Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Promoting the Deployment of 5G	)	GN-Docket No. 21-63
Open Radio Access Networks	)	

COMMENTS OF THE NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

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To: The Commission

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I. INTRODUCTION

The National Telecommunications and Information Administration (NTIA), on behalf of the Executive Branch of the U.S. Government (Executive Branch),[1] submits these comments in response to the Federal Communications Commission's (Commission) Notice of Inquiry in the above-captioned proceeding on open radio access networks (Open RAN).[2] These comments serve as an integrated, cohesive response from numerous agencies within the Executive Branch.

The Executive Branch recognizes that many network operators, both domestically and abroad, face limited options when selecting vendors to develop and deploy wireless networks. Limited competition in the telecommunications infrastructure market can reduce supply chain resilience and security and contribute to higher prices for operators and consumers in the long run. As stated in the Implementation Plan of the National Strategy to Secure 5G, the Executive

[1] *See* 47 U.S.C. § 902(b)(2)(J).
[2] *Promoting the Deployment of 5G Open Radio Access Networks*, Notice of Inquiry, GN Docket No. 21-63 (Feb. 24, 2021), https://www.fcc.gov/document/promoting-deployment-5g-open-radio-access-networks.

Branch agrees that "close coordination between the United States Government, private sector, academic, and international government partners is required to ensure adoption of policies, standards, guidelines, and procurement strategies that reinforce 5G vendor diversity and foster market competition."[3] One promising solution in line with these objectives is open, interoperable networks, including Open RAN. While this response focuses on Open RAN, the Executive Branch's policy is to promote the development of Open RAN alongside other policies, technologies, and architectures that support 5G vendor diversity and foster market competition.[4]

II. POTENTIAL BENEFITS OF OPEN RAN

a. Increased Competition and Related Benefits

The communications industry is shifting away from a hardware-centric model toward softwarization, virtualization, containerization, and other modern information technology approaches. The basic 5G network architecture defined by the 3rd Generation Partnership Project (3GPP) – the primary standards development organization (SDO) for 5G standards - will enable mobile network operators (MNOs) to provide service to millions of customers. This end-to-end focus allows incumbent vendors to offer end-to-end solutions. The problem is that new entrants must develop the entire RAN and some components require expertise that is difficult to obtain. The Open RAN architecture provides additional interface specifications that subdivide the RAN into smaller components with standard interfaces. This disaggregation enables end-to-end 5G networks that are assembled with components from multiple vendors.

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[3] NTIA, *National Strategy to Secure 5G Implementation Plan* (Jan. 19, 2021), https://www.ntia.gov/5g-implementation-plan.

[4] President of the United States of America, *National Strategy to Secure 5G*, (Mar. 2020), https://trumpwhitehouse.archives.gov/wp-content/uploads/2020/03/National-Strategy-5G-Final.pdf.

The Executive Branch fully supports industry's development of Open RAN while recognizing the importance of maintaining a full suite of solutions offered by incumbent vendors. By standardizing interfaces in the radio access network, Open RAN can advance the development of a disaggregated network stack that allows a variety of firms to sell software, hardware, and services independently, while maintaining interoperability. In this way, Open RAN holds the potential to reduce barriers for new market entrants and increase the diversity of vendors offering 5G network equipment and services.

Reducing vendor lock-in and barriers to market entry is expected to increase competition and choice in the telecommunications infrastructure market, which then could lead to increased innovation, reduced prices, and enhanced connectivity—including in rural areas. Increasing choice for operators is important, especially in light of supply chain security concerns arising with high-risk vendors.

The reduction in vendor lock-in applies at all stages (e.g., initial specification, maintenance, and upgrade). Generally, hardware-centric solutions with custom tailored chips offer slightly improved performance, but the advent of so-called "white-box solutions" is beginning to enable operators to reduce costs by avoiding hardware changes (e.g., during maintenance, upgrades, security patches, and network reconfigurations). The specific advantage for Open RAN is that a new entrant could develop a tailored component that better meets the needs of a market niche (e.g., network coverage in a contested RF environment), and the network operator could replace that component of their deployed network with the new vendor's offering via a software upgrade, or replace the unit altogether if vendor-specific hardware is used due to the nature of the open interfaces used in Open RAN.

Independent analysts assess that Open RAN could enable lower upfront deployment costs through more efficient use of bandwidth, greater network visibility, and lower overall unit costs while also potentially lowering future upgrade costs by enabling incremental component-level upgrades instead of complete gNodeB or RAN system replacement.[5] In addition, increased disaggregation will allow firms to more easily compete for specific categories of products and services, such as security software or services, and allow operators to pick and choose among best-of-breed solution providers.[6] In this way, increased competition could spur innovation, leading to improved performance, security, and other outcomes. Some sources cite the potential for Open RAN to lower capital and operating costs by roughly 40 percent for operators.[7] Operators could choose to re-invest these additional funds in the Open RAN ecosystem, driving innovation, competition, and vendor diversity both domestically and internationally.

