DELL Technologies

January 27, 2023

National Telecommunications and Information Administration
Department of Commerce
1401 Constitution Avenue NW
Washington, DC 20230

Re: Public Wireless Supply Chain Innovation Fund Implementation (Docket No. 221202-0260)

REPLY COMMENTS OF DELL TECHNOLOGIES

Dell Technologies Inc. (Dell Technologies) submits these reply comments in response to the request for comment (RFC) issued by the National Telecommunications and Information Administration (NTIA), Department of Commerce, regarding the implementation of the Public Wireless Supply Chain Innovation Fund (Innovation Fund), as directed by the CHIPS and Science Act of 2022. Dell Technologies commends NTIA for seeking comprehensive feedback on the grant program to support the promotion and deployment of open, interoperable, and standards-based radio access networks (RAN) and welcomes the opportunity to respond. We believe that the Innovation Fund creates a unique opportunity to establish U.S. Open RAN leadership and drive large-scale adoption through targeted investments, coordinated actions and partnership with the U.S. Technology Industrial base to address the key technology and process gap areas.

Executive Summary

- The advances in mobile wireless technologies have changed many aspects of society, the way we work, communicate, and socialize, at a rapidly increasing pace. Secure 5G supply, technical know-how, and an Open 5G platform are essential for national economic and security interests.
- Though the U.S. pioneered mobile wireless technologies and was the leader for a long time, the lack of a broad U.S. wireless industry for the past decade has begun to erode its talent base, and there is no scale U.S.-based Open RAN company.
- The lack of a U.S. RAN supply ecosystem is a strategic national security issue that requires immediate action.
- Open RAN can become a technically and economically superior alternative to current proprietary RAN solutions. The current Open RAN ecosystem, however, is not yet mature and needs to address cost, performance, and multi-vendor solution testing and integration gaps to drive adoption.
- One or more U.S.-based Open RAN scaled solution providers or system integration vendors are needed to deliver a nationwide, reliable, and secure network, supporting millions of subscribers, emergency responders and 911 calls, which are essential to enable tier 1 operator Open RAN deployment adoption. Scaled U.S. Open RAN solution providers or system integration vendors orchestrate end-to-end (E2E) solutions and deliver outcomes that de-risk U.S. operator Open RAN deployments.
- NTIA should focus policy and funding on developing a coherent plan to leverage the Open RAN trend, close critical technology and testing gaps, and establish U.S. leadership in 5G / 6G / future generations.

- The most effective and immediately impactful vehicles for NTIA ORAN acceleration funding in 2023 are:
  - Substantial grants to at-scale, domestic **technology** providers for the development of competitive 5G Open RAN Radio and RAN Software and Layer 1 Accelerator solutions.
  - Deployment of **incentives to stimulate** & accelerate public U.S. 5G Open RAN solution **demand**.
- Ultimately, the plan to develop the U.S. Open RAN ecosystem must address four main impediments:
  1. Ensure U.S.-based 5G Open RAN **technology** competitiveness (performance, roadmap, and cost).
  2. Coordinate **multi-vendor testing & certification process** to ensure openness & interoperability.
  3. Establish a U.S.-based Open RAN E2E **systems integration and testing process** to ensure blueprint solutions are consumable, performant, and secure.
  4. **Stimulate domestic public and private sector demand** for U.S.-based 5G Open RAN solutions and eliminate barriers to adoption.

Our following detailed reply comments address gaps in each of the four areas identified above. NTIA should prioritize funding to closing critical Open RAN technology gaps and to create incentives for U.S. operator 5G Open RAN adoption. It is important that the bulk of the funding be made available this year to accelerate 5G Open RAN and establish 6G leadership.

I. State of the Industry

The Open RAN Industry is maturing – Key challenges to accelerate adoption

The Radio Access Network (RAN) is the largest network expense for operators, representing 60-70% of annual capex expense. North America has lost its major RAN suppliers Lucent, Nortel, and Motorola, and the industry has consolidated to 3 major foreign RAN suppliers. Tier 1 operators in the U.S. and globally have pushed for Open RAN development due to inherent risk in the concentrated supplier base and proprietary technology that enables vendor lock-in. Open RAN is an opportunity to capitalize on the pervasive cloud, disaggregation and virtualization technology changes that have driven rapid innovation in the enterprises and public clouds.

