Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Promoting the Deployment of 5G	)	GN Docket No. 21-63
Open Radio Access Networks	)	
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COMMENTS OF
THE OPEN RAN POLICY COALITION

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The Open RAN Policy Coalition ("ORPC" or "Coalition")[1] is pleased to submit these comments in response to the Federal Communications Commission ("Commission") ("Commission") Notice of Inquiry ("NOI") *Promoting the Deployment of 5G Open Radio Access Networks*.[2] This proceeding provides a unique opportunity for policymakers and stakeholders to build and examine a detailed factual record to inform the Commission's and the broader U.S. government's policies to facilitate the ongoing transition to standardized open and interoperable interfaces in the Radio Access Network ("Open RAN").[3] The Coalition and its members believe the Commission has an extraordinary opportunity in this proceeding to promote competition and innovation in the market for secure and reliable networks.

[1] *See* https://www.openranpolicy.org/. As of this filing, the Coalition includes 60 members, including: Airspan, Altiostar, American Tower, Analog Devices, Arm, AT&T, AWS, Benetel, Bharti Airtel, Broadcom, Ciena, Cisco, Cohere Technologies, CommScope, Crown Castle, DeepSig, Dell Technologies, Deutsche Telekom, DISH Network, Facebook, Fujitsu, GigaTera Communications, Google, Hewlett Packard Enterprise, IBM, Inseego, Intel, JMA Wireless, Juniper Networks, Ligado Networks, Marvell, Mavenir, Microsoft, NEC Corporation, NewEdge Signal Solutions, Nokia, NTT, Nvidia, Oracle, Palo Alto Networks, Pivotal Commware, Qualcomm, Quanta Cloud Technology, Radisys, Rakuten Mobile, Reliance Jio, Rift, Robin, Samsung Electronics America, STL Tech, Telefónica, Texas Instruments, U.S. Cellular, US Ignite, Verizon, VMWare, Vodafone, World Wide Technology, XCOM-Labs, and Xilinx..

[2] *Promoting the Deployment of 5G Open Radio Access Networks*, Notice of Inquiry, FCC 21-63 (rel. Feb. 24, 2021) ("NOI").

[3] As used herein, the term "Open RAN" refers to networks that are compliant with O-RAN Alliance specifications. *See* https://www.o-ran.org/specifications.

INTRODUCTION

There is bipartisan consensus among national security and economic competitiveness leaders in Congress and among veterans of the Bush, Obama, and Trump Administrations that the transition to Open RAN is vital to core U.S. national interests, as well as to the interests of our partners.[4] Fortunately, as we discuss in these comments, the communications companies that serve markets in the United States and its partners have reached an inflection point in the development and deployment of Open RAN. In short, the commercial communications ecosystem is rapidly developing and deploying Open RAN, thereby advancing the national interests of the United States and its partners.

In these comments, we discuss the reasons why we believe that Open RAN will provide significant public interest benefits, namely in driving increased competition, innovation and network vendor diversity; providing technological improvements that benefit network management and innovation; potentially making equipment, services and products more affordable, including those in rural and low-income communities; and serving as a complement to parallel advances in 5G and network management, in enhancing network security. Additionally, we explain how stakeholders are addressing key challenges in transitioning networks to Open RAN.

Finally, we believe it is imperative at this inflection point in Open RAN deployment that the Commission and the U.S. government, working with the private sector as well as partners to

[4] *See* Letter from Senator Mark Warner (D-VA) et al., Senate Select Committee Chair, to President Joseph R. Biden (Apr. 6, 2021), https://www.warner.senate.gov/public/_cache/files/1/d/1df21e57-94af-461b-a42a-6cd783585fb1/E823553A6FAE8062B60F9EA6C25BB4D5.biden-ssci-6apr21.pdf; and letter from 22 bipartisan former Cabinet and senior sub-Cabinet national security officials, to President Joseph R. Biden (Apr. 21, 2021) (available at https://www.semiconductors.org/wp-content/uploads/2021/04/2021.04.13-National-Security-Letter.pdf).

help advance the Open RAN transition in several ways. In particular, to promote the development and deployment of Open RAN, the Commission should:

- Identify and Address Regulatory Barriers to Open RAN and Secure Next Generation Network Buildout;
- Work with Stakeholders to Promote a Robust Global Market that Includes Suppliers Based in the United States and Its Partners;
- Partner with Other Agencies in Leveraging Existing Efforts to Facilitate Use Cases and Blueprints for Open RAN; and
- Enable the Universal Service Fund "Rip-and-Replace" Proceeding to Provide Carriers Real-World Opportunities to Deploy Open RAN, Both in the Near-Term and Longer Term.

Below we discuss these proposals in detail. Again, we are grateful for the opportunity to contribute to this foundational record.

I. THE COMMERCIAL COMMUNICATIONS ECOSYTEM IS RAPIDLY DEVELOPING AND DEPLOYING OPEN RAN.

The communications companies that serve markets in the United States and its partners have reached an inflection point in the development and deployment of Open RAN. Since the ORPC was formed in the spring of 2020, creating a coalition with widespread and diverse membership, industry has made significant strides both in developing standards and specifications for Open RAN through the O-RAN Alliance and in real world testing and deployment across the globe.[5] The last two years have seen major milestones in realizing Open RAN for communications networks in the United States and worldwide, with advances accelerating by the month.[6] These milestones are made possible by ongoing investments across

[5] Building on foundational standards for 5G in 3GPP, the O-RAN Alliance is the primary organization developing specifications to enable interoperability between newly disaggregated components of the radio access network. *See* O-RAN Alliance, "About O-RAN Alliance," (last visited Apr. 28, 2021), https://www.o-ran.org/about.

[6] *See* Open RAN Policy Coalition, "Compilation of Recent Open RAN Announcements and Demonstrations," (last updated Apr. 21), https://www.openranpolicy.org/wp-content/uploads/2021/04/ORPC-Compilation-of-Announcements-and-Demos-4.21.21.pdf.

industry to disaggregate components of the RAN, standardize their interfaces, and demonstrate the viability of multi-vendor architectures for various use cases.

As transformational as this transition to open network interfaces will be, Open RAN itself is not a new concept, but rather a continuation of the evolution to standardized open and interoperable interfaces already underway at the network core. Carriers and their vendors have longstanding experience in standardizing aspects of communications networks and migrating technology toward interoperability. Indeed, the O-RAN Alliance specifications themselves build on years of work by technical experts in 3GPP and other settings to further define the RAN in service of next generation networks. The importance of this inflection point derives from the significant impact this move toward interoperability and virtualization in telecommunications in general and the RAN in particular will have at a time when competition between diverse and innovative free market actors captures the core national security and economic competitiveness interests of the United States and partner countries.

The Commission has an important role to play in this moment, beginning with establishing a foundational factual record on which to base future Commission activities to promote Open RAN, and also to inform broader U.S. and international policies. To support the development of this record on Open RAN, below we:

- Explain technical considerations for Open RAN development, including key considerations being addressed by the O-RAN Alliance;
- Categorize vendor Open RAN offerings, including those that are currently available and those that are expected to be released within the next 12-24 months; and
- List several key milestones that reflect the rapid progress underway and anticipated progress in the near future.

