

SPECTRUM AND NATIONAL SECURITY

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED EIGHTEENTH CONGRESS

SECOND SESSION

MARCH 21, 2024

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED EIGHTEENTH CONGRESS

SECOND SESSION

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SPECTRUM AND NATIONAL SECURITY

THURSDAY, MARCH 21, 2024

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 10:05 a.m., in room SR-253, Russell Senate Office Building, Hon. Maria Cantwell, Chair of the Committee, presiding.

Present: Senators Cantwell [presiding], Klobuchar, Markey, Peters, Baldwin, Tester, Rosen, Luján, Hickenlooper, Warnock, Welch, Cruz, Thune, Wicker, Fischer, Sullivan, Blackburn, Young, Budd, Schmitt, Vance, Capito, and Lummis.

OPENING STATEMENT OF HON. MARIA CANTWELL, U.S. SENATOR FROM WASHINGTON

The CHAIR. Good morning. The Committee on Commerce, Science, and Transportation will come to order.

This morning we are having the hearing on spectrum and national security, and appreciate the witnesses being here today. Today's hearing will focus on the interrelationship of these two critical factors, spectrum auction authority and national security, and getting a plan to move forward.

Foreign adversaries' access to Americans' data is a real and growing concern, and we must act to shut the door to protect Americans. But we are seeing this conversation around applications and devices, and we need to consider the national security of communications networks themselves.

So really appreciate our witnesses being here on that point. The network relies on spectrum, whether it is cell phones in our pockets, connected devices in our homes, critical defense systems in our military, radar, satellites for aviation, weather infrastructure spectrum, all essential components of a modern communication system.

Spectrum is a finite resource, which means policymakers must ensure and manage it effectively to the benefits of all Americans. And last year, after 30 years of consensus that auctions were a key part of spectrum management, the FCC's spectrum authority expired for the first time.

We want to renew that. We want to look at today and discuss the outer bands, you know, the 12 and 37 AWS and what we can do to make sure spectrum is made available now to continue to increase capacity, expand the opportunities for new technology and IoT, and leverage the opportunities for areas that aren't covered today to grow our economy of the future.

We must also ensure that spectrum is managed, and our national security colleagues who have been in a very active debate with us over these issues, that we are expanding this capacity for innovation. The private sector and the defense sector both need to advance. They need to advance successfully, and the United States must be the leader in spectrum technology and security.

We have seen firsthand the threats of our foreign adversaries that they pose to the domestic communication network. For example, the presence of unsecure equipment for Huawei and ZTE and our key domestic military installations impacted our communities. Rural providers across the nation, including my home state, are having to replace unsecure equipment costing billions of dollars.

And as development begins on next generation wireless networks, it is critical the United States take a unified approach and continue to have the best spectrum policies in the world. It is clear that spectrum policy has often been the subject of interagency disputes, and that too, with the IO—with the report that was published by NTIA and DOD on dynamic spectrum sharing, moved the discussion to a new level, but more needs to be done.

A domestic approach to spectrum management built on collaboration will allow the United States to continue to lead on the international front. The FCC, NTIA, and NASA, DOD, and others must work together to ensure that we continue to work openly and collectively.

Spectrum management must also embrace innovation like ORAN, open ORAN, which we will hear more about today, which will allow telecom providers to use secure competitive networks.

And innovation must expand spectrum access, with technologies like the dynamic spectrum sharing—harness the opportunities. Other collective spectrum management and technology innovation—I believe we can create a true pipeline. That is what we really want to do. We want to get what we can get now, get it in place, and continue to grow the opportunities.

A sustainable, responsible vision will allow us to move forward on both our private sector and our DOD missions. For this to happen, we must restore the FCC's auction authority and our strategy should include approaches on unlicensed and licensed spectrum.

Today's hearing is about the national security element of that, and clearly once we address that, hopefully we will get our colleagues to focus on how to make these priorities a reality and create that kind of pipeline that will allow us to deal with some of our necessary issues for us to grow this security for the future.

So, with that, I will turn to the Ranking Member, Senator Cruz, for his opening statement.

**STATEMENT OF HON. TED CRUZ,
U.S. SENATOR FROM TEXAS**

Senator CRUZ. Thank you, Madam Chair, for convening this hearing about spectrum policy and national security. It couldn't come at a more critical time. Spectrum auction authority has been lapsed for more than a year.

The Biden Administration has no concrete plans for getting spectrum into the marketplace. And all the while, the mid-band spectrum gap between the United States and China continues to grow.

This is a problem not just for our Nation's wireless companies and their consumers, but for our national security. For too long, our leaders have been—have treated national security and wireless innovation as mutually exclusive.

That is deeply shortsighted. If we want national security, we need wireless innovation. If we want American companies and trusted vendors to prevail against our adversaries, we need to lead on spectrum.

Or to put it another way, if the United States does not dominate in next generation wireless networks and technology, we will become dependent on our adversaries and compromise our national security.

To remain the world leader on 5G and beyond, we need a true mid-band spectrum pipeline. That is why last week, in partnership with Senators Thune and Blackburn, I introduced the Spectrum Pipeline Act.

This legislation is vital for the United States to stay ahead of our adversaries and to advance strong economic growth. It requires the Administration to identify at least 2,500 MHz of prime mid-band spectrum to be reallocated for commercial use and creates shot clocks for the FCC to expeditiously auction at least half of that amount for 5G and 6G.

Importantly, this bill is focused on getting the policy right at the outset, rather than allocating our Nation's spectrum policy to be dictated by where we should spend auction proceeds. And it incentivizes agencies to use their spectrum more efficiently. I have long believed that we need to change the incentive structure to help bring Federal incumbents to the table.

By removing a key obstacle in current law, our bill allows agencies to use spectrum proceeds to replace affected equipment with even better state-of-the-art equipment. This will create a win-win for consumers and Federal agencies.

Our bill also takes in all of the above approach. In addition to the wide area, full power spectrum that is critical to 5G dominance, it maintains our leadership in Wi-Fi too. With its low barriers to entry and freedom from regulation, Wi-Fi is a quintessentially American success story, which is why the bill requires the FCC to make available at least 125 MHz for the unlicensed services before any auction occurs.

In the same vein, the bill requires the FCC to allocate more than 1,000 MHz for licensed or unlicensed services. Speaking of an all of the above approach, today, in partnership with Senator Rosen, I introduced the Satellite and Telecommunications Streamlining Act.

We must promote American innovation on all fronts, and that includes maintaining U.S. leadership in next generation satellite technologies. While I am committed to innovative, tech neutral policies, I would urge my colleagues to be wary of rent seeking attempts by incumbent operators to block competition.

Fostering competition and lowering barriers to entry means less Federal control of the airwaves and greater opportunities for economic growth. I implore my colleagues and stakeholders, do not fight to maintain the status quo.

Similarly, I am disappointed that the majority chose at the last minute to add testimony from one side of the telecom industry, but not the perspective of competitors. We should be allowing lawmakers to hear from all sides on this issue.

We need to work together and develop a harmonized, clear position, and that is what the Spectrum Pipeline Act brings to the table. Unfortunately, the contrast between our bill and the Biden Administration's dilatory, ambiguous approach couldn't be starker. Put simply, spectrum simply is not a priority for the Biden Administration.

We offer a concrete timeline for freeing up spectrum, while the Administration's national spectrum strategy offers perpetual studies, bureaucratic dithering, and no action to free up a single Megahertz.

We offer certainty, while they second-guess decisions and unlawfully withhold legitimately obtained spectrum from regulated entities. We saw this most jarringly in the 2023 World Radio Communication Conference, when the U.S. delegation couldn't get its act together.

We were stuck playing defense as China led the world in promoting Huawei's control of foreign telecom networks or take FCC Chairwoman Rosenworcel's decision to hold T-Mobile's 2.5 GHz licenses hostage for more than a year. While I am glad that Congress was able to step in and clean up the FCC's mess, her inaction will reverberate for years to come.

In addition to depriving millions of consumers of 5G connectivity for more than a year, the Chairwoman undermined confidence in the integrity of FCC auctions and spectrum property rights. We must reverse course. The Spectrum Pipeline Act provides certainty rather than ambiguity.

It promotes competition, not barriers to entry. And most of all, it creates a strong, harmonized position that ensures America leads the world on wireless technology and doesn't fall behind our adversaries.

I look forward to the hearings from today's witnesses and working with my colleagues so that we can finally get our country's spectrum policy back on track.

The CHAIR. Thank you, Senator Cruz. We will now turn to the witnesses, and we will start with you, Dr. Ghosh. Thank you so much for being here.

I love that you are an electrical engineer. We definitely need more women electrical engineers, so thank you so much for your leadership at Notre Dame.

STATEMENT OF PROFESSOR MONISHA GHOSH, DEPARTMENT OF ELECTRICAL ENGINEERING, UNIVERSITY OF NOTRE DAME; POLICY OUTREACH DIRECTOR, SPECTRUMX; RESEARCH PROFESSOR (ADJUNCT), UNIVERSITY OF CHICAGO; JOINT APPOINTMENT, ARGONNE NATIONAL LABORATORY

Dr. GHOSH. Thank you very much. Good morning, and I am happy to testify today. Thank you for the opportunity. As you said, I am a Professor of Electrical Engineering at the University of Notre Dame.

I am also the Policy Outreach Director for Spectrum X, which is the NSF funded center for spectrum innovation. I also took two leaves of absence to serve in Government at the NSF and as the CTO of the FCC.

I continue to be actively engaged with both industry and Government in various capacities, and I hope to offer a balanced perspective. The opinions expressed in this testimony are my own and do not necessarily reflect the position of any of the institutions with which I am affiliated.

So, spectrum policy that enhances U.S. national security is one that satisfies the current and growing future spectrum needs, not wants, of the commercial wireless sector, science, and mission critical Federal applications. The U.S. leads by using exclusively licensed, shared, and unlicensed mechanisms as appropriate, depending on the use case.

Leadership in 5G and 6G, which is already under discussion, extends beyond just making more exclusively licensed spectrum available. 5G and 6G can also be deployed and shared in unlicensed bands, where they are more likely to serve innovative use cases beyond just mobile broadband.

Our leadership and security depend on us developing those innovations before others do, making spectrum easily available, for example, by using the licensed—unlicensed or shared license model is crucial for this innovation to happen here.

Verticals such as factory automation, remote oilfield monitoring, precision agriculture, community networks to serve the underserved, and improved indoor coverage are just some of the emerging applications that are crucial for our economic and national security.

However, these are not well-served today by either cellular or Wi-Fi and are increasingly moving to the shared spectrum CBRS framework for affordable deployments.

CBRS uses something called Dynamic Spectrum Sharing, or DSS, which refers to two or more different types of users, for example, Federal radar and cellular networks, overlapping their operations in frequency, time, and space, where one user is the incumbent and has priority.