From an adoption and deployment perspective, greenfield operators in Japan and the U.S. have the largest Open RAN deployments to date. Adoption with established (brownfield) operators has not yet scaled and Open RAN accounts for <4% of the RAN market in 2022. A consortium of tier 1 European operators and a major Asian operator have established their Open RAN requirements and been active in sponsoring vendor interoperability testing, lab/field trials and limited deployments.

Industry-wide deployment activity has been limited due to the maturity level of the Open RAN multi-vendor ecosystem. The primary issue has been gaps in the total cost of ownership (TCO), performance and roadmap competitiveness vs. established 5G RAN proprietary solutions. Multi-vendor testing, integration, and procurement are complex and a major change in the risk and adoption rate for the operator community. Many operators have identified that the industry lacks large, scaled Open RAN solution providers or systems integrators that can orchestrate performant and cost-effective solution outcomes that can de-risk the transition (contractually & operationally) to Open RAN. In addition, the Open RAN ecosystem has not yet developed and implemented an

efficient and effective process to develop multi-vendor blueprint solutions that have been through system level integration and testing that can offload operator testing.

Dell Technologies has been active in multiple Open RAN trials, bids, and deployments. There are several key challenges related to Open RAN adoption that must be considered:

Key Operator (brownfield) challenges to the adoption of Open RAN

- Higher solution cost / TCO vs. proprietary 5G RAN solutions
- Product/technology feature and performance gaps vs. proprietary 5G RAN solutions
- Lack of scaled U.S. Open RAN vendors for Radios and RAN Software
- Multi-vendor interoperability complexity and lack of certification process
- Lack of E2E multi-vendor blueprints with proven deployment history
- Lack of at scale U.S. Open RAN solution providers or systems integrators to deliver E2E outcomes and de-risk operator transition to Open RAN
- Open RAN operational complexity and unknowns; lack of ready toolsets and know-how to automate and simplify deployment, operations through Life Cycle Management
- Integration and interoperability requirements with legacy RAN (4G/5G) and OSS/BSS systems
- Open RAN Workforce skillset gaps in operator staff that has RAN, RF, cloud, IT, and virtualization skills

II. Technology Development and Standards

To ensure 5G Open RAN technology competitiveness, products and solutions must have performance and TCO better than proprietary 5G RAN products. Two key Open RAN gap areas, (1) Radio Units and (2) RAN Software and Layer 1 Acceleration, will benefit from NTIA funding.

Radio Units

The established proprietary Macro RAN market leaders have a considerable lead in 5G radio technology and sales volume. This has created a gap in the market for competitive, scaled Open RAN Macro Radio vendors that has slowed adoption. The U.S. needs to address the absence of a strong U.S. 5G radio supplier base to support Open RAN adoption and a secure, resilient radio supply chain for critical infrastructure for years to come. A competitive radio portfolio, including multi-band as well as massive MIMO radios, requires significant initial and on-going capital and resource investments in R&D to supply required U.S. 5G frequency band variants. To achieve the required size, weight, power efficiency and performance for competitive Open RAN solutions, a migration to advanced radio frequency (RF) front end chipsets, efficient amplifiers, RF filters and software algorithms is needed. U.S. government investment is critical for developing competitive, scaled domestic 5G Radio Unit suppliers with the capability to innovate in radio technology and the scale to invest in a competitive 5G Radio portfolio and secure supply chain capability.

Dell Technologies recommends that NTIA provide targeted funding to scaled U.S. Open RAN Radio vendors that can accelerate their roadmap and scale to support development of a competitive Radio portfolio for U.S. operators. The receipt of the NTIA funding must deliver Cell tower Radio products that interoperate with other vendors' Distributed Units (DUs). Funding for advanced RF front end chipsets, power efficient power amplifiers RF filters and advanced software algorithms should be considered as well.

RAN Software & Layer 1 Accelerators

A primary issue slowing Open RAN adoption with operators has been meeting the TCO, performance, feature breadth and capacity Key Performance Indicators (KPIs) that are better than proprietary RAN solutions for high capacity, Macro deployment use cases. In addition to the volume/cost advantage for propriety RAN solutions, layer 1 performance/capacity limitations and RAN Software performance & feature set for disaggregated, virtualized solutions vs. 5G proprietary options are the major Open RAN technical issues.

