January 27, 2023

Alan Davidson
Assistant Secretary for Communications and Information
National Telecommunications and Information Administration
U.S. Department of Commerce
1401 Constitution Avenue, NW
Washington, D.C. 20230

Re: Notice and Request for Comment, Public Wireless Supply Chain Innovation Fund Implementation, Docket No. 221202-0260; RIN 0693–XC053

Public Wireless Supply Chain Innovation Fund Implementation

Dear Mr. Davidson,

Analog Devices Incorporated (ADI) is a leading American semiconductor company headquartered in Wilmington, MA which designs, manufactures and sells a broad variety of analog, mixed signal, and digital signal processors. With over $12 billion in revenue, 24,000 employees and 125,000 customers worldwide, ADI plays an important role in producing cutting-edge semiconductors necessary to meet major national and global challenges including developing smart infrastructure, rolling out 5G, building electric vehicles, limiting climate change, and providing solutions for the US military. ADI invests 18 percent of our revenue in advanced research and development and participates in various research consortia to advance the competitiveness of our industry and company. Specifically relevant to this submission, ADI is a leading provider of the semiconductor technology that enables Radio Units to communicate with a range of connected devices, from smartphones and first responders' networks, to connected cars and smart meters.

ADI appreciates the opportunity to respond to the National Telecommunications and Information Administration (NTIA)'s request for comments on the implementation of the Public Wireless Supply Chain Innovation Fund enacted as part of the CHIPS and Science Act of 2022, to support the promotion and deployment of open, interoperable, and standards-based radio access networks (RAN). In general, we wish to associate with the general views expressed in the comments submitted by the Open RAN Policy Coalition (ORPC), of which ADI is an active member. Because the semiconductor industry represents only one segment of the various industry players that participate in ORPC, we add the following thoughts to those inputs that reflect views relevant to ADI and our role in that market.

The O-RAN ALLIANCE and industry to date has made great progress in defining open architectures but it is critically important that the industry achieve scope and scale. Products based upon O-RAN need to achieve performance parity with legacy products so they can be deployed by mobile network operators. In turn mobile network operators need to deploy the products in volume to achieve scale.

ADI sees four areas of O-RAN ecosystem investment that can be catalyzed by the Wireless Innovation Fund:

- Investment in open radio unit development within the United States which can encompass companies that are based in partner countries

- Investment in trials and certification programs to ensure that the various network elements and software are interoperable and comply with the O-RAN ALLIANCE specifications
- Investment in forward looking silicon solutions to optimize power and performance
- Investment in software development to run-on general-purpose processors used for the Open Distributed Unit, Open Centralized Unit, and management functions

ADI's point by point responses provided to the NTIA's Request for Comments support these main investment areas.

In addition, ADI believes it is critical that the industry converge around the O-RAN ALLIANCE standards and specifications and do so with as few variations as possible. This will promote the needed scale and scope in both silicon and software solutions.

Questions on the State of the Industry:

Understanding the current state of the telecommunications industry is important to determining how any topics should be prioritized in the Innovation Fund, and what level of funding a topic should receive.

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?***

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

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

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

    In summary ADI believes that there are four main areas for investment:

    - Investment in open radio unit development
    - Investment in trials and certification programs to ensure that the various network elements and software are interoperable and comply with the O-RAN ALLIANCE specifications
    - Investment in forward looking silicon solutions to optimize power and performance
    - Investment in software development to run-on general-purpose processors to support Open Distributed Unit, Open Centralized Unit, and management functions

    These areas are expounded upon in answer to question 6 and a perspective on standardization is given in the answer to question 7.

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

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?***

In North America there is a need for more radio-frequency (RF) engineers who can design complex radios, semiconductors, and radio software. Access to talent to support development and deployment of interoperable, standards-based RAN has been and continues to be a challenge. The US educational pipeline has strengths in computer science—but communication-centric companies including those pursuing O-RAN technology face a great deal of competition for this talent.

Radio hardware talent continues to be vital to the development of modern cellular networks, and this talent is increasingly scarce in the educational pipeline. Around 2000, North America had a vibrant level of wireless development led by companies such as Lucent Technologies and Motorola and represented almost 40% of the global market[1]. These companies had strong ties to universities to develop and feed talent. Contrast that to today, where the development in North America is significantly reduced with commensurate reductions of these disciplines in universities.

