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National Telecommunications and Information Administration
Washington, DC 20230

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COMMENTS OF INTEL CORPORATION

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I. Introduction

Intel Corporation ("Intel") welcomes the opportunity to provide this response to the National Telecommunications and Information Administration's (NTIA) Request for Comment on the implementation of the Public Wireless Supply Chain Innovation Fund ("Innovation Fund").¹ Intel Corporation is one of the world's largest semiconductor manufacturers; our processors, memory, and other products power much of the world's computing capability. Intel is the only U.S. semiconductor company to have the full range of advanced semiconductor capabilities at high volume, from foundry services to semiconductor architecture and design, as well as leading-edge R&D capabilities. Intel is making unprecedented new investments in U.S. semiconductor manufacturing capacity including the construction of new semiconductor fabrication facilities in Arizona and Ohio and for the manufacturing of advanced semiconductor packaging technologies in New Mexico. Intel semiconductor products are foundational to personal computing, distributed computing, cloud computing, AI, IoT, autonomous vehicles, quantum computing, high-performance computing, 5G and Wi-Fi. In the context of this proceeding, Intel is a leading silicon provider for 5G infrastructure. Intel partners with others in the ecosystem and, since our days as one of the earliest members of the O-RAN Alliance, actively participates in standards bodies to drive innovation in Open RAN.

II. State of the Industry (Questions 1-5)

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.

¹ <https://www.federalregister.gov/documents/2022/12/13/2022-26938/public-wireless-supply-chain-innovation-fund-implementation>

vRAN is the network function virtualization of the RAN; it converts fixed function into virtualized network functions.

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

For over a decade, Intel has been a leader in facilitating the virtualization of networks; this work started at the network core before extending to the Radio Access Network (RAN) through Virtualized RANs (vRANs). vRAN is the network function virtualization of the RAN; it converts fixed function into virtualized network functions.² A virtualized network increases the level of abstraction, making the network simpler and more efficient to manage, enabling the use of commercial off-the-shelf (COTS) hardware with software programmability. Software-defined networking (SDN) and network function virtualization (NFV) are attractive to many network operators due to the potential for cost savings, improved network performance, increased productivity, and enhanced security all playing a significant role in traffic management and power efficiency. Our experience working with operators and members of the ecosystem is that decisions about adoption and deployment of technologies are based on a variety of factors, including financial considerations, maturity of the technology, ease of deployment, etc. In private networks, considerations may also include various use cases, access to spectrum, the infrastructure of the enterprise or private network owner, and system integration. Combining or facilitating the use of multiple spectrum bands or multiple Radio Access Technologies (RATs)

² In the context of this proceeding, “More specifically, the Innovation Fund will support the following activities, as defined in [47 U.S.C. 906\(a\)\(1\)\(C\)](#)...Promoting and deploying network function virtualization to facilitate multi-vendor interoperability and a more diverse vendor market.”

efficiently can be challenging but provides benefits in facilitating ease of use, automation of the network and a cohesive utilization of the network telematics.

Operators with existing “brownfield deployments” face additional challenges in deploying open, interoperable equipment beyond those in new “greenfield deployments”. In particular, operators of “brownfield deployments” often take a more gradual approach in making architectural changes to their networks when those changes involve a large amount of legacy equipment potentially across widespread physical locations while maintaining network reliability and performance. It should also be noted that brownfield deployments can vary extensively in terms of network, customers, and current spectrum holdings (which directly impacts which radios are needed for RAN deployment).

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

Relevant initiatives in the private sector include progress in the O-RAN Alliance³ and Telecom Infra Project⁴ (TIP). For example, the O-RAN Alliance announced that 53 new specifications have been released since July 2022⁵ while TIP continues to launch testing environments for Open RAN orchestration and automation ecosystem⁶. The vRAN and ORAN ecosystem continues to grow, while operators and private networks are also continuing with vRAN and Open RAN deployments.⁷ There

³ <https://www.o-ran.org/>

⁴ <https://telecominfraproject.com/>

⁵ <https://www.o-ran.org/blog/o-ran-alliance-introduces-53-new-specifications-released-since-july-2022>