U.S. vendors are in a strong position to lead and address both issues. Advances in layer 1 accelerator performance with higher capacity and improved TCO are expected from the major U.S. chipset vendors as they continue to optimize for Open RAN architecture and close the performance gap with proprietary solutions. RAN software optimization will be required to maximize performance and capacity with these new accelerators. RAN software performance and features can be addressed with NTIA funding to domestic at-scale suppliers.

III. Integration, Interoperability, and Certification

One of the ecosystem challenges to Open RAN adoption is establishing an effective multi-vendor integration, interoperability, and certifications process. Nationwide mobile networks are complex with tens of thousands of RAN cell sites with complex features and applications ranging from video streaming to E911; system level end to end testing of these capabilities is critical to ensuring Open RAN can be successfully deployed.

Currently, there are two industry efforts that have launched initiatives to address some of these challenges. First, the O-RAN Alliance has established regional Open Test and Integration Center (OTIC) labs led by operators and focused on interface testing to the standard. OTIC labs provide useful environments to integrate disaggregated components, but OTIC testing, as currently defined, stops short of addressing integrated end to end systems. Second, the Telecom Infra Project (TIP) supports the Open RAN ecosystem and has made progress with community-driven Open RAN projects, established a badging process, and conducted limited solution level testing based on European operator input. However, these initiatives have not yet had significant impact due to fragmented industry support and limited U.S. operator input.

The current situation can benefit from NTIA and U.S. industry coordination in establishing a multi-vendor certification and system level testing process to mature blueprints that can accelerate Open RAN adoption. First, there has been no convening body chartered with coordinating a consolidated view of U.S. Open RAN priorities from the U.S. Industry. Second, the current Open RAN initiatives do not sufficiently address E2E system integration, testing and a clear roadmap of priorities.

Establishing U.S. Open RAN test labs to conduct multi-vendor certification testing and an E2E system integration test environment and process for prioritized use cases can provide benefits to both operators and vendors. An E2E multi-vendor system integration testing can address a major concern from operators that Open RAN ecosystem lacks robust multi-vendor blueprints can be consumed and accelerate adoption. Developing a common set of test cases that can be reused between labs and automated for Continuous Integration/Continuous Deployment (CI/CD) will create leverage for maturing multi-vendor interoperability and blueprints. Vendors gain a clearer understanding of system level requirements and will pursue to be included in system level blueprints that gain commercial traction. Further, the U.S. has many existing 5G labs (OTIC, TIP,

Operators, Vendors, U.S. Government) that can be leveraged to minimize the overall investment to implement this capability.

This type of initiative will require active participation of U.S. Industry (operators & vendors) and alignment with the O-RAN Alliance to establish agreements on federated labs, priorities, testing requirements, and KPIs for an Open RAN certification & solution integration process. To support developing these important requirements and ensure strong operator input to the system level requirements, a U.S. Industry-led Open RAN Technical Advisory Committee (TAC) can be formed to ensure industry input on the testing requirements, KPIs and process as well as liaise with the O-RAN Alliance and Test & Integration spec group.

Summary of an U.S. based E2E Open RAN multi-vendor certification and system integration process concept:

- Coordinate and simplify U.S. **multi-vendor interoperability** testing by developing an industry neutral and publicly available **certification process** for prioritized use cases.
  - Leverage significant U.S. 5G lab investment already set-up, including OTIC/TIP/Operator/Vendor labs (federated approach)
  - Align certification requirements with operators, vendors, and O-RAN Alliance

- Establish **E2E System Integration (SI) testing and process** for prioritized use cases to ensure E2E Open RAN is consumable, performant and secure.
  - Establish E2E functional, performance, operational and security requirements, testing & KPIs. Make the results available to increase confidence in E2E tested blueprints and for vendors and SIs to make continuous improvements.
  - E2E Open RAN system testing configuration per use case (such as Rural or Urban Macro) including Open RAN cluster, 5G devices, load simulators, connectivity/ interfaces to core network, transport network, and operational.
  - Develop at scale U.S. E2E system integration & test capabilities with U.S. Open RAN solution providers and system integration vendors.
  - Support developing automation and tools framework to improve the cost and effort to deploy, operate and maintain Open RAN at scale.