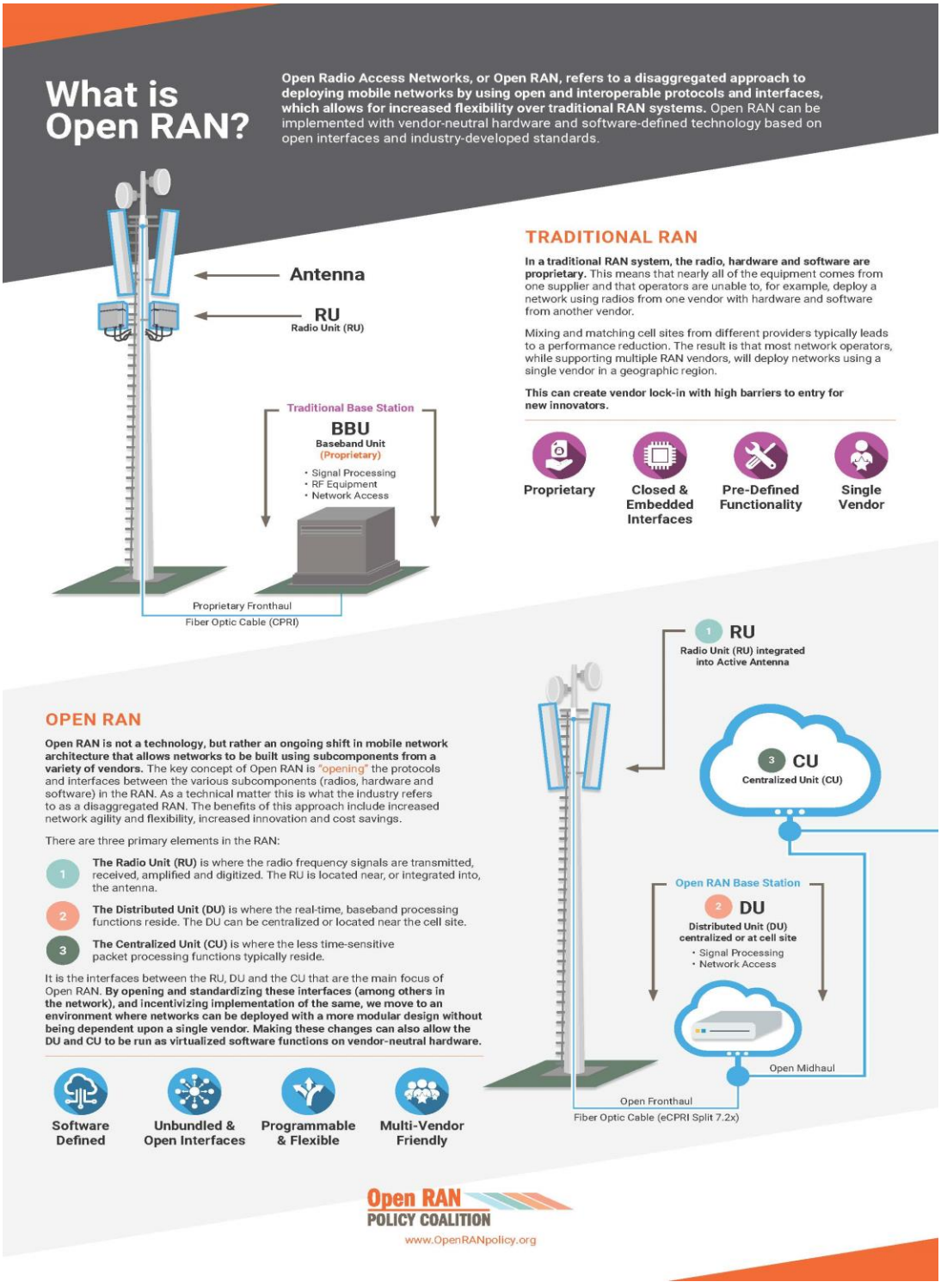
A. Technical Considerations

Communications service providers and telecommunications carriers are working to advance two congruent, complementary evolutions in the RAN: (1) Open RAN, and (2) Virtualized RAN ("vRAN"). As shown in Figure 1 below, Open RAN refers to a disaggregated approach to deploying mobile networks by using open and interoperable protocols and interfaces between the different parts of the RAN, which allows for increased flexibility over traditional RAN systems – in other words, splitting the baseband functionality from the radio functionality with an open and interoperable interface between the two parts.[7] This "functional split" allows for modularity among RAN components so that network owners and operators can incorporate components of the radio base station from a variety of vendors, with the potential to change and evolve pieces of the network more nimbly over time. Many vendors are also exploring ways to provide vRAN, wherein software can be disaggregated from the hardware components of the RAN and baseband units can be deployed on a consistent cloud platform. This "cloudification" enables network owners and operators to automate deployment at scale and optimize the location of workloads.[8] By moving "compute" power and functions from the cell tower to distributed hubs, operators can lower the cost of geographically distant and/or rural deployments, enhance network management, leverage automation to improve spectral efficiency, increase the availability of services and applications, and more. We elaborate on the impact of virtualization in Section III.C. below.

[7] *See* Open RAN Policy Coalition, "What is Open RAN?", (last visited Apr. 28, 2021) https://www.openranpolicy.org/wp-content/uploads/2020/11/Open-RAN-Infographic-FINAL.pdf.

[8] *See* Timo Jokiaho, "Open RAN and O-RAN in Brief," Red Hat Blog (Mar. 24, 2021), https://www.redhat.com/en/blog/open-ran-and-o-ran-brief.

Figure 1. Open RAN Infographic



Originally defined by 3GPP to facilitate Ultra Reliable Low Latency Communication and Enhanced Mobile Broadband requirements, specifications in 3GPP Release 15 divided the

traditional unitary baseband unit into three distinct components: Radio Unit ("RU"), Central Unit ("CU"), and Distributed Unit ("DU").[9] 3GPP has not taken the further step of establishing standardized interoperable interfaces between these three components, but since X-RAN/O-RAN Alliance was founded in February 2018,[10] its members have been working to develop standard specifications for the interfaces between those components, specifically between:

- Orchestrator and RAN components – A1 interface;
- RAN Intelligent Controller ("RIC") and CU/DU – E2 Interface;
- CU-control plane ("CP") and CU-user plane ("UP") – E1 Interface;
- CU-DU – F1 Interface;
- DU-RU – Open FrontHaul; and
- Orchestrator and Cloud Platform ("O-Cloud") – O2 Interface.[11]

Building on this work, last month, the O-RAN Alliance published a Minimum Viable Plan ("MVP") that compiles a collection of completed specifications between those component interfaces into an initial set of O-RAN compliant solutions for deploying Open RAN in commercial networks.[12] This first release of the MVP categorizes published specifications into: open fronthaul, open transport, open hardware, open stack, open cloud, and open testing and integration centers. The O-RAN Alliance notes that "[s]ubsequent O-RAN releases will extend

[9] *See* Figure 1 describing the disaggregation of the BBU and associated characteristics.

[10] *See* XRAN Forum, "XRAN Forum Merges with C-RAN Alliance to Form ORAN Alliance," (Feb. 27, 2018), https://static1.squarespace.com/static/5ad774cce74940d7115044b0/t/5b8f55944ae237d9c09c46a0/1536120213353/xRAN+Press+Release+MWC2018+180227.pdf.

[11] *See* Timo Jokiaho, "Open RAN and O-RAN in Brief," (Mar. 24, 2021), https://www.redhat.com/en/blog/open-ran-and-o-ran-brief; *see also* O-RAN Alliance, "O-RAN Architecture Overview," (last visited Apr. 27, 2021) https://docs.o-ran-sc.org/en/latest/architecture/architecture.html.

[12] O-RAN Alliance, "O-RAN ALLIANCE Introduces Minimum Viable Plan Towards Commercial O-RAN Solutions and 28 New O-RAN Specifications Released Since November 2020," (Mar. 16, 2021), https://www.o-ran.org/blog/2021/3/10/o-ran-alliance-introduces-minimum-viable-plan-towards-commercial-o-ran-solutions-and-28-new-o-ran-specifications-released-since-november-2020.

the MVP with additional features and functionalities based on continuing surveys and updates of the operators' deployment priorities."[13]

In addition to new products from vendors and optionality for carriers, Open RAN architectures will create opportunities for system integrators to provide value in navigating more diverse supply chains. Though a transition to Open RAN may require some shift in network management, particularly where a carrier wishes to build (or has already built) a more complex architecture, the telecommunications industry has a long history of standardizing interfaces to facilitate interoperability between products developed by different vendors. These types of shifts between in-house operations and third-party management are common business decisions that accompany technological advancement in numerous settings. We elaborate further on this notion in Section III.A. below.

B. Publicly Announced Present or Forthcoming Open RAN Offerings

As the O-RAN Alliance continues publication of these standards and specifications, dozens of companies worldwide – including multiple ORPC member vendors, all based in the United States or partner countries[14] – are rolling out innovative O-RAN Alliance specifications compliant offerings with increasing frequency. As a non-exhaustive representative list of examples, below we provide categories of these various offerings that several ORPC members have *publicly announced* as either presently available on the market or coming to market within the next 12-to-24 months:

- Remote Radio Unit ("RRU") Hardware[15]

[13] *Id.*

[14] *See* Section IV.B. *infra*, urging the Commission to work with stakeholders to promote a robust global market that includes suppliers based in the United States and its partners.

[15] *See, e.g.*, RRU hardware offerings from Airspan (based in the United States), https://www.airspan.com/news/gogo-and-airspan-partner-for-5g-air-to-ground-network-development/; Altiostar (United States), https://www.altiostar.com/solutions/ and https://www.altiostar.com/products/; Analog Devices (United States), https://www.analog.com/en/applications/technology/sdr-radioverse-pavilion-home/o-ru-radio-

- Central Unit ("CU") Hardware[16]
- Distributed ("DU") Hardware[17]
- CU Software[18]
- DU Software[19]

platform.html; Benetel (Ireland), https://the-mobile-network.com/2021/01/benetel-unites-with-radisys-for-open-ran-ru/; Hewlett Packard Enterprise (United States), https://www.hpe.com/us/en/newsroom/press-release/2021/02/hewlett-packard-enterprise-paves-way-for-mass-deployment-of-open-ran-in-5g-networks-with-industry-first-open-ran-solution-stack.html; Mavenir (United States), https://mavenir.com/solutions/; NEC (Japan), https://www.nec.com/en/global/solutions/5g/O-RAN_Compliant_5G_Radio_Unit.html; NewEdge Signal Solutions (United States), https://www.newedges2.com/news-media/press-releases/detail/11/newedge-signal-solutions-to-deliver-openran-radios-to-the; Qualcomm (United States), https://www.qualcomm.com/news/releases/2020/10/20/qualcomm-introduces-new-5g-infrastructure-platforms-drive-cellular; Radisys (United States), https://hub.radisys.com/inthenews/qualcomm-teams-with-radisys-to-hasten-5g-deployment-process; STL (India), https://www.stl.tech/virtualised-access-products/virtualized-ran/; Xilinx (United States), https://www.xilinx.com/news/press/2021/mavenir-and-xilinx-collaborate-to-bring-to-market-open-ran-massive-mimo-portfolio.html.

[16] *See, e.g.*, CU hardware offerings from Airspan (United States), https://www.airspan.com/news/airspan-and-siticom-gmbh-partner-to-deliver-5g-stand-alone-industry-4-0-private-networks-in-germany/; Hewlett Packard Enterprise (United States), https://www.hpe.com/us/en/newsroom/press-release/2021/02/hewlett-packard-enterprise-paves-way-for-mass-deployment-of-open-ran-in-5g-networks-with-industry-first-open-ran-solution-stack.html; Mavenir (United States), https://mavenir.com/solutions/; QCT (Taiwan), https://www.qct.io/product/index/Server/rackmount-server/2U-Rackmount-Server/QuantaGrid-D52Y-2U; Radisys (United States), https://the-mobile-network.com/2021/01/benetel-unites-with-radisys-for-open-ran-ru/; Xilinx (United States), https://www.xilinx.com/video/application/5g-cu-acceleration.html.