DSS may require systems to share information with each other, employ databases, or sensing to ensure that the primary user can continue to operate in the band without harmful interference. It is becoming increasingly clear that DSS will be an integral component of all future systems requiring access to spectrum.

This is true of the U.S. and internationally. Spectrum is getting congested everywhere in the world and the physics of propagation remain the same. The innovative three tier sharing adopted by the U.S. and CBRS has demonstrated conclusively that spectrum can be shared successfully between mission critical applications such as Navy radar and commercial applications.

At the same time, access to the spectrum using General Authorized Access, or GAA, has allowed the innovations mentioned earlier to develop. However, DSS needs to be more scalable and truly dynamic to address the protection needs of different types of incumbents in other bands.

Furthermore, 6G needs to be sharing native, that is incorporate spectrum sharing mechanisms by design to coexist with incumbent service providers, as stated by the white House in its recent 6G statement.

Advanced approaches for DSS that leverage technologies such as smart antennas need to be evaluated. Sensing, too, is a fundamental technology that enables DSS. However, the separate sensing network deployed for CBRs cannot protect incumbents that are geographically more distributed than Navy radars.

We need to consider alternatives such as cooperative distributed sensing approaches that perhaps leverage the dense footprint of base stations and devices themselves. Improved receivers and accurate definitions of harmful interference can also lead to better spectrum sharing, as described in FCC's recent policy statement.

Long term spectrum R&D is essential for the sustained development and testing of DSS approaches in real world environments to prove their robustness in protecting incumbents in various bands.

NTIA's all of Government approach to the National Spectrum Strategy and implementation plan is a necessary first step. I urge this committee to consider ways that this long term R&D into DSS can be adequately and sustainably funded in industry, academia, and Government.

Finally, all of this requires that the FCC's auction authority is restored. Even shared spectrum can be auctioned. Thank you for the opportunity to share my views and I welcome your questions. [The prepared statement of Dr. Ghosh follows.]

PREPARED STATEMENT OF PROFESSOR MONISHA GHOSH, DEPARTMENT OF ELECTRICAL ENGINEERING, UNIVERSITY OF NOTRE DAME; POLICY OUTREACH DIRECTOR, SPECTRUMX; RESEARCH PROFESSOR (ADJUNCT), UNIVERSITY OF CHICAGO; JOINT APPOINTMENT, ARGONNE NATIONAL LABORATORY

Good morning Chairwoman Cantwell and members of the Committee. Thank you for the opportunity to testify today on the extremely timely and important topic of spectrum policy and technologies and their impact on national security.

INTRODUCTION

My name is Monisha Ghosh, and I believe that I can offer a broad and balanced perspective on the matters before this Committee, given my years of experience working in the wireless industry, government research and regulatory organizations, and academia.

To summarize my professional background, I am currently a Professor of Electrical Engineering at the University of Notre Dame. I came to academia in 2015 when I joined the University of Chicago after 24 years working in industry on wireless research and development, at Philips Research, Bell Labs and Interdigital, including contributing to the TV White Spaces (TVWS), an early Dynamic Spectrum Sharing (DSS) effort where we demonstrated the first cognitive radio that operated in the TVWS while protecting incumbents. I took two recent leaves of absence from academia to serve in government: 2017–2019, as a Program Manager in the Computer and Network Systems (CNS) division of the Computer and Information Science and Engineering (CISE) directorate at the National Science Foundation (NSF), where I helped manage NSF's research programs in spectrum and wireless and started the first program to study the applications of artificial intelligence (AI) and machine learning (ML) in wireless networks, and January 2020 to June 2021 as the Chief Technology Officer (CTO) at the Federal Communications Commission (FCC), where I worked primarily on helping craft the rules for unlicensed access in the 6 GHz band and a pilot project with the U.S. Postal Service (USPS), as directed

by Congress, to examine the feasibility of automatically gathering broadband coverage data using apps on smartphones mounted in postal vehicles.¹

I continue to be actively engaged with both industry and government as an academic. I have co-chaired the FCC's Technological Advisory Council's (TAC) working group on Advanced Spectrum Sharing since 2022, where we deliberate on technologies for advanced spectrum sharing. I am also an active member of industry's NextG Alliance, developing standards for 6G and beyond, and participated in the National Spectrum Consortium's (NSC) Partnering to Advance Trusted and Holistic Spectrum Solutions (PATHSS) Task Group which partnered with the Department of Defense (DoD) to explore efficient sharing solutions in 3.1–3.45 GHz.

In addition, I am the Policy Outreach Director for SpectrumX,² NSF's Center for Spectrum Innovation, led by the Wireless Institute³ in the College of Engineering at the University of Notre Dame. SpectrumX was initiated in September 2021 with a five-year \$25M NSF grant that brings together 56 researchers and staff from 30 universities and a number of Minority Serving Institutions (MSIs) with broad expertise spanning radio technologies, wireless terrestrial and satellite networks, scientific uses of spectrum and economic considerations related to spectrum allocations. A Memorandum of Agreement (MOA) is in place among the NSF, FCC, and the National Telecommunications and Information Administration (NTIA) to ensure that the research undertaken in SpectrumX, and the NSF Spectrum Innovation Initiative more broadly, can directly impact spectrum issues of importance to the Nation. In addition to research, major focus areas of the Center are broadening participation in spectrum research and developing a workforce that can continue to expand U.S. leadership in spectrum policy and wireless technologies.

Disclaimer: The opinions expressed in this testimony are my own and do not necessarily reflect the positions of the various organizations with which I am affiliated.

SUMMARY OF TESTIMONY

I will focus my remarks today on the following three areas:

- (1) *Spectrum Policy that enhances U.S. National Security.* National security is ensured by leadership in spectrum policy and relevant technologies, not only in the commercial wireless sector but also in science (e.g., weather forecasting and radioastronomy) and mission-critical Federal applications. The spectrum needs of *all* these applications are growing, and the U.S. should continue to lead by ensuring that policies and technologies that allow spectrum to be sustainably allocated to all uses are explored: exclusive licensing, shared usage and unlicensed, according to current and future spectrum *needs*, not *wants*. The use-cases that will be deployed should be carefully considered when spectrum is allocated under different licensing regimes: determining the right mix will deliver the appropriate policy that continues to ensure leadership.
- (2) *Dynamic Spectrum Sharing (DSS), or Dynamic Spectrum Access (DSA)* refers to two or more different types of users, e.g., television and unlicensed wireless devices or Federal radar and cellular networks operating over the same frequencies at the same time and in the same geographical area. Usually, a primary user, or incumbent, has priority in the band, unlike unlicensed bands where all users are treated as co-equals. DSS may require systems to share information with each other, employ databases or sensing to ensure that the primary user is protected from harmful interference. It is becoming increasingly clear that DSS will be an integral component of all future systems requiring access to spectrum. This is true in the U.S. and internationally: spectrum is getting congested everywhere in the world since the physics of propagation remains the same. The innovative 3-tier sharing adopted by the U.S. in the Citizens Broadband Radio Service (CBRS) has demonstrated conclusively that spectrum can be shared successfully between mission-critical applications such as Navy radar and commercial applications. The CBRS framework, by making easily available spectrum under GAA (General Authorized Access), has also spurred innovative use cases that are not well served by either Wi-Fi or operator-deployed cellular networks. However, we need to develop sharing technology further to be more scalable and truly dynamic to ad-

¹REPORT TO THE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION OF THE SENATE AND THE COMMITTEE ON ENERGY AND COMMERCE OF THE HOUSE OF REPRESENTATIVES. <https://www.fcc.gov/sites/default/files/report-congress-usps-broadband-data-collection-feasibility-05242021.pdf>

²SpectrumX: <https://www.spectrumx.org/>

³Wireless Institute at Notre Dame: <https://wireless.nd.edu/>

dress the protection needs of different types of incumbents. In addition to creating spectrum policy to support DSS, the next generation of cellular technology, 6G, that is already under discussion worldwide, needs to be “sharing native,” *i.e.*, “incorporate spectrum sharing mechanisms by design to coexist with incumbent service providers”⁴ as stated by the White House.

- (3) *Long term spectrum research and development* is essential for the U.S. to continue leading the world in delivering innovative spectrum policies and technologies. The NTIA recently released the National Spectrum Strategy (NSS)⁵ and the Implementation Plan,⁶ thoughtfully written documents laying out a collaborative agenda that includes industry, government and academia for addressing immediate spectrum challenges as well as developing long-term planning, research and development (R&D), and education and workforce development (EWD). Many of the outcomes listed in the plan detail how the NSF through its spectrum initiatives, including SpectrumX, can address the needs of data collection, experimentation and testbeds, and developing educational activities. In order for such R&D efforts to impact policy in the near term and to be transformative in the long term, adequate funding needs to be prioritized for collaborative efforts between industry, academia and government to continue to grow.

DETAILED TESTIMONY

- (1) *Spectrum Policy that Enhances National Security*

The U.S. has long led the world in innovative spectrum policies from allocating spectrum for unlicensed services in the eighties, to developing auction mechanisms in the nineties and now exploring sharing mechanisms in the new century. These innovations have spurred economic vitality not just in the U.S., but worldwide. Although commercial wireless expansion is extremely important, we also need to ensure that services that are critical to our Nation’s security continue to have priority access to the spectrum that is indispensable to their operations and mission, such as radars (land, sea and airborne) for defense, weather, and aviation; dedicated terrestrial, ground-to-air, and ground-to-space communication links; position, navigation, and timing systems including GPS; environmental remote sensing satellites; and radio telescopes. Furthermore, commercial wireless use cases are growing beyond conventional mobile broadband and Wi-Fi to include verticals such as factory automation, remote oil-field monitoring, precision agriculture, community networks to serve the underserved and to provide improved indoor coverage; these emerging applications are not well served today by either Wi-Fi or cellular and are increasingly moving to the shared spectrum framework available in the CBRS band for affordable deployments.⁷

High-power, exclusively licensed spectrum will continue to be the backbone for delivery of wide-area mobile broadband coverage outdoors, while Wi-Fi will continue to utilize the unlicensed bands for indoor use and short-range outdoor use. However, true sharing, where systems occupy the same spectrum in time and space, is extremely challenging when, for example, megawatt airborne radars and high-power outdoor base stations operating at hundreds of kilowatts need to coexist. On the other hand, sharing may be easier with low/medium power systems deployed indoors or at lower heights. It is widely recognized that 80 percent of all data either originates or terminates indoors,⁸ which further accentuates the need to improve indoor connectivity. Leveraging the natural RF isolation provided by buildings, especially newer energy-efficient buildings with low-E glass, can lead to spectrum sharing where the same spectrum that is used by high-power outdoor incumbents can be reused by indoor systems. This is similar to 6 GHz unlicensed usage in the U.S., but the model can be extended to shared licensed use as well. In fact, the neutral-host

⁴White House Joint Statement Endorsing Principle For 6G: Secure, Open and Resilient by Design, <https://www.whitehouse.gov/briefing-room/statements-releases/2024/02/26/joint-statement-endorsing-principles-for-6g-secure-open-and-resilient-by-design/>

⁵NTIA National Spectrum Strategy, https://www.ntia.gov/sites/default/files/publications/national_spectrum_strategy_final.pdf

⁶NTIA National Spectrum Strategy Implementation Plan, <https://www.ntia.gov/sites/default/files/publications/national-spectrum-strategy-implementation-plan.pdf>

⁷OnGo Alliance Use Cases for CBRS, <https://ongoalliance.org/ongo-solutions/>

⁸A 5G America’s Whitepaper on Energy Efficiency and Sustainability in Mobile Communications Networks, December 2023, <https://www.5gamericas.org/wp-content/uploads/2023/12/Energy-Efficiency-and-Sustainability-in-Mobile-Communications-Networks-WP.pdf>

model deployed using CBRS indoors accomplishes this today⁹ and China, too, has allocated the 3.3–3.4 GHz band for shared indoor use.¹⁰ However, as detailed in my comments presented at the NTIA’s listening session in April 2023, the amount of shared spectrum available today, 150 MHz, is far lower than the total mid-band spectrum allocated for exclusively licensed use (~ 600 MHz) and unlicensed spectrum (~1900 MHz)¹¹ and may not be enough to fully support the many innovative use-cases that are being developed. Our European allies have recognized the value of low/medium power shared licensing and are expanding usage by 400 MHz in 3.8–4.2 MHz.¹² It should be noted though that these allocations do not leverage DSS, which can further improve spectrum utilization by sharing spectrum with primary as well as secondary users.

