January 27, 2023

DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration
Washington, DC 20230

Ref: Public Wireless Supply Chain Innovation Fund Implementation, Docket No.
221202-0260, RIN 0693-XC05

XCOM Labs is pleased to provide comments to the Public Wireless Supply Chain
Innovation Fund (PWIF) Implementation Request for Comments (RFC) issued on
December 13, 2022. As a U.S. company founded with the vision of inventing next
generation of wireless technologies to enable a new ecosystem of applications for both
commercial and public sector use, we applaud the investment that the United States is
making to enable such innovation.

The United States must play a leadership role in 5G and next-generation communication
technology. Its role is not only critical in ensuring the security and integrity of the future
national telecommunications network but to establish an enduring innovative edge in 5G
technologies which will be foundational to the next industrial revolution. The nation that
leads in this technology will likely shift the global center of gravity for innovation and
confer the substantive benefits that 5G promises such as economic development and
national competitiveness, as well as certain military applications.

To do that, the United States must accelerate the process of adopting 5G Open RAN
infrastructure and incentivize domestic 5G component innovation and manufacturing.
Open RAN advancements will enable high performance systems, demanding applications
and groundbreaking technologies that will increase capacity, resiliency, and security.
Ultimately, the United States cannot harness the full potential of 5G or gain a competitive
advantage in wireless technology if it fails to invest in Open RAN infrastructure and
associated innovation today.

The United States is at risk of failing to address the challenges and bottlenecks of domestic
wireless innovation and commercialization. We are underinvesting in domestic small
suppliers and the market is currently dominated by large incumbent infrastructure vendors,
all of which are non-United States based companies that have a closed RAN approach.
These large, incumbent vendors are slow to innovate and develop disruptive technologies

that would have negative impacts on their current revenue streams. Current 5G and beyond roadmaps are driven by a small number of these large, foreign incumbents with an approach antithetical to Open RAN.

Strategic investments in small, innovative U.S.-based companies with a history of introducing and commercializing disruptive technologies would, however, complement current incumbent vendor offerings and create a highly competitive landscape which is essential for US leadership. Resources directed towards nontraditional innovative companies is what can give the US a leap-ahead advantage in 5G and beyond technologies. In addition to spurring competition and innovation, investing in small domestic suppliers also helps the United States diversify its critical domestic supply chain. Limited investment in innovative Open RAN technology in the United States not only stifles technological breakthroughs but risks running into 5G and telecommunications supply chain bottlenecks plaguing the industry today.

Our motto at XCOM has always been "The only way to predict the future is to invent it". This "keep inventing" spirit enabled me and my leadership team to innovate and productize several wireless technologies that generated over $100 billion in value while I served as CEO/Chairman of Qualcomm. XCOM believes this motto aligns with the spirit of American ingenuity. When the United States put forth the goal in the early 1960's to put a man on the moon before the end of the decade, the technology to do so had not even been invented. With United States government financial backing along with a clear vision on the mission's impact on United States leadership globally, we successfully surpassed our competitors in the "space race" which also spawned countless other technological advancements.

Decades later, with the passing of the CHIPS and Science Act, our government has again both made the serious commitment and offered a complementary vision of leveraging United States innovators to regain leadership in key technological areas such as 5G wireless innovation. XCOM is tightly aligned with this vision and is dedicated to driving wireless innovation at scale by providing radical improvements in spectral efficiency and latency and powering next generation mobile networks designed for high throughput broadband services, virtual reality (VR), robotics and automation, extremely dense IOT device support, and ultra-reliable coverage.

XCOM has leveraged the Open RAN ecosystem in the development of breakthrough innovations based on distributed-massive MIMO, a 5G network enhancement technology built on Open RAN standards. This innovation employs joint processing to increase spectral efficiency and network capacity up to six times (vs closed RAN 5G systems) in high user density scenarios. Open RAN provided an excellent platform for XCOM to

innovate on. As a start-up with limited resources and funds, we focused our efforts to innovate in the DU while relying on other system elements from the Open RAN ecosystem. This enabled us to develop this groundbreaking technology in a short period of time. In comparison, our previous attempts at innovating on Closed RAN systems weren't successful.

I hope NTIA prioritizes investments in commercializing such Open RAN based high performance innovations essential for US to gain wireless leadership.

Please don't hesitate to contact me for any further engagement around our response or interest in this program.

Sincerely,

Dr. Paul E. Jacobs
Chairman & Chief Executive Officer
XCOM Labs, Inc
9450 Carroll Canyon Drive
San Diego, CA 92121
paul@xcom-labs.com

XCOM Labs response to the NTIA - Public Wireless Supply Chain Innovation Fund Request for Comments on Implementation January 27, 2023

<u>**Questions on the State of the Industry**</u>
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?

XCOM Response:

The two chief challenges to the United States' adoption of Open RAN are 1) the lack of competition and therefore innovation within the domestic wireless ecosystem and 2) the lack of funding availability for "leap frog", wireless innovation based on Open RAN which would radically improve performance, programmability, and efficiency of next generation wireless technology.