[17] *See, e.g.*, DU hardware offerings from Airspan (United States), https://www.airspan.com/news/airspan-to-partner-with-rakuten-mobile-to-deliver-air5g-openrange28-mmwave-platform/; Altiostar (United States) https://www.altiostar.com/solutions/ and https://www.altiostar.com/products/; Hewlett Packard Enterprise (United States), https://www.hpe.com/us/en/newsroom/press-release/2021/02/hewlett-packard-enterprise-paves-way-for-mass-deployment-of-open-ran-in-5g-networks-with-industry-first-open-ran-solution-stack.html; Mavenir (United States), https://mavenir.com/solutions/; QCT (Taiwan), https://www.qct.io/product/index/Server/rackmount-server/1U-Rackmount-Server/QuantaGrid-SD2H-1U; Radisys (United States), https://the-mobile-network.com/2021/01/benetel-unites-with-radisys-for-open-ran-ru/; XCOM (United States), https://www.xcom-labs.com/ (details of announcement forthcoming); Xilinx (United States), https://www.xilinx.com/applications/wired-wireless/telco.html.

[18] *See, e.g.*, CU software offerings from Altiostar (United States) https://www.altiostar.com/solutions/ and https://www.altiostar.com/products/; Mavenir (United States), https://mavenir.com/solutions/; Radisys (United States), https://www.prnewswire.com/news-releases/benetel-integrates-its-radio-unit-with-radisys-5g-ran-software-to-enable-openran-deployments-301200880.html.

[19] *See, e.g.*, DU software offerings from Altiostar (United States), https://www.altiostar.com/solutions/ and https://www.altiostar.com/products/; Mavenir (United States), https://mavenir.com/solutions/; Radisys (United States), https://plugfestvirtualshowcase.o-ran.org/europescenario05.html; XCOM-Labs (United States) https://www.xcom-labs.com; Xilinx (United States), https://www.xilinx.com/publications/presentations/xilinx-5g-telco-accelerator-cards.pdf.

- System Integration/Services[20]
- Telco Cloud Software[21]
- Core Network Elements[22]
- End-to-End Open RAN Solutions[23]

By the time of this filing, there will be new announcements that are not captured in the above examples. The ORPC is therefore continuously tracking public announcements of its members' offerings, and as this proceeding continues, we will provide the Commission further details about these offerings to help build the detailed factual record that the Commission and the U.S. government and its partners need to develop for forward-looking policymaking.

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[20] *See*, *e.g.*, system integration/services offerings from Altiostar (United States), https://www.altiostar.com/solutions/ and https://www.altiostar.com/products/; Hewlett Packard Enterprise (United States), https://www.hpe.com/us/en/newsroom/press-release/2021/02/hewlett-packard-enterprise-paves-way-for-mass-deployment-of-open-ran-in-5g-networks-with-industry-first-open-ran-solution-stack.html; Mavenir (United States), https://mavenir.com/solutions/; NEC (Japan), https://www.nec.com/en/global/solutions/5g/Open_vRAN.html#anc-OurSIcapabilityasEcosystemenabler; QCT (Taiwan), https://www.qct.io/Press-Releases/index/PR/Corporation/QCT-Joins-Hands-with-IBM-for-Global-Strategic-Alliance/4/0; Robin.io (United States), https://robin.io/platform, Radisys (United States), https://www.radisys.com/press-releases/radisys-becomes-commercial-systems-integrator-onos-cord-project; XCOM (United States), https://www.xcom-labs.com/ (details of announcement forthcoming).

[21] *See*, *e.g.*, telco cloud software offerings from Cohere Technologies (United States), https://www.cohere-technologies.com/general/press-releases/spectrum-multiplier/; DeepSig (United States), https://www.deepsig.ai/omnisig-sdk; Hewlett Packard Enterprise (United States), https://www.hpe.com/us/en/solutions/communications-industry-transformation.html; QCT (Taiwan), https://go.qct.io/telco/; STL (India), https://www.stl.tech/virtualised-access-products/; Mavenir (United States), https://mavenir.com/solutions/; NEC (Japan), https://www.nec.com/en/global/solutions/5g/Telco_cloud.html; Robin.io (United States), https://robin.io/platform/.

[22] *See*, *e.g.*, core network offerings from Mavenir (United States), https://mavenir.com/solutions/; Hewlett Packard Enterprise (United States), https://www.hpe.com/us/en/newsroom/press-release/2020/03/hpe-speeds-up-5g-adoption-with-cloud-native-5g-core-software-stack-available-as-a-service.html; NEC (Japan), https://www.nec.com/en/press/202011/global_20201104_04.html; QCT (Taiwan), https://go.qct.io/telco/; Xilinx (United States), https://www.xilinx.com/products/technology.html.

[23] *See*, *e.g.*, end-to-end Open RAN solutions from Airspan (United States), https://www.airspan.com/news/rakuten-mobile-and-airspan-networks-sign-mou-to-bring-openrange-vran-solution-to-rakuten-communications-platform-global-customers/; Altiostar (United States) https://www.altiostar.com/solutions/ and https://www.altiostar.com/products/; Hewlett Packard Enterprise (United States), https://www.hpe.com/us/en/newsroom/press-release/2021/02/hewlett-packard-enterprise-paves-way-for-mass-deployment-of-open-ran-in-5g-networks-with-industry-first-open-ran-solution-stack.html; Mavenir (United States), https://mavenir.com/solutions/; QCT (Taiwan), https://go.qct.io/telco/; Robin.io (United States), https://robin.io/5g/ran-service/.

C. Key Milestones and Prospective Targets

Although interoperability and virtualization in the RAN have been key areas of focus for technologists for some time, industry has demonstrated significant, rapid progress in bringing these features to bear in domestic and international commercial networks over the last few years. Even those skeptical about the near-term deployment of Open RAN at scale recognize that it is presently a significant player in important scenarios.[24]

Every week, members of the Open RAN community are announcing new efforts and additional progress toward advancing Open RAN deployment. Notable highlights from major Open RAN deployment efforts announced by network operators in the United States include:

- In 2020, DISH entered the retail wireless business through its acquisition of the Boost Mobile and Ting Mobile brands and customer assets, and is presently building the United States' first cloud-native, Open RAN-based 5G broadband network, beginning with service in Las Vegas later this year.[25] Among other developments, DISH has entered into multi-year agreements with over 20 partners providing Open RAN-based solutions, including Mavenir, Altiostar, Amazon, VMWare, Nokia, Fujitsu, MTI, Intel, Qualcomm, Tucows, and Palo Alto Networks. In December 2020, DISH reached a significant milestone by completing its first fully Open RAN-compliant network communication, validating end-to-end 5G connections using the industry's first Open RAN compliant FCC radio, developed by MTI, with software partner Mavenir and core vendor Nokia.

- In March 2021, Verizon announced that it will begin deploying O-RAN compliant equipment this year, supplied by Ericsson, Samsung, and Nokia.[26] Verizon anticipates that the bulk of its equipment supply will comply with Open RAN specifications by next year.[27] Verizon also contributes as an active O-RAN Alliance Board member and Working Group cochair to advance the open interface model with a wide range of

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[24] *See* Strand Consult, "Open RAN: The Future, not the Present" (Mar. 9, 2021), https://strandconsult.dk/blog/open-ran-the-future-not-the-present/.

[25] DISH, *DISH and AWS Form Strategic Collaboration to Reinvent 5G Connectivity and Innovation* (Apr. 21, 2021), https://dish.gcs-web.com/news-releases/news-release-details/dish-and-aws-form-strategic-collaboration-reinvent-5g.

[26] Mike Dano, "Verizon to start deploying open RAN gear this year" (Mar. 11, 2021), https://www.lightreading.com/open-ran/verizon-to-start-deploying-open-ran-gear-this-year/d/d-id/768021#:~:text=Koeppe%20added%20that%20Verizon%20will,hardware%20vendors%20into%20its%20network.

[27] *Id.*

ecosystem stakeholders, while, in parallel, partnering with key suppliers to successfully conduct vRAN trials as a move to hardware-agnostic solutions.

- AT&T is a founding member and chair of both the O-RAN Alliance and ORPC, and it has conducted numerous demonstrations and trials, including collaboration with CommScope on Vendor Agnostic Operations, Administration and Maintenance Architecture and O1 Interface Specification; with Nokia on Open Source Near-Real-Time RAN Intelligent Controller running at the network edge on an Akraino-Based Open Cloud Platform; with Ciena, Radisys, Wind River, and DISH on 5G Edge orchestration and optimization, with Commscope and Intel on mmWave 5G gNB and 7.2x Open Fronthaul; with Samsung to create a successful data session using the enhanced Common Public Radio Interface; and more.[28]

These operators' activities in the United States complement numerous other domestic and international advances that include organizations based in the United States and in partner countries, including the below non-exhaustive list of highlights:

- In April 2020, Rakuten Mobile launched its fully virtualized mobile network in Japan using Altiostar's cloud-based RAN, developed in collaboration with Intel, and an open ecosystem of vendors in both 4G and 5G.[29] Rakuten Mobile's network in Japan brought together many hardware and software providers for both a virtualized 4G and containerized 5G network, and an open ecosystem of vendors in both 4G and 5G, such as Altiostar, Intel, Qualcomm, NEC, Nokia, Cisco, Mavenir, Robin.io, and Airspan, among others. Additionally, Rakuten Mobile offers the Rakuten Communications Platform (RCP), the world's first cloud-native telco platform, to operators, enterprises and governments with the need for a 4G or 5G network. Based on Rakuten Mobile's next generation mobile network in Japan, it combines advanced virtualization and automation technology, including containers and microservices. Rakuten Mobile has announced Memorandums of Understanding to explore various opportunities for RCP and Open RAN with companies including Telefónica, STC, Ligado Networks, and Etisalat.[30]

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[28] O-RAN Alliance, "O-RAN Alliance Continues to Grow as Global Operators and Suppliers Reach Across Borders to Collaborate on Open Innovation in Radio Access Networks," (Feb. 20, 2020) at 2, https://static1.squarespace.com/static/5ad774cce74940d7115044b0/t/5e4ed59178b98159a8b1f881/1582224786007/2020-02-20_O-RAN+progress+PR_v1.0.pdf; Sanjay Kodali, "Samsung and AT&T Achieve Open RAN Milestone," (last visited Apr. 15, 2021), https://www.samsung.com/global/business/networks/insights/blog/samsung-and-at-t-achieve-open-ran-milestone/.

