



Alan Davidson
Assistant Secretary of Commerce for Communications and Information
National Telecommunications & Information Administration
1401 Constitution Ave., NW
Washington, D.C. 20230

January 27, 2023

Submitted Electronically

Re: National Telecommunications & Information Administration (“NTIA” or the “Agency”) Public Wireless Supply Chain Innovation Fund (the “Innovation Fund”) Implementation Request for Comment [Docket No. 221202-0260, RIN 0693-XC05]¹

Dear NTIA Administrator Davidson,

Thank you for the opportunity to participate in this ground-breaking opportunity to accelerate the adoption of open, interoperable and standards-based Radio Access Networks (“**RAN**”).

Wind River has been a leader in mission critical software for over 40 years and provides a standard infrastructure component in mission critical projects across the globe and beyond. Our software runs the “can’t fail” computing systems of the most important modern infrastructure, including aircraft, rail, automobiles, medical devices, manufacturing plants, energy and utilities, and communications networks, from the Mars rover to James Webb telescope.

This history has enabled us to develop a unique set of skills and depth of knowledge that is very important for the infrastructure requirements of 5G networks. Wind River is committed to the development, adoption, and use of Open RAN in the telecom market. We believe the only path to expeditious and wide adoption of virtualized RAN requires an open and collaborative partnership with all the vendors in this space. Wind River Studio Operator is our infrastructure product currently in widespread deployment across US and European service providers. Wind River Studio Cloud Platform is the commercialized release of an open source project called StarlingX. Wind River was also recently named 5G Technology Vendor of the Year by Light Reading.²

The O-RAN Alliance defines O-Cloud as a cloud computing platform comprised of a collection of physical infrastructure nodes that meet Open RAN requirements to host the relevant Open RAN functions, the supporting software components, and the appropriate management and orchestration functions. StarlingX is Open RAN’s reference O-Cloud infrastructure.

StarlingX is an open source project hosted in the Open Infrastructure Foundation (formerly Open Stack Foundation), of which Wind River is an active and contributing member. It is a Kubernetes and bare metal

¹ NTIA, *Public Wireless Supply Chain Innovation Fund Implementation*, Request for Comment (Dec. 13, 2022), Docket No. 221202-0260, <https://www.federalregister.gov/documents/2022/12/13/2022-26938/public-wireless-supply-chain-innovation-fund-implementation>.

² <https://www.lightreading.com/wind-river---winner-of-light-reading-leading-lights-award-for-5g-technology-vendor-of-year/v/d-id/782673>

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first approach which uses a highly distributed architecture and enables operators to deploy 10s of 1000s of sites and manage them from a central pane of glass. This is recognizing the unique challenges of Open RAN as a highly geo-distributed architecture with challenging operational concerns. Solving the integration, deployment, and operational challenges on a disaggregated and open architecture is a focus of Wind River as these are major pain points for operators as they evaluate the transition from purpose built 5G networks to an open, multi-vendor network.

Wind River is a leader in the edge infrastructure platform market in the virtualized RAN space. Wind River has 2 years of virtualized 5G deployment experience with tier one providers such as Verizon and Vodafone. This includes the first end to end 5G virtualized data session and the first multi-vendor Open RAN deployment. Wind River is committed and 100% focused on the specific requirements of the far edge virtualized space with an ultra-low latency, highly distributed, and 5-9s reliable solution.

5G is a unique environment, and typical cloud solutions are not always a good fit for far edge remote sites which have different characteristics than the typical public cloud core. Wind River specializes on enabling this far edge intelligent economy. As this technology becomes more ubiquitous the need for more interoperability labs and dedicated development and test teams becomes more important.

It's difficult to predict the eventual use cases as we build Open RAN networks which enable connected and intelligent devices at the network edge. The current dominant operator use case is the virtualized central and distributed unit applications to enable basic telecom connectivity. But the real future in 5 and 6G will be the applications and systems which are enabled by this open and virtualized environment. We can speculate on a few known current use case ideas, such as autonomous driving, drone control, automated factories, and energy grid optimization. However, much like no one knew what applications and widespread changes the internet would create, real-time, hyper connected, intelligent devices and systems enabled by an open, virtualized network will change our day to day lives in ways we cannot even begin to imagine today.