First, the United States is underinvesting in domestic small suppliers and current 5G, and beyond roadmaps are driven by a small number of large, foreign incumbents with an approach antithetical to Open RAN. Additionally, these incumbent vendors are not motivated to innovate or develop disruptive technologies that would have negative impacts on their existing revenue streams.

Traditional, incumbent wireless vendors have closed RAN platforms and are the primary suppliers to the major mobile network operators (MNOs). These traditional vendors do not have incentive to accelerate and bring Open RAN to the fore front as this will disrupt their ongoing revenue streams with the MNOs. Thus these incumbent, large wireless vendors, even if they have plans to implement Open RAN, will likely not move quickly in bringing open technologies to the market. Additionally, an aggressive transition to new Open RAN vendors by MNOs could imply losing technical support on the substantial previous generation legacy equipment supplied by these incumbent vendors. There is the promise that Open RAN will benefit these MNOs but the transition of existing networks to Open RAN architecture is likely to be slow, especially in brownfield networks.

Strategic investments in small, innovative United States-based companies with a history of introducing and commercializing disruptive technologies would, however, complement incumbent vendor offerings and create a highly competitive landscape for the United States to leverage. In addition to spurring competition and innovation, investing in small domestic suppliers also helps the United States diversify its critical domestic supply chain. Without

dedicated investment in Open RAN chip products, for example, the United States not only stifles technological breakthroughs but risks running into 5G and telecommunications supply chain bottlenecks plaguing the industry today.

Second, the United States must prioritize the expansion of 5G Open RAN infrastructure and 5G component innovation. High performance, Open RAN systems require the dedicated development in wireless innovations, such as distributed-massive MIMO systems that provide massive advances in performance. In addition, investment in Open RAN based chips would further the system performance and improve energy efficiency and costs. Such chip development projects are typically not within the means of small businesses due to huge capital funding needs in the order of tens of millions of dollars. A strategic investment by the United States government could fund such development by innovative Open RAN vendors while benefiting from an accelerated and tailored roadmap for their mission critical needs. Innovative Open RAN wireless development enable United States vendors to "leap-frog" current wireless technology and gain global leadership in mobile network infrastructure market currently dominated by non-United States companies. Advanced technology that would increase the capacity of mid-band spectrum by a factor of 10 or more would maximize the return on spectrum investments; support wireless coverage that would reliably cover millions of devices in an industrial environment; birth a new ecosystem of commercial and government applications and use cases; and incubate workers needed for developing and operating the new application ecosystem.

One of the biggest impediments of any mobile technology adoption, including Open RAN, for private networks is the limited spectrum available. . Lack of useable mobile spectrum for private enterprises will stifle mobile network deployment for Industry 4.0 applications. Investment in Open RAN based innovations that maximize spectral efficiency and enable high performance applications, such as robotics, VR/AR, and dense IoT delivers multiple benefits.

It would enable Open RAN to leapfrog closed RAN systems and create a virtuous cycle of economic value creation by leveraging a strong United States-led ecosystem of webscalers, IT companies, application developers, software developers, and robotics companies. This would drive 5G Open RAN ecosystem in the US (and its partner countries) to take a lead in a rapidly growing Private wireless global market estimated to be several billion dollars soon. Additionally, it would bolster technical skills development across the industry in the United States and among its partners.

Another barrier to wider adoption of 5G Open RAN systems is the complexity of network planning and deployment. Cellular networks require specialized RF engineers and tools, that are typically expensive, in short supply, and mostly focused on large scale MNO projects. NTIA should invest in productizing "self-planning" systems - 5G Open RAN technologies that are easy to plan and deploy by non-specialized workers.

The deployment of private mobile networks holds much promise for Open RAN technology as there is not as much incumbent mobile vendor equipment deployed, and with this "greenfield" environment new, price competitive RAN technology will be a great option for private enterprises. Since public mobile networks have large installed base using closed RAN systems, feature parity of Open RAN systems becomes a requirement for compatibility in such hybrid environments. In contrast, private network needs of enterprises are driven by specific use cases, and much easier for Open RAN vendors to address.

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

XCOM Response:

As indicated above, since incumbent mobile network equipment vendors are based on monolithic, proprietary interfaces, it would be extremely difficult to integrate Open RAN based systems. Since it takes much investment and time for an upcoming Open RAN vendor to incorporate and certify 3GPP compliant features the replacement of a traditional RAN vendor element with an Open RAN element may represent a step back for the MNO in terms of operations and maintenance.

Since introduction of an Open RAN vendor into an existing network typically represents a loss of market share and revenue for incumbent, closed RAN vendors, there is generally a reluctance on their behalf to co-operate for any integration efforts.