[29] Altiostar, "Rakuten Mobile and Altiostar to Launch World's First Cloud-Native, Container-Based 5G Radio Access Network Solution," (Feb. 27, 2020), https://www.altiostar.com/5g_cloud_native/.

[30] *See* Press Releases, Rakuten Mobile, "Rakuten Mobile and Telefónica sign MoU to Cooperate on Open RAN," (Sep. 16, 2020), https://corp.mobile.rakuten.co.jp/english/news/press/2020/0916_01/; "STC and Rakuten Mobile Sign a Memorandum of Understanding," (Oct. 12, 2020), https://corp.mobile.rakuten.co.jp/english/news/press/2020/1012_01/); "Rakuten Mobile and Ligado Networks sign Memorandum of Understanding to enter into commercial trials for 5G mobile private networks based on the Rakuten Communications Platform," (Feb. 12, 2021),

- Telefónica has established an Open RAN consortium of hardware and software companies aimed at the development and deployment of Open RAN in 4G and 5G, comprising the necessary design, development, integration, operation, and testing activities required to materialize Open RAN, with deployments in Spain, UK, Germany, and Brazil. In March 2021, Telefónica deployed an Open RAN proof-of-concept network covering 81,000 inhabitants in Argentina, partnering with IBM as a systems integrator, and incorporating technology elements from Altiostar, Red Hat, Quanta, Gigatera, and Kontron.[31]

- On April 29, 2020, Indian integrated telecommunications services provider, Bharti Airtel, announced that it had deployed Altiostar's open vRAN solution across multiple major cities in India.[32]

- NTT DOCOMO has already realized interoperability between base station equipment of Fujitsu, NEC, and Nokia with O-RAN Alliance-compliant fronthaul and X2 interfaces in their 5G commercial service.[33]

- Since February 26, 2018, when JMA Wireless announced its open vRAN and work with Telecom Italia, it has since has deployed multi-operator, open, virtualized RAN in multiple locations across multiple operators, in both outdoor dense city networks and large-scale venues such as stadiums, and within buildings for private wireless use, providing validation of implementation and scale of vRAN software in real-world use.[34]

- Intel is a pioneer in the development of an O-RAN compliant FlexRAN software reference architecture that has enabled leading Open RAN software vendors and many OEM hardware providers. Intel also works with various virtualization and cloud computing software providers to enable support for and integration with FlexRAN.

- Inseego is partnering with many in the Open RAN community to develop and deploy capabilities at the network edge that maximize the range and economic value of Open RAN deployment, including: deploying customer premise equipment ("CPE"), which are

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https://corp.mobile.rakuten.co.jp/english/news/press/2021/0212_01/; "Etisalat and Rakuten Mobile Sign a Memorandum of Understanding" (Mar. 22, 2021), https://corp.mobile.rakuten.co.jp/english/news/press/2021/0322_01/.

[31] Ray Le Maistre, "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/.

[32] Altiostar, "Bharti Airtel deploys Open vRAN with Altiostar" (Apr. 29, 2020), https://www.altiostar.com/bharti-airtel-deploys-open-vran-with-altiostar/.

[33] NTT DOCOMO, "DOCOMO to Commence Deployment of World's First 4G/5G Multi-vendor Radio Access Network Conforming to O-RAN Specifications" (Sep. 18, 2019), https://www.nttdocomo.co.jp/english/info/media_center/pr/2019/0918_00.html.

[34] "Collaborative work between TIM and JMA Wireless for future 5G RAN mobility innovation" (Feb. 26, 2018), https://info.jmawireless.com/collaborative-work-between-tim-and-jma-wireless-for-future-5g-ran-mobility-innovation; "JMA Wireless Launches XRAN Fully Virtualized Adaptive Baseband Software to Radically Change the Game for In-Venue Wireless" (Feb. 26, 2018), https://info.jmawireless.com/jma-wireless-launches-xran-fully-virtualized-adaptive-baseband-software-to-radically-change-the-game-for-in-venue-wireless.

interoperable and RAN vendor agnostic, to extend the reach of individual cell towers; Integrated Access Backhaul ("IAB") and similar concepts that enable mesh architectures in urban environments for mmWave 5G services and extend the reach of mmWave;[35] and, the city-sized commercial 5G test bed of Lake Nona, Florida, to develop and deploy network slicing capabilities that allow the Open RAN operator and the CPE provider to enhance security and optimize network efficiency.

- Radisys is helping to accelerate the Open RAN ecosystem by working closely with various ecosystem partners for both mmWave and sub-6 GHZ solutions. Radisys RAN software is powering numerous NEPs trials/deployments with Open RAN architecture across the globe.[36]

- VMware, Inc. and Deutsche Telekom announced the companies are collaborating on an open and intelligent vRAN platform running on Intel servers, based on O-RAN Alliance specifications, to bring agility to RANs for both existing LTE and future 5G networks.[37]

- Altiostar, STC, and STC Solutions announced that STC became the first operator in Middle East and North Africa to run live O-RAN sessions.[38]

- Working with NEC and Altiostar, VodafoneZiggo started trials for Open RAN in the Netherlands.[39]

- AWS, Cisco, and JMA were part of a collaborative team to deliver CBRS-enabled private 5G wireless network for DoD supporting Open RAN.[40]

- VMware, Inc. announced the release of its Telco Cloud Platform RAN, which helps providers virtualize RAN functions on a platform specifically optimized for the RAN and with support for Intel FlexRAN software reference architecture. This same platform can also be used for Open RAN, giving providers the flexibility to evolve to the future – from

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[35] *See* Inseego, "Seize the 5G FWA Opportunity with Inseego" (Apr. 4, 2021) at 8, https://protect-us.mimecast.com/s/8t7RCyPAzGc6Dn83UZ5prK.

[36] *See e.g.* Radisys, "Radisys Contributes Seed Code to the O-RAN Alliance's 5G NR Stack Reference Architecture," (Jul. 2, 2019), https://www.radisys.com/press-releases/radisys-contributes-seed-code-o-ran-alliance-s-5g-nr-stack-reference-architecture.

[37] *See* VMWare, "VMWare and Deutsche Telekom Unveil Collaboration on Cloud-Based Open and Intelligent Virtual RAN Platform," https://www.vmware.com/company/news/releases/vmw-newsfeed.VMware-and-Deutsche-Telekom-Unveil-Collaboration-on-Cloud-Based-Open-and-Intelligent-Virtual-RAN-Platform.f98eda01-4ba4-41ad-bd82-9744b6bf324a.html.

[38] Altiostar, STC Tests First Live Open RAN Network in MENA, https://www.altiostar.com/stc-tests-first-open-ran-on-live-network-in-mena/.

[39] VodafoneZiggo and NEC start trialing Open RAN technology (Oct. 19, 2020), https://www.nec.com/en/press/202010/global_20201019_04.html.

[40] *See* Press Release, Federated Wireless, "Federated Wireless Spearheads Department of Defense 5G Private Wireless Deployment for Industrial IoT Automation," (Feb. 17, 2021), https://www.federatedwireless.com/federated-wireless-spearheads-department-of-defense-5g-private-wireless-deployment-for-industrial-iot-automation/.

traditional RAN to virtualized RAN (vRAN) to Open RAN – without having to disrupt their operations or overhaul their network design.[41]

- Vodafone announced in 2020 that will deploy the open interface, disaggregated RAN technology at a minimum of 2,600 sites in the UK by 2026, and in April 2021 announced the creation of an R&D center in the UK to support the design and development of future open networks. In parallel, Vodafone has been working in different technology integration trials across the world, testing solutions from different providers of Open RAN ecosystem.

Beyond the highlights listed above, many more real-world deployments, trials, demonstration projects, and specifications and standards development activities are underway, rolling out into 2021 and beyond. Building on the foundational specifications emerging from the O-RAN Alliance, groups like the Telecom Infra Project ("TIP") are working to accelerate innovation and commercialization in open and interoperable RAN.[42] Vodafone is currently chair of TIP and actively participates in multiple groups, helping to improve the ecosystem and collaborating with the experience obtained through different trials of Open RAN ongoing in Turkey, DRC, Ireland, Greece and UK, deployed together with vendors like Parallel Wireless, Mavenir or JMA.

Moreover, as part of the rigorous activities industry leaders undertake when executing a technology evolution of this kind, vendors are investing in and leveraging "Open Testing and Integration Centers," which provide collaborative, open, and impartial working environments to:

- Support wide adoption of O-RAN specifications and promote the openness of O-RAN ecosystem via demos, community events (e.g. speaker sessions, workshops, tutorials), lab and field trials, etc.;

- Demonstrate implementations and solutions based on O-RAN specifications via plugfests and proofs of concept (PoC);

[41] VMware Paves a Path for Radio Access Network Modernization, https://www.vmware.com/company/news/releases/vmw-newsfeed.VMware-Paves-a-Path-for-Radio-Access-Network-Modernization.8a78cc80-fa1c-42d0-a6b4-d8d986f0d94a.html.

[42] Telecom Infra Project, "OpenRAN," (last visited Apr. 15, 2021), https://telecominfraproject.com/openran/.