IV. Trials, Pilots, Use Cases, and Market Development

The following chart illustrates the major Open RAN use cases ranging from public to private enterprise/vertical/ federal. Dell Technologies recommends that NTIA and U.S. industry establish a consolidated view of U.S. 5G Open RAN priorities and roadmap that will accelerate U.S. Open RAN adoption and support advancing the global Open RAN ecosystem.

Major Open RAN Reference Architecture / Use Cases

Attributes	Government	Enterprise	Verticals	Macro Urban	Macro Rural
Primary User	DoD/Machines	Employees	Machines	Consumers	Consumers
Quality Requirements	Security/Availability/ Throughput/Latency	Throughput/Security	Throughput/Latency Security /Availability	Throughput / Availability	Throughput /availability
Purpose	Sense & Control / Connect & Secure	Sense & Control / Connect & Secure	Sense & Control / Connect & Secure	Inform & Entertain	Inform & Entertain
Coverage	Indoor/On-prem Outdoor	Indoor	Indoor/Outdoor	Outdoor/Indoor	Outdoor/Indoor
Devices	IoT, XR	Mobile/PC/ IoT/XR	Mobile/PC/IoT/XR	Mobile / PC / IoT	Mobile / PC / IoT
Business Model	Private	Private/Public	Private/Public	Public	Public

Dell Technologies further recommends that the top priority for funding is to close Open RAN technology/product performance gaps vs. 5G proprietary RAN. As described in Section II, the (1) Radio Units and (2) RAN Software & Layer 1 Accelerators are the primary determinants of Open RAN capacity, performance, and cost. With performant Open RAN Radio Unit supply and Distributed Unit/RAN Software solutions from multiple vendors, Open RAN adoption will accelerate for the high-volume Macro deployments.

To support driving Open RAN adoption, incentives, or offsets for U.S. operators to deploy U.S. Open RAN should be prioritized. This can include consideration for the advanced Proof of Concepts (PoCs) and trials that lead to Open RAN deployment. Operators face incremental costs for this activity without clear Return of Investment (ROI) until open-based solutions reach maturity; these costs can be offset.

To qualify for funding, vendors should be required to support and offer Open RAN compliant and interoperable products/solutions.

In terms of use cases, NTIA should prioritize Macro 5G use cases (Rural to Urban) with operators to address operator system integration and operability concerns. Rural deployment requirements are typically less demanding than Urban and have the potential to move quickly from system integration to deployment. Further, this use case is a candidate for U.S. Rip & Replace initiative and the underserved U.S. 5G Rural Broadband buildout. NTIA should not fund a particular application use case, as the objective here is to enable a scaled reliable nationwide mobile network infrastructure.

Select Private 5G use cases can also be considered. These use cases have Open RAN as part of the solution but are typically centered around the application. Note that substantial U.S. government investment has already been directed to establish the need for 5G in many of these use cases (DoD RPP's for example), and NTIA should attempt to leverage those existing efforts rather than duplicate them. For example, directing funds to convert existing use cases based on proprietary RAN systems to Open RAN would be an efficient path to accelerate demand.

NTIA should consider the ecosystem benefit from the use cases funded. Demonstrating use cases does not guarantee progress. Instead, focusing on open interface certifications and products ability to deliver cost, capacity, and KPIs better than the current networks will have an impact on all use cases.

V. Security

The key zero trust security considerations within the Open RAN ecosystem are: multi-vendor management, the Open Fronthaul connecting radios to base station equipment, a new RAN application framework comprising rApps and xApps, Artificial Intelligence/Machine Learning (AI/ML) in the RAN, and other general network considerations including open-source software, virtualization/cloudification, and distributed denial-of-service.

There are several aspects that impact the implementation of a secure Open RAN compliant system. Open RAN benefits from the disaggregated nature of CU/DU (Control Unit/Distributed Unit) in RAN architecture, which inherently ensures security of supply, robustness, and agility. The disaggregated, open, and non-exclusive Open RAN architecture, however, also imposes more challenges for its security and privacy protection operation.

