Before the

National Telecommunications and Information Administration

Department of Commerce

Washington, D.C. 20230

In the matter of	)	
	)	
Public Wireless Supply Chain Innovation	)	Docket No. 221202–0260
Fund Implementation	)	

COMMENTS OF THE INSTITUTE FOR THE WIRELESS INTERNET OF THINGS AT NORTHEASTERN UNIVERSITY

The Institute for the Wireless Internet of Things (WIoT)[1] at Northeastern University respectfully files these comments on the National Telecommunications and Information Administration's ("NTIA") Request for Comments (RFC) on the Public Wireless Supply Chain Innovation Fund Implementation.[2] WIoT commends the NTIA for seeking comments on this topic. This document aims at providing comments on a specific subset of matters raised by the NTIA, as outlined below.

1. ***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?***

   We believe that the Open Radio Access Network (RAN) paradigm presents a tremendous potential for the design and operations of 6G networks which are more flexible, faster to deploy and update, more secure, customizable, and overall with improved performance over traditional, monolithic cellular architectures. Nonetheless, there are still significant challenges toward the full realization of the Open RAN vision. These will require a substantial effort in research and development in the next two to three years, to accelerate, capitalize on, and commercialize innovative and clean-slate approaches for the design and management of cellular networks, unencumbered from the legacy of traditional vendors. *Key directions for research and development include—but are not limited to—open cellular architectures, closed-loop control with different time scales, including real time control, programmable network components, energy efficiency, and security.*

[1] https://www.northeastern.edu/wiot/

[2] https://www.govinfo.gov/content/pkg/FR-2022-12-13/pdf/2022-26938.pdf

We thus encourage the NTIA to promote research efforts as core parts of the Innovation Fund. Projects in this space will be successful if they manage to translate innovative research into deployable solutions, thus sponsored research efforts should include a lab-to-product pathway and standardization tasks for the coordination with relevant Standard-Development Organizations (SDOs) and industry alliances.

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

   The Innovation Fund will be truly successful in fostering a U.S.-based wireless networking renaissance if the sponsored project and teams can be free to innovate without the need to spend time and money in dedicated effort to set up testing solutions. Therefore, we encourage the NTIA to consider the establishment of publicly-available reference platforms where researchers can plug-and-play their solutions for testing at a *system level*. Indeed, while device-to-device, interface-based interoperability is essential to diversifying the vendor ecosystem, end-to-end, system testing makes it possible to evaluate key elements of the Open RAN vision, including the performance gain introduced by dynamic, data-driven closed-loop control of the RAN,[3] and to develop Artificial Intelligence (AI) and Machine Learning (ML) solutions for the orchestration and control of the network. Such reference platforms should be open, available to the public, sustainable, extendable (e.g., to test hardware acceleration solutions), and have a track record of supporting experimenters in the Open RAN space.

   Trials should cover a variety of scenarios in which Open RAN systems are expected to be deployed, focusing on use cases such as (i) private networking in different industrial plants, warehouse, ports, mining sites, etc; (ii) rural connectivity; and (iii) urban, high-density deployments, among others. This requires testing platforms that are agile and that come with the possibility of creating virtual—but realistic—wireless scenarios for the testing of the same stack and technologies under different conditions. The same platforms and trials can be pivotal to the collection of large-scale datasets that can be used to train AI/ML models that would then generalize in production

[3] Large-scale O-RAN trials conducted by WIoT researchers on Colosseum [1] clearly demonstrate that data-driven control enabled by O-RAN improves the network performance in terms of key 5G metrics such as spectral efficiency and latency [2–4].

deployments.

Finally, virtualization, programmability, and software-based approaches should be front and center of proof concepts and trial platforms sponsored by the Innovation Fund, with the goal to facilitate the transition of solutions and approaches across testbeds and commercial deployments.