Given some of these challenges, many of the brownfield Open RAN deployments by Mobile Network Operators (MNOs) thus far have been smaller-scale or rural projects. This risk-contained strategy to minimize disruption for higher value customers is understandable. At the same time, it doesn't advance Open RAN in a meaningful way as small, Open RAN vendors don't benefit from the monies and profits that are largely driven in urban areas and cities. This results in a lack of investment into innovation and high performance applications so critical to US's success going forward.

NTIA could incentivize operators who are willing to invest in Open RAN for private enterprise networks (with a potential to scale), urban areas and high-performance Industry 4.0 applications. This would help bridge the above-mentioned gap and provide a platform for value-creation through Open RAN.

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?**

XCOM Response:

One of the key gaps to furthering the cause of Open RAN is the lack of certification and interoperability labs that can provide Open RAN vendors and potential customers assurance of standard capability. In addition, small startup Open RAN vendors do not typically have large budgets to invest in this kind of testing and certification, so the lack of governmental assistance is also an inhibitor. Likewise, small startup vendors are not able to afford adequate representation in all the standardization bodies.

Specific investments in the development of promising prototype Open RAN innovations to commercialization will help address this gap. Current gaps in R&D: General purpose X86 or ARM based chips are not best suited to enable high performance wireless communication applications. High performance Open RAN systems require development of specific chips which are typically not within the means of small businesses due to the requisite capital funding. Despite these chips' radical impact on improvement in performance, programmability and efficiency, the United States is underinvesting in domestic innovative small suppliers who have the expertise and track record to develop high performance wireless technologies that are essential for US to gaining leadership in 5G and beyond .

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

XCOM Response:

In the evaluation of grant proposals put forth the NTIA should ask the proposer how their solution will benefit both private and public sectors. NTIA can then assess whether the potential project has the ability to be applied in a dual use, both public and private sector, scenario. For example, a wireless innovation that enables the advancement of smart warehouse logistics given that warehouse logistics are an environment across both sectors.

Private wireless networks for enterprises present a huge opportunity for 5G Open RAN ecosystem to take leadership in. However, there are impediments to acceleration. First, there is a lack of adequate spectrum available for demanding applications at-scale. While the US has done a commendable job by making CBRS available as a shared spectrum to the industry, still challenges remain. Since the availability of spectrum varies by market, it is difficult to provide a standardized quality of experience for all the locations of a large enterprise. Investment in technologies that maximize spectral efficiency by significant orders of magnitude can address this challenge in a big way.

Secondly, industrial private wireless networks need to be integrated to existing IT and OT systems. Given the limited resources and funds for small Open RAN vendors, there are only a small number of such projects that can be stood up. NTIA could help accelerate this adoption by investing in several pilots or initial deployments that focus on high system performance, demanding Industry 4.0 applications, and with a potential to scale for a majority of enterprise locations.

Another barrier to wider adoption of 5G Open RAN systems is the complexity of network planning and deployment. Cellular networks require specialized RF engineers and tools, that are typically expensive, in short supply, and mostly focused on large scale MNO projects (mostly closed RAN networks). NTIA should invest in productizing "self-planning" systems - 5G Open RAN technologies that are easy to plan and deploy by non-specialized workers.

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?

XCOM Response:

As a developer of advanced wireless technologies, XCOM has experienced the challenges of hiring the right expertise for this endeavor, and we fully support the focus that PWIF has in this area. XCOM has a heritage of formulating internship programs which allows engineering students and recent graduates to work side-by-side with the most experienced technical talent. Investments that are made in a project to propel advanced wireless solutions from prototype to project will fuel immediate development in our wireless expertise workforce, and the enablement of an advanced ecosystem of applications for the metaverse and industry 4.0 will drive the creation of a new workforce expertise in those application areas. Similar to how the smartphone spurred innovation of an ecosystem of applications, highly advanced wireless networks will enable a new generation of industrial applications and will need a workforce to support it. In addition, NTIA should provide weight to proposal grants that include academia partners, which will provide early workforce growth.

Also, as mentioned before, NTIA should invest in productizing "self-planning" systems - 5G Open RAN technologies that are easy to plan and deploy even by non-specialized workers.

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?

XCOM Response:

The PWIF can help facilitate further public and private investment by evaluating the merit of ground breaking technologies brought forth by innovative companies. Prior to the groundbreaking CHIPS and Science Act investments which aim to help United States innovators to regain leadership in key technological areas, 5G wireless innovation had been stifled with limited investments and R&D opportunities in Open RAN.

Examples of private investments in Open RAN include companies investing in near-term opportunities to develop and deploy private wireless. While the cost of the integrated Open RAN solution is typically lower than a classic RAN solution, establishing private network is a large undertaking for some enterprises. Vendors are investing in software and hardware that comply with evolving Open RAN specifications, but such Open RAN adoption is in the early stages with most customer engagements are focused on prototypes or small deals with regional operators. In addition, Open RAN architecture is relatively nascent, and most commercially available solutions focus on one interface, the open fronthaul connections between the radio unit and the baseband. These limited offerings cannot support the full architecture of telecommunication hardware and software ecosystem without significant customization, and integration is limited. Most of the carriers' spending as well is for upgrades to legacy networks and Open RAN integration in telecommunication equipment will take time, resources, and funding to scale.