⁶ <https://telecominfraproject.com/the-telecom-infra-project-launches-testing-environment-for-openran-orchestration-and-automation-ecosystem/>

⁷As noted earlier, vRANs are based upon the principles of Network Function Virtualization. In the context of this proceeding, “More specifically, the Innovation Fund will support the following activities, as defined in [47 U.S.C. 906\(a\)\(1\)\(C\)](#)...Promoting and deploying network function virtualization to facilitate multi-vendor interoperability and a more diverse vendor market.”

have also been a host of public sector initiatives ranging from work at the Federal Communications Commission (FCC) to NTIA's 5G Challenge to efforts by the Departments of Commerce and State.

In terms of gaps, one of the most critical pieces of the Radio Access Network is the radio unit (RU). The RU connects the user equipment to the network by processing radio signals and transmitting, receiving, and converting the signals for the RAN base station. High performance, cost-effective radios are needed to support 5G public and private deployments, including ORAN. 5G deployments require radios for a variety of frequency bands ranging from low-band to mid-band to high-band, including support for Massive MIMO.

To maximize the impact of the funding and complement public and private initiatives, NTIA could consider the impact of projects across the ecosystem. Making funds available earlier in the process would also accelerate the impact of those funds.

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?

Workforce challenges are an important issue faced in a variety of areas and technologies throughout our society. These challenges might be better addressed more holistically rather than within the Innovation Fund directly.

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?

Investments in Open RAN have been made by a variety of public and private entities; Intel has been investing in virtualizing the network for over a decade. The Innovation Fund can consider focusing on ways to reduce barriers which may impede Open RAN, from a technology or interoperability perspective, such as the availability of 5G radios and RAN Intelligent Controllers (RICs) across the ecosystem or interoperability certification labs. In terms of deployments, investigating strategic opportunities that could have multiplier effects might be beneficial. For example, specific public sector private network deployments could serve as a blueprint for other private networks (e.g. a U.S. federal agency private network could serve as a model for other U.S. government agencies to replicate or study rather than “reinventing the wheel”).

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?

For open interoperable and standards-based RAN, global supply chains are a tremendous advantage – especially in terms of procuring equipment for trials and deployments – because the underlying hardware equipment is itself standards based. A fundamental element of the value proposition for virtualized RAN is the ability to increase the use of readily available, commercial off the shelf hardware equipment.

III. Technology Development and Standards (Questions 6-8)

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?

The most RAN and core network elements which would most benefit (and provide most benefit to the ecosystem) from support from the Innovation Fund are radios and RICs.

As stated above (question 2), one of the most critical pieces of the Radio Access Network is the radio unit (RU). 5G deployments require radios for a variety of frequency bands ranging from low-band to mid-band to high-band, including support for Massive MIMO. Network operators require solutions which support the frequency bands they utilize; these bands vary from carrier to carrier with even more variability in the global market and in private networks. Simply put, if a technology solution does not include a radio supporting the specific spectrum bands required then it is not a viable option.

Another area that could benefit is RAN Intelligent Controller (“RIC”) which is a software-defined component responsible for controlling and optimizing RAN functions in Open RAN architecture; this allows innovative new applications such as power management, traffic steering, and massive MIMO optimizations to name a few.

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,

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

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

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

5G and open and interoperable standards are available. Historically, technologies have significantly benefited from economies of scale. Therefore, funding which drives demand and facilitates economies of scale can help further increase the cost-effectiveness of products.

It should be noted that standards development of 5G and Open RAN continues to evolve as is customary in any standards development effort. Over the longer-term, technical barriers and complexity could be further significantly reduced in the next generation (6G) RAN.

Criteria to define equipment as compliant with open standards for multivendor network equipment interoperability is usually developed by industry experts in relevant forums. For example, one commercially successful example is the Wi-Fi Alliance, which defines these criteria for IEEE 802.11 standards.

