



Viavi Solutions Inc.
1445 South Spectrum Boulevard
Suite 102
Chandler, Arizona 85286
USA

Tel +1 408 404 3600 direct
+1 408 404 4500 fax

www.viavisolutions.com

January 27, 2023

Submitted via Regulations.gov and email to innovationfund@ntia.gov

National Telecommunications and Information Administration
Herbert C. Hoover Building
1401 Constitution Avenue, NW
Washington, DC 20230

RE: Docket No. 221202-0260: Request for Comment on the Public Wireless Supply Chain Innovation Fund

VIAVI Solutions Inc. appreciates the opportunity to comment on the National Telecommunications and Information Administration's (NTIA) implementation of the Public Wireless Supply Chain Innovation Fund (the Innovation Fund). This comment letter provides: (1) a summary introduction discussing key areas NTIA should support and criteria for grantees; (2) a brief overview of VIAVI's operations; and (3) responses to several of the NTIA's questions, particularly focusing on the need for the NTIA to promote independent, open testbeds for all vendors to use to develop new products, as well as end-to-end testing and certification of those products to ensure the security, functionality, and interoperability of all products in the 5G Open Radio Access Network (Open RAN) ecosystem.

I. Introduction

VIAVI is a U.S.-based company that develops technology that maintains, secures, and optimizes wireless networks worldwide. As a trusted Open RAN test and optimization provider, VIAVI is well positioned to assist the NTIA in developing criteria for Innovation Fund projects that advance the seven statutory goals of the Innovation Fund outlined in the FY 2021 National Defense Authorization Act.¹ In particular, the NTIA should ensure that a significant portion of

¹ The FY 2021 National Defense Authorization Act, which authorized the Innovation Fund, requires the NTIA to issue grants to projects that support the following:

the \$1.5 billion appropriated under the CHIPS and Science Act of 2022² funds the following types of projects:

- **Development and deployment of technology that will optimize the functioning and security of 5G networks.** Congress directed the Department of Commerce to support projects “[p]romoting and deploying security features enhancing the integrity and availability of equipment in multi-vendor networks” and “promoting and employing technology . . . that will enhance competitiveness in [5G] and successor wireless technology supply chains that use open and interoperable interface radio access networks.”³ It is crucial both for national security and competitiveness that as 5G expands throughout the country, networks perform well and are protected from breaches.
- **An Open RAN research and innovation testbed** that will stimulate and accelerate the buildup of the Open RAN ecosystem. A government-funded testbed open to all vendors will allow small and new market entrants to innovate new products without the cost of building their own testbed. It also will allow standards-setting organizations to develop and improve standards and offer blueprints of open, interoperable, and standardized Open RAN solutions that meet or exceed operator investment requirements. It is crucial that this testbed be open to all vendors worldwide who are approved to participate in the U.S. 5G ecosystem, and that it be operated by an independent third party that does not, and will not, have a stake in the outcome of the testing. This independent testbed will mitigate risks and allow for pre-commercialization evaluation, interoperability certification, and continuous improvement of both products and standards.
- **Standards-based testing, badging, optimization, and certification programs** that will allow vendors to obtain independent review of their products operating within the global

(i) Promoting and deploying technology, including software, hardware, and microprocessing technology, that will enhance competitiveness in the fifth-generation (commonly known as ‘5G’) and successor wireless technology supply chains that use open and interoperable interface radio access networks.

(ii) Accelerating commercial deployments of open interface standards-based compatible, interoperable equipment, such as equipment developed pursuant to the standards set forth by organizations such as the O-RAN Alliance, the Telecom Infra Project, 3GPP, the Open-RAN Software Community, or any successor organizations.

(iii) Promoting and deploying compatibility of new 5G equipment with future open standards-based, interoperable equipment.

(iv) Managing integration of multi-vendor network environments.

(v) Identifying objective criteria to define equipment as compliant with open standards for multi-vendor network equipment interoperability.

(vi) Promoting and deploying security features enhancing the integrity and availability of equipment in multi-vendor networks.

(vii) Promoting and deploying network function virtualization to facilitate multi-vendor interoperability and a more diverse vendor market.