Firms around the world stand to benefit from new market opportunities arising from the disaggregation of the functional elements of the RAN. U.S.-based companies are actively collaborating with firms in a number of countries, including in Europe and East Asia. International partnership and collaboration with industry and likeminded governments will be key to ensuring global interoperability in Open RAN-based architectures. Participation in Open RAN specifications development and deployment by companies from a broad range of countries

[5] Essing, N. H., Westcott, K., Nesargi, S. S., Loucks, J., & Wigginton, C., "Next-gen radio access networks," Deloitte Insights (Jan. 28, 2021), https://www2.deloitte.com/xe/en/insights/industry/technology/technology-media-and-telecom-predictions/2021/radio-access-networks.html.

[6] *Id.*

[7] *See e.g.,* Duval, A., Hall, R., Matsuhashi, I., Sugiyama, M., & Chang, A., "Softwarisation of Wireless Equipment," Goldman Sachs Group, Inc. (Sept. 2, 2019) (rep.); Wang, J., Roy, H., & Kelly, C., "5G New Radio: Revenue and Deployment Opportunities," Accenture Strategy (2019) (rep.).

underscores the fact that Open RAN is backed by a broad range of operators, vendors, and governments.

b. Benefits to Consumers

Open RAN holds the potential to lower operators' network costs and generate savings that could, in turn, be passed to consumers through lower relative pricing. In at least one high-profile instance, a network operator indicated that Open RAN-related cost reductions were passed on to consumers in the form of lower prices.[8] More large-scale deployments are needed in order to determine whether this is representative of a trend, but the Executive Branch encourages the Commission to consider the wide range of potential benefits Open RAN architectures may unlock for consumers and enterprises.

Open RAN presents a broad set of expected advantages, including with respect to innovation, network security, and supply chain resilience, all critical factors in supporting consumers' reliance on secure, robust wireless connectivity.[9] Further, operators may opt to invest their potential cost savings in other activities that would benefit consumers, such as enhanced network security management, additional value-added features for the same price plan, further Open RAN-related research and development, or systems integration activities. Therefore, we encourage the Commission to consider the broader scope of potential public policy benefits accruing from Open RAN beyond expected competitive consumer pricing strategies.

[8] Gabriel, C., "Rakuten shows what open RAN enables, halving the cost of unlimited data," Rethink Research (Mar. 6, 2020), https://rethinkresearch.biz/articles/rakuten-shows-what-open-ran-enables-halving-the-cost-of-unlimited-data/.

[9] "Building the 5G Economy," CTIA (Jan. 25, 2021), https://api.ctia.org/wp-content/uploads/2021/01/2021-Wireless-Briefing-2_9.pdf.

The Commission should also consider that Open RAN could support the development of private 5G networks. This new market consists of 3GPP compliant 5G networks that are dedicated to the needs of a single organization or enterprise (e.g., manufacturing plant, hospital, or smart warehouse). Private 5G networks will be optimized to meet that organization's unique traffic patterns, such as guaranteeing ultra-reliable low latency communication by limiting massive machine communications (e.g., IoT sensor support). Open RAN will support fast innovation for small networks with limited geographical area that maximize operational efficiency for a specific organization's use case.

c. Benefits from Artificial Intelligence and Machine Learning

Artificial intelligence holds promise in helping to manage, automate, and streamline various processes upon which 5G and different aspects of open architecture, such as virtualization, would depend. These tools will need to be evaluated for their relative benefits and drawbacks (such as those related to privacy, efficiency, or security) within the contexts of their use. The use of artificial intelligence/machine learning (AI/ML) techniques in the Open RAN context can be diverse and varied, from looking at signaling messages to tracing low-intensity credential attacks to scanning the data packets to optimize network configurations. The open interfaces supported by Open RAN should allow for innovation to happen along the various intersections where AI/ML can be most helpful, without needing additional standards or application programming interfaces (APIs).

With respect to privacy considerations, it is important that privacy-preserving learning methods are used by external vendors who seek to access network or customer data. Regarding security features, AI/ML can help augment the vulnerability and fault detection capabilities of an Open RAN deployment, but it would be too early to mandate such use, given the fast moving

nature of the technology and the potential for false positives. The Commission should monitor this issue in collaboration with the Executive Branch, including through communication with industry and civil society.

III. SECURITY CONSIDERATIONS OF OPEN RAN

a. Supply Chain Security and Resilience

As stated in the February 23, 2021, Executive Order on America's Supply Chains, the Biden-Harris Administration is committed to securing America's supply chains, including those in the information and communications technology (ICT) sector. This commitment builds on numerous previous actions by the executive and legislative branches to address supply chain risks, including those from adversary governments. Notable actions include Section 889 of the 2019 National Defense Authorization Act, which prohibited government contracting with or procurement of equipment from five Chinese firms: Huawei Technologies Company, ZTE Corporation, Hytera Communications Corporation, Hangzhou Hikvision Digital Technology Company, and Dahua Technology Company.[10] In addition, Executive Order 13873, published on May 17, 2019, grants the Secretary of Commerce the authority to prohibit certain information and communications technology and services (ICTS) transactions that pose an undue risk to U.S. national security.[11] An Interim Final Rule implementing the Executive Order was released on January 19, 2021, and became effective on March 22.[12] The Department of Commerce

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[10] John S. McCain National Defense Authorization Act for Fiscal Year 2019, Pub. Law No. 115–232, § 889, 132 Stat. 1645 (2018).