Wind River will be a part of that transformation and we look forward to participating and helping to define this future. To your questions:

Questions on the State of the Industry

Question 1. *What are the chief challenges to the adoption and deployment of open and interoperable, standards-based RAN, such as Open RAN? Are those challenges different for public vs. private networks?*

There are several challenges related to the change in model that Open RAN represents. In the previous model, typically all RAN components were integrated and provided by a single vendor. Those systems work very well but have limited flexibility. A one size network that is efficient and not capable of rapid deployment and customization at the appropriate level for individual customer needs chokes potential pathways to innovation. Moving from that model to one of virtualization and disaggregation exposes some new issues:

- Expectation of Parity: The new system must be proven to work as good if not better than before with the same or lower operating expense.
- System integration and cloud native skills gap: Because all parts were previously integrated by the vendor, operators now have to develop new skills in technology and process. This skills gap is perceived as a large risk to adopting O-RAN by service providers.
- Availability of Open RAN specifications-compliant radios: Every network is different and comes with its own set of requirements. To add to that complexity each country / region has specific regulatory requirements around spectrum, emission and filters. Recent chipset shortage and supply chain issues have hampered Open RAN Radio availability for all markets.
- Ecosystem Boost Needed: Lack of skilled resources, lack of centralized lab to integrate the Open RAN building blocks, and lack of active participation from top manufacturers and mobile network operators is pushing out adoption of Open RAN.
- 5G Monetization Challenges: While the 3rd Generation Partnership Project has been successful in disaggregating the hardware and software network functions as well as defining a services-based architecture we are yet to see the 5G use cases in action. As the network evolves towards intelligent edge and innovative use cases are deployed carriers will realize the potential of Open RAN networks.

Question 1(a). *What are the challenges for brownfield deployments, in which existing networks are upgraded to incorporate open, interoperable, and standards-based equipment?*

- Inter-Operability: Traditional networks, management & billing systems are not going anywhere any time soon. The new Open RAN networks will have to seamlessly integrate with these legacy networks.
- Performance & Reliability: We have yet to have a large-scale Tier 1 Open RAN commercial network whose performance could be compared to traditional RAN network. The reliability of cellular networks is considered the gold standard, with upwards of 5-9s availability. These high performing networks have been built and optimized over the years. The concern of a new virtualized environment is that a simple malfunction of a router could cause large-scale service disruptions.
- Adoption of Standards: The O-RAN Alliance is defining standards which include architecture and interfaces for the goal of portability. The adoption of Open RAN standards is dependent on time to market and the maturity level of the specifications. Furthermore, vendors and operators need to invest in their existing implementations to align it with the new standards, trusting that it can perform the same as before without any impact on user experience.

Question 3. *What kind of workforce constraints impact the development and deployment of open and interoperable, standards-based RAN, such as Open RAN? How (if at all) can the Innovation Fund help alleviate some of these workforce challenges?*

- Along with our above comments we would note that the complexity of open systems choices requires a simple leveling process (validation and certification) of components so that customers can easily interchange parts at will and learn from each other in an ongoing manner.
- At this stage, operators wishing to move to Open RAN must start from scratch. Having a blueprint to work from would be immensely helpful as it would set up success through shared knowledge and experiences based on best practices. We could call this an ORAN Blueprint. It could be like the original Energy Star system by the EPA.
- In addition, funds channeled toward industry development through related organizations such as the Open Infrastructure Foundation and the Linux Foundation as well as to participating companies. This could also include funds for parallel standards development and code implementation to accelerate O-RAN and 5G adoptions.
- In our experience with commercial deployments that require ongoing development of customer features and addressing field issues, most of the time the workforce is occupied with these tasks, and standardization naturally receives a lower priority. If the fund could be used to delegate an additional workforce (in the form of open community collaboration), it would help to boost the development of the Open RAN standards without risking any commercial deployments and new prospect engagements.

Question 4. *What is the current climate for private investment in Open RAN, and how can the Innovation Fund help increase and accelerate the pace of investment by public and private entities?*

- Blueprints: The challenge here is that Open RAN is a concept and framework that is being created by operators for their own environments. Having a blueprint (or set of blueprints) to demonstrate what “it” is could be useful. The difficulty of integrating multiple vendors’ equipment and software and automating operations of these disparate components presents a significant risk factor for operators, which is an impediment to market acceptance and the pace of virtualization adoption.