Private wireless networks present a huge opportunity for 5G Open RAN to take leadership in a market estimated to be billions of dollars soon. NTIA could accelerate this adoption by investing in several pilots or initial deployments that focus on high system performance, demanding Industry 4.0 applications, and with a potential to scale for a majority of enterprise locations.

It would enable Open RAN to leapfrog closed RAN systems and create a virtuous cycle of economic value creation by leveraging a strong United States-led ecosystem of webscalers, IT companies, application developers, software developers, and robotics companies. Additionally, it would bolster technical skills development across the industry in the United States and among its partners.

There has also been concrete, but limited, public investment and R&D efforts to help advance Open RAN innovation, notably the DoD 5G testbeds and other federal agencies' 5G and wireless innovation. For instance, 5G and wireless telecommunications entities have received support from the federal government to help carriers rip and replace specific equipment in rural areas and boost Open RAN adoption.

Generally, resources have been directed primarily towards traditional and large companies, which undermines the United States-leap ahead advantage in 5G and beyond technologies by undercutting opportunities for nontraditional players to bring forth their innovative solutions.

Traditional venture capital investment has in the past decade favored software and has shunned slightly longer returns on investment that are associated with hardware R&D and interoperable equipment.

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?

XCOM Response:

The criticality of United States leadership in 5G and next-gen communication technology cannot be underscored enough: it will ensure the security and integrity of the future national telecommunications network, establish an enduring innovative edge in the technological underpinnings of the next industrial revolution; and allow the United States to benefit from the resulting economic development and national competitiveness, to include advanced military applications.

Strategic investments in small, innovative United States based companies with a history of introducing and commercializing disruptive technologies would, however, complement current incumbent vendor offerings and create a highly competitive landscape for the United States to leverage. In addition to spurring competition and innovation, investing in small domestic suppliers also helps the United States diversify its critical domestic supply chain. Without dedicated investment in Open RAN chip product, for example, the United States not only stifles technological breakthroughs but risks running into 5G and telecommunications supply chain bottlenecks plaguing the industry today.

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.

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?

XCOM Response:

The current Open RAN standards ecosystem defines the interfaces between the core network, CU, DU, RU, UE and the management entities. There are numerous standards specs, and several interoperability efforts. One of the biggest challenges is to define one, harmonized set of requirements that allow for cost efficient and timely interoperability for all vendors, and not just the large, well-funded, and mostly foreign incumbent vendors that can afford to support multiple standards bodies and inter-op plug fests, given the large number of resources at their disposal.

XCOM proposes that the NTIA incents Open RAN vendors to more fully develop the interfaces and features defined by the ORAN group and 3GPP standards so that elements in the stack can interoperate, such as the RU and the fronthaul. In addition, today there is still work in progress in terms of conformance testing, so it is critical that the NTIA invests in establishing conformance testing standards as well.

XCOM endorses further innovation in all of the Open RAN elements, but particularly sees an opportunity to implement advanced features which provide a leap frog in performance for wireless networks by investing specifically in DU innovation.

It is recommended that NTIA strongly consider 5G network enhancement technology built on Open RAN standards bring extreme increases network capacity such as six times in high user density scenarios. These types of technologies leverages a distributed massive MIMO (d-mMIMO) technology, which has several capacity and coverage benefits, for various scenarios, including tactical networks, dense urban broadband, private enterprise networks, mission critical networks, warehouse automation, industrial IoT, and Virtual Reality (VR) training and simulation applications.

In high density scenarios, these types of d-mMIMO architectures enables up to 6 times spectral efficiency as compared to conventional, closed RAN based 5G systems. Arguably, spectrum continues to be the most valuable and strategic asset for wireless networks. In addition to enabling demanding applications, spectral efficiency improvements would drive better return on existing investments, increase shared used of spectrum by network operators, defense and enterprises, and strengthen the United States' and its partners' positioning for next generation wireless leadership.

A focus on high-performance, high-value application projects could enable Open RAN to leapfrog closed RAN systems and create a virtuous cycle of economic value creation by leveraging a strong United States-led ecosystem of webscalers, IT companies, application

developers, software developers, and robotics companies. This would drive the United States (and its partner countries) to take a lead in a rapidly growing Private wireless global market estimated to be several billion dollars in the near future. Additionally, this would bolster technical skills development across the industry at home and among its U.S. partners.

Any technology considered should be fully standards based – requiring no changes to 5G devices or Open RAN compliant Radio Units (RUs). Innovations where the functionality runs in the Open RAN Distributed Unit (DU) on commercial-off-the-shelf (COTS) IT hardware that American companies dominate. United States government can ensure that Open RAN compatible RUs, with lighter processing needs, can be sourced from multiple United States (and partner country) based vendors, leading to supply chain diversification and acceleration.