[11] *Executive Order on Securing the Information and Communications Technology and Services Supply Chain*, E.O. 13873, Nat'l Archives and Records Admin. (May 15, 2019), https://trumpwhitehouse.archives.gov/presidential-actions/executive-order-securing-information-communications-technology-services-supply-chain/.

[12] *Securing the Information and Communications Technology and Services Supply Chain*, 86 FR 4909-4928, U.S. Dept. of Commerce (Jan. 19, 2021),

committed to issuing a subsequent final rule in which it will consider and respond to additional comments received. The ICTS rule lists Cuba, the Democratic Republic of Korea, Iran, the People's Republic of China, Russia, and Venezuela as "foreign adversaries," meaning that ICTS transactions that involve ICTS designed, developed, manufactured, or supplied by persons owned by, controlled by, or subject to the jurisdiction or direction of these authoritarian governments may be subject to review under the E.O. 13873 rule.[13]

Open RAN could enhance supply chain security by creating additional resilience and redundancy in global telecommunications equipment manufacturing by facilitating the emergence of new vendors. In addition, Open RAN can prevent vendor lock-in by allowing operators to mix and match hardware and software from a number of vendors, creating additional diversity, resilience, and redundancy. While Open RAN may have benefits for supply chain security and resilience, it is not a replacement for governments taking action in collaboration with industry to protect critical infrastructure, including ICT networks, from a full range of security threats, including those posed by untrusted, high-risk vendors. Open interfaces also provide an opportunity to decouple security sensitive operations from purpose-built RAN equipment, and to ensure these security critical operations can be run on cloud infrastructure built on trusted platforms.

b. Network Security

It may be premature to attempt a direct security comparison between Open RAN and traditional RAN architectures at this time when Open RAN technologies are still in development

https://www.federalregister.gov/documents/2021/01/19/2021-01234/securing-the-information-and-communications-technology-and-services-supply-chain.

[13] "ICT Supply Chain," U.S. Dept. of Commerce, https://www.commerce.gov/issues/ict-supply-chain.

and testing phases.[14] Nevertheless, open architectures, such as Open RAN, offer operators increased visibility and understanding of the behavior of the system compared to closed architectures.[15] This increased visibility with open architectures could lead to earlier discovery and rapid correction of issues inherent to a specification. It is also easier for operators to understand normal vs. abnormal behavior across open interfaces to improve independent threat detection capabilities not available for closed interfaces. Software must be actively maintained and monitored in order to identify potential security threats during development and to mitigate risks that arise post-release.

Software security vulnerabilities can be present in both open- and closed-source solutions. This highlights the importance for operators and integrators to understand the whole software supply chain involved with both Open RAN and traditional solutions. Vulnerabilities are also regularly found in commonly used code, even in code that has been tested, evaluated, and widely used for years. The lack of publicly disclosed vulnerabilities does not necessarily mean there are no vulnerabilities and there may be vulnerabilities that cannot yet be mitigated. A culture of response and resilience is necessary. Suppliers of code, both proprietary and open source, should be encouraged to work with security researchers to implement coordinated disclosure policies, and should be prepared to handle vulnerabilities that affect multiple suppliers. Suppliers, both open and closed, should have product security teams that can quickly

[14] Amy Zwarico and Sébastien Jeux, "The O-RAN ALLIANCE Tackles Security Challenges on All O-RAN Interfaces and Components," O-RAN Alliance (Oct. 24, 2020), https://www.o-ran.org/blog/2020/10/24/the-o-ran-alliance-security-task-group-tackles-security-challenges-on-all-o-ran-interfaces-and-components.

[15] *Open RAN Security in 5G*, Open RAN Policy Coalition (Apr. 2021), https://www.openranpolicy.org/wp-content/uploads/2021/04/Open-RAN-Security-in-5G-4.29.21.pdf.

triage new issues, with adequate resources to develop mitigations and relationships with those who have deployed systems to promulgate solutions.

Efforts such as a Software Bill of Materials (SBOM) can aid in better understanding potential risks from upstream software sources that may be vulnerable or otherwise out-of-date.[16] SBOM transparency and subsequent analyses including independent evaluation of open-source software would allow vendors and operators to better understand what vulnerabilities may exist in solutions under consideration.

In multi-vendor RAN deployments, the level of accountability and trust can depend on a variety of factors, such as what role each vendor plays, who integrated the network (e.g., the operator, one of the equipment vendors, or a third-party integrator), and the overall comfort level of the operator and integrator with the vendors used in the network. Currently, there is no substantial evidence that a multi-vendor deployment would increase or reduce accountability and trust versus a single-vendor deployment.

One advantage to open and interoperable networks is that an operator has the option of "swapping" one vendor for another in just part of the network—something that is not feasible in closed architecture deployments without considerable degradation of network performance. This choice is an important factor to consider for cases in which an operator loses trust in one of its vendors.