- (2) *Dynamic Spectrum Sharing (DSS)* needs to consider both co- and adjacent-channel interference concerns of incumbents. There is no one-size-fits-all solution to these potential interference scenarios. Sound spectrum policy should be based on fundamental technical analyses, measurements and testing which includes all stakeholders, such as the Federal agencies (e.g., FCC and NTIA) and spectrum stakeholders (commercial wireless, DoD, scientists). Most of the current spectrum allocations that share between incumbent services and new entrants (e.g., Television White Spaces (TVWS), 6 GHz and CBRS) employ some variants of a spectrum-use database to assign channels so that the incumbent is protected. These methods rely on predicted propagation and interference based on models, and often do not take into account many of the details of the systems that will coexist in the band. Interference protection contours are thus often set to satisfy worst-case interference scenarios which may have a low probability of occurrence resulting in overprotection and spectrum-underutilization. Database-mediated sharing is a proven technique for a number of frequency bands, but may not be suitable for all situations since this method is inherently less dynamic and does not react in a timely fashion to actual propagation and interference conditions. The FCC TAC in 2022 published a whitepaper on lessons learnt from CBRS¹³ that summarizes how future centralized spectrum management systems based on databases could be improved and become more dynamic. The Advanced Spectrum Sharing Working group will continue addressing DSS under the new FCC TAC charter.¹⁴ More advanced technical approaches for DSS can be developed that leverage specific characteristics. For example, modern wireless systems, both cellular and Wi-Fi, use smart antenna array systems that tailor the transmitted energy optimally in 3-dimensional space towards intended users. The same systems could also be adapted to steer energy away from incumbent systems. Such approaches require changes in 6G and beyond standards to be “sharing native”, i.e., designed from the very beginning to operate in shared frequency bands with incumbents instead of solely in licensed or unlicensed bands where deployed systems utilize standards that do not account for incumbent use: an exception is Dynamic Frequency Selection (DFS) in Wi-Fi bands with incumbent Federal radars. Sensing is an integral technology that enables DSS, however, the separate sensing network deployed for CBRS cannot protect incumbents that are geographically more distributed than Navy radars: we need to develop distributed sensing approaches that leverage the dense footprint of base-stations and devices to develop cooperative sensing approaches to detect incumbents. Improved receivers and accurate definitions of “harmful inter-

⁹ 5 Bars Indoor For Everyone—The Power of CBRS and Neutral Hosts in Wireless Networks, <https://ongoalliance.org/5-bars-indoor-for-everyone-the-power-of-cbrs-and-neutral-hosts-in-wireless-networks/>

¹⁰ China Issues 5G Spectrum Licenses For Indoor Coverage, February 2020, <https://www.gsma.com/futurenetworks/5g/china-issues-5g-spectrum-licences-for-indoor-coverage/>

¹¹ Comments of Professor Ghosh at the NTIA Listening, April 17 2023, <https://ntia.gov/sites/default/files/publications/ghosh.pdf>

¹² Ofcom, Evolution of the Shared Access Licence Framework, Call For Inputs, https://www.ofcom.org.uk/data/assets/pdf_file/0032/255965/call-for-inputs-evolution-of-shared-access.pdf

¹³ Recommendations to the FCC Based on Lessons Learned from CBRS, FCC TAC, December 2022, https://www.fcc.gov/sites/default/files/recommendations_to_the_federal_communications_commission_based_on_lessons_learned_from_cbrs.pdf

¹⁴ FCC 2024–2025 Working Groups Charter, <https://www.fcc.gov/sites/default/files/2024%20TAC%20WG%20Charters.pdf>

ference” can also lead to better spectrum sharing as described in FCC’s recent policy statement.¹⁵

- (3) *Long term spectrum research and development* is essential for sustained development and testing of DSS approaches in real-world environments to prove their robustness in protecting incumbents in various bands. The 7.125–8.4 GHz band has a very different mix of incumbent users compared to 3.1–3.45 GHz and may require different approaches. The NSS Implementation Plan lays out very concrete steps to address these issues, but the longest-term deliverable is set for November 2027. DSS R&D efforts will most definitely need to continue beyond this. While the 3.1–3.45 GHz has been studied for a few years within PATHSS, the 7.125–8.4 GHz band requires in-depth analysis into incumbent use, propagation mechanisms and possible use-cases. I urge this Committee to consider ways that this long-term R&D into DSS can be adequately and sustainably funded in industry, academia and government. Furthermore, as demands on spectrum from all users continue to grow, new bands will need to be continually evaluated for sharing and perhaps new sharing modalities developed.

CONCLUDING REMARKS

The U.S. leads the world today in innovations in spectrum policy that have delivered wireless applications that impact all aspects of our life, from broadband connectivity to national security and scientific breakthroughs. This leadership must continue to ensure that all options are evaluated to create a sustainable spectrum strategy for every system that requires access to spectrum. Dynamic Spectrum Sharing is a key technological innovation that was conceived of and first implemented in the U.S.; however, we must continue the innovations to ensure that both policies and technologies lead to the development of a truly sharing-native wireless ecosystem that continues to serve all needs.

I thank you for the opportunity to share my thoughts on this very important topic and welcome any questions.

The CHAIR. Thank you so much. We will now turn to Ms. Brown. Welcome. Thank you so much for being here. I am sure you will introduce herself a little more detailed but thank you so much for your leadership at Wi-Fi Forward.

STATEMENT OF MARY L. BROWN, EXECUTIVE DIRECTOR, WIFIFORWARD

Ms. BROWN. Thank you, Chair Cantwell, Ranking Member Cruz, and members of the Committee for the opportunity to testify today. I serve as Executive Director of Wi-Fi Forward and have over 30 years of experience helping foster U.S. leadership in Wi-Fi technologies.

Thank you for holding this national security hearing that enables us to consider how Wi-Fi technologies play an important role in our national defense and safety. I will focus on just three dimensions of that topic.

First, how the U.S. Wi-Fi industry has been battling Chinese interests that would obstruct Wi-Fi growth globally. Second, how Wi-Fi provides communications resilience and redundancy.

Third, the hidden strength of Wi-Fi, its ability to coexist in the same set of spectrum frequency used by others, including Federal and military users, without causing harmful interference, thereby fueling economic growth and technology innovation without relocating Federal systems.

Wi-Fi has been in the center ring, fighting against China’s global spectrum priorities. The Chinese Communist Party has prioritized

¹⁵ Policy Statement, Promoting Efficient Use of Spectrum through Improved Receiver Interference Immunity Performance, <https://docs.fcc.gov/public/attachments/FCC-23-27A1.pdf>

influencing spectrum allocation decisions worldwide, both to maximize Huawei and ZTE's global influence and power, and to undercut U.S. leadership.

In 2020, the FCC led the world to open the 6 Gigahertz band for unlicensed Wi-Fi. But as countries move to follow our lead, China advanced its own agenda, seeking to make 6 Gigahertz a band for exclusive license mobile use in dozens of proceedings around the world.

Later in 2023, at the World Radio Conference, China aggressively worked to dismantle the U.S. led momentum for unlicensed spectrum, urging a global plan to advantage Chinese government sponsored companies by allowing only exclusive licensed mobile networks in the upper half of the 6 Gigahertz band.

Thanks to U.S. leadership, China's attempts largely failed. Post WRC, U.S. companies can and will continue to engage country by country to encourage harmonized unlicensed use, which benefits the U.S.

That said, we already see that China has simply changed venues. Its vigorous campaign for Huawei and ZTE positioned as the fight against Wi-Fi continues. We therefore appreciate this committee's focus on how spectrum policy advances U.S. national security and economic interests, both at home and abroad.

Second, Wi-Fi enables the public to reliably connect and communicate in places such as their homes, businesses, and schools. When a major cell phone carrier recently experienced a widespread network outage, it notably advised its customers to use Wi-Fi communications until cellular service could be restored.

Consumers connected to Wi-Fi barely noticed any disruption and were able to access a number of Wi-Fi voice and messaging applications to communicate during the outage, all because Wi-Fi networks are ubiquitous where people live and work.

And these Wi-Fi networks are resilient by design due to the tremendous investments Wi-Fi providers and developers have made to keep pace with consumers' growing demands for the technology. In fact, the vast majority of data we consume each day is delivered via Wi-Fi.

For at least one mobile provider, 87 percent of its customer smartphone traffic is carried over Wi-Fi. Network outages also occur when natural disasters strike, making redundant Wi-Fi and other networks important to ensuring connectivity.

For example, operators frequently open their Wi-Fi networks to any and all users in the wake of natural disasters such as the recent wildfires in Maui and Hurricane Ida in 2021. Third, and finally, the coexistence capabilities of Wi-Fi are a U.S. national security strength.

Coexistence means more spectrum can be provided for commercial use without resource consuming reallocation of Federal systems that support critical national security missions.

Whether in the 5 Gigahertz band for Wi-Fi or for CBRS in a band used by Navy radars, we have seen the U.S. Government able to commercialize valuable spectrum resources and unleash economic growth and innovation without incurring exorbitant costs to displace and relocate critical Federal incumbents like DOD, NASA, and NOAA, among others.

Wi-Fi technology is a bedrock of our Nation's connectivity here at home and is pivotal to our national security and global competitiveness. Thank you for the opportunity to share this information with you, and I look forward to your questions.

[The prepared statement of Ms. Brown follows.]