47 U.S.C. § 906(a)(1).

² Pub. L. No. 117-167.

³ 47 U.S.C. § 906(a)(1)(C)(i), (vi).



testbed. Such a program will give operators confidence in purchasing vendors' products, which will increase supply chain participation and reduce both supply chain and operational risks.

- **Independently operated pilot programs** that demonstrate proof-of-concept of all the different segments and layers of the Open RAN systems.
- **Research in 5G, Open RAN optimization, and 6G development** by supporting development of Radio Intelligent Controller platforms and applications.

In awarding the grants, the NTIA should consider the following criteria:

- Whether grant applicants have a proven track record of developing, testing, deploying, scaling, and optimizing the relevant technology.
- Whether grant applicants have a proven track record of providing tools for preventing cyber attacks in all networks under development, operation, and support.
- Grant recipients should be headquartered in the United States with numerous innovation centers in the United States.
- The activity funded by the Innovation Fund should focus mainly on projects and activities in the United States.
- How the investment will promote not just the creation, but also the sustainability, of 5G and the future Open RAN and 6G networks across the country.
- How the investment will expand 5G access in rural and other underserved communities.
- Whether the investment will help create jobs in the United States.
- Whether the investment will be matched by other public or private investment.
- What ties a grant recipient has to China or other adverse nations and what steps the grant recipient has taken to avoid adverse influence in its operations. It is critical that we develop this technology at home and do not inadvertently share these taxpayer-funded advancements with adverse nations.

We discuss these projects and criteria in greater detail below in response to specific questions posed by the NTIA.

II. VIAVI Solutions, Inc.

VIAVI (formerly JDS Uniphase Corporation) is headquartered in Chandler, Arizona, and operates in 22 countries around the world. In the United States, it has significant operations in Santa Rosa, California; San Jose, California; Germantown, Maryland; Indianapolis, Indiana;



Wichita, Kansas; and Colorado Springs, Colorado. VIAVI employs approximately 1600 people in the United States.

VIAVI creates technology that helps manage the network lifecycle for complex 5G and fiber networks. VIAVI also provides expertise in light management and optical coatings that protect many nations' banknotes and enable advanced technology such as 3D sensing, used in applications such as facial recognition on smartphones.

Of particular relevance to the NTIA's implementation of the Innovation Fund, VIAVI develops and supports independent network and service test, optimization, and operation solutions for more than 200 tier one service providers around the world, as well as the top global network equipment manufacturers. With our Open RAN suite of products, we support well over 50 companies producing other Open RAN products. Those companies range from the producers of components like a mobile phone to critical backend mobile network components, such as the Radio Unit, Distributed Unit, and Centralized Unit of the Core Network. We help certify, benchmark, optimize, and verify all interoperability use cases and interfaces. We also develop and end-to-end verify the RAN Intelligent Controller (RIC), which controls the allocation of mobile and wireless airwaves on a given network. That process includes critical security testing, network automation, orchestration, and optimization.

Additionally, we provide network positioning, navigation, and timing (PNT) solutions to secure critical communications infrastructure, including Open RAN. 5G networks depend on accurate PNT and synchronization. Current GPS and fiber technologies are subject to interference and security vulnerabilities. VIAVI innovates in new low earth orbit and fiber technologies that support artificial intelligence efforts to address these current and future vulnerabilities.

VIAVI also provides infrastructure testing, monitoring, optimization, monetization, control, and security of 5G technology and networks in line with all relevant current standards (e.g., O-RAN, Open RAN, Telecom Infra Project, 3GPP) and emerging standards. VIAVI is also involved in developing and researching the upcoming 6G innovative technologies and services.

We offer high performance, independent, best-in-class tools and services targeting early-stage research through system testing to network deployment, optimization, and maintenance. Our solutions are hardware agnostic. They work with appliance-based hardware networks, as well as cloud-native solutions. We also provide a complete family of "digital twins" of the 5G and Open RAN network components.

Given its experience in developing technology and services to test and optimize the performance and security of wireless networks, VIAVI is well positioned to advise the NTIA about how to design aspects of a grant program that will advance the seven statutory goals of the Public Wireless Supply Chain Innovation Fund.⁴

⁴ 47 U.S.C § 906(a)(1).