Turning to security specifications, adherence to those defined by 3GPP is important in both open and closed architecture systems. Because open architecture specifications, such as

[16] *Software Bill of Materials*, National Telecommunications and Information Administration, https://www.ntia.gov/SBOM. A 'Software Bill of Materials' (SBOM) is effectively a nested inventory, a list of ingredients that make up software components. The NTIA SBOM is a multistakeholder process intended to address transparency around software components and was approved by a consensus of participating stakeholders.

those promulgated by the O-RAN Alliance, build upon the 3GPP specifications, additional care should be taken to ensure the open architecture specifications do not contradict those defined by 3GPP and, if necessary, define their own architecture-specific security specifications.

Finally, virtualized environments in the telecommunications industry are not unique to Open RAN. Many traditional, closed-RAN manufacturers are using virtualization and containerization for their core network solutions as well. The security of virtualized environments should not be new to operators or equipment vendors because of its application in 4G and 5G core networks along with its general use in other server applications.

IV. THE ROLE OF GOVERNMENT

a. Government Incentives and Regulation

As stated in the National Strategy to Secure 5G, the Executive Branch is working to reinforce 5G vendor diversity and foster market competition. In line with these objectives, one important policy solution that the Commission should consider is international spectrum harmonization to enable economies-of-scale for network equipment and increased competition as vendors can sell the same equipment across multiple markets. Another option the Commission should consider is issuing a "general extension" for all recipients of funding under the Secure and Trusted Communications Networks Reimbursement Program to ensure operators have sufficient time to consider options, design networks, and carry out deployments, as described in the Commission's Second Report and Order on "Protecting Against National Security Threats to the Communications Supply Chain Through Commission Programs."[17] Such an extension would not preference any solution but would give operators adequate time to consider Open

[17] *Protecting Against National Security Threats to the Communications Supply Chain Through FCC Programs*, Second Report and Order, 35 FCC Rcd 14284, 14379 (2020), https://docs.fcc.gov/public/attachments/FCC-20-176A1.pdf.

RAN deployments if desired. Given security tradeoffs of delayed "rip-and-replace," the Commission should consider requiring operators to submit information to prove that they have plans in place and are diligently following through on implementation.

The Administration is actively investigating what options would be best suited to incentivize domestic production of 5G infrastructure, including Open RAN, and grants and tax incentives are both under consideration. To this end, NTIA hosted two industry listening sessions focused on market incentives for 5G security and vendor diversity to hear feedback from industry on actions that the Executive Branch can take to support these objectives. Industry raised several priorities to incentivize and promote additional U.S. production, including ensuring an open, competitive, and level playing field for American firms globally, procuring Open RAN solutions for government needs when appropriate, and providing appropriations for the Public Wireless Supply Chain Innovation Fund (PWSCIF), which would provide grant funding to support innovative new technologies and market entrants.

The Executive Branch is also supporting research and development in advanced wireless communication technologies through several agencies, including the National Science Foundation, the Department of Energy's National Labs, NTIA's Institute for Telecommunication Sciences, and the National Institute of Standards and Technology (NIST). Additionally, government-funded testbeds are being established in order to document how to connect and deploy the various components of an Open RAN architecture in addition to incumbent vendor equipment. These facilities could provide a template for operators as they build out and deploy 5G and future generations of wireless networks.

b. International Cooperation

The Commission's substantial regulatory expertise would benefit international discussions on Open RAN. The Commission should continue its involvement in relevant global fora, such as the Asia-Pacific Economic Cooperation (APEC) forum and the Organization for Economic Cooperation and Development (OECD), working in close coordination with Executive Branch agencies. Other noteworthy fora that have been exploring Open RAN-related issues include the Quadrilateral Security Dialogue (the "Quad"), the Group of Seven (G7), and the Prague 5G Security Conference.

It is important to recognize that multilateral fora may differ in membership, mandate, and other key characteristics. Some may be better suited to raising initial awareness on Open RAN, carrying out technical research and analysis, or helping to forge normative consensus on common governmental approaches. The United States intends to pursue broad international engagement, including in bodies like those cited above, but will calibrate specific approaches based on what would be most beneficial for the members of a given forum or best advance common interests.

The Executive Branch intends to embrace good faith, productive discussions in such fora on potential concerns about Open RAN, viewing these as an opportunity to better understand possible impediments and coordinate constructively with other governments in addressing them. The Commission's regulatory and telecommunications knowledge could contribute to discussions with industry and international partners to inform principles on what governments can do to promote open and interoperable networks. This is particularly the case for advancing Open RAN in developing countries in order to improve the ecosystem and advance U.S. Internet policy goals as described in more depth in section five.

c. Demonstration Projects, Research, and Testbeds

The interest in open architectures for 5G networks, of which Open RAN is an example, has resulted in many new software and hardware components. Their functionalities and interoperability with other solutions are often difficult to evaluate in simulations or in laboratory settings. Two innovation zones that have been already created by the Commission are providing opportunities to researchers and practitioners to test operational benefits associated with Open RAN. The Platforms for Advanced Wireless Research (PAWR) testbeds deployed in the Innovation Zones in Salt Lake City and New York City are being used to test the capabilities, functionalities, and limitations of the various components of such open architectures. The Executive Branch recommends that the Commission solicit feedback from the investigators leading the testbed efforts for any adjustments that would be needed to better support Open RAN testing. While the National Science Foundation (NSF) is already adding two testbed platforms (AERPAW in Raleigh, North Carolina for unmanned aerial vehicle (UAV) applications and another platform for rural broadband connectivity), it is likely that additional custom testbeds may need to be established.[18]

NIST is working through partnerships with industry, federal agencies, and the research community to advance breakthrough propagation measurement, calibration, and channel modeling approaches and technologies. Its outputs and measurement data support the development of new standards (such as those considered by the O-RAN alliance) and products while also accelerating next generation wireless network deployments.[19]

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[18] "Aerial Experimentation and Research Platform for Advanced Wireless," About AERPAW, https://aerpaw.org/.