Questions on Technology Development and Standards

Question 6. *What open and interoperable, standards-based network elements, including RAN and core network elements, would most benefit from additional research and development (R&D) supported by the Innovation Fund?*

- Three items would be most helpful:

- **Blueprints:** As noted above, having a proven model to work from would significantly speed the time to deployment as well as a system for sharing ongoing learnings and development.
- **Systems Integration Lab:** Having a multi-vendor lab (or lab network) where vendors can build and test their integration, with collaboration from the operator, will be important. In a recent white paper³, Vodafone prescribed a “multivendor lab network.” However having a government-funded lab, or lab network, could achieve many of the same objectives such as:
 - A central lab can scale up and dimension as required.
 - Labs are not assigned for a single operator, so a high level of synergy is feasible. Wider equipment is available for testing, in a hardware and software pool of resources approach, as different operators may have different hardware models.
- According to a report from the GSM Association (GSMA), the energy cost of mobile networks accounts for about 23% of the total operator cost, and RAN consumes 73% (of the 23%). To achieve sustainability and operating expense reduction in today’s mobile networks, we need a standardized approach to evaluating, testing, measuring, and monitoring energy consumption of dis-aggregated multi-vendor Open RAN. O-RAN Alliance provides the best environment for vendors and operators to work together and align the industry on this important topic.

Question 7. *Are the 5G and open and interoperable RAN standards environments sufficiently mature to produce stable, interoperable, cost-effective, and market-ready RAN products?*

The O-RAN Alliance, comprised 32 operators around the globe and many more vendors, is the standards body the industry looks to and provides many opportunities for interoperability testing via plugfests. Operators are looking toward “O-RAN compliant” solutions for their Open RAN projects. Part of what makes it effective is the global scale and participation.

Question 8. *What kinds of projects would help ensure 6G and future generation standards are built on a foundation of open and interoperable, standards-based RAN elements?*

Along with our comments stated elsewhere we would note the key to 6G success is built on successful 5G deployments happening faster.

Questions on Integration, Interoperability, and Certification

Question 9(a). *Are interoperability testing and debugging events (e.g., “plugfests”) an effective mechanism to support this goal? Are there other models that work better?*

Plugfests are a proven pathway to foster collaboration to solve a particular issue that others can then learn from. An important component is to ensure that the results of those plugfests are shared and promoted and that an increasing number of plugfests are orchestrated with common sharing

³ <https://www.windriver.com/resource/open-ran-system-integration>



platforms for the learnings. Further, plugfests can be seen as a resource drain for speculative results. If the fund was able to incentivize participation, it could help boost contributions.

Question 12. *What existing gaps or barriers are presented in the current RAN and open and interoperable, standards-based RAN certification regimes?*

The traditional pull for open technologies comes from eco-systems of applications that reward technology investments in the backbone designed to enable them in the market. Currently a large pool of these applications have not been enabled by the traditional homogenous RAN solutions that are somewhat monolithic in purpose. In order to incentivize these new application eco-systems for consumers, we need to incentivize the shift to an O-RAN opportunity so that the telecommunications and private 5G vendors can put these applications into play. This in turn creates a market momentum for innovation and service delivery.

Questions on Trials, Pilots, Use Cases, and Market Development

Question 13. *What are the foreseeable use cases for open and interoperable, standards-based networks, such as Open RAN, including for public and private 5G networks? What kinds of use cases, if any, should be prioritized?*

Use cases include energy saving through optimization of homogenous network equipment, energy savings with smart grid operations, autonomous driving initiatives, intelligent manufacturing facilities, and network optimization using network slicing and other techniques. The “killer app” has yet to be fully identified. Some future use cases are not known and use cases will continue to emerge as the interoperability partners build a reliable and cost effective open 5G network.

Question 14. *What kinds of trials, use cases, feasibility studies, or proofs of concept will help achieve the goals identified in 47 U.S.C. 906(a)(1)(C), including accelerating commercial deployments?*

Accelerating commercial deployments will require proofs of concept, not only for deployments of disparate software and hardware vendors, but also for proving the day 1 and day 2 operational capabilities of an entire solution. Full edge-to-edge 5G virtualized radio access networks (vRAN) use cases are the first step as this is the most basic service provider table stakes use case.

Questions on Security

Question 17. *“Promoting and deploying security features enhancing the integrity and availability of equipment in multi-vendor networks,” is a key aim of the Innovation Fund (47 U.S.C 906(a)(1)(C)(vi)). How can the projects and initiatives funded through the program best address this goal and alleviate some of the ongoing concerns relating to the security of open and interoperable, standards-based RAN?*



Executive Orders 13800⁴ and 14028⁵ have established a framework to enable the US Government and the commercial sector to work together in improving the cybersecurity of critical infrastructure. These executive orders and the regulations that are derived from them are applicable to communication infrastructure. EO 14028 enables the Cybersecurity & Infrastructure Security Agency (CISA) the authority to lead the national effort in managing both cyber and physical risk to the infrastructure of the United States.