Our current understanding is that a leading Chinese supplier has been developing and commercializing such technology. US investment in d-mMIMO as an extremely spectral efficient, Open RAN based technology would help neutralize Chinese advantage and position US and its partners for long term wireless leadership.

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?

XCOM Response:

There are many standards and only a small set of the standards are applicable for the larger pool of vendors developing Open RAN technology. Specifically, small companies are inhibited in participating in standards bodies from a financial perspective, which leads to a few large incumbent vendors driving standards based on their interests.

There are several specifications but not with adequate details to drive easy interoperability for end-to-end systems.

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

XCOM Response:

We propose that the NTIA provides funding support to allow small companies to have an equal voice in the major standards bodies associated with 5G and beyond and Open RAN. In addition, we recommend:

- A "minimal" subset of specs to enable Open RAN "certification process" (similar to FCC) or "conformance testing process" (similar to 3GPP).
- United States based labs that are affordable and easily accessible to small vendors with basic certification/conformance testing infrastructure, process and personnel.

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

XCOM Response:

A vendor should be required to pass the baseline certification / conformance tests, that promotes interoperability between multiple vendors to be able to claim to be an Open RAN vendor.

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?

XCOM Response:

The definition of 6G is in its early stages. 6G may entail use of expanded set of spectrum beyond mmW, performance improving algorithms and network sharing at all levels. Management and SON aspects of networks would further evolve with the addition of ML/AI components. For next generation networks to be competitive and innovative, Open RAN needs to be widely embraced.

A focus on Open RAN projects that deliver radical spectral efficiency improvements and enable demanding high throughput and low latency applications, such as VR, real-time video, robotics, and dense IoT for defense and industry needs will position us well for 6G and beyond.

6G projects should include research and development engineering studies and laboratory prototypes to evaluate early-stage innovation. These projects should build upon the current generation of 5G Open RAN wireless technology for advanced Industry 4.0+ applications.

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?

XCOM Response:

As stated previously, XCOM recommends:
- The advancement of certification and conformance specifications definition
- Encourage United States based certification/conformance labs made available to small vendors
- Invest in small vendor certification
- After being certified, invest in vendor use case demonstrations and leveraging testbeds.

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

XCOM Response:

Open RAN "plugfests" are challenging for smaller companies that have limited budget and resources. As a result, they are usually attended by larger well-funded vendors. Since there are too many standards specs and little guidance as to what the minimal required certification or conformance guidelines are, these events usually end up being dominated by larger companies.

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

XCOM Response:

A "minimal" subset of specs to enable Open RAN "certification process" (similar to FCC) or "conformance testing process" (similar to 3GPP).
United States based labs that are affordable and easily accessible to small vendors with basic certification/conformance testing infrastructure, process and personnel.
One option may be to fund and enable System Integrators (SIs) to drive multi-vendor integration and lifecycle management of end-to-end Open RAN systems.

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

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

XCOM Response:

Yes, the certification of open, interoperable, standards based equipment is necessary for a successful marketplace, which will allow faster deployment and focus on innovation;

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

XCOM Response:

This can happen in one of two ways:
Option-1: United States government group, e.g. ORPC, can enforce a "minimal" subset of specs to enable Open RAN "certification process", similar to FCC's equipment certification program
Option-2: An industry forum, e.g. O-RAN, can define a minimal "conformance testing process", similar to 3GPP's conformance process
Once the certification specs or conformance specs are defined, United States based labs that are affordable and easily accessible to small vendors with basic certification/conformance testing infrastructure, process and personnel, are needed.

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?

XCOM Response:
An alternative to certification would be that a single standards organization to release conformance specs. A vendor should be required to pass the baseline conformance tests, that includes interoperability with multiple vendors, to be able to claim to be an Open RAN vendor.

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

XCOM Response:

XCOM's position is that the NTIA should incent Open RAN vendors to more fully develop the interfaces defined by the ORAN group and 3GPP standards so that elements in the stack can interoperate, such as the RU and the fronthaul. In addition, today there is still work in progress in terms of conformance testing, so it is critical that the NTIA invest in establishing conformance testing standards as well.

NTIA further can encourage innovation in all of the Open RAN elements, but additionally encourage advance features which provide a leap frog in performance for wireless networks by investing specifically in DU innovation.

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?

XCOM Response:

Open RAN-based wireless networks will unlock and enable groundbreaking innovation in key use cases, notably in the defense, socio-economic, and life sciences sectors. With investments in Open RAN solutions, XCOM envisions a future where "everything goes wireless" - machines, sensors, cameras, robots, connected cars and more. Such a connected world requires extremely high-performance Open RAN-based wireless networks built at scale for mission critical government applications, manufacturing plants, warehouses, enterprise private networks, smart cities, stadiums, venues, universities, and schools.