With the enactment of the CHIPS and Science Act, much focus has been on the particular challenges in developing, attracting and retaining a microelectronics workforce including factory operators and technicians as well as the degree-level computer, software, materials and process engineers necessary to maintain the steady pace of innovation. But workforce challenges extend to all parts of the IT ecosystem that depend so heavily on professionals with STEM backgrounds.

These workforce challenges require a multifaceted approach that spans the educational continuum from K-12 through community college, university, and post-graduate work to lifelong learning. To address that need, many technology companies, including ADI, partner with local education institutions at all levels to address current and future workforce needs. With the enactment of the CHIPS Act, its dedicated funding and focus on workforce development, and its requirement that companies seeking semiconductor manufacturing incentives develop a workforce development plan, a more coordinated effort on workforce development in the mobile telecommunications sector is also possible and should be leveraged. Parties that seek incentives under the Wireless Innovation Fund, should be encouraged to include effective and creative workforce development components in their proposals that will help build the pipeline of talent, attract, and retain new talent, and retrain existing talent. This could involve offering internships, developing relevant curricula, working with educational institutions, and collaborating with industry partners and leveraging other strategies to achieve these objectives.

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?***

5. ***How do global supply chains impact the open, interoperable, and standards-based RAN market, particularly in terms of procuring equipment for trials or deployments?***

Questions on Technology Development and Standards:

Understanding the current state of open and interoperable, standards-based RAN and the standards that inform its development will assist NTIA in maximizing the impact of grants. Questions in this section will be used to assess the maturity of the technology and related standards to help determine which topics should receive additional investment.

[1] https://www.rcrwireless.com/20171204/analyst-angle/analyst-angle-will-5g-result-fewer-mobile-infrastructure

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? (summary)***

An overview of the Open Radio Architecture is needed to answer this question. The O-RAN ALLIANCE, which includes operators, infrastructure vendors, silicon providers, and research institutions, works together to standardize open interfaces and disaggregate the legacy cellular infrastructure into interoperable subsystems as depicted in Figure1 below[2]. The O-RAN ALLIANCE is currently focused upon the latest generations of 3GPP[3] developed specifications, specifically 4G (E-UTRA or LTE in the 3GPP specifications) and 5G (NR in 3GPP) waveforms and associated protocols[4].

There are a few key elements that form the basis of the O-RAN architecture:

- Service Management and Orchestration which includes the Non-Real time RAN Intelligent Controller (RIC)
- Near Real Time RAN Intelligent Controller
- O-CU (Open Central Unit) which is further divided into Control Plane (CP) and User Plane (UP) in the O-RAN Architecture (O-CU-CP and -UP in Figure 1)
- O-DU (Distributed Unit)
- O-RU (Radio Unit)

The overall goal of the O-RAN ALLIANCE is to establish open interfaces between these elements and to virtualize as much of the functionality currently embodied in hardware-centric devices.

[2] O-RAN ALLIANCE O-RAN Architecture Description 7.0, Figure 4.1.2
[3] 3GPP – The Mobile Broadband Standard Partnership Project
[4] O-RAN ALLIANCE O-RAN Architecture Description 7.0, Section 1.3.1