- Test and verify the conformity of RAN equipment to O-RAN interface specifications, based on O-RAN conformance test specifications;

- Test and verify the interoperability of RAN equipment from different vendors (or the same vendor) using O-RAN interface specifications, based on O-RAN interoperability test specifications;

- Foster and develop the technical capabilities of integrators via workshops, tutorials, etc.

- Conduct functional and performance (load, capacity) tests of end-to-end systems or sub-systems; and

- Provide feedback to O-RAN community about the experiences with O-RAN specifications acquired during the testing, enabling implementation-driven specification.[43]

As discussed in more detail below, these activities are being augmented by key government efforts in support of – but not mandating or otherwise predetermining – the success of technical efforts to open and standardize interfaces in the RAN. For example, ORPC and its members see promising prospects for the 5G Challenge under development by the Department of Defense and NTIA, as well as other efforts to further incentivize industry innovation and deployment. Momentum on substantive advances is driving significant progress in Open RAN and ORPC looks forward to ongoing work with the Commission to continue building that momentum in the years ahead.

II. OPEN RAN WILL PROVIDE SIGNIFICANT PUBLIC INTEREST BENEFITS.

As the Commission well appreciates, this NOI comes at the outset of a technological revolution, where personal and professional activities that could previously only be conducted on computers, are now managed on our cell phones. As we deploy 5G technology this will shift

[43] O-RAN Alliance, "Testing & Integration of O-RAN Solutions," (last visited Apr. 16, 2021), https://www.o-ran.org/testing-integration#:~:text=Open%20Testing%20and%20Integration%20Centre%20(OTIC)%20provides%20a%20collaborative%2C,physical%20space%20in%20order%20to%3A&text=Test%20and%20verify%20the%20conformity,O%2DRAN%20conformance%20test%20specifications.

even further by enabling enhanced mobile broadband, ultra-reliable low latency communications and the massive Internet of Things. Rapid implementation of 5G RAN technology will be an essential part of this revolution. The Open RAN Policy Coalition formed to bolster wireless leadership of the U.S. and its partners by promoting policies to advance the adoption of open and interoperable solutions in the RAN, and thereby foster innovation, spur competition and expand the supply chain for advanced wireless technologies including 5G. In addition to increasing competition, innovation, and network vendor diversity, Open RAN provides technological improvements that benefit network management and innovation; has the potential to make services and products more affordable which can create business cases for network expansion in rural areas; and as a complement to parallel advance in 5G and network management, Open RAN will enhance network security. We elaborate on these benefits below.

A. Open RAN Will Drive Increased Competition, Innovation and Network Vendor Diversity.

Open RAN will facilitate competition, innovation, and network diversity in three essential ways: (1) increased modularity in the network architecture enables more participation across a varied set of vendors, (2) this modularity also prevents vendor "lock-in" by enabling carriers to upgrade their networks more rapidly as innovative features become available for components over time, and (3) the ability to upgrade more quickly – especially when paired with the speed and agility of virtualization – can engender a virtuous cycle for innovation and adoption wherein architecture can be tailored more nimbly to function and network management can more effectively navigate evolving architectures.

Enabling more participation. The additional modularity in network design will help grow the market of suppliers and lower the barrier to entry for new participants. Because Open RAN constitutes a fundamentally open architecture, it opens the ecosystem to new suppliers,

increasing the diversity of RAN solutions. Network operators will have the option to choose from a variety of suppliers, creating the opportunity for network solution vendors to offer standardized solutions to many operators, instead of developing unique, one-off solutions for individual operators. The greater availability of such standardized equipment would in turn drive down the costs of network components, permit the entry of new market players and expand the existing market by increasing the number of competitors that network operators can turn to when they procure RAN elements. Network operators would also be afforded more flexibility for configuring their networks in an open architecture design. Open RAN will allow operators to customize the RAN to provide new services and applications to specific users such as enterprise customers and do so more quickly than in a closed model where network operators must work with their existing vendors to develop and deliver the feature.

Preventing vendor lock-in. By standardizing or "opening" what are today largely vendor-specific protocols and interfaces that connect the various subcomponents in the RAN, networks can be deployed with a more modular design without being dependent on a single supplier. Developing, standardizing, and validating open interfaces allows reliable interoperability across different market players and provides network operators with greater options to mix equipment from different suppliers in the same RAN, and other layers of the network, and to utilize multivendor deployments. This ability to mix-and-match with different suppliers providing different components of the network, can increase competition by preventing "vendor lock" where proprietary or semi-proprietary implementations of RAN components inhibit competition among suppliers. Modularity allows network operators to use multiple vendors in their network without being locked into a single source because there is more interoperability. With interoperability, operators can move from one vendor to another slowly over time rather than

flash cutting from one vendor to the next. This modularity also allows an operator to use equipment from different vendors in parallel to avoid reliance on a single source.

Creating a virtuous innovation cycle to reduce cost. Acting Chairwoman Rosenworcel previously noted that the RAN is currently the most expensive and most restrictive part of the network.[44] According to some estimates, the RAN accounts for 65-to-70 percent of the total cost of network ownership.[45] Increasing competition, innovation, and network vendor diversity can create a virtuous cycle to reduce costs of deploying and operating a network – and potentially speeding the ability to build out 5G networks in both urban and rural environments.

B. Open RAN Provides Technological Improvements that Benefit Network Management and Innovation.

In addition to these benefits, Open RAN also provides or otherwise leverages technological improvements. For example, Open RAN architectures often focus on leveraging the advantages of the parallel migration toward software-based networks and virtualization that allow for more functionality and increased use cases.[46] A software-based network moves the network functions to the software that exist on general purpose servers found in every cloud data center as opposed to traditional environments wherein network operators have deployed purpose-built physical equipment to support network functions. This type of programmable RAN infrastructure lowers costs and simplifies the roll-out of new features and functions at distributed RAN locations at the network's edge. Moreover, open interfaces enable these new network

[44] Remarks of Commissioner Jessica Rosenworcel at Mobile World Congress Americas Los Angeles, California (Oct. 22, 2019), https://docs.fcc.gov/public/attachments/DOC-360362A1.pdf.

[45] *See* O-RAN Alliance White Paper, *O-RAN: Towards an Open and Smart RAN*, at 6 (Oct. 2018), https://static1.squarespace.com/static/5ad774cce74940d7115044b0/t/5bc79b371905f4197055e8c6/1539808057078/O-RAN+WP+FInal+181017.pdf; Accenture Strategy, *OpenRAN: The Next Generation of Radio Access Networks*, at 4 (2019), https://www.accenture.com/_acnmedia/PDF-113/Accenture-Open-RAN-The-Next-Generation-Radio-Access-Network.pdf#zoom=50.

[46] *See* Section III.C. below.

features and functions to operate on any vendor's hardware without having to send out engineers and technicians as frequently to perform vendor-specific integration, as is common practice today. The management interfaces of RAN equipment standardized by the O-RAN Alliance enable consistent and automated operation of RAN in a vendor independent fashion. Thus, Open RAN will complement efforts to replace much of the time-consuming and manual work of maintaining, upgrading, and optimizing networks with light-touch, centrally managed, automated computing processes.

As another example of technical improvement provided by Open RAN, use of the RAN Intelligent Controller ("RIC") provides carriers advanced control functionality, delivers increased efficiency, and improves radio resource management. Specifically, the RIC helps commercial operators balance the RAN load and enable dynamic spectrum sharing among multiple radio access towers to alleviate network congestion and manage network resources more efficiently. The RIC also enables operators to leverage analytics from their network traffic and develop data-driven approaches including advanced ML/AI tools to improve resource management capabilities.[47]

More generally, as we move into the innovations of a 5G-powered world, exactly which innovations and capabilities will arise will only become clear with experience over time. Likewise, Open RAN provides foundational capabilities that network owners and operators will be able to leverage in myriad presently unforeseen ways as new needs emerge. As an example, in a previous technological advance, the boost of consumer speeds in 4G LTE led to broadband video services on mobile devices that were not widely predicted during the 4G standard-setting

[47] *See generally*, Eugina Jordan, *Open RAN 101–Role of RAN Intelligent Controller: Why, what, when, how? (Reader Forum)*, RCRWirelessNews, (Jul. 30, 2020), https://www.rcrwireless.com/20200730/opinion/readerforum/open-ran-101-role-of-ran-intelligent-controller-why-what-when-how-reader-forum.

process. Similarly, industrial and enterprise use of the new capabilities unlocked by 5G and Open RAN are promising, but it is unclear which specific use cases made possible by these new capabilities will prove most impactful in the drive to unlock a new wave of American innovation and competitiveness. This underscores the importance of the U.S. government investing in advanced wireless testbeds that will drive an understanding of the potential use cases and streamline the development and deployment of Open RAN, including future features and functionality.

C. Open RAN Has the Potential to Make Services and Products More Affordable, Including Those in Rural and Low-Income Communities.

Recognizing that individual companies commenting on this NOI may be able to provide more detailed, unique perspectives on cost considerations, Open RAN has the potential to drive down costs and expand network coverage in rural and cost-sensitive communities in two ways: (1) as discussed above, increased modularity and virtualization invites more competition into the market and can reduce costs for purchasing and operating RAN equipment; and (2) moving computing functionality away from the cell tower to concentrate DU/CU functionality and network management in the cloud at distributed hubs can lower the cost of that hardware at the edge, allowing network owners to buy and deploy more to expand network coverage. The physical equipment that traditional RAN systems require account for a significant portion of the network's cost,[48] whereas Open RAN system architecture allows network operators to "take advantage of existing computing and storage infrastructure offered by cloud providers, instead of incurring all such costs in-house."[49] The incorporation of cloud technology into the Open RAN

[48] *See* Kiran Rathee, "Telecom Equipment Space Presents Big Opportunity with Open RAN," Financial Express (Jan. 20, 2021) https://www.financialexpress.com/industry/telecom-equipment-space-presents-big-opportunity-with-open-ran-vaghela/2174279/.