Key Open RAN applications include:
- Spectral Efficiency improvements (5-10x or more)
- Mobile Edge Compute (MEC)
- Smart Warehouse/ Fulfilment Center Automation
- Dense industrial Internet of Things (IoT)
- Smart factory – robotics, video, IoT
- High resolution Virtual and Augmented Reality (VR/AR) applications for military training, industrial training, manufacturing, education, maintenance, live simulation, visualization, telemedicine, and entertainment.
- Drone swarms for surveillance and critical infrastructure inspection

Ultimately, new 5G and Open RAN innovation can expand and underpin the Industry 4.0 ecosystem, extended reality applications, and bolster United States workforce development. Industry 4.0 environments include "smart" warehouses, manufacturing automation, enhanced logistics, and industrial maintenance. Industry 4.0 manufacturing customers would benefit from Open RAN solutions as it would boost performance of end-to-end network, decrease overall costs of network and cost of ownership for vendors and customers.

Projects focused on high-performance, high demand applications could enable Open RAN to leapfrog closed RAN systems and create a virtuous cycle of economic value creation by leveraging a strong United States-led ecosystem of webscalers, application developers, software developers, and robotics companies. This would bolster technical skills development across the industry in the United States and among its partners.

Open RAN can also enable demanding 5G applications for DoD and Industry to include AR/VR, real time video, with substantially less spectrum utilized, to advance soldier training and decision planning support, and help advance interoperability and utilization of unmanned platforms such as robots and drones.

Additional area of focus in Open RAN investment is an Open RAN Chip development, which would radically improve performance, programmability, and efficiency thus providing benefits as follows:
- Accelerate - Enables American vendors to leap-frog current wireless technology and gain global leadership in mobile network infrastructure market currently dominated by non-American companies.
- Spectral Capacity – Operators in the US and its partner countries can increase capacity on mid-band TDD spectrum by 10x or more, maximizing the return on spectrum investments.
- Investment protection – Operators, government, and enterprises benefit from next generation networks that serve the most demanding mobile broadband and industry 4.0 needs for several years to come.
- Ultra-Reliable Coverage - Wireless coverage that can reliably support millions of devices in an industrial environment.
- Application Advancement – Birth a new ecosystem of commercial and government applications and use cases.
- Workforce Development - Incubates workers needed for developing and operating the new application ecosystem.

14. What kinds of trials, use cases, feasibility studies, or proofs of concept will help achieve the goals identified in 47 United StatesC. 906(a)(1)(C), including accelerating commercial deployments?

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

XCOM Response:

In order to enhance U.S. competitiveness in 5G and beyond, it is important to invest in radical spectral efficiency improvements and high performance, high demand Industry 4.0 applications that would help Open RAN leapfrog closed RAN systems by creating a virtuous cycle of economic value creation. A strong United States-led ecosystem of webscalers, IT companies, application developers, software developers, and robotics companies would increasingly create more and more value through this cycle. This would bolster technical skills development across the industry in the United States and among its partners.

We propose NTIA invests in 5G Open RAN projects that enable high-performance, high demand applications, such as warehouse automation, robotics, VR/AR, dense industrial IoT across defense and enterprise segments. Such projects should have significant scalability potential to generate value beyond the initial deployment and throughout their lifecycle. Funding criteria could include a committed plan to deploy Open RAN at-scale based on a successful outcome of a POC or pilot that is funded by NTIA. Automation and VR applications can drive significant productivity improvements and workforce skill development across the US.

Historically, many of the brownfield Open RAN deployments by Mobile Network Operators (MNOs) thus far have been smaller-scale or rural projects. This risk-contained strategy to minimize disruption for higher value customers is understandable. At the same time, it doesn't advance Open RAN in a meaningful way as small, Open RAN vendors don't benefit from the monies and profits that are largely driven in urban areas and cities. This results in a lack of investment into innovation and high performance applications so critical to our success going forward.

NTIA could incentivize operators who are willing to invest in Open RAN systems for urban areas, private networks (with potential to scale), and high performance Industry 4.0 applications. This would help bridge this gap and provide a platform for value-creation through Open RAN.

Additionally, investments in Open RAN Chip development would radically improve performance, programmability, and efficiency thus providing benefits as follows:
- Accelerate - Enables American vendors to leap-frog current wireless technology and gain global leadership in mobile network infrastructure market currently dominated by non-American companies.
- Spectral Capacity – Operators in the US and its partner countries can increase capacity on mid-band TDD spectrum by 12x; maximizing the return on spectrum investments.

- Investment protection – Operators, government, and enterprises benefit from next generation networks that serve the most demanding mobile broadband and industry 4.0 needs for several years to come.
- Ultra-Reliable Coverage - Wireless coverage that can reliably support millions of devices in an industrial environment.
- Application Advancement – Birth a new ecosystem of commercial and government applications and use cases.
- Workforce Development - Incubates workers needed for developing and operating the new application ecosystem.