III. Responses to Specific NTIA Questions

In our answers below to specific questions posed by the NTIA regarding implementation of the Innovation Fund, we address areas in which VIAVI has the greatest expertise and experience. We also have indicated where responses to a particular question may apply to additional questions.

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?

Although the idea of an open and interoperable network has been discussed for several decades, more recent technological advancements and demand for services have now made its development imperative to expand economic growth in the United States and ensure our competitiveness with other countries. We must address three main categories of challenges to make Open RAN a reality: (a) long and short term supply chain risks; (b) obstacles to integration; and (c) operational risks.

(a) Supply Chain Risks

Only a handful of vendor companies globally provide the component parts necessary for 5G network infrastructure. This creates two significant supply chain risks. First, there is little redundancy in the supply chain. If one or more vendor companies experiences operational challenges, operators will struggle to access the necessary parts to build and maintain network components, similar to what we saw during the height of the pandemic. Second, relying on foreign companies—particularly those located in countries with interests adverse to the United States—provides opportunities for those countries to act against U.S. interests. The NTIA should endeavor to address these issues on both a short-term and long-term basis.

In the short term, the NTIA should invest in grant recipients that minimize their exposure to bottlenecks in the supply chain, as well as risks posed by foreign adversaries. To address longer term challenges, the NTIA should fund the development of a U.S.-based supply chain for both Open RAN hardware and software. Innovation Fund support will encourage private investment and allow for market innovation more quickly than the private marketplace would create on its own.

One of the biggest costs to market entry for smaller vendors is ensuring the ability to test their products appropriately. Testbeds are expensive, and operators can limit access to their preferred vendors. NTIA can support the growth of a U.S.-based supply chain by funding an independent, open, U.S.-based testbed platform. Such a testbed will enable new market entrants and startups to mitigate the risk of making a large investment in testing and certification processes and infrastructure and ensure faster time to market for innovative suppliers.

(b) Obstacles to Integration

For Open RAN to work, all network components, including both software and hardware, need to be integrated and operate well together. This is challenging for many reasons, including the following:

- **Changing Specifications.** The 3rd Generation Partnership Project (3GPP), which develops specifications for Open RAN, continuously updates the specifications for each generation of new technology (e.g, 4G, 5G, 6G) and will continue to require new incremental features, capabilities, security enhancements, and bug fixes to be integrated into the end-to-end system going forward. In a single vendor scenario, the vendor itself must address this challenge, but in an Open RAN or multi-vendor environment, either the operator or a contracted dedicated systems integrator must ensure all parts of the system operate together even as the specifications change for each component part. NTIA support for an open, global testbed and certification platform will allow operators and integrators to mitigate the risk that various part of the system might not meet the specifications or work together.
- **Incompatible components.** Most vendors include at least one open-source or commercial third-party component in their solution designs, which can mean that different vendors involved in Open RAN may include components that are incompatible with each other. Again, an open, global testbed that allows vendors to test their products' interoperability and performance and that provides certification programs can mitigate such risk.
- **High costs.** The costs of integration and optimization for Open RAN will be high. All components of the end-to-end system likely will receive frequent updates. Each update must be tested and integrated into the full end-to-end chain in a continuous pipeline including continuous integration (CI), continuous deployment (CD), and continuous testing (CT). Further, each update must be validated against functional, performance, security, and operational requirements.
- **Lack of market certainty.** Startup and new entrant vendors will continue to innovate and produce new Open RAN products, but ultimately market forces will likely lead to consolidation. Without knowing which vendors will emerge, it will be challenging for operators to have confidence that the same vendor will be around to maintain, support, and service products purchased from the vendor. Therefore, operators' initial investment in the first products to market will be risky, and the products will be expensive to replace. And if the vendor agreed to provide continued support for evolving specifications, it will be expensive for them to make the transition between initial products to market and future products. Here again, a global, open testbed can accelerate Open RAN network development, which will reduce uncertainty in the market.