The improvements to the security initiated by these Executive Orders can be a complicated and overwhelming effort for vendors to comply with. However, the lack of compliance increases the risk to the country's critical infrastructure. With this in mind, the Innovation Fund can be used to enable the private sector to develop implementations of an agreed-to reference architecture for the rest of the vendors to use. By having three different vendors providing the reference implementation promotes fair competition and enables the RAN vendors to focus on their value-add attributes, while being assured that they are building on a compliant, agreed to, and secure foundation. The Innovation Fund can be used to accelerate the O-RAN Alliance Security Work Group⁶ (the "**Working Group**") in the definition of the reference architecture that can then be implemented by a selected set of vendors.

Question 17(a). *What role should security reporting play in the program's criteria?*

Security Reporting should be the cornerstone of the program and should be implemented as soon as possible. Without the ability to measure, the ability to improve cannot exist. Types of metrics to measure include, but are not limited to:

- Common Vulnerability and Exposures (CVEs) in the fielded devices.
 - CVEs are becoming a polarized subject, but the Innovation Fund can be used to enable the Working Group to determine what reporting needs to include along with the frequency of the reports.
- National Institute of Standards and Technology Secure Software Development Framework (NIST SSDF).
 - Memorandum for the Heads of Executive Departments and Agencies, M-22-18, states that vendors to the USG must align to the NIST SSDF, provide a self-attestation form, and define a Plan of Action & Milestones (POA&M) for any shortcomings.
 - Another reporting topic would ensure all RAN vendors have self-attested to the NIST SSDF and a rolled up status of the execution against the POA&Ms.
- Third party penetration results on each vendor's RAN component. It is acknowledged that this information must be treated with high confidentiality.

⁴ <https://www.cisa.gov/executive-order-strengthening-cybersecurity-federal-networks-and-critical-infrastructure>

⁵ <https://www.cisa.gov/executive-order-improving-nations-cybersecurity>

⁶ <https://www.o-ran.org/blog/the-o-ran-alliance-security-work-group-continues-defining-o-ran-security-solutions>

Question 17(a). *What role should security elements or requirements, such as industry standards, best practices, and frameworks, play in the program's criteria?*

While there are many standards and specifications related to security, the following list should be considered as core in the development of communication infrastructure:

- The aforementioned NIST SSDF
- NIST 800-207 Zero Trust Architecture
- NIST 800-53 Security and Privacy Controls for Information Systems and Organizations
 - This includes certification of cryptographic algorithms used.
- Center for Internet Security (CIS) Benchmarks as applicable for the individual technology components in the RAN offering
- Alignment with the many initiatives that the Open Source Security Foundation (OpenSSF)⁷ is driving to include:
 - SigStore⁸
 - Supply Chain Levels for Software Artifacts (SLSA)⁹

Question 20. *How is the “zero-trust model” currently applied to 5G network deployment, for both traditional and open and interoperable, standards-based RAN? What work remains in this space?*

While there are various published articles on the alignment to Zero Trust Architecture (“ZTA”), this is yet another area that the Working Group can provide clear definition to. For example, some articles reference the use of Transport Layer Security (“TLS”) 1.2. While there is a select subset of ciphers that provide perfect forward secrecy in TLS 1.2, this, among many other requirements, must be clearly articulated to the RAN community regarding ZTA to provide a secure implementation.

Questions on Program Execution and Monitoring

Question 24. *How can NTIA maximize matching contributions by entities seeking grants from the Innovation Fund without adversely discouraging participation?*

Matching requirements can include monetary contributions and/or third-party in-kind contributions (as defined in 2 CFR 200.1).

⁷ <https://openssf.org/>

⁸ <https://www.sigstore.dev/>

⁹ <https://slsa.dev/>

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Thank you again for your work in promoting Open RAN. Wind River acknowledges the complexities of this matter and the size of NTIA's task. It is our hope that these and other comments will help the Agency proceed in a way that will best enable and unlock the potential of this incredible technology for years to come.

Sincerely,

A handwritten signature in black ink, appearing to read 'BLeBlanc', with a long horizontal flourish extending to the right.

Bryan LeBlanc
Chief Executive Officer
Wind River