[49] *See* "Leveraging O-RAN to Stimulate US Investment and Leadership in Wireless Technology," DISH at 6 (Mar. 2020) ("DISH").

architecture reduces network operating costs,[50] and interoperable subcomponents lower the "barrier to entry for small players to enter the [RAN] ecosystem" which allows for "cost-efficient solutions" and for "operators to unlock efficiencies."[51] Lowering the costs to operate the network can therefore help drive down the cost of 5G service to customers.[52]

D. As a Complement to Parallel Advances in 5G and Network Management, Open and Interoperable RAN Will Enhance Network Security.

As we detail in our paper *Open RAN Security in 5G*, published today, 5G networks will have improved security and subscriber privacy in comparison to previous generation networks.[53] Several innovations in a secure network design framework and wireless technology will intersect to create a highly secure and resilient 5G network. We will have more agile and layered security as we transition from centralized core and radio access networks to distributed, virtual networks. As we shift the compute functionality to distributed hubs, operators are implementing new and embedded security functionalities to ensure a highly secure mobile network.

Security Benefits of Open RAN. As a complement to these security capabilities, Open RAN has the potential to build upon the security enhancements already enabled by 5G and allow the operator to fully control the security of the network, ultimately enhancing the operational security of their network. One benefit is greater visibility to security events: A network operator will have direct access to more data about network performance because the components are disaggregated and connected through open interfaces. This will allow them to gain visibility of

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[50] *See e.g.* DISH at 6; *See also* Rathee, *Telecom Equipment Space Presents Big Opportunity for Open RAN* (stating that a recent study "project[ed] average savings for cloud network deployments to be 37% over five years").

[51] *See e.g.* DISH at 6.

[52] *See* Nimish Sawant, *Open RAN Technology to Play Major Role in India's 5G Ambitions*, Zenger (Feb. 11, 2021) (stating that Open RAN's architecture "should result in lower prices for 5G customers, as Open RAN cuts upfront capital and operational expenditures").

[53] *See* Open RAN Policy Coalition, *Open RAN Security in 5G*, https://www.openranpolicy.org/.

potential security problems earlier. Data also can be finer-grained and represent activities between/within network functions that were previously hidden by internal vendor interfaces. Further, data about the running state of network functions will be more easily available through open management interfaces. This data can be combined with security log data to drive root cause analysis.

Open RAN also allows operators to build upon the capabilities enabled by 5G to shift the security capabilities closer to the edge of the network and stop attacks closer to the source. The introduction of open interfaces in the RAN allows the operator to distribute security analytics throughout the network and move RAN monitoring to the edge. This creates opportunities to create edge-focused analytics that speed the detection and prevention of network attacks, threats, and vulnerabilities and drive closed-loop actions at the RAN which blocks malicious traffic from reaching the core network. Rapid detection and response can enable efficient and more secure support of mobility services, especially IoT services by more effectively preventing DDoS attacks on the RAN by rogue mobile devices. Distributed security analytics allows an operator to share insights between the RAN and core, as well as between different RAN locations. Such insights can be used to take measures to protect radio units adjacent to a unit under attack or to use insights about the core to protect potentially vulnerable RAN units.

Open RAN will also allow operators to integrate best-in-class security platforms with open interfaces defined to be secured using modern, industry-standard security protocols. Since security platform vendors typically provide native support for standard protocols and interfaces, the operator can integrate new security platforms without implementing custom adaptors for vendor-proprietary protocols and interfaces. Furthermore, network function vendors will deliver

regular protocol updates to stay current with the protocol releases, allowing operators to stay current with industry best practices at no extra cost.

Finally, Open RAN can speed the complete automation of network management. Automation enables zero-touch management which eliminates the security risks inherent in human access to network functions. Such risks include the threat of humans accidentally altering the security posture of a network function or maliciously harvesting credentials, changing configurations, or implanting malware within the network. Automation also increases closed-loop response to changes in the network. For example, by using an open management interface for checking the security posture of a network function, the operator can quickly detect and fix degraded configurations – or anomalous network activity within the perimeter of a network – through closed-loop management.

Open RAN supported by cloud-based services will also increase the speed with which operators can install software and operating system security patches, thus enabling the operator to minimize the amount of time a vulnerability is in the network. This advantage will be particularly important to small rural carriers, who may have more limited resources to dedicate to upgrading and patching network software. The recent "Hafnium" attack on Microsoft Exchange servers demonstrates that even well after patches have been developed, tested, and deployed by vendors the actual processing of patching vulnerable servers may take months or years. By contrast, cloud-based services can be centrally managed from a vulnerability patching standpoint—dramatically reducing the time to secure those servers once patches have been deployed.

911 and Emergency Communications Reliability. Beyond its inquiries about network security and reliability in general, the NOI also seeks comment on the potential impact of Open

RAN on public safety communications and specifically on 911 and wireless emergency alerting.[54] While in some cases the cloud capabilities and virtual functions that generally correspond with Open RAN can enhance the reliability of these crucial public safety communications functions, from a network architecture and management perspective, the unique needs of 911 do not relate to the RAN as a distinct aspect of the network. In other words, any considerations relating to the accommodation of 911 and emergency alerting with respect to next generation network architecture are being addressed more broadly in the context of 5G.[55]

Still, it is worth noting that the public safety community has long recognized the benefits of interoperability within telecommunications networks.[56] 911 networks across the country currently exist in a "hybrid" state, as over one third of the nation's 911 authorities have or are preparing to transition to NG911 capable or compliant IP-enabled systems.[57] With greater scalability and flexibility than current 911 systems, NG911 will allow public safety answering points to share information more quickly and with greater accuracy.[58] As CSRIC VII noted, "[i]nteroperability in a legacy E9-1-1 environment is limited by the technology that is used to support legacy E9-1-1 service."[59] However, these limitations do not pertain particularly or

[54] *See Promoting the Deployment of 5G Open Radio Access Networks*, Notice of Inquiry, FCC 21-31, para. 39, 50 (2021).

[55] *See* Open RAN Policy Coalition, 5G and Open RAN Security: Next Generation Trust, 1 (Jun. 25, 2020), available at https://www.openranpolicy.org/open-ran-policy-coalition-releases-papers-on-security-and-standards/.

[56] *See, e.g.*, 3GPP, *Delivering Public Safety Communications with LTE* (July 2013), https://www.3gpp.org/news-events/1455-public-safety (recognizing the benefits of interoperability for next generation public safety network during the transition to LTE); National Public Safety Telecommunicators Commission, *Best Practices for Public Safety Interoperable Communications Networks* at 3 (discussing the use of interoperable frequency and channels in public safety networks).

[57] Federal Communications Commission, *Report on the Current State of Interoperability in the Nation's 911 Systems*, CSRIC VII at 5 (2021), https://www.fcc.gov/file/18394/download.

[58] *Id.* at 8.

[59] *Id.* at 13.

specifically to the RAN, but instead stem from the specific infrastructure and technology used to support legacy E9-1-1 service.[60]

Additionally, all carriers must comply with Wireless E911 Location Accuracy Requirements regardless of the RAN that they deploy,[61] and Open RAN will not affect the service requirements for deploying z-axis location information technology.

III. STAKEHOLDERS ARE ADDRESSING KEY CHALLENGES IN TRANSITIONING NETWORKS TO OPEN RAN AND FINDING OPPORTUNITIES IN NEW FLEXIBILITY.

A. As in Previous Advances Toward Standardized and Interoperable Technology, Open RAN Will Facilitate Specialization and System Integration.

The NOI seeks comment on the role of system integrators and whether the flexibility created by disaggregation of the RAN would also make the deployment of Open RAN more complex, therein pose challenges to seamless interoperability and performance, make deployments more time-consuming, or increase network management costs for smaller operators.[62] In short, while there may be challenges, they are not different in kind from previous advances in interoperability. This shift is part of the broader shift in 5G – telco to data/IP, hardware to virtual, and closed to open in the core and RAN. Stakeholders recognize these challenges and are stepping up to meet them.

Technological advances, particularly regarding standardized interoperability, enable specialization that naturally leads to – and, over time, ultimately facilitates – system integration. This is a feature of open and interoperable interfaces, which ultimately reduces complexity and

[60] *Id.*

[61] Wireless E911 Location Accuracy Requirements, Sixth Report and Order and Order on Reconsideration, PS Docket No. 07-114, FCC 20-98 (rel. Jul. 17, 2020) (Sixth R&O) (requiring carriers to transmit vertical location information, or "z-axis location information," with wireless 911 calls).

[62] NOI at paras. 47-48.

cost, and promotes flexibility. While carriers, like all operators of complex enterprises, have a natural preference for a single point of contact when managing their networks, system integration has long been a part of network deployment and management. There may be some system integration challenges that are specific to the transition to Open RAN, but the general challenge of system integration is not a new one for carriers. In many of our members' experiences, system integration options for Open RAN are not more complex as compared to deployment of proprietary RAN. While some aspects of system integration may be different in some ways than in a proprietary RAN setting, these differences do not constitute greater complexity or cost. Additionally, as described above, the expected benefits in other areas should provide balance to additional complexity that may come from new system integration.

B. Open Source Software Does Not Present Challenges Unique to Open RAN.

The NOI asks about network vulnerabilities that may be introduced via open source software. In short, all aspects of software security assurance are important for network security, including the security of open source software.[63] However, open source software does not present challenges that are unique to Open RAN. In all networks, understanding what is in the software code, where it came from, what it does, and how it will be maintained and secured is required for any type of software – open source or proprietary. Moreover, all hardware runs using code, and all code can have vulnerabilities that need to be managed. Software security is key to network security, whether the software is open source or proprietary.