PREPARED STATEMENT OF MARY L. BROWN, EXECUTIVE DIRECTOR, WIFI FORWARD

Chair Cantwell, Ranking Member Cruz and members of the Committee, thank you for the opportunity to testify today. I serve as the Executive Director of WifiForward, and have over 30 years of experience helping foster U.S. leadership in Wi-Fi technologies.

Thank you for holding this national security hearing that enables us to consider how Wi-Fi technologies play an important role in our national defense and safety. I will focus on just three dimensions of that topic. First, how the U.S. Wi-Fi industry has been battling Chinese interests that would obstruct Wi-Fi growth globally. Second, how Wi-Fi provides communications resilience and redundancy. Third, the hidden strength of Wi-Fi—its ability to coexist in the same set of spectrum frequencies used by others, including Federal and military users, without causing harmful interference, thereby fueling economic growth and technology innovation without relocating Federal systems.

Wi-Fi has been in the center ring fighting against China's global spectrum priorities. The Chinese Communist Party has prioritized influencing spectrum allocation decisions worldwide—both to maximize Huawei's and ZTE's global influence and power, and to undercut U.S. leadership.

In 2020, the FCC led the world to open the 6 GHz band for unlicensed Wi-Fi. But as countries moved to follow our lead China advanced its own agenda seeking to make 6 GHz a band for exclusive, licensed mobile use in dozens of proceedings around the world.

Late in 2023, at the World Radio Conference, China aggressively worked to dismantle the U.S.-led momentum for unlicensed spectrum, urging a global plan to advantage Chinese government-sponsored companies by allowing only exclusive, licensed mobile networks in the upper half of the 6 GHz band. Thanks to U.S. leadership, China's attempts largely failed.

Post-WRC, U.S. companies can and will continue to engage country by country to encourage harmonized unlicensed use, which benefits the U.S. That said, we already see that China has simply changed venues—its vigorous campaign for Huawei and ZTE, positioned as a fight against Wi-Fi, continues. We therefore appreciate this Committee's focus on how spectrum policy advances U.S. national security and economic interests both at home and abroad.

Second, Wi-Fi enables the public to reliably connect and communicate in places such as their homes, businesses and schools. When a major cell phone carrier recently experienced a widespread network outage, it notably advised its customers to use Wi-Fi communications until cellular service could be restored. Consumers connected to Wi-Fi barely noticed any disruption, and were able to access a number of Wi-Fi voice and messaging applications to communicate during the outage, all because Wi-Fi networks are ubiquitous where people live and work. And, these Wi-Fi networks are resilient by design due to the tremendous investments Wi-Fi providers and developers have made to keep pace with consumers' growing demands for the technology. In fact, the vast majority of data that we consume each day is delivered via Wi-Fi. For at least one mobile provider, 87 percent of its customers' smartphone traffic is carried over Wi-Fi.

Network outages also occur when natural disasters strike, making redundant Wi-Fi and other networks important to ensuring connectivity. For example, operators frequently open their Wi-Fi networks to any and all users in the wake of natural disasters, such as the recent wildfires in Maui and Hurricane Ida in 2021.

Third, the coexistence capabilities of Wi-Fi are a U.S. national security strength. Coexistence means more spectrum can be provided for commercial use without resource-consuming relocation of Federal systems that support critical national security missions. Whether in the 5 GHz band for Wi-Fi, or for CBRS in a band used by Navy radars, we have seen the U.S. Government able to commercialize valuable Federal spectrum resources, and unleash economic growth and innovation, without incurring exorbitant costs to displace and relocate critical Federal incumbents, like DOD, NASA, or NOAA, among others.

Wi-Fi technology is a bedrock of our Nation's connectivity here at home and is pivotal to our national security and global competitiveness. Thank you for the opportunity to share this information with you, and I look forward to your questions.

The CHAIR. Thank you so much, Ms. Brown. Mr. Johnson, it is a reappearance, right? You have been here before.

Mr. JOHNSON. I have been here before as a staffer.

The CHAIR. OK. So, well thank you so much for coming back. I appreciate it.

**STATEMENT OF CLETE D. JOHNSON, SENIOR FELLOW,
CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES;
PARTNER, WILKINSON BARKER KNAUER, LLP**

Mr. JOHNSON. Thank you so much. Madam Chair, Senator Cruz, Senators, as a former Army officer, former Senate Intelligence Committee and adjunct Senate Commerce Committee staffer, FCC and Commerce staffer, let me just say it is a distinct honor to be here in this room, because this committee in this room, which is the birthplace of the cybersecurity framework, it played such a crucial role in the bipartisan push for Government, industry collaboration in tech—on tech security.

Now we need to apply those principles to spectrum policy. This is critical to the security of the U.S. and our allies, because future networks will be developed either by us or by autocracies, China, Russia, Iran, and North Korea. It is that simple and our security as a market democracy is at stake.

We need to leverage spectrum for our principles, dynamism, innovation, freedom, not surveillance, control, and oppression too. So, to secure our core national interests, we have to maximize all spectrum uses from weapons and defense systems to licensed and unlicensed commercial networks.

This will be hard—we are pretty good at technical achievements, particularly at the intersection of military and commercial capabilities. Spectrum availability is an optimization challenge, not a scarcity problem. Radio waves are a critical resource, so we can either argue about scarcity or we can work together to optimize.

Our security depends on this choice. Spectrum allocation is a national security issue because supply chains derive from spectrum bands. That is one reason why we are spending billions of dollars to Rip and Replace Huawei and ZTE gear, because they were often the only suppliers of radios for the spectrum that some small carriers used. We can't let that happen again.

But we are falling behind in two areas. First, globalization, global harmonization of spectrum bands creates global scale, and companies designing for large global market have significant advantages over those designing for a smaller market. The more that our spectrum bands are harmonized with allies in global markets, the more scale trusted suppliers have for secure equipment.

We need the world's tech discourse to take place in our spectrum bands, the frequency languages that we speak, but we are in danger of giving away that position to China and its untrusted suppliers. Particularly in licensed mid-band spectrum where China leads us by two and a half times.

For scale and power, China wants to design equipment that speaks the most common frequency language, so they are taking

our role as the leader of globally harmonized spectrum. If we are—and we are beginning—we are becoming a spectrum island largely outside of harmonized bands.

If this continues, U.S. technology will be a U.S. only dialect with limited influence and global scale. Huawei and ZTE and others would gain advantages across critical use cases, from 5G infrastructure, to connected vehicles, to advanced manufacturing.

Rip and Replace restrictions can be helpful, but they are costly and insufficient. We have to be able to compete with China at the same scale in the first place, and harmonized spectrum is indispensable to that.

Second, capacity. We need enough spectrum capacity to innovate and manufacture, but today we are anemic in licensed wide area coverage, which will soon run out of capacity unless we act urgently. Local unlicensed connectivity, like Wi-Fi in a home or office, is like the capillaries of the wireless ecosystem, nourishing local applications and network functions.

As Senator Cruz and Mary have both said, our wireless capillaries are robust and healthy. We have far more unlicensed spectrum than China or any other country, which is one of the reasons Wi-Fi is such a resounding American success story.

But our arteries, the licensed wide area coverage providing mobile connectivity across our vast continent, are already near capacity, with nothing coming in the spectrum pipeline. Here we have gone from world leader to drastically trailing China and it is getting worse.

Make no mistake, this is a national security crisis, and it is a platform for China to shape the world's networks for its own autocratic interests. And also, battlefields of the future will be shaped by commercial spectrum availability.

For operational warfighting reasons, it is crucial that future network and tech like AI, cyber operations, battlefield communications are developed by us, not China. So, in conclusion, we need to act urgently to optimize our spectrum use so that America can lead in all areas of the wireless environment.

This begins with restoring the FCC's authority to auction spectrum. The lapse in this authority severely damages U.S. security every day it lapses. We need to restore auction authority so that spectrum studies become a pipeline for concrete advances in capacity and auctions for mid-band spectrum.

This will benefit all parties. The only loser in a zero sum game is U.S. national security. We need our best commercial and Government engineers to find opportunities to optimize. So, with that, I would love to take your questions and expand on these important points, but this is—we have a moment we need to seize here.

[The prepared statement of Mr. Johnson follows:]

PREPARED STATEMENT OF CLETE D. JOHNSON, SENIOR FELLOW, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES; PARTNER, WILKINSON BARKER KNAUER, LLP

Spectrum and National Security

Chairwoman Cantwell, Senator Cruz, Members of the Committee, thank you for allowing me to share my perspective on spectrum and national security.

It is a special honor to be here today, as this Committee—and this very room, the birthplace of the NIST Cybersecurity Framework—have played such an impor-

tant role in developing U.S. cybersecurity and network security policy. The bipartisan consensus that has shaped this policy over the past two decades, advancing the principles of technology innovation and dynamism and government-industry collaboration, in many ways began here.

With your leadership, we now have the opportunity to apply these principles to U.S. spectrum policy. This is absolutely crucial to the security of the United States and our allies, because spectrum policy is key to the future of the networks and applications on which our societies operate. Those networks and applications will be developed either by us, with the free market principles this Committee has long espoused, or by the deepening autocratic alliance of China, Russia, Iran, and North Korea.

It is that simple. The security of the United States as a free market democracy hangs in the balance. Fortunately, successive Administrations and Congresses have taken meaningful actions to address this threat, and now we have the opportunity to leverage spectrum policy in favor of our principles—dynamism, innovation, and freedom rather than surveillance, control, and oppression. This will require maximizing all critical uses of spectrum, from weapons and defense systems to commercial 5G and next generation wireless networks, including both local wireless connectivity and wide area coverage.

To secure our core national interests, we have to lead the world in all of these areas, and we can. However, right now we are in danger of falling far behind China in mid-band licensed spectrum that can support wide area coverage, which is critical to bringing mobile services and technologies to every part of the country. This is a grave threat to the security of our network infrastructure.

Addressing this severe licensed spectrum shortage while also maintaining our present world-leading position in defense systems and local wireless connectivity will be difficult. But as this Committee well knows, the United States is quite capable of accomplishing difficult technical achievements, particularly at the intersection of military capabilities and commercial strength. One example in the spectrum arena that I saw first-hand as an Army logistics officer in the late 1990s: The Department of Defense partnered with large industry players to develop and scale the RFID tag system for real-time global tracking of supply shipments, thereby revolutionizing supply chains and inventory management. This example is one of many reasons the United States leads the world in both military force projection capabilities and commercial dynamism.

We need to apply that type of solutions-oriented action to spectrum policy as well. As one astute colleague put it, spectrum availability is “an optimization challenge, not a scarcity problem.” The invisible radio waves that make up the radiofrequency spectrum are a critical natural resource, and we can either argue over their scarcity or work together to optimize their use. Our economic and national security depends on making the right choice.

Why Does Spectrum Matter for Network Security?