- **Lack of mandatory standards and specifications.** Aligning standards and specifications is a challenging and resource-intensive but necessary step to mitigate integration issues and costs. Currently, the European Telecommunications Standards Institute (ETSI) is working with the O-RAN Alliance to include some specifications for interoperability into ETSI standards. For Open RAN to succeed, this process needs to continue. Importantly, the process likely will reveal problems in the specifications such as ambiguity, security concerns, or bugs that would impede an open and interoperable standard. It will be important to address those issues before either the government or private sector invests in hardware and software. The NTIA should direct significant resources to this diligence process.

(c) Operational Risks

To date, the Open RAN vendor community has focused on creating a 5G system with functionality, features, and performance that compare to those of legacy vendors. It has not focused on operational requirements to help the network overcome natural and man-made disruptions (e.g., storms, earthquakes, vandalization, theft, fraud, security incidents, software bugs, and hardware faults). Nor have the standards-setting organizations given as much attention to operational standards. This means that operators will be working in a sub-par operational environment with little recourse to request that vendors comply with appropriate standards.

In the short term, the lack of operational standards will cause vendors to offer significantly different products from each other, which could pose substantial operational risks if operators need to seek new vendors because of supply chain consolidation or security disruptions. The NTIA should invest in the development of uniform standards and projects that support the operationalization of new technologies consistent with those standards. One such project should be a digital twin testbed to allow testing of how various technologies work against such standards. This will help improve both the standards themselves and the technology. It will also reduce the total cost of operation and mitigate integration issues.

2. What ongoing public and private sector initiatives may be relevant to the Innovation Fund?

Organizations such as the Next-G Alliance, US Ignite, the Telecommunications Industry Association, the Alliance for Telecommunications Industry Standards, the Telecom Infra Project, the 5G Alliance for Connected Industries and Automation, ETSI, the 3rd Generation Partnership Project, the Telecom Engineering Group, the TeleManagement Forum, and the O-RAN Alliance all sponsor initiatives that benefit the overall Open RAN ecosystem.

Platforms for Advanced Wireless Research (PAWR), led by US Ignite and funded by the National Science Foundation, builds large-scale wireless testbeds for research across four U.S. cities (POWDER in Salt Lake City; COSMOS in New York City; AERPAW in the Research

Triangle Park, North Carolina; and ARA in Ames, Iowa).⁵ The Innovation Fund should expand PAWR and similar initiatives by funding an Open RAN global testbed that would enable more U.S.-based public and private operators to invest in more trials and proofs of concepts.

2a. What gaps exist from an R&D, commercialization, and standards perspective?

2b. How might NTIA best ensure funding is used in a way that complements existing public and private sector initiatives?

The lack of uniform, mandatory standards for Open RAN makes it difficult for researchers, vendors, and operators to build the Open RAN ecosystem. Uniform, mandatory standards will give researchers and developers goals for functionality, interoperability, and security. It will be difficult for current public and private sector initiatives to make substantial progress until uniform, mandatory standards emerge.

The NTIA should invest in the development of standards. Both vendors and operators should contribute to the development of standards to ensure they are feasible to meet and satisfy operator requirements. The standards should provide blueprints of open, interoperable, and standardized offerings meeting or exceeding operator investment requirements.

To help implement the standards, the NTIA also should fund an open, independent, global testbed platform that allows testing against those standards. This testbed will increase industry participation, which will reduce supply chain risks and improve the operation of the technology. It also will foster faster innovation and allow vendors to scale up production more quickly with minimum capital expenditure requirements.

Once researchers, developers, and vendors can demonstrate they meet these standards in the testbed environment, they will be able to sell those products commercially to buyers who will have much more confidence that the equipment will function properly in the Open RAN environment.

⁵ VIAVI is a major sponsor of and active participant in PAWR.

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?