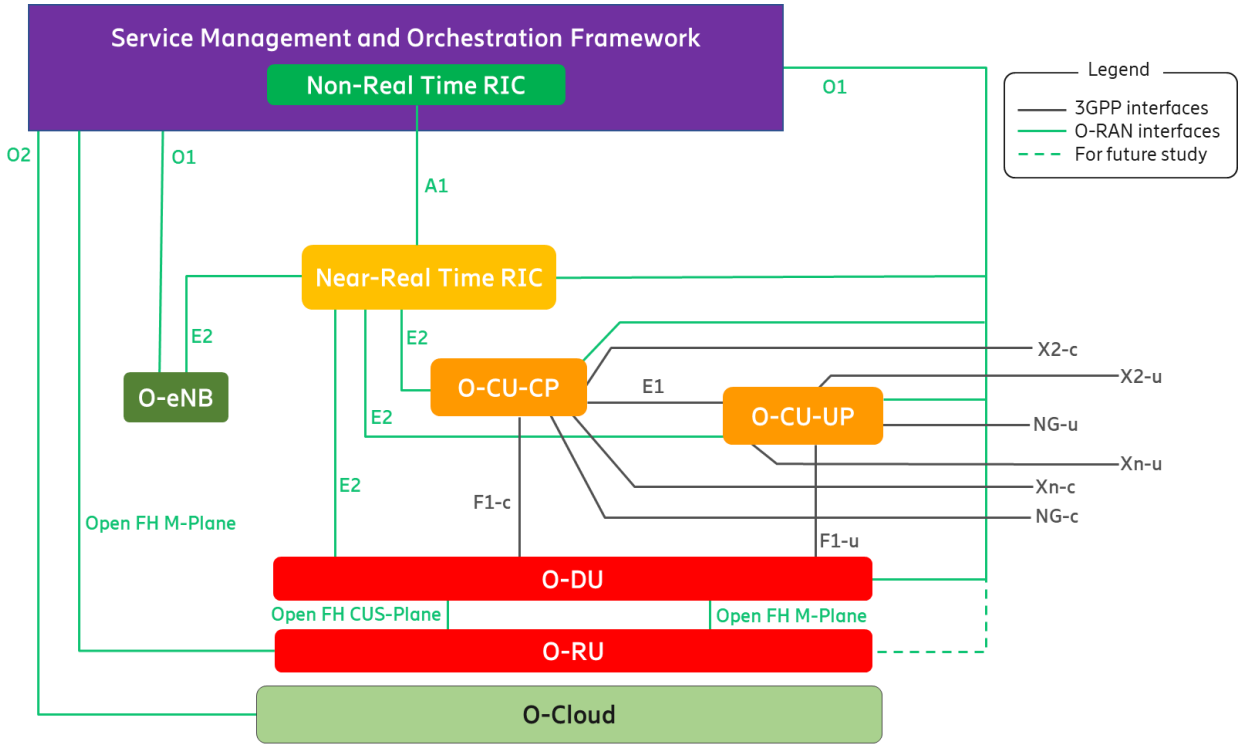

Figure 1: Logical Architecture of O-RAN

Figure 1 can be simplified and compared to a legacy cellular base station (also called a gNode B, for a 5G cellular Base Station) below:

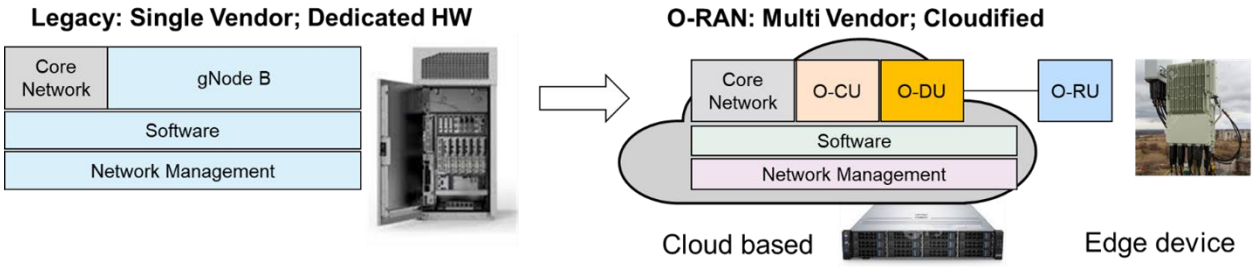

Figure 2: Migration from Legacy to Open RAN

The Distributed Unit (O-DU) and Central Unit (O-CU) are largely virtualized and run software on general purpose server processors with hardware accelerators. The Radio Unit (O-RU), which is typically mounted on poles and towers at the edge of the RAN network, translates digital signals into radio waves and is a largely hardware centric physical node[5] with general-purpose processors to host management software.

[5] O-RAN ALLIANCE O-RAN Architecture Description 7.0, Section 4.3.6

With this background, the shift from legacy architectures to open and virtualized architectures as depicted in Figure 2 indicates multiple areas of investment:

1. Investment is needed to strengthen US participation in the Radio Unit supply chain. North America no longer has a major radio vendor which supplies infrastructure devices to mobile network operators, military, or private networks. Many silicon companies like Analog Devices provide complete reference designs which reduce the time and money necessary to create commercial Radio Units. However, transforming the reference design into a commercial Radio Unit still requires significant design, development, manufacture, and test resources. This transformation is capital intensive and necessarily begins without customer commitments, thus many companies are reticent to make the investment, and there is little appetite in the Venture Capital community to support infrastructure hardware. This is an excellent opportunity for the Public Wireless Supply Chain Innovation Fund to act as a catalyst, enabling the Open RAN ecosystem by providing early financial support to enable Radio Unit development where a large part of the R&D and manufacturing are done in the United States.