There is a direct relationship between the availability of spectrum and the ability of manufacturers and innovators to enhance and expand the state of wireless technologies. Spectrum is the lifeblood of the wireless ecosystem, serving as a core component of the technology landscape and the mutually interrelated technology development processes. This relationship is not perfectly linear or sequential, but to be clear, our security interests depend directly on spectrum availability.

Wireless research and development, technology design, standards and intellectual property, and thus hardware, software, and the applications they enable—that is, the wireless network supply chain and capabilities—are specific to particular spectrum bands. If we view Huawei, ZTE, TikTok, and other China-based “national champions” as a threat, then we must view commercial 5G spectrum availability in the United States as an antidote to that threat.

In the future, we may achieve the technological ability to obviate the connection between particular spectrum bands and technology design and development, but that is not the present reality. That is one reason why we have had to expend billions of dollars (and still counting!) to “rip and replace” Huawei and ZTE gear, as those China-backed companies were the only suppliers that built radios for the spectrum bands on which many of our small carriers operated. We should never let that happen again.

It is a national security imperative to make commercial spectrum available for 5G and future-generation wireless technologies to secure the U.S. position as the leader in trusted network technologies as autocrats seek to take the lead. China’s aggressive strategy to dominate technology in general, and 5G and future-generation networks and applications in particular, underscores the significant impacts that spec-

trum access and technology processes have on the security of the wireless supply chain and the applications the network enables.

There are two elements of this spectrum environment that are becoming security setbacks for the United States: (1) global harmonization and scale, and (2) U.S. capacity.

First, global harmonization and scale. The specific spectral frequencies available to commercial operators are indispensable to the ability of a trusted and commercially viable equipment market to develop in a harmonized environment. Wireless antennas, radios, and other network components are typically designed to operate under a band-specific framework. While future technology developments in chipsets, software, and artificial intelligence may enable wireless radios and equipment to operate without regard to spectrum-specific design, the ability of network equipment to speak different frequency “languages” is not likely to be achieved in the immediate near term. This further underlines the need for trusted and harmonized frequency availability, and for leadership by the United States and our allies.

Global harmonization of spectrum bands creates global scale for technology development, and developers that are designing for a large global market have significant tangible and intangible advantages over those that are designing for a smaller market bespoke user or use. The more that U.S. spectrum uses are harmonized with our allies and global markets, the more scale trusted suppliers have for secure technology development. In short, we need the world’s technology discourse to take place in the spectrum bands in which we operate—the frequency “languages” that we speak—but we are in danger of giving away that position to China and its untrusted suppliers.

China knows that this starts with leading in the availability of licensed mid-band spectrum for wide-area coverage; today, it leads the U.S. by 2.5 times in access to these frequencies. For scale and market positioning purposes, China wants its developers to design equipment that speaks the frequency language most broadly spoken in the mid-band environment, putting it on a trajectory toward adopting or even leading globally harmonized spectrum. Meanwhile, the United States is becoming a mid-band spectrum island that operates largely outside of core globally harmonized spectrum bands; if this trajectory continues, the U.S. technology ecosystem will operate within a U.S.-only spectrum “dialect” that lacks influence and global scale.

The result of this dichotomy is that China-based national champions like Huawei and ZTE would gain enormous advantages across a variety of critical use cases and architectures. Connected vehicles are a prime example. The Department of Commerce’s Bureau of Industry and Security (BIS) is currently examining the state of this marketplace to determine the threat landscape for foreign adversary influence over integral communications technologies and services associated with such vehicles. BIS is proposing a rule to govern transactions that might otherwise enable untrusted China-based suppliers to become embedded in this technology. Targeted restrictions can indeed be valuable, but as we have seen in the “rip-and-replace” setting, they are both costly and insufficient. It is necessary that U.S. and allied technology developers can compete with China-based developers at the same capacity and harmonized scale in the first place. The availability of harmonized spectrum is indispensable to that imperative.

Critically, the risks of autocratic leadership in essential wireless supply chain elements extends to Federal and military uses of commercial systems as well. As Deputy National Security Advisor Anne Neuberger has highlighted, the security considerations that exist in a purely commercial setting are also central to the future battlefield. The technology ecosystem in which our warfighters will wage the battles of the future will be shaped by commercial spectrum availability for current and future generations of wireless. For operational warfighting reasons, it is crucial that future technology, standards, hardware, software, and applications—including AI, cyber operations, and battlefield communications—are developed by U.S. and allied companies with sufficient spectrum harmonization and scale to lead the world.

Second, U.S. capacity. As NTIA recently highlighted in its National Spectrum Strategy Implementation Plan, “U.S. leadership in next-generation technologies and services requires greater spectrum access for both the private and public sectors in the near- and medium-term.” Indeed, it is essential that U.S. wireless companies have the spectrum resources they need to work alongside like-minded nations to innovate and manufacture advanced wireless technologies and their components—including chipsets, software, radios, and more—for use in both the commercial and Federal sectors. Today, however, the United States is anemic regarding this critical network input for licensed wide area coverage, which will run out of capacity in the coming years unless we act with urgency to address the shortage.

Consider local wireless connectivity (for instance, WiFi in a building or home or office campus) as the “capillaries” of the wireless ecosystem, drawing on broadband service to nourish local applications and network functions. Our wireless capillaries are robust and healthy; the United States has far more unlicensed spectrum allocated than China or any other country, which is one of many reasons that WiFi is a resounding American success story. But the “arteries” of our wireless ecosystem—the licensed wide area coverage that provides mobile connectivity broadly across our vast continent—are already near capacity, with no further expansions presently in the spectrum pipeline. We have gone from leading the world on this metric to drastically trailing China and a dozen peer countries, and that deficit is expected to grow substantially in the next decade.

The existing disparity between U.S. licensed mid-band spectrum allocations as compared to the rest of the world is a major national security challenge, as it has created a platform for China to shape the near-term and future technology environment in its own strategic interest. China is ensuring that its mid-band arteries have plenty of capacity, while our 5G and next-generation mid-band wireless ecosystem is limited today and soon to reach its limits, putting a corollary structural bound on the ability of the U.S. to lead in these technology developments. This problem broadens the threat landscape throughout the global network technology supply chain, further highlighting the imperative of ensuring there are sufficient licensed spectrum allocations available to support U.S. innovations in wireless.

Addressing the Risks of the U.S. Spectrum Shortage

We must act urgently to optimize spectrum use so that the United States can lead in all key areas of the wireless environment. This optimization process should be organized to benefit all parties, so everyone comes to the table transparently and with an eye to mutual benefit and advancing the interests of the United States, rather than a zero-sum game with distinct losers and winners. The real loser in this zero-sum approach is U.S. national security.

This obviously must begin with restoring the FCC’s statutory authority to auction spectrum. The ongoing lapse in this authority severely damages U.S. leadership, and thus U.S. security, every additional day it lasts. We need urgent action to restore auction authority in such a way that the studies of the bands identified in NTIA’s Implementation Plan are not just academic, but instead lead to concrete advances in spectrum capacity and auctions for necessary licensed mid-band spectrum.

With this authority in place, stakeholders should work together collaboratively and with urgency to make spectrum optimization a reality, particularly in the bands identified for study in NTIA’s Implementation Plan. Again, this process is not a zero-sum game; it should and will create mutual benefits. Federal agencies, including the Department of Defense, can maintain and in many cases upgrade or otherwise advance their vital operations, while commercial providers can build out innovative 5G networks nationwide to drive U.S. technological leadership worldwide.

Government and industry should collaborate on initiatives to maximize spectrum use in any given band. Most immediately, we must advance presently viable spectrum sharing regimes; when fully clearing a spectrum band for new uses is not practical, coordinated sharing through proven methods can be a solution. Government and industry should collaborate to advance “static” sharing, in which parties benefit from predictable spectrum access by coordinating their use over geography, time, or frequency. These sharing methods provide coordinated access and certainty, and technological developments are increasing the precision of these sharing methods. We should focus immediately on these proven models of sharing to advance our national interest in maintaining 5G leadership globally.

In parallel over the long term, we should also seek breakthroughs in “dynamic” spectrum sharing—in which each party’s use of frequencies changes dynamically according to real-time needs—to overcome existing practical impediments to real-world implementation. Such breakthroughs will likely take years to become practically and economically viable at scale, and U.S. global leadership and collaboration with allies will be required to address the need for global harmonization and scale sufficient to support diverse and competitive trusted suppliers in such a sharing environment. Absent strategic leadership, bespoke U.S.-only sharing frameworks could mean we deploy more slowly than other countries that simply implement globally harmonized, standardized frameworks, and the custom sharing solutions would be so circumstance-specific that they would have no global market.

In conclusion, U.S. spectrum leadership is directly pertinent to a secure supply chain and application ecosystem, and thus to our core national security interests. We must not walk away from globally harmonized bands and cede the supply chain to China. Rather, we must undertake immediate steps to maintain U.S. leadership in spectrum policy to secure the technology future.

This will require recognizing that spectrum policy is not a fight between commercial interests and national security. That binary frame is a false and dangerous dichotomy in the twenty-first century, when U.S. national security derives from economic strength and technological innovation as much as traditional sources of power.

I look forward to your questions.

The CHAIR. Thank you. Thank you, Mr. Johnson. Ms. Rinaldo, thank you for being here to talk about Open RAN and what advantages that would give the U.S. on technology. Thank you.

**STATEMENT OF DIANE RINALDO, EXECUTIVE DIRECTOR,
OPEN RAN POLICY COALITION**

Ms. RINALDO. Well, wonderful. Thank you to Chairman Cantwell, Senator Cruz, and members of this Committee. My name is Diane Rinaldo, and I am the Executive Director of the Open RAN Policy Coalition.

On behalf of the Coalition, I am grateful for this opportunity to discuss the transformational role of open and interoperable solutions, particularly as we navigate the implementation of 5G technology and prepare for 6G and beyond.

My goal today is to paint a picture of American innovation, regained opportunity, and economic alternatives, but none of this could happen without the lifeblood of our industry, the spectrum.

Put simply, we cannot deploy more Open RAN and reap its benefits unless we have a sufficient amount of licensed spectrum which powers the G's and Open RAN. Right now, we do not, and this committee can play a central role in addressing that shortfall.

Founded in 2020, the Open RAN Policy Coalition promotes policies to drive the adoption of Open RAN. Our coalition represents a diverse group of communication and technology companies unified under a common goal, dismantling technological and market barriers to cultivate a competitive, secure, and resilient wireless market. Since launching the Coalition, Open RAN has seen tremendous growth with more than 100 global deployments, including the world's largest right here in the U.S. with Dish Wireless.

ORAN has achieved its initial goal of providing additional vendor choice for mobile operators. However, our story is far from complete, and more work must be done. Today, most of the work from the Coalition is focused on international efforts.

As developing nations look to deploy 5G, Open RAN is a viable and desirable option, offering a cost effective and adaptable solution. And while our education mission at the Coalition is incredibly important to bring heightened awareness to international partners, Coalition members are eager to benefit from deployments here in the U.S.