[19] *NextG Channel Model Alliance*, National Institute of Standards and Technology, https://www.nist.gov/ctl/nextg-channel-model-alliance.

The Department of Defense's 5G-to-xG program is investing $600 million into 5G networks at select DoD bases to conduct experiments pursuant to DoD inspired use cases. [20] The 5G networks deployed will consist of a mix of current commercial grade, and in some cases, 5G stand-alone deployments, at an enterprise scale, using software-based, standardized RAN splits. Results from initial experiments that explore verticals such as smart warehouses, dynamic spectrum sharing, and tactical edge networking will start to become available in 2022; insofar as these reflect the impact of Open RAN designs on end-to-end network performance metrics, they complement investments by NSF.

The interconnection of testbeds to better simulate the challenges of actual end-to-end network deployments is needed. However, the individual testbeds must be stable enough to realize the benefits of interconnected testing. Several industry-led and government-led efforts are ongoing to initiate new testbeds to evaluate system integration and interoperability issues faced by multi-vendor Open RAN deployments.

Rigorous testing and verification of Open RAN components will increase their reliability and trustworthiness in commercial deployments. Low-cost access to robust and comprehensive test environments will increase the competitiveness of small-business vendors in the Open RAN ecosystem and promote vendor diversity. The Commission should encourage an industry-led interoperability testing program for 5G RAN solutions that is synchronized with federal open architecture testing and R&D efforts.

[20] "DOD Announces $600 Million for 5G Experimentation and Testing at Five Installations," Department of Defense (DoD) (Oct. 8, 2020), https://www.defense.gov/Newsroom/Releases/Release/Article/2376743/dod-announces-600-million-for-5g-experimentation-and-testing-at-five-installati/.

As Open RAN is an evolving technology, an important place to focus is on the development of options and testing standards for the different ways Open RAN functionality can be configured across the radio network elements, known as a functional split. To the extent possible, the Commission should look for ways to facilitate testing and integration of Open RAN equipment in real life use cases through approaches like Innovation Zones rather than playing a direct role in the promotion and development of specific types of Open RAN equipment and functions. In addition, the Commission could consider partnering with federal agencies such as the Department of Homeland Security, DoD, NIST, NSF, and NTIA to support research in technologies useful for Open RAN development.

As Open RAN networks are expected to support a broad range of critical and essential services, the resilience of these systems will be important. The Resilient & Intelligent NextG Systems (RINGS) program established by NSF with federal and industrial partners seeks to address resilience in a broader, more fundamental context. The Commission should promote research in the resilience and security of Open RAN networks and encourage interoperability testing for 5G RAN solutions through private and federal sector R&D partnerships. The Executive Branch welcomes collaboration with the Commission and industry on testing. Rigorous testing and verification of Open RAN components will increase their reliability and trustworthiness in commercial deployments. Low-cost access to robust and comprehensive test environments will increase the competitiveness of small-business vendors in the Open RAN ecosystem and promote vendor diversity.

d. Support for Industry-Led Standards Development

The U.S. Government supports preserving and maintaining a diverse, competitive market for 5G equipment and services. Industry-led standards are essential for innovation, network

security, and job creation. The Executive Branch supports open, iterative standards processes, in which the resulting standards are state-of-the-art, fit-for-purpose, and developed through open, bottom-up, industry-led, consensus-based processes free of undue influence of state-actors or their proxies. The Executive Branch is working to strengthen its capacity for standards engagement and will promote, encourage, and coordinate closely with the U.S. private sector to understand trends and barriers to participation in industry-led standards developing organizations (SDOs). While the U.S. Government has not participated in the development of O-RAN Alliance specifications, it continues to prioritize supporting industry in standards development.

The international interest in Open RAN is anticipated to open opportunities for U.S. and international companies, but intervention or manipulation by governments could lead to geographic fragmentation of the technology through government mandated, country-specific standards and requirements. As the technology develops and final specifications are standardized, it is critical to the global potential of open, interoperable networks that all countries recognize and accept voluntary, industry-led consensus-based standards for technologies for the entire wireless ecosystem. Governments may be motivated to take a top-down approach to standards development or mandate national standards using indigenous technologies. The Commission can work with Department of Commerce, Department of State, and other Executive Branch agencies to emphasize the importance of all countries accepting industry-led standards development for wireless networks.