   Investment in open radio unit development will yield a high return. Radio units consume most of the power of the network and up to 70% of the network capital budget. In addition, the diverse number of bands (globally there are over sixty 5G bands) and the unique combination of bands require a very diverse number of radio units to meet market needs. Thus, facilitating the ecosystem around radio units should be a priority.

2. While US semiconductor companies such as ADI are investing in solutions for wireless infrastructure, some directed investment towards silicon to support the most advanced mMIMO capabilities in the O-RU and for accelerators in the O-DU/CU is recommended. These radio units employ beamforming with large antenna arrays (32 individual antenna elements or more) and requires the latest generation digital beamforming processors and transceivers.

   6G, while nascent and yet to be specified, is likely to increase the number of antenna elements in the O-RU and thus require even further integration at leading process nodes to reduce energy, cost, size, and weight of the radio units. Thus, investment in digital signal processors and radio transceivers for future generations will keep the US lead in these critical components and reduce the power consumption for these products.

3. Software and protocol stacks that reside on the O-DU and O-CU processors are an area that needs development. Investment is needed to increase functionality to meet the complexity of 3GPP specifications including the diversity of O-RU types (e.g., bands, power levels, antenna counts) and to meet carrier grade requirements. In particular, the mMIMO O-RU solutions require the most complex O-DU/O-CU solutions. In addition, investment in software for the Radio Intelligent Controllers (RIC), both the Non-Real Time RIC and Near-Real Time RIC is recommended. The RIC is unique to O-RAN and is fundamental to the virtualization of certain software functions.

4. The development of test beds and trial deployment in conjunction with a commercial carrier network is another area of investment. The scope of the effort can include interoperability

between vendors and testing security protocols. More specific recommendations can be found in answer to Questions 13-16.

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:

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

In general, it is critical that the O-RAN industry converge around standards and specifications with as few permutations as possible. This will promote the needed scale and scope in both silicon and software solutions. Silicon solutions that support multiple standardized interfaces, particularly for the fronthaul, are not optimized and the associated software requires multiple variants.

One of the O-RAN ALLIANCE specification efforts is the interface between the O-RU and O-DU which is the Open FH (Fronthaul) depicted in Figure 1 and is defined by O-RAN's Working Group 4. The O-RAN ALLIANCE has selected a single split point, known as "7-2x" but allows variations.

At present, the specifications for Split 7.2a fronthaul and functions are sufficiently mature for less complex O-RU product types, specifically those that employ 8 antenna elements or less. These radio units are typically designed for macro, micro and small cells products.

The specifications for the more complex radio units, typically those that employ 16 antenna elements or more (mMIMO units) are still in development. Currently the O-RAN ALLIANCE has defined split 7.2b fronthaul interface and functional splits for these product types, but there is significant activity in Working Group 4 to increase the complexity of the mMIMO o-RU by including more functionality in the 0-RU.

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

Stable specifications, including functional splits and interfaces, will allow energy and cost-efficient silicon solutions to be developed for the O-RU. Likewise, stability and convergence of specifications allows software and the general-purpose processors and accelerators used in the O-DU/CU to be optimized. Introduction of multiple functional splits and associated specifications for similar product use cases will result in less optimized silicon solutions and increased development costs.

From a standards perspective, improving stability, interoperability, cost effectiveness and market readiness is made possible by reducing the permutations of optional operating modes/messages that occur between the O-RU and O-DU. The vast number of complex messages can lead to unforeseen issues or expose implementation misinterpretations which are difficult to foresee especially when driven and processed by equipment of different vendor origin.

O-RAN standards, in particular Working Group 4 which is responsible for the fronthaul specification, tend to provide multiple optional means to realize the same action in the name of efficiency and architectural design limitations. The burden of optionality complicates interoperability which may be mitigated by defining Interoperability Profiles. These profiles select a subset of standardized functions to support a particular RAN deployment use case and provide guidance for what equipment vendors should target to support. As Open RAN continues to evolve it is important that these interoperability profiles (which are to a limited extend defined in WG4) are kept up to date

and extended as necessary or otherwise risk increasing the entry barrier and interoperability issues for equipment vendors and RAN owners.

