capital cost reduction of 67% to 75% at each edge site.

Figure 3. ESG Modeled Savings for 5G Edge Deployments (Cost to Procure and Deploy Edge Sites)



Source: Enterprise Strategy Group

ESG's cost savings analysis modeled the expected cost to procure hardware, software, applications, and maintenance contracts over a three-year timeframe. While ESG assumed a per-node cost of $20K for both the alternative solution and Wind River, in practice, the per-node cost can vary greatly depending on vendor, technology, and business requirements. While the particular savings may change for your scenario, the fact that Wind River enables organizations to deploy far less physical hardware at each edge site will mean significant savings at scale regardless of the cost basis used.

ESG also validated the results of performance testing that showed significantly lower latency between the RU (radio unit deployed at the tower) and DU (distributed unit deployed at the far edge data center) (up to 2265µS faster than competing solutions in some cases). Where each µS of latency directly translates to kms of distance, this means that the Wind River solution enables significantly more distance between the towers and far edge data centers. This extended reach could result in a greater DU to RU ratio, meaning fewer far edge data centers may be required, as each data center can cover more physical area and support more towers. With each data center costing potentially hundreds of thousands of dollars, any reduction in the quantity required could provide significant savings.

In addition to the significant savings provided by deploying less hardware and fewer sites, ESG learned that organizations could expect to save even more over time based on:

- Greater number of cores available for applications – Wind River's cloud platform requires only two cores per server to run, while alternative solutions can consume 6 to 18 cores of processing power per server to supply all control, storage, and management functions. With more cores available for application workloads, Wind River can handle more applications or provide improved performance for existing applications, improving end-user experience.

- Lower power consumption – By deploying less hardware at each site to handle the same workloads, CSPs will see a significant reduction in power and cooling costs at each site. ESG's model predicts substantial annual power and cooling savings of up to $5,600/year saved per site, per year. While maybe not impressive on its own, over a three-year period across 100 sites, this could mean $560,000 per year in operational savings. For 1,000 sites, it would result in $5.6M in savings per year.

- Additional storage capacity – Each server has available storage capacity to support applications. Increasing capacity can be achieved by adding more servers to the edge site and remotely provisioning them. This allows for fast and efficient scaling on demand.

- Centralized management – Since Wind River Studio is a private cloud architecture, a single user can visualize, manage, and collect intelligence on a large-scale network of nodes. This includes the ability to remotely update systems without a truck-roll and site visit.

- Zero-touch provisioning — The initial deployment of servers to remote sites can be set up using zero-touch provisioning. A basic server can be deployed to edge locations where software can be pushed to the server and enabled. When deploying this with thousands of servers, it can be a massive cost savings and big time-to-market advantage.

The requirement for open-source software, along with the shift towards cloud computing, a distributed network architecture, fault tolerance at all levels, and the need for capacity to support 5G edge devices, led to the development of the StarlingX open-source project, which in turn led to Wind River Studio. Wind River Studio is a commercially supported version of StarlingX. A core part of Wind River's ability to achieve these results is the fact that this software was developed specifically for the CSP environment, where five to six nines of reliability is required with a truly hardened system.

The Bigger Truth

The evolution to 5G is creating new opportunities for CSPs to dramatically improve how and where they deliver services and the type of services they can deliver. However, it is imperative that any solution must meet or exceed traditional standards for reliability, operational efficiency, and delivery of superior customer experiences. Indeed, as CSPs continue to mature their digital transformation initiatives, it is even more important for them to drive greater operational efficiencies in a highly distributed and disaggregated 5G architecture. Plus delivering a differentiated customer experience and innovative new products and services will be critical to expanding revenues.

To help achieve these goals, Wind River Studio was created with the purpose to enable CSPs to build 5G networks better and faster. ESG believes the business justification for Wind River Studio is a very clear one. Extensive experience in the communication service provider industry enabled them to develop solutions to accelerate the rollout of 5G services to drive adoption for both consumer and enterprise customers. The Wind River solution can reduce initial deployment and operational costs by up to 75%. Consider the impact this would have on 1,000 site deployment. ESG estimates initial capital and operational savings could exceed more than $70M. Over the long term, organizations can potentially attain even greater benefit from Wind River Studio's overall design to support the growth of 5G-enabled edge applications that open new revenue streams for CSPs.

If you are a communication service provider looking for the right 5G solution to accelerate your deployment and significantly reduce costs, while also creating greater operational efficiencies and enabling value-added innovative services, ESG recommends you consider Wind River as your partner for success.