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

In the past three years, WIoT has been involved in significant efforts to develop and make available to the public state-of-the-art platforms for research and development of Open RAN solution. These platforms include Colosseum, the world's largest wireless network emulator with hardware-in-the-loop, Arena, an indoor software-defined testbed with 64 antennas, and X-Mili, a programmable, production-ready multi-node 5G standalone and Open RAN testbed. Specifically, Colosseum [1] is a massive RF and computational facility that can emulate different wireless scenarios (e.g., open field, downtown area, shopping mall, or a desert, among others), generating more than 52 terabytes of data per second with software-defined radios that emulate up to 65,536 80 MHz RF channels. Colosseum was originally developed by DARPA for the Spectrum Collaboration Challenge, and is now being operated and extended by WIoT through support from the U.S. National Science Foundation (NSF), the MITRE Corporation, the Massachusetts Technology Collaborative, and the Office of the Under Secretary of Defense for Research and Engineering (OUSD(R&E)). Recently, multiple commercial radios have been tested in joint emulation with the traditional Colosseum software-defined radios, and new compute nodes with state-of-the-art GPUs have been added to the data center for AI and ML training. WIoT is also part of the PAWR Project Office, which has managed the $100 million NSF PAWR public-private partnership toward the creation of four city-scale programmable testbeds across the U.S.

These platforms have been extensively used by the research community to demonstrate and test Open RAN capabilities [2–12] in a continuum of emulated and over-the-air environments. They have also been instrumental to the development of OpenRAN Gym [5, 6], the first publicly-available research platform for data-driven O-RAN experimentation at scale, which has been deployed through softwarized workloads on Colosseum, Arena, and the PAWR platforms.

To properly leverage the capabilities of such systems, the Innovation Fund should:

- capitalize on capabilities that already mature (as discussed above) and developed through

funding from federal, state, and private sources *so that sponsored projects have the opportunity to deploy and test Open RAN solutions from day 0*; and

- provide support for improvement and extension of such platforms and testbeds to support 6G use cases and requirements, for example by extending emulation in Colosseum to larger bandwidths and more devices (including a wider set of commercial radios and Open RAN radio units).

WIoT believes that this strategy represents a time- and cost-effective solution to kickstart research, development, and testing on reference platforms shared across projects sponsored by the Innovation Fund.

4. ***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?***

   Testing in the Open RAN space needs to build confidence in the maturity of the ecosystem, the viability in terms of multi-vendor support, and to demonstrate the effectiveness of closed-loop control and end-to-end data-driven workflows for RAN optimization.

   The testing and validation should be performed on reference platforms that can replicate scenarios for multiple use cases of interest, including rural and urban, public and private networks, and focused applications (e.g., support for vehicular communications, including Unmanned Aerial Vehicles (UAVs), autonomous robot scenarios, virtual and extended reality, among others). In this sense, Colosseum can represent a first, baseline reference platform where different scenarios of interest can be tested. In addition, WIoT can leverage the infrastructure of the Northeastern University global campus, deploying programmable, open testing solutions that replicate the over-the-air capabilities of Arena and X-Mili in a variety of different environments. For example, the Roux Institute in Portland, ME, can become a pivotal center for the experimental evaluation of rural connectivity solutions in partnership with local entities and organizations.

5. ***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? Are interoperability testing and debugging***

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

The Innovation Fund should strive to organize testing and validation of multi-vendor solutions which integrate a mix of different technologies and partners, including application developers for the RAN Intelligent Controllers (RICs) from innovative small businesses and startups. The openness the next-generation networks introduce will indeed act as a catalyst for new ventures that want to enter the telecom ecosystem, thus creating a more diverse and robust environment. In addition, the Innovation Fund should promote the adoption of new approaches to RAN development and deployment, which adopt and test the best practices in automation and orchestration for virtualized cloud-native systems.

As for the "plugfests", they often incur into fragmented demonstrations which are limited to either a few components at a time or lead to replication of efforts across different demos and vendors. Therefore, we believe that such events would benefit from a common, shared platform that makes it easy to onboard and test xApps/rApps and other Open RAN components, without the need to develop integration and testing from scratch every time, thus unleashing the true potential of innovation for future wireless networks. This is the rationale with which WIoT researchers have created OpenRAN Gym [6], a research platform that combines open source frameworks for RAN, core, edge, and O-RAN in an integrated, easy-to-deploy and easy-to-use fashion which simplifies the onboarding of new researchers and innovators in the Open RAN space.

References

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