Unfortunately, additional movement in the U.S. has been handicapped due to the expiration of spectrum auction authority. With no new bands in the pipeline for future deployments, Open RAN has limited opportunities to grow. Furthermore, the FCC's Rip and Replace program is stalled due to lack of funding.

The passage of the Secure Equipment Act in 2021 deemed Huawei and ZTE a national security threat, yet it still litters our networks. Huawei continues to service U.S. network functions, in-

cluding software updates in rural communities. If additional funding is not forthcoming, we must develop a Plan B.

Open RAN was a nascent concept when the FCC catalog was drafted three years ago. With the deployment of more than 100 networks around the world, Open RAN is now a viable option and our Nation's rural carriers deserve more choice.

The Coalition also continues to have productive conversations with the Department of Defense, specifically the future G and 5G cross-functional teams offices. DOD's use of commercially viable and available products stimulates the ecosystem while leveraging the best that industry has to offer.

Most recently the Naval Air Station at Whidbey Island issued a contract to build a standalone 5G network. This project includes seven coalition—several coalition members including Dish Wireless, Cisco, JMA Wireless, and Intel.

These partnerships build trust and are crucial and are crucial to the security and resiliency of our DOD networks. Last December, *The Wall Street Journal* wrote an article that Huawei expects 9 percent growth, with their Chairman claiming that they are back to business as usual.

I know this article gave a lot of people heartburn. I am here today to tell you that we are your good news story. Coalition members over the past year, Nvidia up 262 percent, AMD up 115 percent, Broadcom up 100 percent, Microsoft up 50—excuse me, 63 percent. Dish has deployed the world's largest global network, covering 73 percent of Americans. AT&T has made a \$14 billion investment in Open RAN.

Newcomers JMA Wireless, Cohere Technologies, and DeepSig are paving the way on private networks, spectral efficiencies in AI. There are 127, excuse me, companies participating in the Open RAN ecosystem from 21 different countries. The continued success is not a given. I implore this committee to reauthorize spectrum authority.

That will give us the indispensable resource that we need to compete. The geopolitical battle for secured networks will not be won between governments but through market forces. Give us the tools we need to win at 3GPP.

We hold the strategic advantage. The wind is at our back. It is time to hit the gas and not the brake. Thank you so much and I look forward to your questions.

[The prepared statement of Ms. Rinaldo follows.]

PREPARED STATEMENT OF DIANE RINALDO, EXECUTIVE DIRECTOR,
OPEN RAN POLICY COALITION

Chairwoman Cantwell, Senator Cruz, and Members of the Committee, my name is Diane Rinaldo, and I am the Executive Director of the Open RAN Policy Coalition. On behalf of the Coalition, I am grateful for this opportunity to discuss the transformational role of open and interoperable solutions in Radio Access Networks (what is commonly known as 'Open RAN'), particularly as we navigate the implementation of 5G technology and prepare for 6G and beyond.

My goal today is to paint a picture of American innovation, regained opportunity, and economic alternatives, but none of this could happen without the lifeblood of our business, spectrum. Put simply, we cannot deploy more Open RAN and reap its supply chain security benefits unless we have a sufficient amount of licensed spectrum—the Gs and Open RAN run on licensed—in the pipeline. Right now, we do not, and this Committee can play a central role in addressing that shortfall.

Launch of the Coalition

Founded in 2020, the Open RAN Policy Coalition promotes policies to drive the adoption of open and interoperable solutions in RAN. Our coalition represents a diverse group of communication and technology companies unified under a common goal: dismantling technological and market barriers to cultivate a competitive, secure, and resilient wireless market. Our members include carriers, vendors, cybersecurity and cloud service providers, innovators, startups, and established technology companies, all committed to the collective health of the competitive and diverse mobile ecosystem. This initiative transcends technological advancement; it represents a strategic shift towards fostering innovation, stimulating competition, and broadening the supply chain for next-generation wireless technologies, including 5G.

The deployment of advanced mobile networks like 5G is at a pivotal moment, not only for technology policy but for economic security and global connectivity. Open RAN is at the heart of this transformation, influencing how we approach economic and security challenges. A robust and diverse supply chain is critical, and international cooperation on wireless technology is now more vital than ever.

Since launching the Coalition, Open RAN has seen tremendous growth, with more than 100 global deployments. It has achieved its initial goal of providing additional vendor choice for mobile operations; however, our story is far from complete, and more work must be done.

Global Challenges

The undeniable truth is that we face global challenges in maintaining our competitive edge. The Chinese Communist Party's Belt and Road initiative and Digital Silk Road, with more than 150 participating countries, is a CCP strategic security initiative based on prioritized networking deployments. Beijing's "national champions" such as Huawei and ZTE are competing against U.S. and other free market-based companies at a significant advantage, enjoying the full financial backing of the Chinese Communist Party and with the strategic intent of creating vendor lock-in. While Open RAN reduces costs in hardware and software and creates the possibility of breaking vendor lock-in, these heavy foreign investments tip the scales more than those cost savings can ever compete with.

My experiences in various roles, including on the House Intelligence Committee and as the head of the NTIA, have highlighted the persistent issue of developing nations' financial constraints, which make them susceptible to predatory moves by malign actors, such as the CCP. To close that funding gap, we must simplify and expedite the processes for our companies to compete effectively on what is an artificially uneven playing field. Globally harmonized spectrum for trusted suppliers provides one important element to do just that.

The Coalition's global engagement spans over 80 countries, promoting open and interoperable telecommunications standards. This presence not only enhances connectivity and economic growth but also strengthens international relations. The Coalition's efforts in bridging the digital divide in underserved regions exemplifies our commitment to global leadership and technological advancement. We work with governments around the world at each stage of adoption. Regardless of the starting point, our work will drive governments upwards on the adoption curve, catalyzing private sector activity.

Today, among its many engagements, the Coalition is focused on working with the Quadrilateral Security Dialogue and was tasked in September 2021 by its four members—Australia, Japan, India, and the United States—work toward synchronizing allied Open RAN development efforts. Since our first project, we have expanded that mission to include other important and like-minded countries. In 2024, we are expanding further to include support of the new Global Coalition on Telecommunications (GCOT), which includes the United Kingdom, Canada, Australia, Japan, and the United States, which will become the broadest governmental coalition to date.¹

The journey of the Open RAN movement is a testament to innovation and opportunity based on robust competition in diverse markets. Conceptually and technically, this is the opposite of the CCP's command and control approach to supporting its "national champions." To maintain momentum, we must adopt a holistic approach to countering global market distortions and developing competitive parity for U.S. and allied vendors. The Coalition seeks not to reinvent the wheel but to ease the path forward, ensuring the continued evolution and success of the telecommunications industry.

¹ <https://www.ntia.gov/press-release/2023/statement-assistant-secretary-davidson-global-coalition-telecommunications>

Where we are today:

Today, most of the Coalition's work has been focused on international efforts. As developing nations look to deploy 5G, Open RAN is a viable and desirable option, offering a cost-effective and adaptable solution. And while our education mission at the Coalition is incredibly important to bring heightened awareness to international partners, Coalition members are eager to deploy in the United States. Unfortunately, additional movement in the U.S. has been handicapped due to the expiration of spectrum auction authority. With no new bands in the pipeline for future deployments, Open RAN has limited opportunities to grow further in the United States.

Furthermore, the FCC's "Rip and Replace" program is stalled due to a lack of funding. The passage of the *Secure Equipment Act* in 2021 deemed Huawei and ZTE a national security threat, yet it still litters our networks. Huawei continues to service U.S. network functions, including software updates in rural communities. If additional funding is not forthcoming, we must develop a Plan B. Open RAN was a nascent concept when the FCC catalog was drafted three years ago; with the deployment of more than 100 networks, Open RAN is now a viable option and our Nation's rural carriers deserve more options.

The Coalition continues to have productive conversations with the Department of Defense, specifically the Future G and 5G Cross-Functional Teams offices. DoD's use of commercially viable and available products stimulates the ecosystem while leveraging the best industry has to offer. Most recently, the Naval Air Station at Whidbey Island issued a contract to build a standalone 5G network. This project includes several members, including DISH Wireless, Cisco, JMA Wireless, and Intel. These partnerships build trust and are crucial to the security and resiliency of networks.

The Good News Story

Last December, the Wall Street Journal wrote that *Huawei Expects 9 percent Revenue Growth*, with their Chairman claiming they are back to "business as usual." I know this article gave a lot of people heartburn.

I'm here today to tell you we are your good news story. Coalition members over the past year:

- Nvidia 262 percent
- AMD 115 percent
- Broadcom 100 percent
- Microsoft 63 percent
- DISH deployed the world's largest Open RAN to date
- AT&T invested \$14 billion dollar in Open RAN
- Newcomers JMA Wireless, Cohere Technologies, and DeepSig are leading in private networks, spectral efficiencies, and artificial intelligence
- 127 companies in 21 countries are now participating in the Open RAN ecosystem

Continued success is not a given. I implore this Committee to reauthorize spectrum auction authority that will give us the indispensable resource that we need to compete. The geopolitical battle for secure networks will not be won between governments; it can only be won by market forces. Give us the tools we need to win at 3GPP. We hold the strategic advantage, but we can't do this without you.

Thank you and I look forward to your questions.

The CHAIR. Thank you so much. Thank you for being here. Dr. Furchtgott-Roth, am I saying that correctly? No. Tell me the pronunciation.

Dr. FURCHTGOTT-ROTH. Furchtgott-Roth.

The CHAIR. Furchtgott-Roth. Furchtgott-Roth, thank you so much for being here.

I appreciate your testimony, particularly this fine point about Huawei's global network sales that continue today and how that really is leading some countries to continue to have—espionage hostile countries, if you will, or terrorist groups are a threat against us.

So, thank you for that in your testimony. Look forward to hearing the rest of it.

**STATEMENT OF HAROLD FURCHTGOTT-ROTH,
SENIOR FELLOW AND DIRECTOR, CENTER FOR THE
ECONOMIC OF THE INTERNET, HUDSON INSTITUTE**

Dr. FURCHTGOTT-ROTH. Chair Cantwell, Ranking Member Cruz, members of the Senate Commerce Committee, thank you for inviting me here today.

Today's hearing is about the relationship between Federal spectrum policy and American national security. Some viewers view the two as a zero sum game. I disagree. I see the two as complementary. Attending to national security concerns protects commercial interests in spectrum, and robust commercial development to spectrum promotes American national security.

For much of the past century, America has been the global leader in enabling new and innovative wireless services. Communications lawyers and policy practitioners such as those of us in this room call this spectrum policy.

Most Americans are unfamiliar with the concept. They simply know that their smartphones and other wireless devices work, and they trust that our Government can keep us safe from new wireless military technologies, such as the types of drones that are currently being used in Ukraine.