V. THE GLOBAL STATUS OF OPEN RAN

a. International Deployments

It is appropriate for the Commission to consider the international dimensions of Open RAN, given the cross-border nature of supply chains, of telecommunications infrastructure markets, and of industry efforts and enthusiasm for Open RAN itself. Open RAN is also becoming an important part of international wireless deployments. This is true even in developing countries where new deployments known as greenfield deployments and testing provide opportunities for companies to explore the technology and see how it might fit within their broader networks.

Some specific examples of existing and planned international deployments include:

- *Argentina:* IBM has embarked on a pilot project with Telefónica in Argentina, acting as the integrator for an Open RAN trial in Puerto Madryn covering over 81,000 people.[21]
- *Brazil:* In June 2020, Telefónica Brazil's subsidiary, Vivo, announced it was conducting Open RAN pilots in collaboration with Altiostar, Gigatera Communications, Intel, Supermicro, and Xilinx. These were the first virtualized network trials in Brazil at the time of their launch. Vivo's Director of Network Planning has highlighted how the Open RAN trials will serve as a catalyst for local software development and will attract a skilled programming workforce.[22]
- *Colombia:* In May 2021, Millicom announced plans to deploy an O-RAN compliant Open RAN 4G network utilizing 700 MHz spectrum in partnership with Parallel Wireless in Colombia. At the time of its announcement, the planned network would be the largest deployment of an Open RAN network in Latin America.[23]

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[21] Maistre, R. L., "Telefónica deploys Open RAN in Argentina with IBM, TelecomTV," (Mar. 26, 2021), https://www.telecomtv.com/content/open-ran/telef-nica-deploys-open-ran-in-argentina-41140/.

[22] "Vivo conducts OpenRAN technology pilots in Petrolina and Juazeiro," Teletime, (Jun. 20, 2020), https://teletime.com.br/30/06/2020/vivo-ja-realiza-pilotos-da-tecnologia-openran-em-petrolina-e-juazeiro/.

[23] "Parallel Wireless Partners with Millicom to Deliver First 4G O-RAN Networks in Latin America," Parallel Wireless (May 13, 2021), https://www.prnewswire.com/news-releases/parallel-wireless-partners-with-millicom-to-deliver-first-4g-o-ran-networks-in-latin-america-301289181.html.

- *Democratic Republic of the Congo (DRC) and Mozambique:* In 2019, Vodafone launched Open RAN trials in the DRC and Mozambique as part of the Telecom Infra Project's Open RAN initiative. Vodafone has started working with a number of new vendors supplying Open RAN technology including the U.S. companies Parallel Wireless and Mavenir and UK-based Lime.[24]

- *Germany*: Deutsche Telekom announced plans to deploy an Open RAN solution to serve the town of Neubrandenburg, a town of about 65,000 residents later in 2021. The deployment has several technology partners, including Dell, Fujitsu, NEC, Nokia, and Mavenir. Telefonica Germany announced it initiated an Open RAN pilot project in the Bavarian town of Landsberg (with about 28,000 residents) and plans to gradually expand the project throughout 2021. Telefonica selected NEC as main system integrator for the pilot project; other technology partners include Dell, Intel, Altiostar, Xilinx, RedHat, GigaTera and Supermicro.[25]

- *Ghana:* In 2020, the Ghana Investment Fund for Electronic Communications (GIFEC), a universal access service fund launched an agreement with Parallel Wireless to deploy Open RAN technology in Ghana.[26]

- *India*: Airtel deployed Altiostar's open vRAN solution across multiple cities in India, partnering with IBM and Red Hat. The solution is 5G ready and can be upgraded to 5G using the same architecture.[27]

- *Indonesia:* Indosat is working with the GSM Association (GSMA) and Telecom Infra Project (TIP) to trial Open RAN in Indonesia. One of the trials will take place at a universal service obligation base station in one of the archipelago's most under-developed areas.[28]

- *Ireland:* Vodafone Ireland has announced plans to deploy an initial 30 Open RAN base stations in Ireland. The deployments include radios from Comba Telecom, a virtual baseband unit from Supermicro, and software from Parallel Wireless and VMware. The

[24] "Vodafone pioneers innovative network tech to increase suppliers and extend rural internet access," Vodafone, (Oct. 7, 2019), https://www.vodafone.com/news/press-release/vodafone-pioneers-innovative-network-tech-to-increase-suppliers-and-extend-rural-internet-access.
[25] Maistre, R. L., "Deutsche Telekom preps 2021 Open RAN rollout," TelecomTV (Dec. 10, 2020), https://www.telecomtv.com/content/open-ran/deutsche-telekom-preps-2021-open-ran-rollout-40429/.
[26] "Parallel Wireless Helps to Deliver on Ghana Investment Fund for Electronic Communications (GIFEC) Connectivity Vision Across Ghana," Cision (Apr. 22, 2020), https://www.prnewswire.co.uk/news-releases/parallel-wireless-helps-to-deliver-on-ghana-investment-fund-for-electronic-communications-gifec-connectivity-vision-across-ghana-849222631.html.
[27] "Bharti Airtel deploys Open vRAN with Altiostar," Altiostar, (Feb. 3, 2021), https://www.altiostar.com/bharti-airtel-deploys-open-vran-with-altiostar/.
[28] "Indosat trialling Southeast Asia's first OpenRAN," Developing Telecoms (Mar. 11, 2020), https://www.developingtelecoms.com/telecom-technology/wireless-networks/9314-indosat-trialling-southeast-asia-s-first-openran.html.