The May 2021, the “Executive Order on Improving the Nation’s Cybersecurity” required agencies to plan and move toward implementing advanced zero trust 5G architectures for the protection of the Federal Government’s information resources. While there are still some challenges to overcome to implement a 5G zero trust architecture that are not unsurmountable around the various interfaces, O-Cloud and RIC, the adoption of an integrated solution is paramount.

Dell Technologies recommends the creation of a National Information Assurance Partnership (NIAP) Technical Community (TC) for a series of Open RAN Protection Profiles (PPs). A key goal for the TC is to ensure that PPs are generated as the result of collaboration between Government, industry, and academia.

Key Benefits of the NIAP TC formation are:

- Consistency
- Transparency
- Collaboration
- Scalability
- Improved "time to market"
- Leverages industry expertise
- International participation
- Collective ownership of the process

The formation of NIAP PPs will ensure that both Security Functional Requirements (SFRs) and security assurance requirements (SARs) are appropriate for the technology and the government’s needs. This produces results that can be compared across technology areas related to Open RAN.

The Open RAN Steering Committee (SC) facilitates the work of individual TCs and performs oversight of all TCs. The Communications Security, Reliability, and Interoperability Council

(CSRIC VIII) can function in conjunction with NIAP to form the Open RAN SC. This ensures consistency and completeness of the PPs developed by each Community.

VI. Program Execution and Collaboration

Recommendations

The lack of a broad U.S. wireless industry has jeopardized future leadership in 5G and 6G, particularly Open RAN. This lack of a robust and resilient U.S. RAN supply ecosystem is a strategic national security issue that requires immediate action. Both industry and government recognize the need to develop U.S.-based Open RAN suppliers that can deliver high performance, certified products, and best-in-class systems integration capabilities. A focused investment strategy directed to U.S. entities will best deliver these objectives.

Dell Technologies recommends:

- The most effective and immediately impactful vehicles for NTIA Open RAN acceleration funding in 2023 are:
  - Substantial grants to at-scale, domestic **technology** providers for the development of competitive 5G Open RAN Radio and RAN Software and Layer 1 Accelerator solutions.
  - Deployment **incentives to stimulate** & accelerate public U.S. 5G Open RAN solution **demand.**
- Additionally, establish a more efficient and effective process to coordinate multi-vendor interoperability certification and E2E system integration testing that can accelerate Open RAN adoption and enable future innovation.
  - Leverage large existing investment in U.S. labs to offset investment and expedite implementation.
  - Develop comprehensive E2E functional, performance, operational and security testing to validate E2E blueprint KPIs.

Summary recommendations for the four main areas required to develop the U.S. Open RAN ecosystem:

1. Top priority for NTIA funding to scaled, U.S. Open RAN vendors close fundamental 5G Open RAN **technology & products gaps** vs. proprietary 5G solution impacting Open RAN adoption.
   - Radio Units
     - Enable enhanced performance, feature breadth, TCO, power efficiency and frequency band coverage vs. proprietary 5G Radio Unit solutions.
   - RAN Software & Layer 1 Accelerators
     - Enable enhanced performance, TCO, capacity and feature breadth vs. proprietary 5G RAN solutions.
2. Coordinate **multi-vendor interoperability certification process** to ensure U.S. Open RAN products are open and interoperable.
3. Establish **E2E System Integration and test process for** prioritized reference architectures to ensure **multi-vendor blueprints** are consumable, performant and secure
   - Leverage large existing investment in U.S. labs (OTIC/TIP/Operator/Vendor/U.S. Government) to lower expense and expedite implementation.

- Develop comprehensive E2E functional, performance, operational and security testing to validate E2E blueprint KPIs.

4. **Stimulate U.S. Open RAN demand through incentives** and offsets to Operators and select Verticals that deploy U.S. Open RAN solutions.
   - Public - Rural to Urban Macro solutions.

VII. Conclusion

Dell Technologies thanks NTIA for taking the necessary steps in effectively using the available funding to support U.S. industry and build up the U.S. ORAN market to ensure global leadership. Dell Technologies is encouraged that following this comment period, NTIA, in coordination with other agencies, will be able to effectively take steps to reach these goals.