IV. Integration, Interoperability, and Certification (Questions 9-12)

Certification regimes can have an impact on driving market adoption of open, cost-effective, standards-based technologies. Again using the Wi-Fi example, the Wi-Fi Alliance has enabled for “Wi-Fi” products based upon the IEEE 802.11 standards leading to a technology that has been deployed worldwide. The Wi-Fi Alliance has a well-established, well-recognized certification program (Wi-Fi CERTIFIED™) in which products can be tested with respect to industry-agreed standards for

interoperability, ease-of-use, security, and a range of application specific protocols. Wi-Fi Alliance has completed more than 65,000 Wi-Fi certifications since 2000⁸⁸ and has utilized an array of tools including to name a few, plugfests, authorized test labs, automation of testing scripts, etc. These tools facilitate interoperability between products from different vendors and enable a vibrant ecosystem of devices.

The O-RAN Alliance has organized plugfests to accelerate integration of open interfaces with its worldwide Open Testing and Integration Center (OTIC) issuing badges and certificates to vendors which passed conformance and interoperability testing. The Telecom Infrastructure Project (TIP) also offers testing and integration efforts to accelerate market adoption. It could be very beneficial for the Open RAN ecosystem if an organization developed a similar (to Wi-Fi Alliance) type of interoperability certification for Open RAN products. this is an area which could be considered for Innovation Fund support.

V. Trials, Pilots, Use Cases, and Market Development (Questions 13-16)

The Innovation Fund can consider supporting strategic opportunities in trials, pilots, use cases and market development including mechanisms that could assist smaller commercial carriers and private networks. For example, as noted in question 4, rather than fund many separate private networks in a wide variety of verticals, NTIA could consider whether there are specific private network deployments which could serve as a blueprint for other private networks (e.g. a U.S. federal agency private network that other US government agencies could replicate). There may also be specific areas where automation

⁸⁸ https://www.wifi.org/download.php?file=/sites/default/files/private/Product_Certification_Highlights_202202.pdf

of scripts could be useful to various operators and deployers rather than each individual entity needing to develop everything themselves.

VI. Program Execution and Monitoring (Questions 21-26)

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?

NTIA should carefully consider how to focus funding to drive results with meaningful progress towards deployment and adoption of open and interoperable, standards-based RAN. For example, , rather than a very large number of projects spread out evenly over the life of the program, meaningful progress would more likely require a smaller set of projects focused on enabling technologies to accelerate commercial deployments with more funding in the near-term (i.e. front-loading more of the funding rather than equally distributed over ten years).

Additionally, given the significant investment, we believe it is important that NTIA outline clear metrics at the onset of the process to ensure that potential applicants have clear guidance on reporting requirements and measurements of success for the program. Given the intended goal of the program, Intel believes program metrics specific to ORAN could include analysis of deployment of technologies in both greenfield and brownfield networks; the variety of technologies funded (radios, software, virtualized technologies); and the balance of funding between the different functions of the program R&D, commercialization, and deployment. Furthermore, metrics used in existing R&D programs such as rates of commercialization, adoption rates, time to transition, costs and cost savings, would also be relevant to measuring success of the program.

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).

NTIA could require matching contributions such as monetary contributions or project expenditures including headcount from businesses/industry to better leverage grants. There may need to be exceptions (e.g. in the case of non-profits).

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

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”?

U.S. competitiveness in 5G, and eventually 6G, is an important issue for U.S. policymakers, just as it is for policymakers worldwide due to the crucial role that connectivity plays in our lives, our societies, and our economies. Yet connectivity is also a global undertaking including 5G standardization within 3GPP and ITU-R. The U.S., similar to other countries, would benefit from enabling

competitiveness in 5G, while recognizing the importance of global partners and the need to facilitate economies of scale and market access in a global market.

NTIA should also carefully consider any requirements it may impose in terms of network components. For example, it would be important to avoid “Buy America” requirements which could actually impede, rather than accelerate, deployments. Any domestic content requirements should consider existing supply chains in the ITC industry and other requirements and waivers similar broadband deployment programs have issued.

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

NTIA could continue to collaborate with other countries to facilitate information sharing about successes and challenges encountered.

VII. Conclusion

Intel appreciates the opportunity to provide our response to the NTIA’s Request for Comment on the implementation of the Public Wireless Supply Chain Innovation Fund. We look forward to NTIA’s progress on the implementation of the fund and are available to provide any additional information.