Sadly, American leadership in wireless technologies is now challenged not just from competitors abroad, but also from paralyzed domestic policy. The unthinkable has happened. The FCC's legal authority to hold auctions has lapsed.

No new bands of Federal spectrum to transfer to the commercial sector are to be found, and coordination between the various Branches of Government on spectrum policy is absent. The end result? American leadership in international spectrum coordination wanes.

Our global competitors speed ahead. American consumers are left behind. And our Nation's ability to be nimble in the midst of new forms of wireless warfare is potentially compromised.

Let me tell you a secret, the greatest undeveloped natural resource in the world is spectrum. The country that harnesses it will control the 21st century. U.S. spectrum just a few decades—U.S. commercial spectrum just a few decades ago was worth about \$10 billion. Today, it is worth more than \$1 trillion.

Decades from now, our children will look back and laugh at the wireless technology of 2024. Technology will advance with or without new legislation. The Congress can—Congress cannot legislate technological change or economic growth.

The Congress can make new technology and economic growth more likely by unleashing the extraordinary power of human resources, of the greatest scientists in the world, of the greatest engineers of the world, the greatest entrepreneurs in the world, and of the American consumer.

The Cold War was won with stronger personal liberty and with the unrivaled economic power of the United States. And that is likely to be one of the great national security advantages that we will have in the 21st century if we, in fact, can unleash economic growth. There are four key steps Congress can take. More spectrum is transferred from Federal to non-Federal users.

Much, if not most, of that spectrum used is for different commercial applications. All of the above, but including particularly full powered licensed applications, the most valuable form of spectrum today.

Vital national security interest is not compromised, and substantial improvements in spectrum policy rights—and spectrum property rights, allowing more flexible use, less costly contract and lease arrangements, and improved enforcement against interference. The Spectrum Pipeline Act of 2024 addresses the first three points. It is an excellent start.

It would benefit American consumers enormously. They may not know what spectrum is or what policy is, but they will know when more competitors offer better and lower cost wireless services. The time to act is now. Be bold. Be decisive, not just for today, but for the rest of the 21st century. Thank you very much.

[The prepared statement of Dr. Furchtgott-Roth follows.]

PREPARED STATEMENT OF DR. HAROLD FURCHTGOTT-ROTH, SENIOR FELLOW AND DIRECTOR, CENTER FOR THE ECONOMIC OF THE INTERNET, HUDSON INSTITUTE

Chair Cantwell, Ranking Member Cruz, and Members of the Senate Commerce Committee, thank you for inviting me to testify before you today.

Today's hearing is about the relationship between Federal spectrum policy and American national security. Some observers view national security concerns involving spectrum and commercial interests in spectrum as a zero-sum game: focusing on one of these priorities is to detriment the other. I disagree. I see the two as complementary: attending to national security concerns protects commercial interests in spectrum *and* robust commercial development of spectrum promotes American national security.

For much of the past century, America has been the global leader in enabling new and innovative wireless services. Communications lawyers and policy practitioners call this *spectrum policy*. Most Americans are unfamiliar with the concept; they simply know that their smartphones and other mobile devices work. And they trust that our government can keep us safe from new wireless military technologies, such as the types of drones that are currently being used in the wars in Ukraine and in Gaza.

American consumer electronic devices work because American policy decisions enable them to work. From competitive auctions for FCC licenses; to the development of unlicensed applications like Wi-Fi and Bluetooth; to the competitive market for private wireless providers; to new forms of wireless communications like 3G, 4G LTE, and now 5G; and to innovative new satellite services, America has led. Meanwhile, the rest of the world has followed.

Sadly, American leadership in wireless technologies is now challenged not just from competitors abroad, but also from paralyzed domestic policy. The unthinkable has happened: the FCC's legal authority to hold auctions has lapsed; no new bands of Federal spectrum to transfer to the commercial sector for licensed or unlicensed purposes are to be found; and coordination between the various branches of government on spectrum policy is absent. The end result?

American leadership in international spectrum coordination wanes. Our global competitors speed ahead. American consumers are left behind. And our Nation's ability to be nimble in the midst of new forms of wireless warfare is potentially compromised.

Today I will compare the success of America's historical spectrum policy with today's comparatively weak spectrum policy and discuss the hazards this presents for American national security. I will also discuss the Spectrum Pipeline Act of 2024, a bill that will move America in the right direction on spectrum policy, as well as best practices for spectrum policy going forward.

I. QUALIFICATIONS

I am Senior Fellow and Director of the Center for the Economics of the Internet at the Hudson Institute. I am also president of an economic consulting firm, Furchtgott-Roth Economic Enterprises. Additionally, I am an adjunct professor at

Brooklyn Law School, where I teach communications law, as well as at the University of Baltimore Law School, where I teach law and economics.

From 1997 to 2001, I served as a Commissioner of the Federal Communications Commission, having been nominated by President Clinton and confirmed unanimously by the Senate. Previously, I was chief economist of the House Commerce Committee where, among other responsibilities, I worked on legislation that became the Telecommunications Act of 1996. After I left the FCC, I served for eight years on the Spectrum Advisory Committee to the Department of Commerce.

I have in the past also served the Federal government on national security topics. I served on a Federal advisory committee on telecommunications for the National Security Agency. I was a research analyst at the Center for the Naval Analyses, a think tank for the Navy. Early in my career, I was an analyst in the National Security Division of the Congressional Budget Office and an intern in the National Security Division of the Office of Management and Budget. I received a Ph.D. in economics from Stanford University and an S.B. in economics from the Massachusetts Institute of Technology.

I have authored or coauthored four books and hundreds of reports and articles, many related to spectrum and national security. Together with my Hudson colleague Kirk Arner, I am currently writing a textbook on communications law informed with an economic perspective.

II. 19TH CENTURY SPECTRUM POLICY

Early development of spectrum in the middle and late 19th century was heavily focused on military applications. The U.S. Army helped develop overland wireless telegraphy, and the U.S. Navy in particular developed wireless telegraphy for communications between ships as well as between ships and land. At international conferences on spectrum in the late 19th and early 20th century, military interests in spectrum policy largely dominated the position of the U.S. government.

For a century and half, the U.S. military has helped train generations of wireless engineers and technicians, as well as developed and adopted countless new wireless technologies. During that time, American wireless military technologies have been at least comparable to, and often better than, those of our adversaries.

III. 1934–2009: AMERICAN LEADERSHIP IN COMMERCIAL WIRELESS TECHNOLOGY AND SPECTRUM POLICY

For the 75 years between 1934 and 2009, the United States was unquestionably at the forefront of commercial spectrum policy due to its focus on private interests and competing commercial services rather than purely government ownership, which was a position that dominated in most other countries. U.S. commercial spectrum policy was heavy-handed and far from perfect during much of this period, but it nevertheless tended to be more market-oriented than those of other countries. The end result was to the benefit of the United States and the entire world.

To that end, one of the most successful economic policies in the last few decades has been the use of competitive auctions to transfer spectrum from Federal use to private use. In 1927, the Federal government claimed exclusive right to all wireless spectrum. Between 1934 and 1994, the FCC would take small blocks of wireless spectrum and assign new licenses to political friends or to lottery winners who could game the system. Such assignments, today referred to as “beauty pageants,” took years, and the results do not make for a good civics lesson.

Around 1960, Ronald Coase, a future economics Nobel Laureate, proposed assigning FCC licenses through an auction. At the time, Professor Coase was denounced as a crackpot by politicians, but over time, Coase’s wisdom emerged. In 1994, Congress granted the FCC temporary auction authority.

Over the next 30 years, large swaths of Federal spectrum have efficiently been transferred to commercial licensees. And until the past few years, Congress has routinely extended temporary auction authority every few years.

While the U.S. Treasury has collected hundreds of billions of dollars in auction receipts, the far bigger winner has been the American consumer who today enjoys wireless devices and networks, the existence of which would have been impossible under 1994 spectrum allocations. Imitation is the sincerest form of flattery, and nearly every country in the world has imitated American spectrum auction policy in subsequent years. Wireless services and the devices and software enabled by them, fostered in the United States, have done as much if not more than any other technology in human history to lift individuals out of poverty and provide opportunities for prosperity that would have otherwise been unimaginable.

American spectrum policy innovations existed beyond just auction authority. These include private broadcasting; commercial space services; competitive commer-

cial mobile wireless services, including Generations 1.0 through 4.0 of mobile wireless broadband and accompanying innovative handset markets; Part 15 unlicensed spectrum and associated applications; and spectrum license secondary markets.

During this period, American national security was not adversely affected by spectrum policy. If anything, our national security was enhanced by a vibrant private sector of wireless technologies that helped develop and complement wireless military technologies. Competing demands for spectrum were rarely in conflict.

The end result of better spectrum policy was a profoundly successful U.S. commercial wireless industry. By my estimates, wireless services were a substantial engine for economic growth in the United States between 1990 and 2010. New wireless services spawned the creation and development of countless businesses in the United States. Some are the largest in the world; others are small businesses. As with any competitive market, some have succeeded and some have failed. But all competed to develop new technologies and new wireless services.

American consumers benefitted too. By my estimate, the consumer welfare value of commercial spectrum in the United States easily exceeds \$10 trillion. Most of that value has been generated in the past 35 years.

Success in America generated imitation abroad. Other countries consciously emulated U.S. spectrum policy, creating independent regulatory agencies, allowing unlicensed devices, commencing spectrum auctions, and allowing competing commercial providers of wireless services. Even countries that remained avowedly “communist” all became implicitly “capitalist” with their embrace of commercial wireless competition. Other countries not only imitated the American commercial structure; they also uncharacteristically deferred to America in international fora such as the International Telecommunications Union and other technical standards-setting bodies.

Imitation may be the sincerest form of flattery. But in economics, imitation of a competitive market structure is a victory not to flatter America, but to benefit people around the world—particularly the poorest of the poor. Between 1987 and 2020, little more than a single generation, roughly a third of the world’s population escaped the lowest form of subsistence to a higher rung on the income ladder. And more than 2 billion people today have a higher standard of living than their parents, likely the greatest leap in human welfare in history. I attribute much of that improvement to the development of commercial wireless technologies. Commercial wireless technologies are novel in their ability to reach rich and poor alike. They affect the lives of everyone but particularly those whose hope is most fragile.

IV. THE LAST 15 YEARS OF SPECTRUM POLICY: AMERICA LOSES ITS EDGE

Over roughly the last 15 years, the United States has lost its edge in spectrum policy. Partly, other countries have caught up. And partly, America has stumbled. There are several reasons why.

First, because most other countries began allocating spectrum many decades after the United States, these countries have the advantage of not having vestiges of spectrum allocations that made technological sense decades ago but no longer make sense today. America is not so lucky.