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

Figure 1 shows the logical architecture of the O-RAN ALLIANCE. At a minimum, equipment entities, such as O-CU, O-DU, O-RU should fully comply with the O-RAN interfaces defined in green. These open interface standards enable multi-vendor interoperability. Compliance is verified in 3 processes: Conformance (CONF), Interop Testing (IOT), and End-to-End (TIFG) and all defined within the Test and Integration Group within the O-RAN ALLIANCE (for the OFH of O-DU to O-RU for instance).

However, even with an open standard, interpretations of that standard can exist between multiple vendors. Open Test and Integration Centers have been brought into to resolve this issue. These OTICs are unbiased third parties that can provide industry-wide certification of multi-vendor interoperation.

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?

Questions on Integration, Interoperability, and Certification:

Challenges associated with systems integration and component interoperability can hinder the adoption of open and interoperable, standards-based RAN. This section will help NTIA structure the NOFOs in a way that most effectively addresses these challenges and facilitates adoption. NTIA also welcomes feedback on the effectiveness of certification regimes in driving open and interoperable, standards-based RAN adoption.

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?

ADI is keenly interested in the Wireless Supply Chain Innovation Fund to spur development and adoption of commercially viable Open Radio Units. Given the maturity level of the fronthaul specifications cited in response to 7.a, a first step is to fund the development of 7.2a products including O-RU and associated O-DU/O-CU solutions. Subsequently, more complex O-RU product types based upon split 7.2b or 7.2c (including mMIMO) can be introduced.

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

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

An initiative to be potentially funded through the Wireless Innovation Fund is the development of a test bed and trial in conjunction with a commercial carrier network. The scope of the effort can include interoperability between vendors. The ORPC is in the process of publishing a report on test bed mapping.

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

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

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

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

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

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

As stated in response to Question 10, a field trial in conjunctions with a network operator is a potential area where the NTIA can support with funding.

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

A key aim of the Innovation Fund is to promote and deploy technologies that will enhance competitiveness of 5G and successor open and interoperable, standards-based RAN. We have seen a range of Open RAN trials, pilots, and use cases underway across the United States and internationally to date. This section will inform the types of NOFOs NTIA publishes and administers as the Department works to accelerate adoption.

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?***

Consistent with the approach advocated in response to question 9, the simpler product types based upon the O-RAN 7.2a specification should be funded first with a roadmap to more complex mMIMO products. This will allow the ecosystem to develop maturity with a less complex product type. In addition, these products are applicable in carrier networks, private networks, and government/ military applications.

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?***

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

In order to achieve scale and scope, it is critically important that O-RAN products have commercial adoption in carrier networks, as well as private and government/military networks. A proof-of-concept test bed, developed in conjunction with one or more mobile network operators, is a first step towards achieving commercial viability. The involvement of large US operators is critical to both establishing product requirements (for example band support) and Key Performance Indicators (KPIs) for successful commercial deployment. This can lead to pilot markets and eventually to commercial deployments if the products meet requirements and KPIs.

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

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?***

Questions on Security:

Strengthening supply chain resilience is a critical benefit of open and interoperable, standards-based RAN adoption. In line with the Innovation Fund's goal of "promoting and deploying security features" to enhance the integrity and availability of multi-vendor network equipment, and Department priorities outlined in the National Strategy to Secure 5G Implementation Plan, this section will inform how NTIA incorporates security into future Innovation Fund NOFOs.

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?***

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

Vendor security reporting should be required by Telecom Operators/Customers following industry best practices. The O-RAN ALLIANCE WG11 work effort includes defining a standardized security test. Test reports driven by open standard organizations like this should be considered.

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

Industry standards and customer requirements are critical for security and enhancing open competition. Supporting and contributing to organizations like O-RAN ALLIANCE is essential since these organizations are defining security requirements and interoperable interface APIs. A specific example is the security controls for the Open Fronthaul. WG11 is actively discussing and defining the security requirements for Authentication, Confidentiality, Integrity, and Authorization based on 802.1X, MACsec, and other alternatives.

18. ***What steps are companies already taking to address security concerns?***

Analog Devices has taken an industry-leading position by building security anchored in immutable silicon HardWare Root-of-Trust (HW RoT). A HW RoT provides the strongest security anchor. The HW RoT is chained up, securing the higher layers of Operating Systems and software applications. This type of immutable silicon-based trust anchor creates a resilient multi-layered security posture following industry best practices.