Key areas in need of research and development funding to develop the Open RAN ecosystem include:

- The Open Fronthaul between the radio hardware unit and distributed unit software needs additional research and development to increase its performance for massive multiple input / multiple output (MIMO) and increase the utility of Open Radio Units (O-RU) for spectrum sensing and analysis. It is also critical to fund research and development into automation of testing, verification, and optimization tools.
- Improving the overall coverage performance in a cost-effective manner for Frequency Range 2 frequencies in 5G, including further improvement of integrated access and backhaul.
- Both the non-real time RAN Intelligent Controller (RIC) and near-real time RIC need further investment in terms of advanced use cases (e.g., energy efficiency, resiliency, and overall network optimization, especially around Massive MIMO and mmWave).
- The RIC also needs further research and development to increase the portability of apps between RICs from different vendors.
- New test methodologies for systems that employ artificial intelligence and machine learning (AI/ML) is a critical need given the highly dynamic nature and dependence on training data of such systems.

7. Are the 5G and open and interoperable RAN standards environments sufficiently mature to produce stable, interoperable, cost-effective, and market-ready RAN products? If not:

7a. What barriers are faced in the standards environment for open and interoperable RAN?

7b. What is required, from a standards perspective, to improve stability, interoperability, cost effectiveness, and market readiness?

The standards for open fronthaul for basic radio configurations (e.g., up to 4x4 MIMO) are the most mature. All the other standards currently in development, such as for advanced fronthaul applications, beamforming, shared O-RU, and the interfaces around the RIC (E2, A1, O1) are still not mature enough for a wide consensus and adoption across the industry.

Developing and improving consistent standards and specifications is crucial for the Open RAN ecosystem to develop in a stable, interoperable manner. The NTIA should fund projects to

develop and improve testing of hardware, software, and networks to ensure that the Open RAN ecosystem will be fully functional, stable, and safe. Specifically:

- Testing the end-to-end performance, capacity, and scalability of all the Open RAN components.
- The certification and badging process that assures equipment deployment readiness needs improvement.
- Ability to raise confidence that the network intelligence (e.g., in apps on the RIC, or embedded in the RAN functions themselves) are operating effectively and safely, behave well as part of a system, and avoid costly or harmful corner cases.

7c. What criteria should be used to define equipment as compliant with open standards for multivendor network equipment interoperability?

We should expand the current assessment procedures that focus mostly on functional and conformance testing to also score equipment in terms of its performance, robustness, and the amount of other equipment with which it can interoperate. An NTIA-funded global, independent, open test platform will provide such an environment to measure and attain compliance and interoperability assurance for current and new Open RAN vendors.

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?

To ensure the most value for taxpayer funds, the NTIA should promote not just near-term technology, but long-term growth. One key project NTIA should fund is the development of next generation research testbeds that fully embrace the tenets of an open, virtualized, intelligent, and interoperable Open RAN, especially around foundational technologies like artificial intelligence and machine learning, new network topologies, security and resiliency, and distributed cloud. These testbeds can be made more relevant by embodying realistic and authentic networks (e.g., through advanced simulations and digital twins). The NTIA should fund research of mechanisms by which real network behavior can be used to create these testbeds while protecting against exposure of sensitive data to ensure the testbed environment operates like the actual ecosystem as much as possible.

9. How can projects funded through the Innovation Fund most effectively support promoting and deploying compatibility of new 5G equipment with future open, interoperable, and standards-based equipment?

Innovation Fund support for an open global testbed platform with various testing mechanisms and tools will be required to achieve real interoperable deployment. This testbed would include:

- Conformance testing over open standardized interfaces that would allow participation by 3GPP, O-RAN Alliance, the Telecom Infra Project, and others.
- Inter-operability testing among components connected over open interfaces.
- Use case-based testing with the RAN Intelligent Controller.
- End-to-end integration testing, i.e., UE-emulator based validation testing.
- High load testing for the whole system and individual components.
- Security testing for the whole system and individual components. This would also be applied to virtualized/cloudified system.
- Digital twin adaptation in test configuration to find problems before and after commercial deployment.
- Testing and feedback to improve the Open RAN standards and interoperability requirements.

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

See discussion of Question 10.

10. How can projects funded through the program most effectively support the “integration of multi-vendor network environments”?