CTO of Vodafone Ireland has indicated that this deployment may be expanded to additional sites.[29]

- *Italy:* Telecom Italia has deployed an Open RAN solution connected to its live network to serve the province of Ravenna using radios from Microelectronics Technology and software from JMA Wireless.[30]

- *Japan:* In 2019, Rakuten deployed a multi-vendor Open RAN network using hardware and software from a range of vendors, including Altiostar, Airspan, and Nokia. The network was initially deployed as a 4G LTE network with plans to upgrade to 5G NR with sub-6 GHz radios from NEC. Current plans call for 44,000 base stations.[31]

- *Kuwait*: Kuwait's Zain Group, which operates in Kuwait, Bahrain, Iraq, Jordan, Saudi Arabia, Sudan, and South Sudan, has selected Parallel Wireless Open RAN to modernize existing 2G and 3G infrastructure.[32]

- *Peru:* In May 2019, Internet para Todos (IpT) started operating as a rural mobile infrastructure operator, supported by Peru's regulatory framework. IpT began as a collaborative initiative between Telefónica, Facebook, IDB Invest, and the Development Bank of Latin America with the goal of bringing connectivity to geographically complex areas of Latin America through an open and innovative business model. IpT, operating with Telefónica and ENTEL, deployed more than 3,100 base stations using Open RAN across Peru. IpT expects to reach 31,000 localities by the end of 2021, connecting 6 million people.[33]

    - Radisys is working with Qualcomm to develop open and interoperable interface compliant 5G solutions.

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[29] Hardesty, L., "Vodafone Ireland deploys open RAN tech at 30 sites," FierceWireless (Nov. 19, 2020), https://www.fiercewireless.com/tech/vodafone-ireland-deploys-open-ran-tech-at-30-sites.
[30] Maistre, R. L., "TIM takes its first step into Open RAN territory," TelecomTV (Apr. 27, 2021), https://www.telecomtv.com/content/open-ran/tim-takes-its-first-step-into-open-ran-territory-41356/.
[31] "Open RAN Integration: Run With It," iGillottResearch Inc. (2021) (rep.), https://igr-inc.com/Checkout/?ID=1634; *see also* "Announcement of Issuance of New Shares and Disposal of Treasury Stock through Third-Party Allotment," Rakuten, Inc. (Mar. 12, 2021), https://global.rakuten.com/corp/investors/assets/doc/documents/20210312_PPT_E.pdf.
[32] "Zain Selects Parallel Wireless Open RAN to Modernize Existing 2G and 3G Infrastructure," Cision (Feb. 20, 2019), https://www.prnewswire.com/news-releases/zain-selects-parallel-wireless-open-ran-to-modernize-existing-2g-and-3g-infrastructure-300798258.html?fbclid=IwAR23dCDEpM2PB8JbT3hT5A5EgTMuiSWtlNJktJz6DTmNWRL53l-AXVi2E0g.
[33] "Internet para Todos will expand Internet connectivity in Latin America," CAF Development Bank (Feb. 25, 2019), https://www.caf.com/en/currently/news/2019/02/internet-para-todos-internet-for-everyone-will-expand-internet-connectivity-in-latin-america/.

- *Saudi Arabia*: Saudi Telcom Company (STC) has signed a deal with Rakuten Mobile to boost Open RAN solutions.[34]
    - Telkomsel, Indosat Ooredoo, XL Axiata, and Smartfren are testing the Parallel Wireless Open RAN solution.[35]
    - TIP, GSMA, the Indonesian Government, and Telkom University launched a new Community Lab.[36]
- *Turkey*: Vodafone Group, along with Parallel Wireless, launched the first Open RAN trial deployment in Turkey in 2019. As part of the Telecom Infra Project's Open RAN initiative, the deployment spanned 25 sites in the Bozüyük district of Bilecik Province to test 2G, 3G, and 4G solutions. The Bilecik Province was selected because of its diverse landscape, which offers a mix of rural and urban settings. Upon successful completion of the trial, Vodafone and Parallel Wireless authored a TIP Playbook.[37]
- *UAE*: Etisalat has launched open virtual RAN (open vRAN) using virtualization products developed by Altiostar, Cisco, and NEC, among other suppliers. Etisalat plans to rollout open vRAN across the UAE. Etisalat is conducting Open RAN trials of 2G, 3G, 4G, and 5G in collaboration with Parallel Wireless in its markets across the Middle East and is planning to gradually expand its rollout of open vRAN across the UAE.[38]
    - Vi has been running Open RAN trials with Mavenir. BSNL has shortlisted Mavenir to provide Open RAN solutions through state-owned ITI Limited.[39]
- *United Kingdom:* Vodafone in the United Kingdom has announced plans to replace Huawei equipment at 2,600 base stations with Open RAN compliant solutions. The