In order to accelerate standards-based, inter-operable Open RAN systems, we propose:

- Spec: A harmonized, common subset of specs to enable end-to-end Open RAN certification process should be established ASAP. A US government entity or an industry group or forum (e,g O-RAN) can be entrusted with this.
- Certification: Government funded United States based labs for certification testing based on the spec above. Such labs should support small vendors with certification and conformance testing infrastructure, tools and personnel as needed.
- Multi-vendor integration: Another function of these labs should be multi-vendor testing and integration for end-to-end systems. One option could be to fund and enable US based System Integrators (SIs) for integration and lifecycle management of such systems.

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

XCOM Response:

There are a very limited number of Open RAN testbeds available in the United States and the existing ones do not have the flexibility expected from a true open based architecture. Furthermore these testbeds are limited in features and resources they can support, limiting the number of use cases that can be demonstrated. Since open architecture standards are still evolving, current testbed systems have closed infrastructure which favors existing major vendors and who have not fully embraced the benefits of Open architecture.

This stymies opportunities for testing and adoption for open architecture based deployments.

To address this, the government should encourage more development and vendor participation in the area of Open architecture based infrastructure especially in the area of Open RAN based systems. It is equally important to evaluate what are the limitations in current testbeds and identify necessary upgrades that need to be performed so that it can be

transformed into a true Open architecture based system wherein interoperability testing between multiple vendors can be tested. Once Open testbeds requirements are identified and scaled across the United States, it would help unlock meaningful innovation of Open architecture based 5G and future generation systems.

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?

XCOM Response:

The purpose of testbeds is to address the requirements to support a variety of use cases. For instance, Machine to Machine communications is very time sensitive hence a network that is designed to support URLLC would take precedence over a network designed to support eMBB which means Mobile Edge Compute (MEC) is required. Conversely, Augmented/Virtual Reality (AR/VR) training being a high throughput and low latency application would require both URLLC and eMBB feature sets. Therefore, it is important to have a testbed that has end-to-end feature support based on the target applications.

Open architecture allows for the flexibility to build and tune the testbed and or network to meet the requirement of a dynamic set of use cases. For example, massive MIMO is best deployed for use cases where users are spatially separated in wider outdoor area and there is demand for high broadband. Conversely, when users confined to a limited area and require broadband data, small cells or distributed MIMO using Open RAN architecture would be more suitable. Different DU vendors may further choose to implement additional features such as Coordinated Multi-Point (CoMP) from one vendor and Location Positioning from another vendor, however, both using the same Open RU's.

Scalability beyond POC or pilot is a very important criterion. One of the desired outcomes for a pilot could be readiness for the same 5G Open RAN solution to be commercially deployed at scale. As mentioned earlier, Private networks present a great opportunity for 5G Open RAN to take a lead. NTIA could incentivize pilots that overcome the major adoption barriers, (eg spectral efficiency, ease of deployment, integration to IT/OT systems), solve the main enterprise customer pain points (eg reliable wireless network for automation), and have the potential to scale for large number of enterprise locations.

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 United StatesC 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?

XCOM Response:

Security event logging and transfer to a centralized location is a 3GPP requirement as per TS 33.511 and TS 33.117. However the benefits are not clear for the sub-components of Open RAN architecture. Heavy logging requirements for DU, CU, and RU, beyond the minimally required reporting towards network management entities may impact system performance unnecessarily.

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

XCOM Response:

3GPP security requirements cover over a hundred use cases for gNB. The O-RAN security workgroup is mapping these use cases to Open RAN architecture. The industry needs O-RAN Security Group to provide security conformance test guidelines that are tailored to Open RAN architecture and are not just a mapping of 3GPP specs.

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

XCOM Response:

For Open RAN, as with any other network, the biggest security threats are around
      1) access: mitigated by authorization & authentication protocols
      2) service availability: mitigated by denial-of-service prevention mechanisms
      3) data privacy: mitigated by encryption
Companies have been implementing one or more of these mitigation strategy for quite some time. However, the key will be to provide an end-to-end secure multivendor Open RAN architecture without performance degradation caused by over-protecting the individual elements. This requires conformance metrics for performance with security.

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

XCOM Response:

The innovation fund can be used to incentivize vendors to drive security conformance test guidelines within O-RAN that are tailored to Open RAN architecture and have clear performance metrics.

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?

XCOM Response:

In the zero-trust model, instead of assuming everything behind a firewall is safe, the main assumption is that a breach happens at all times and each request is verified as though it originates from an open network. Currently O-RAN specs require zero-trust model for O1 interface only. In order to support the zero-trust model, O1 enforces confidentiality, integrity, authenticity through an encrypted transport, and an access control model. O-RAN needs to provide clear recommendations, on which interfaces or elements should implement the zero-trust policy, without impacting performance.

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 United StatesC. 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?

XCOM Response:

Given the unprecedented amount of funding provided, it is reasonable to expect the government would make sure this money is being spent with great intentionality, filling gaps in industry R&D where traditional streams of funding do not flow, and in a way that spurs domestic innovation, competition, and United States technological leadership.