Plugfest-based interoperability testing and debugging events that facilitate integration and adaptation are necessary but not sufficient to integrate multi-vendor network environments. In addition to such events, the entire system must undergo benchmark testing (e.g., load, energy efficiency, AI/ML training outcome). Testing beyond interoperability and debugging is necessary to ensure the assembled systems can handle realistic network loads and scenarios with performance similar to that of incumbent, monolithic vendors. That testing will provide operators with more confidence to deploy the new technology, which will facilitate the commercialization of these products.

An NTIA-funded open, global, and independent testbed platform will support the interoperability of the system in the following ways:

- **Collaborative research and development initiatives.** For example, industry consortia or public-private partnerships can bring together different vendors and stakeholders to work on developing and testing open, interoperable, and standards-based equipment.
- **Realistic simulations.** Testbeds and digital twins or “living labs” provide a platform for vendors and network operators to test and debug equipment in simulated real-world environments, which can help to identify and resolve any compatibility issues before the equipment is deployed in a live network.
- **Certification and onboarding programs.** Vendors can demonstrate their products meet certification standards in the testbed environment. Certification programs can provide a mechanism for vendors to demonstrate their compliance and performance, which will give confidence to purchasers of their equipment.

11. How do certification programs impact commercial adoption and deployment?

11a. Is certification of open, interoperable, standards-based equipment necessary for a successful marketplace?

Yes, such certification facilitates ecosystem development and reduces the total cost of the Open RAN system. Furthermore, such a framework reduces security risks. It will also help to establish trust in the marketplace and provide operators with the confidence to invest more in Open RAN solutions.

11b. What bodies or fora would be appropriate to host such a certification process?

The Next-G Alliance, the Telecom Industry Association, the Alliance for Telecommunications Industry Solutions, US Ignite, O-RAN Alliance, 3GPP, and the Telecom Infra Project would be appropriate organizations to produce such a process.

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

Currently, certifications are optional. It should be mandatory for elements of the Open RAN system to undergo testing and pass a clearly defined testbed certification and evaluation process. It is also important to expand certifications to include load and performance testing in addition to functional certifications.

12a. Are there alternative processes to certification that may prove more agile, economical, or effective than certification?

Use case badging with a global open testbed using CI/CD agile process could serve as an alternative to certification.

12b. What role, if any, should NTIA take in addressing gaps and barriers in open and interoperable, standards-based RAN certification regimes?

NTIA should fund and support an open, global testbed and certification platform developed and operated by an independent third party. The platform should offer testing, optimization, and certification mechanisms and tools that will enable interoperable deployment of a 5G Open RAN ecosystem. It is important that the testbed be operated by an independent, gold-standard supplier and allow multiple vendors and operators to use it for testing and certification purposes. Such a testbed would allow new competitors to produce technology and to operate within the 5G ecosystem, which would benefit the U.S. economy, reduce supply chain risks, and promote innovation.

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?

Open and interoperable standards-based networks, such as Open RAN, have a wide range of potential use cases for both public and private 5G networks. Some examples, in order of priority, include:

1. **Rural and remote areas.** Open RAN can provide connectivity to areas that are difficult to reach with traditional network infrastructure.
2. **Public safety.** Open RAN can be used to deploy dedicated networks for public safety agencies, such as police and fire departments, to improve their ability to communicate during emergencies.
3. **Increased competition.** Open RAN can increase competition among vendors, which can drive down costs, improve innovation and time-to-market, and avoid vendor lock-in.
4. **Industrial Internet of Things (IIoT).** Open RAN can enable the deployment of low-cost, low-power networks that are well suited for industrial IIoT applications such as smart factories and predictive maintenance.
5. **Private networks.** Open RAN can be used to deploy private 5G networks for specific industries or organizations, such as hospitals, ports, and airports.

6. **Pandemic inspired used cases.** For example, identifying behavior patterns in subscribers that correlate with disease spread and how those behaviors change as a result of disease and public health messaging, possibly with a feedback loop between messaging and response.

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?

- End-to-end interoperability testing involving the Open RAN hardware and software.
- Studies and proofs of concept that focus on artificial intelligence and machine learning workflows, testing and characterizing the testability of multi-vendor components embedding artificial intelligence.
- Studies and proofs of concept that focus on multi-vendor interoperability, scalability, and continuous integration.