19. ***What role can the Innovation Fund play in strengthening the security of open and interoperable, standards-based RAN?***

The Innovation Fund can strengthen RAN security by supporting contributions and participating in standard organizations like O-RAN ALLIANCE. In addition, the funding can help set up open test beds that will evaluate the vendors' systems' security.

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?***

The "zero-trust model" is critical to the long-term security posture of RAN. The O-RAN ALLIANCE WG11 has been defining security standards based on the "zero-trust model". Work is still ongoing in 15 areas: Security Testing, O1, Fronthaul C/U/S-Plane, SW Bill of Materials, Near RT RIC, Non-RT RIC, O-Cloud, Shared O-RU, Certificate Management, App LCM, Security Log, SMO, AI/ML, O-RU Centralized User Management, Blockchain. Work remains in all the above areas.

Questions on Program Execution and Monitoring:

The Innovation Fund is a historic investment in America's 5G future. As such, NTIA is committed to developing a program that results in meaningful progress toward the deployment and adoption of open and interoperable, standards-based RAN. To accomplish this, we welcome feedback from stakeholders on how our program requirements and monitoring can be tailored to achieve the goals set out in 47 U.S.C. 906.

21. ***Transparency and accountability are critical to programs such as the Innovation Fund. What kind of metrics and data should NTIA collect from awardees to evaluate the impact of the projects being funded?***

22. ***How can NTIA ensure that a diverse array of stakeholders can compete for funding through the program? Are there any types of stakeholders NTIA should ensure are represented?***

23. ***How (if at all) should NTIA promote teaming and/or encourage industry consortiums to apply for grants?***

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).***

25. ***How can the fund ensure that programs promote U.S. competitiveness in the 5G market?***

    The program objective is to build/strengthen/extend US innovation and manufacturing leadership in what is fundamentally a global market (the US market share of wireless revenue is estimated at 16%). With respect to the objectives of security through supply diversity, we believe it is appropriate to consider vendors across the US and allied markets. Fragmenting the communications infrastructure markets among North America, Europe, Japan, Australia, India, Korea, and other important markets would be a terrible outcome, as it will tend to lead to more fragile supply chains.

    The NTIA-managed Wireless Innovation Fund should aim to support engineering and manufacturing work in the US, even when that may be part of a global development effort (e.g., multinational development team). One possible approach would be to recognize that many development and manufacturing efforts will be multi-national and establish criteria whereby only the US-based elements of the program would be eligible for Innovation Fund grants (but the project itself would not be disqualified based on the fact that it is not entirely/exclusively developed in the US.)

    Ultimate success of the program would be measured not simply by the revenue/market share of US infrastructure captured by NTIA Innovation Fund backed technology, but by the Open RAN revenue/market share across US and Allied markets.

We recognize that certain market segments (defense applications, for example) may require a domestic (or narrower list of "trusted" allies) supply chain/design provenance. There are programs like the Microelectronics Commons that emphasize this market base—we believe that the NTIA Wireless Innovation Fund program should complement the Microelectronics Commons, rather than duplicate its structure.

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

   b. ***How should NTIA address potential grantees based in the U.S. with significant overseas operations and potential grantees not based in the U.S. (i.e., parent companies headquartered overseas) with significant U.S.-based operations?***

   c. ***What requirements, if any, should NTIA take to ensure "American-made" network components are used? What criteria (if any) should be used to consider whether a component is "American-made"?***

26. ***How, if at all, should NTIA collaborate with like-minded governments to achieve Innovation Fund goals?***

    There are active strategic discussions on communications infrastructure in such international groups as the QUAD and EU/US TTC. We see value in structuring the NTIA eligibility in such a way that allies in these groups would not see the NTIA program as a competitive threat, but rather as a valued contribution to a broader, healthier, expanding supply ecosystem. Note that a structure that provides support for the portion of activity that is domestic without disqualifying programs with international content would create a system that other allied countries could match without creating a "zero sum game" dynamic.

Additional Questions:

NTIA welcomes any additional input that stakeholders believe will prove useful to our implementation efforts.

27. ***Are there specific kinds of initiatives or projects that should be considered for funding that fall outside of the questions outlined above?***

28. ***In addition to the listening session mentioned above and forthcoming NOFOs, are there other outreach actions NTIA should take to support the goals of the Innovation Fund?***