[34] "Rakuten Mobile signs deal with STC to boost OpenRAN tech," RCR Wireless (Oct. 13, 2020), https://www.rcrwireless.com/20201013/5g/rakuten-mobile-signs-deal-with-stc-to-boost-openran-tech.
[35] "Parallel Wireless is the First Vendor to Power TIP's OpenRAN Community Lab in Indonesia," Parallel Wireless (Feb. 2, 2021), https://www.prnewswire.com/news-releases/parallel-wireless-is-the-first-vendor-to-power-tips-openran-community-lab-in-indonesia-301219409.html.
[36] "The Telecom Infra Project inaugurates New Community Lab in Indonesia," Telecom Infra Project (Feb. 1, 2021), https://telecominfraproject.com/telecom-infra-project-inaugurates-new-community-lab-in-indonesia/.
[37] "Telecom Infra Project," OpenRAN (Apr. 27, 2021), https://telecominfraproject.com/openran/.
[38] "Etisalat Launches Open vRAN with Altiostar, NEC and Cisco," The Fast Mode (Jan. 7, 2020), https://www.thefastmode.com/technology-solutions/16173-etisalat-launches-open-vran-with-altiostar-nec-and-cisco.
[39] "Vodafone Idea Deploys Mavenir OpenRAN Solution," Mavenir (Jan. 27, 2021), https://mavenir.com/press-releases/vodafone-idea-deploys-mavenir-openran-solution/.

deployment is planned to start in 2022 and would account for roughly 35 percent of the base stations currently served by Huawei.[40]

b. Observations from International Deployments

Greenfield deployments are increasingly common. The most prominent may be Japan's Rakuten, which has deployed an Open RAN 4G and 5G network for commercial use. Upgrades to existing networks, also known as brownfield deployments, continue as well, with mobile network operators globally integrating network virtualization to lower costs and increase efficiency. As they upgrade networks, operators are seeking vendors capable of providing greater openness and interoperability.

Deployments in developing countries are important for a variety of reasons. Collectively, the developing world represents a market of 4 billion people without access to mobile Internet. In addition, 3G population coverage in rural areas of low-income countries hovers at just over 50 percent.[41] Deployments in the developing world will help the Open RAN industry achieve scale. This will benefit the U.S. and its domestic Open RAN industry.

It is important to note that Open RAN is not the sole province of startups or mobile network operators—incumbent vendors have also incorporated aspects of open architectures into their integrated solutions and have openly supported the development of Open RAN in their own systems and are contributors to the O-RAN Alliance.[42]

While the Commission and Executive Branch agencies' focus is on U.S. economic competitiveness and leadership, the emergence of vibrant Open RAN ecosystems outside of the

[40] Morris, I., "Vodafone UK to swap big part of Huawei for open RAN," Light Reading (Nov. 2, 2020), https://www.lightreading.com/vodafone-uk-to-swap-big-part-of-huawei-for-open-ran/d/d-id/765104.
[41] "The State of Mobile Internet Connectivity 2020," GSMA (2020), https://www.gsma.com/r/wp-content/uploads/2020/09/GSMA-State-of-Mobile-Internet-Connectivity-Report-2020.pdf.
[42] "Membership," O-RAN ALLIANCE (2021), https://www.o-ran.org/membership.

United States (e.g., as targeted by the European MOU referenced in the NOI) may be mutually beneficial. This assumes that participants in foreign ecosystems are based in countries with respect for the rule of law, that these ecosystems are meaningfully open to participation by and engagement with American stakeholders, and that relevant "host" governments do not seek to leverage domestic ecosystems as part of a perceived zero-sum competition with the United States or other countries active in Open RAN. Under such circumstances, the emergence of strong, foreign-based ecosystems alongside U.S. ecosystems could facilitate cross-border partnership opportunities and greater innovation overall — reinforcing the importance of our global, interconnected, interoperable communications infrastructure — which the United States should welcome.

Ultimately, the Open RAN industry and ecosystem need to reach scale and industrialization (i.e., wide use of Open RAN and virtualized network architectures globally) to yield the best results, achieve price advantages, and spur innovation. What happens in the U.S. Open RAN market affects the international market for Open RAN, just as what happens abroad in the Open RAN market affects the U.S. market for Open RAN.

VI. CONCLUSION

The Executive Branch of the United States Government strongly supports increased vendor diversity for the 5G ecosystem and sees open, interoperable networks, including Open RAN, as a necessary component to achieve diversification. While Open RAN is an industry-led initiative, there are several ways that the Commission can support its development. This includes collaboration with the Executive Branch and industry on research and development focused on interoperability, performance, and security testing; and support for related industry-led standards development. In addition, international cooperation with allied and partner governments, as well

as industry, will be essential to create open, interoperable, and standards-based interfaces that are truly global.

The Executive Branch greatly appreciates the efforts of the Commission to gather information and input from a range of stakeholders as it weighs policy options. Along with other recommendations highlighted in this response, the Executive Branch encourages the Commission to evaluate ways in which it can enable operators to deploy Open RAN options as part of the Secure and Trusted Communications Networks Reimbursement Program, including by providing sufficient time for operators to test, plan and deploy. The Executive Branch welcomes this opportunity for robust interagency collaboration with the Commission, including through international outreach and research and development cooperation.

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