[63] *See* Communications Security, Reliability, and Interoperability Council VII, "Report on Risks to 5G from Legacy Vulnerabilities and Best Practices for Mitigation," at 41-44 (Jun. 10, 2020), https://www.fcc.gov/file/18918/download.

More broadly, as we described in our comments in the NTIA-DoD 5G Challenge NOI, it is crucial that policymakers note the distinction between (1) open and interoperable technologies such as Open RAN, and (2) open source software.

> "Open and interoperable technologies," including Open RAN among other components of the 5G network, refers to defined standards for open (i.e., transparent, not proprietary) interfaces between different components of the 5G network that allow for modularity to facilitate interoperability among a diverse community of suppliers. Generally, Open RAN is based on standards and specifications developed through the O-RAN Alliance and 3GPP, among others. In contrast, "open source" refers to an open (i.e., public, not private) effort to design a framework or utility software whose source code can be used freely by organizations to build a final product with or without modifications.[64]

Software security assurance in general and open source software security in particular are indeed important policy and security imperatives, and the Coalition urges the Commission to note that open source software does not present concerns that are specific to Open RAN.

C. Virtualized Operating Environments Enable Efficient Network Management and Enhance Network Security and Reliability.

Virtualized operating environments provide an array of features for network managers that help reduce costs, improve network performance, and simplify infrastructure expansion, while providing the necessary features to maintain high quality experiences for customers.[65] As noted above, moving software and computing functions away from the cell tower to aggregate functionality at distributed locations facilitates network management at scale. This scale can help expand networks to reach more customers in remote rural areas or to densify parts of the network in high demand to provide better customer experience in heavily populated urban environments.

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[64] *See* Comments of Open RAN Policy Coalition, Docket No. 210105-0001, RIN: 0660-XC04, at 2-3 (filed Feb. 10, 2021) https://www.openranpolicy.org/wp-content/uploads/2021/02/ORPC-5G-Challenge-NOI-Letter-final-for-submission-2.10.21-c3-c3.pdf (distinguishing "open source" from "open and interoperable technologies").

[65] Samsung, "Realizing the Benefits of Virtualized RAN," https://www.samsung.com/global/business/networks/insights/blog/realizing-the-benefits-of-virtualized-ran/.

A network's ability to operate effectively at scale will only become more important with the ever-increasing connectivity demands and more functions relying on network infrastructure.

Moreover, lowering the barrier to entry for diverse vendors means cloud service providers that previously have not engaged in supplying communications network infrastructure can now contribute their services to the networking environment. This diversity of suppliers and increase in software defined functionality can also increase the amount and variety of applications and services available to network owners and operators as software environments allow developers to drive app ecosystems.

In addition, virtualization also enables more automation and serves as a predicate for machine learning and artificial intelligence applications that can improve efficiency across the network, including with respect to spectrum management. RAN virtualization can also provide the ability to aggregate, analyze, and adjust a network's spectrum use in real time and more effectively negotiate that use with others sharing the band. These capabilities have important implications for security as well, enabling operators to leverage cloud security solutions to proactively detect, isolate, and manage threats.

D. Interoperability Standards, Use Case Demonstrations, and Real-World Deployments are Lowering Barriers to Open RAN Adoption By Established Operators.

As evidenced by the inflection point in Open RAN deployments and O-RAN compliant supplier contracts that are taking place in the United States and all over the world, newly-developed Open RAN standards such as the O-RAN Alliance's Minimum Viable Plan will themselves drive deployment of O-RAN compliant equipment. In the absence of interoperability standards, the RAN community was not focused on interoperability. With these standards, carriers now have the option to incorporate network components with open interfaces and the market is already shifting, including among large incumbent carriers such as Verizon and

Telefónica whose announcements of new steps to an Open RAN future have come in the weeks following the O-RAN Alliance's rollout of the MVP. As such, the primary barrier to Open RAN deployment is coming down.

Moreover, as noted above and discussed further below in Section IV, additional partnerships in testbeds and demonstration projects, as well as real-world deployments (including in the unique "Rip-and-Replace" proceeding) will be valuable in demonstrating how Open RAN integrations can work in particular scenarios that are presently believed to be difficult.

E. Network Architectures Integrating Open RAN Can Create Efficiencies that Lower Energy Consumption.

The disaggregation of the RAN will allow for greater adaptability, functionality, and energy efficiency. By opening interfaces and increasing flexibility, Open RAN enables rapid rollout of efficiency measures across the RAN supply chain. Understanding the impact on power usage in particular is critical for both cost savings and sustainability, as a major part of energy consumption in mobile networks stems from the RAN. We expect that data center efficiencies, cloud multiplexing gains, radio frequency efficiencies, and other innovations associated with Open RAN and related advances in network technology will enable improvements in energy efficiency to reduce electricity demands at the cell site.

IV. THE COMMISSION AND THE U.S. GOVERNMENT CAN HELP ADVANCE THE OPEN RAN TRANSITION IN SEVERAL WAYS.

As the above makes clear, Open RAN will play a critical role in promoting the U.S. economic and national security interests – as well as those of our partners – in the years to come. The Commission and other U.S. government agencies and international partners have an important role to play in ensuring Open RAN's deployment and success. To be clear, the Coalition does not support government mandates or preferences that would govern how carriers build their networks. Instead, we strongly support the industry leadership and carrier choice that

is presently proving to be an effective and efficient path to the Open RAN future. To that end, ORPC supports policies that promote and accelerate the ongoing migration to Open RAN. The Commission has four immediate opportunities to contribute to this effort: (1) identifying and addressing regulatory barriers; (2) working with stakeholders to promote trusted suppliers and a multilateral global market; (3) partnering with other agencies to facilitate Open RAN use cases and blueprints; and (4) enabling the USF "Rip-and-Replace" proceeding to provide carriers real-world opportunities to deploy Open RAN.

A. The Commission Should Identify and Address Regulatory Barriers to Open RAN and Secure Next Generation Network Buildout.

Perhaps the most important steps the Commission can take to ensure that the American public reaps the benefits of Open RAN are steps designed to advance the deployment of 5G networks more broadly. Put simply, the more broadly 5G deployments occur, the more opportunities there are for carriers to experiment with and implement Open RAN or intermediate steps toward Open RAN. Greater access to 5G-capable spectrum resources and new infrastructure (including both towers and small cells) will afford operators more flexibility to incorporate and transition more parts of the network to open interfaces at scale. Likewise, more broadband deployment even outside the 5G context, such as efforts to expand coverage in remote areas, will further facilitate the adoption of Open RAN.

Moving forward, we urge the Commission to continue its pursuit of policies that allow 5G and Open RAN to develop organically, based on the preferences of consumers and carriers rather than those of policymakers. The increased density of 5G networks is likely to result in a more complex network environment, with more entities involved in providing services at each layer of the network "stack." For the reasons detailed above, this will benefit consumers in multiple ways, promoting competition and innovation alike. However, neither the Commission

nor any other policymaker can foretell exactly how innovators will or should design these architectures to best achieve those benefits. By eschewing regulatory mandates regarding Open RAN's development, the Commission can help ensure that the numerous participants in the 5G ecosystem work together to innovate and deploy services that are focused on meeting network needs. This is the way to ensure U.S. leadership in 5G and Open RAN alike.

B. The Commission Should Work with Stakeholders to Promote a Robust Global Market that Includes Suppliers Based in the United States and Its Partners.

In addition to promoting deployment of 5G and other next-generation networks, the Commission should work to promote a global marketplace in which manufacturers both within the United States and in partner countries compete to develop and sell components and software for use at all layers of the network stack. Critically, the United States' and its partners' interests are best served by a robust and resilient global marketplace. The domestic U.S. market is large, but it is not large enough on its own to support the diversity of trusted suppliers that U.S. carriers and the 5G market will need in the future. Efforts to promote a global market that encourages vendors based in both the United States and its global partners will not only advance competition and innovation but will also help ensure that those partners themselves benefit from secure networks, satisfying another core U.S. national security interest. Only a multinational, diverse vendor base of trusted suppliers will have the capacity to provision components and software capable of servicing the U.S. and other partner countries' markets.[66] For instance, the total combined GDP and population of the markets in which there are existing Open RAN

[66] The G7 countries alone account for more than 750 million people, 10 percent of the global population, and a combined GDP of nearly $34 trillion – about 39% of global GDP. *See* NationMaster, *Group of 7 countries (G7): Statistical Profile*, https://www.nationmaster.com/country-info/groups/Group-of-7-countries-(G7) (last visited Apr. 14, 2021).

deployments, trials or testing facilities is $55 trillion and 3.3 billion people, respectively, comprising 58.7 percent of global GDP and 42.6 percent of the global population.[67] The "addressable market" that remains available for open and interoperable competitive RAN solutions is even larger than that.

As President Biden stated in his February 24 Executive Order on America's Supply Chains, "close cooperation on resilient supply chains with allies and partners who share our values will foster collective economic and national security and strengthen the capacity to respond to international disasters and emergencies."[68] U.S. policy therefore should expressly aim to nurture a diverse, competitive collection of suppliers based in the United States and other partner countries. There are several concrete ways in which the FCC and other U.S. government agencies can advance this U.S. national interest.