Proposals should not only give details of what specifically vendors will do with their money with projected timelines but should have tangible metrics on potential impact to the advancement of Open RAN, public and private sector applications, and features of the United States wireless ecosystem that would make it more competition such as enhanced infrastructure and supply chain diversification.

As mentioned earlier, NTIA should prioritize pilots that enable readiness for larger scale deployment. Metrics could include resolution of the adoption barriers identified, specific customer problems solved, and scale achieved (eg size of project, capacity, # demanding applications, # devices, # locations).

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?

XCOM Response:

The NTIA must ensure it takes into consideration United States based non-traditional and newer entrants who have a history of introducing and commercializing disruptive technologies. The United States is underinvesting in domestic small suppliers. Current 5G and beyond roadmaps are driven by a small number of large, foreign incumbents with an approach antithetical to ORAN. These incumbent vendors are not incentivized to innovate or develop disruptive technologies that would have negative impacts on their existing revenue streams. Strategic investments in small, innovative United States based companies, however, complement current incumbent vendor offerings and create a highly competitive landscape for the United States to leverage. The absence of which could stifle critical technological breakthroughs.

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

XCOM Response:

The NTIA can encourage teaming by including an increased weightage in the evaluation criteria which would favor diverse teaming such as industry and academia, for example. In addition teaming relationships can be fostered by sponsoring networking and information exchange between potential PWIF grantees.

A focus on high performance, Industry 4.0 applications (eg automation, VR/AR, dense IoT) would drive a broader and stronger participation, including Open RAN OEMs, network operators, webscalers, system integrators, application developers, IT companies, IoT and robotics companies.

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).

XCOM Response:

In order to expedite the process of receiving grant proposals and issuing grant awards in support of the spirit of the PWIF, it is recommended to not make matching contributions an immediate focus for the program. Given the complexity of matching arrangements this would delay the goal of forwarding United States technological innovation. It is suggested that matching grants could be examined after an initial period of two to three years.

25. How can the fund ensure that programs promote United States competitiveness in the 5G market?
         a. Should NTIA require that grantee projects take place in the United States?

XCOM Response:

It is recommended that the NTIA should be intentional in terms of investing a majority of projects in the United States, through considering proposals for external projects based on how those projects are achieving the goal of furthering the goal of stimulating United States innovation. In addition, by keeping the projects in the United States the goals of increasing workforce development are further achieved.

US is a global leader in IT and Software with the largest webscalers, IT companies, and application developers being based here in our country. 5G Open RAN is an excellent platform to leverage this strength to gain leadership in the wireless industry. A strong focus on Industry 4.0 applications would enable a broader and stronger participation from the Software industry, creating a virtuous cycle of value-creation, and setting the stage for US's wireless leadership.

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

XCOM Response:

To achieve the goal of stimulating wireless innovation in the United States there should be a majority investment in companies and technologies that are United States based. In order to remain competitive United States companies, as they grow, will naturally expand their operations globally. It will be critical that United States companies that have a global

presence are operating in allied countries. NTIA should be clear on the list of countries that are aligned with the interest of the United States. In addition, though we recommend a primary investment in United States companies, the NTIA should allow and consider proposals that have non-United States companies participating as a partner or subcontractor to a United States based company.

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"?

XCOM Response:

As a part of the grant proposal submission process, it is recommended that the NTIA request supply chain details in terms of the origination of components. Since it is difficult to implement wireless systems with all United States based suppliers it is recommended that key elements such as semi-conductors and software development are either United States made or supplied by allied nations. It should be sufficient benchmark if the majority of a system or wireless element is developed and integrated by a United States company.

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

XCOM Response:

XCOM is a founding and active member of the Open RAN Policy Coalition (ORPC). ORPC has been playing an instrumental role in driving adoption of Open RAN with like-minded governments through forums such as the Quad Open RAN Forum. We propose strengthening the collaboration with ORPC even further to help in achieving Innovation Fund goals.

XCOM recommends that the NTIA further collaborate with the agencies with a focus on international collaboration and investment such as the State Department, USAID, and the Development Finance Corporation. These entities can lead investment and coordinate with allied governments on furthering the goal of establishing a robust global ecosystem of open and advanced wireless technology. In addition these United States entities have a broad and current view of the global environment and are key in leading those types of projects. NTIA should have a seat at the table to ensure that the domestic efforts associated with PWIF are aligned with this global approach.

<u>Additional Questions</u>
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?

XCOM Response:

As mentioned earlier, leapfrog technologies are typically initiated and developed by small businesses that have a limited budget. In addition to investing in such technologies, it would be helpful for the NTIA to also provide investment for these companies to participate in standards body activities and test bed certifications.

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?

XCOM Response:

In addition to a cadence of industry day events, the NTIA could consider sponsoring match making events such as virtual pitch days for potential PWIF grantees. This would help smaller companies with more limited bandwidth connect with companies aligned in their common goals.