14a. What kinds of testbeds, trials, and pilots, if any, should be prioritized?

The NTIA should prioritize funding testbeds that will stimulate the buildup of the open ecosystems and help create scale. This global testbed will also become the focus of mitigating risks, empowering pre-commercialization evaluation, interoperability certification, and continuous improvement in standards. These testbeds should specifically provide the following features:

- End-to-end testing
- Fronthaul interoperability
- Transport/Synchronization/Network Security testing, impairment generation
- Interoperability testing. For an open and disaggregated network, interoperability testing is key, and the development of testbeds that target identified use cases (such as Industry 4.0) is of paramount importance. The testbeds should involve commercial 5G equipment: centralized units, distributed units, and radio hardware units of multiple vendors should be supported, with extensive emulation and testing capabilities (e.g., RIC testing).
- Challenging learning capability. This form of testing would ensure that the artificial intelligence and machine learning have benign operation over all conceivable operational scenarios. It would serve to highlight challenges that produce undesirable outcomes.

The testbeds should serve as a platform for evaluating customer-specific use cases in specific deployment scenarios. Additionally, the testbeds should be designed to facilitate the

implementation and evaluation of novel technological innovations, as well as the development of solutions for achieving interoperability among them.

15. How might existing testbeds be utilized to accelerate adoption and deployment?

Some existing ecosystem-based testbeds, like the PAWR platforms led by US Ignite and funded by the National Science Foundation, provide a good starting point to build wireless research environments and enable plugfest activities. As mentioned above, however, although plugfest-based testbeds provide venues for debugging and facilitate the integration and adaptation of new technologies, they are not sufficient for benchmarking and interoperability testing to ensure the assembled systems can handle realistic network loads and scenarios with performance similar to that of incumbent, monolithic vendors. Other commercially available testbeds, such as the one provided by VIAVI, highlight the state of maturity of the different components at any point in time, providing more information to operators when choosing their vendors. The Innovation Fund can extend the capabilities of both the ecosystem and the commercial testbeds by funding an Open RAN global testbed that would encourage more U.S.-based public and private operators to invest in more trials and proofs of concept. This would enable new entrants and startups to mitigate the risk of large investment in testing and certification processes and infrastructure and would ensure faster time to market for innovative suppliers.

16. What sort of outcomes would be required from proof-of-concept pilots and trials to enable widespread adoption and deployment of open and interoperable, standards-based RAN, such as Open RAN?

The proof-of-concept pilots and trials, which should take place on a global testbed, should enable users to:

- Assess supply-chain readiness, from the hardware and software perspective.
- Assess readiness of technical specifications to enable true interoperability and advanced capabilities (e.g., orchestration, intelligent automation).
- Assess the level of interoperability that can be brought to market.
- Assess how the supply chain should be organized in different deployment scenarios.
- Assess the security risks associated with embedding intelligence and cloudification in commercial networks.
- Demonstrate that the system can withstand adversarial challenges.
- Prove that a digital twin can reliably reproduce adverse events that mimic real events. The adverse events should include traffic surges, network element failure, power failure,

concentration of traffic due to adverse weather, sports events, fires, explosions, and other emergencies.

- Demonstrate readiness for deployment, including installation, integration, and maintenance.

Questions 17–20

As a founding member of the Open PNT Industry Alliance (OPIA), VIAVI strongly supports the Alliance’s response to Questions 17 through 20 urging the NTIA to incorporate security-oriented PNT principles from several authoritative sources into programs initiated through the Public Wireless Supply Chain Innovation Fund.

25a. Should NTIA require that grantee projects take place in the U.S.?

Yes, the NTIA should require that grantee projects take place in the United States. This requirement should extend to grantee partners in academia, government, community groups, and regional and national associations. Further, applications from companies and institutions headquartered in the United States should receive preference. Those requirements will further the CHIPS and Science Act’s goals of developing U.S. technology, industrial capacity, and human skills, as well as advancing our national security. Such a focused application of resources will enhance domestic technology capacity and drive future enhancements and competitiveness in technology, services and human capital.