First, they should continue to leverage formal and informal multilateral associations such as the Quad (India, Australia, Japan, and the U.S.) and the G7 (Canada, France, Germany, Italy, Japan, the United Kingdom and the United States) to turn these principles into concrete policy.[69] These countries have a commitment to shared values including free and open markets, leaving them well-positioned to forge a common approach to policies relating to the intersection of technology, security, and the broader economy. These nations can convene dialogues among

[67] According to an internal ORPC member survey, vendors have Open RAN deployments, trials, and/or testing facilities in the following markets: Argentina, Australia, Brazil, Burkina Faso, Canada, Central African Republic, Chile, Colombia, Democratic Republic of the Congo, Germany, Guinea, India, Indonesia, Ireland, Italy, Japan, Malaysia, Mozambique, Netherlands, Peru, Saudi Arabia, Singapore, Spain, Taiwan, Turkey, United Arab Emirates, Uganda, United Kingdom, United States, Vietnam, and Zambia.

[68] Executive Order on America's Supply Chains (Feb. 24, 2021), https://www.whitehouse.gov/briefing-room/presidential-actions/2021/02/24/executive-order-on-americas-supply-chains/.

[69] *See* Letter from Multiple Associations on Open RAN to the governments of Australia, Japan, India, and the United States, (Apr. 21, 2021); *see also* Open RAN Policy Coalition paper, "Open RAN and the G7 Digital and Technology Track, (Apr. 9, 2021).

diverse stakeholders, promote the development of unifying standards through industry-led standards bodies, provide lawful forms of fiscal support for research and development, provide tax incentives, and otherwise work to advance Open RAN's adoption. Institutions such as the G7 can and should launch task forces convening member nations' development and development finance agencies to coordinate and enable adoption within aid recipient countries, and among their small business agencies to facilitate growth of an innovative Open RAN ecosystem.

Second, the Commission and other stakeholders in the push for advances in Open RAN should support Congress in fully funding the Multilateral Telecommunications Security Fund and related initiatives through relevant agencies. In the Utilizing Strategic Allied Telecommunications Act ("USA Telecom Act"), which itself was incorporated into the FY 2021 National Defense Authorization Act ("NDAA"),[70] Congress created the Multilateral Telecommunications Security Fund to facilitate cooperation with foreign partners to accelerate global adoption of trusted and secure network equipment – and Open RAN in particular. A bipartisan collection of Senators has called on President Biden to request at least $1.5 billion in funding. The Commission should support that request. It also should work with other federal agencies involved in foreign policy and international aid, including the Department of State, the Export-Import Bank, the United States Agency for International Development, and the Development Finance Corporation, to ensure that the funds are used to promote safe and secure networks among the United States' partners.

[70] Public Law No: 116-283 (enacted Jan. 1, 2021).

C. The Commission Should Partner with Other Agencies in Leveraging Existing Efforts to Facilitate Use Cases and Blueprints for Open RAN.

The Commission can also play a role in facilitating and promoting new use cases for Open RAN. These efforts can provide "proof of concept," for instance, in new features, functionality, and standards coordination, as well as in challenging transition or integration scenarios, making clear the benefits of Open RAN architectures while also advancing technologies and practices that will facilitate Open RAN's continued success.

There are various means by which the Commission can promote new use cases and blueprints of Open RAN. First, it should work to ensure that relevant actors fully fund innovation-promoting efforts such as testbeds, demonstration projects, and challenge competitions. As Acting Chairwoman Rosenworcel has emphasized for years, "sandbox" approaches such as these allow developers to "set up small experiments to tinker with their projects and expose them to real-world conditions."[71] These proven approaches have succeeded in incubating past technological advances, and they will accelerate the growth of new use cases and implementation scenarios for Open RAN, promoting its utility and deployment. If fully funded at the $1.5 billion sought by leading Senators, the Public Wireless Innovation Fund established in the NDAA alongside the Multilateral Telecommunications Security Fund would provide an enormous boost for such activities. The Commission should support its full funding and should endeavor to work with NTIA and grantees to realize and spread the benefits of the innovations that arise from this funding.

The Commission also can promote use of *existing* testbeds to demonstrate Open RAN's capabilities, such as those developed through the National Science Foundation (NSF)-funded

[71] Jessica Rosenworcel, *Sandbox Thinking*, DEMOCRACY: A JOURNAL OF IDEAS (Fall 2014), https://democracyjournal.org/magazine/34/sandbox-thinking/.

Platforms for Advanced Wireless Research (PAWR) program. These fully programmable wireless networking testbeds, designed and developed by leading wireless researchers in four cities across the country, can be used to show how Open RAN architectures support new innovations in areas such as spectrum sharing and network automation. This program includes established interagency coordination through the PAWR program between NSF and the Department of Defense, and NSF and the Commission, and the PAWR testbed teams currently partner with 35 leading wireless companies and associations who have contributed nearly $50 million in cash and in-kind equipment as a part of the PAWR Industry Consortium.

The Commission is also well situated to partner with other agencies or private sector entities to enable demonstration projects in which providers demonstrate that particular Open RAN solutions meet applicable performance, security, and interoperability standards in various deployment scenarios. The benefits of modularity become manifest when components and software offered by different providers demonstrably work well together. By advancing opportunities for providers to demonstrate their offerings' interoperability and secure, reliable service, the Commission would be supporting competition and the benefits associated with Open RAN. Relatedly, the Commission can increase access to spectrum that can be used by market participants to test Open RAN solutions by making spectrum available for research purposes in Commission-designated Innovation Zones – another means of ensuring that Open RAN solutions can be optimized and improved before they reach the market, promoting consumer confidence and accelerating adoption.

Finally, as Acting Chairwoman Rosenworcel has noted,[72] the Commission should work with other government actors to provide incentives for critical Open RAN research. Entities across the federal government can pool resources to provide seed funding for Open RAN research, to sponsor interagency challenge competitions, to host plugfests, or to promote other means of encouraging development and deployment of new Open RAN solutions.

D. The Universal Service Fund "Rip-and-Replace" Proceeding Should Provide Carriers Real-World Opportunities to Deploy Open RAN, Both in the Near-Term and Longer Term.

One of the most crucial tools the Commission can use to promote Open RAN is already in place. The agency's "Rip-and-Replace" rules, coupled with Congress's appropriation of $1.9 billion to fund the removal, replacement, and disposal of network components that pose a national security threat, affords carriers and policymakers a unique opportunity to facilitate deployment of Open RAN solutions. To best leverage this opportunity, the Commission should take several specific steps in connection with its Rip-and-Replace responsibilities.

First, the Commission should provide greater clarity as to timing for carriers considering replacing current networks with Open RAN solutions. Carriers agree that given practical challenges such as the limited availability of tower crews, there may not be sufficient time for them to meet the replacement deadlines even in the simplest replacement options, much less conceptualize and implement paradigm-shifting approaches such as the choice to pursue Open RAN solutions. To provide carriers sufficient opportunity to consider their options, the Commission should clarify that it will be liberal in granting extension requests for good cause – including consideration of Open RAN possibilities – and it should issue a general extension for

[72] *See* Jessica Rosenworcel, Acting Chairwomen, Fed. Commc'n Comm'n, Remarks on Accelerating 5G in the United States at the Center for Strategic and International Studies (Mar. 18, 2021)(transcript available at https://docs.fcc.gov/public/attachments/DOC-370910A1.pdf).

all recipients in order to facilitate the most efficient use of public funds for the deployment of secure and future-proof networks.

Second, the Commission should leverage the Rip-and-Replace process and related funding to inform testbeds, demonstration projects and pilots, which in turn can accelerate and enhance network upgrades. As mentioned above, in addition to the Multilateral Telecommunications Security Fund, the USA Telecom Act also authorized $750 million to promote Open RAN over the next 10 years, directing NTIA to begin issuing grants within 18 months to promote such deployments. As the Commission implements Rip-and-Replace, it can forge partnerships with NTIA and other federal agencies and departments to promote Open RAN deployment. For example, agencies such as the Department of Defense might provide technical assistance or other incentives for carriers replacing networks near military bases or other federal properties to migrate to Open RAN. Alternatively, they might allow for or incentivize experimentation or testbeds that might be infeasible in a purely commercial setting. The Commission can then review the outcomes of these efforts to develop a more robust understanding of the challenges and opportunities associated with the shift to Open RAN, paving a wider path for the next generation of carriers to make that transition.

Third, the Commission should exercise its oversight authority over monies distributed under its Rip-and-Replace program to collect information regarding whether and how such funds are being used to promote Open RAN deployments. This data will afford the Commission insight into the circumstances under which a particular carrier chooses to migrate to Open RAN – or, instead, to remain with proprietary RAN – and understand the carrier's considerations in making these decisions. This information can better inform the Commission in developing policies to promote Open RAN deployment outside the Rip-and-Replace setting.

Fourth, the Commission should help build awareness on Open RAN solutions and urge providers installing Open RAN solutions to share best practices and otherwise coordinate their activities to the extent they are lawfully permitted to do so. The Commission could itself provide a forum for such information-sharing. Alternatively, it could work informally with a private-sector organization whose members may consider deploying Open RAN via the Rip-and-Replace proceeding – for example, the Competitive Carriers Association (CCA), the Rural Wireless Association (RWA), or other associations.

Last but not least, the Commission should itself use the Rip-and-Replace process as a model for the broader transition to Open RAN architectures both at home and abroad. While some carriers are apt to replace potentially compromised networks with Open RAN alternatives, others may rely for now on traditional network architectures – and still others are not subject to the Rip-and-Replace framework at all. Over time, however, many of these providers are likely to migrate toward Open RAN. The experience of providers migrating to Open RAN during the Rip-and-Replace process will be immensely valuable to others, revealing potential pitfalls, workable solutions, and best practices that can smooth the industry-wide shift to Open RAN. The Commission should use this docket or another forum as a repository for these learnings, and produce materials summarizing information that will facilitate future deployments.

CONCLUSION

The Coalition and its members look forward to working with the Commission on this important and promising proceeding.

/signed/ Diane Rinaldo

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