Second, American spectrum policy has not been particularly innovative over the past 15 years. Of course, record amounts of spectrum have been transferred from the Federal government to the FCC for auction. Additionally, new bands of spectrum have been reserved for unlicensed users. But the structure, and arguably the scale, of these developments were largely foreseeable in 2009. Worse yet, in the past few years, the Executive Branch has chosen not to make additional bands of Federal spectrum available for transfer to the FCC. The process of how these decisions are made is remarkably opaque. Yet the end result remains: today, there is no pipeline of Federal spectrum to transfer for commercial development.

Third, FCC spectrum-related decisions are slow, costly, and cumbersome. This often prevents spectrum from being available to entities that can most efficiently use it. This result is not necessarily different from the pre-2009 period, but it diminishes American competitiveness. The exact property rights for the use of spectrum by both licensed and unlicensed spectrum are not well-defined, and where defined, they are not predictably enforced. Routine license transfer approvals can be delayed with little explanation or reason. Non-routine license transfers are even more complicated, sometimes requiring concessions unrelated to the licenses at issue. Sharing and leasing arrangements are slightly easier than before, but they are not as common as they should be in efficient spectrum markets. Interference within band and across bands is all too common, with slow enforcement mechanisms. The concept of an efficient spectrum market in which spectrum is put to its highest valued use will remain elusive until property rights are better defined; contract and lease rights are predictably and expeditiously executed at minimal costs; and protections from inter-

ference are predictably, expeditiously, and costlessly enforced. In the absence of efficient spectrum markets, interested parties are left to plead with government officials for special consideration; this differs little from a command-and-control economy or the “beauty pageants” of a pre-auction FCC.

Fourth, no country has yet developed truly efficient spectrum markets, and the efficiency of spectrum markets in the United States, limited as it is, may yet be better than spectrum markets in other countries—but not all. Some countries, such as Korea, have strong executive administrations that can make expeditious decisions without the years of haggling that characterize American spectrum policy.

Fifth, in the past 10 years in particular, public disagreements between Federal users—in particular, DoD users—on the one hand and commercial users on the other have emerged in several bands, including the L-Band, 3 GHz, C-Band, and 12 GHz. Other countries with militaries less focused on the wide array of technologies deployed by the U.S. have had fewer conflicts between government and private users.

Sixth, FCC spectrum auction authority, for the first time, ended for an extended period of time. Shockingly, most countries in the world likely have governments with authority to auction spectrum—except the United States. Also, recommendations from NTIA to the FCC on not reallocating certain spectrum that would interfere with national security-sensitive Federal users were for the first time ignored. In an unseemly display, cabinet officials as private citizens have made public statements contradicting the positions of their agencies with regard to national security recommendations. And rather than coordinate exclusively through NTIA, some Federal agencies in recent years communicate independently with the FCC. Consequently, rather than hear a single voice from the administration, the FCC sometimes hears multiple voices, not all with the same message.

Seventh, China complicated American spectrum policy 15 years ago by publicly proclaiming its intention to dominate 5G technology as a matter of official government policy. Over the past 120 years, many centrally-planned economies have announced “5-year plans” and other ambitions to develop and to dominate various technologies. All have failed miserably, with China’s efforts in 5G as a notable exception.

Finally, the Federal government does not have the means to assess the value of its spectrum holdings. No one knows how much they are worth. Could a private company approach the government and offer a large sum for a band of spectrum in a specific location either on a purchase or lease basis? No. By comparison, private parties can lease Federal land for grazing or other purposes, but not spectrum. Conversely, could a Federal agency approach a private company and offer a large sum for a band of spectrum in a specific location, either on a purchase or lease basis? No. We are very far from an efficient allocation of either Federal or non-federal spectrum.

Perhaps the most visible manifestation of today’s weak American spectrum policy can be seen in the success of Huawei’s global network equipment sales. Despite widespread concerns in the intelligence communities of many countries, many of America’s closest allies have approved the purchase of Huawei and ZTE network equipment. Substantial evidence has been accumulated demonstrating surreptitious information collection by China and other adversaries via Huawei and ZTE network equipment. Part of the concern is espionage by hostile countries, and part of the concern is sabotage not only by nation states but also by terrorist groups sophisticated enough to hack into relatively unsecure Huawei and ZTE equipment. Not only do these decisions enhance the finances of Huawei and ZTE, but they also undermine the national security of the United States and our allies.

Perhaps even worse, the standing of the United States in international fora has fallen. The United States is more isolated at the ITU and American companies are less successful in international standards-setting bodies today than they were in previous years.

In recent weeks, Americans have seen the harmful effects of wireless technologies controlled by our adversaries, including technologically unsophisticated ones. Attacks likely enhanced with wireless technologies killed American service members in the Middle East.

Hostile drones frequently attack American ships in the Red Sea and the Gulf of Aden. When a wireless network suffers an outage in the United States, sabotage by our adversaries is immediately feared. Wireless networks have become frequent avenues for espionage and potentially for sabotage.

V. ADMINISTRATION AND CONGRESSIONAL EFFORTS TO FIX SPECTRUM POLICY

Spectrum policy has never been a partisan issue, and therefore efforts to correct American spectrum policy should be bipartisan. Both the Biden administration and Congress recognize the weakness of American spectrum policy today. The administration has over the past several months introduced a “National Spectrum Strategy” that calls for a review of several bands of Federal spectrum that might be transferred to the FCC for reallocation to the commercial sector, including licensed spectrum. The National Spectrum Strategy is a good start, but the proposed timelines to complete studies for the review of various bands of spectrum—for which countless studies have previously been completed—are much too delayed. And crucially, while the Strategy calls for the studying of various bands for potential future use, it does not request the near-term teeing up a single speck of spectrum for Federal auction.

Several bills have been introduced in Congress to remedy American spectrum policy, but I would like to recommend one in particular introduced by Senator Cruz together with Senator Thune and Senator Blackburn: the Spectrum Pipeline Act of 2024.

VI. THE SPECTRUM PIPELINE ACT OF 2024

This bill contains much-needed statutory language that would repair a recently broken system. Here are a few examples:

- *Extending auction authority:* The Act would extend auction authority generally for five years and for several more years for identifiable bands of spectrum. Of course, one day, Congress ought to extend it permanently.
- *Identifying Federal spectrum to transfer to the FCC:* For the first time in decades, no Federal spectrum is scheduled to transfer to the FCC and the private sector. The Act would require the Department of Commerce to identify 1250 megahertz of spectrum to transfer to the FCC within 2 years, and 2500 megahertz of vital mid-band Federal spectrum to be transferred within 5 years. These are large amounts of spectrum, but they are consistent with the administration’s National Spectrum Strategy.
- *Setting timelines for auctions:* No major FCC spectrum auctions are currently scheduled. The Act, by comparison, sets an expeditious, tangible schedule for auctions of mid-band spectrum. These will be important steps to get more licensed spectrum for commercial use.
- *Enhancing unlicensed services:* Unlicensed services like Wi-Fi work in tandem with licensed services such as 4G LTE and 5G mobile broadband. The Act would require the FCC to identify at least 125 megahertz for unlicensed spectrum.
- *Avoiding earmarks for spectrum auction receipts:* The Act does not earmark FCC spectrum auction receipts to fund specific pet programs. Such earmarks distort spectrum policy and conflate it with other policy objectives. Instead, receipts would, under current law, go to the U.S. Treasury, a small but much needed boost to reduce a Federal debt of \$35 trillion—and growing.
- *Brevity and narrowness:* The Act is efficiently brief and does not delve into extraneous concerns.

VII. SPECTRUM POLICY GOING FORWARD

The Spectrum Pipeline Act is an important, but not final, step for spectrum policy going forward. The 21st century is, and will continue to be, the wireless century. Today, we look back at wireless technologies of just a decade or two ago, and we recognize how primitive those technologies are today. A few decades from now, our children will look back at the wireless technologies of today and similarly think of how primitive they were.

One cannot know the specifics of future technologies, but there is no doubt that new wireless technologies have yet to be imagined. We can take the steps necessary today to create a hospitable environment for those new technologies. At its foundation, this involves an environment based on market mechanisms: clear property rights for spectrum; clear contract rights for spectrum; and clear tort remedies for interference with spectrum.

Coase’s Theorem, as it has come to be known, posited that absent transaction costs, negotiations between private parties over privately owned assets results in the assets being put to their highest-value and most economically efficient use. Under these market conditions, according to Coase and common sense, spectrum will be put to its best and highest-value use. These are policy criteria that cannot

be easily legislated. America needs policy leaders who will strive to allow efficient market principles, not command-and-control decisions, to direct Federal spectrum policy.

Our national security will be enhanced if the greatest advances in wireless technology are once again in the United States and if countries around the world once again look to the United States for leadership in spectrum policy. We need more spectrum in the commercial sector, spectrum that can be put to higher valued uses. The Spectrum Pipeline Act of 2024 is an excellent start.

Our adversaries will take the opposite approach. They will seek to control new wireless technologies with better centralized planning and more government control. As long as we remain committed to efficient market solutions, their efforts will fail.

The CHAIR. Thank you very much to all the witnesses. I think you did a great job at setting the stage for the need, the urgent need for the United States to lead in what will be the technology—communication technology of the future, and certainly laid out some of our immediate challenges as it relates to China.

I wanted to start with you, Dr. Ghosh, you mentioned this. Well, everybody is on one note very crisply, solve the Rip and Replace problem. So, thank you for that and we are trying. Definitely want to try to further our efforts there aggressively.

And I think it is you, Mr. Johnson, who talked about—no, Ms. Rinaldo—I mean, I am definitely in support of a, what I would call a technology NATO. You know, the countries that you mentioned, Australia, Japan, India, the United States working collectively on setting the standard for technology.

You know, you can't have government backdoors. You can't have these kinds of violations. And we say to the rest of the world community, these are the standards by which you buy technology. I think that would be very helpful today. So, definitely supportive. But this notion of continued R&D.

Listen, we all wish we could have moved forward a year ago, but not all our colleagues were on board with that, and they were successful at convincing some not to move forward. But, your notion of continued R&D investment, how do we achieve that?

How do we achieve what you are talking about as it relates to really catapulting the U.S. into continued leadership position here?

Dr. GHOSH. Thank you for that question. So, the National Science Foundation is the lead research agency for the country, and, they have done a fabulous job of funding most of the R&D that has happened.

In the recent past, we have had other agencies like NTIA also come in with research funding to help the—grow this ecosystem of spectrum research, as well as things like ORAN. I really think when we look at advancing R&D, it shouldn't be off in a silo by itself.

The better we integrate academia with industry, with Government, to tackle the really important problems facing us today in this world of communications, the more effect that research funding will have.

The Spectrum X, the research center that I am a part of, which is led by the University of Notre Dame, is an excellent example of one way that we can go about getting this research funding out. It is a nationwide center.

It has about 47 and growing number of universities. It is a way to educate the next generation, the workforce needs. We have

heard from a lot of the agencies that the spectrum workforce is aging, and we need the next generation to be educated in all of the various aspects, starting from the engineering and technical, to the policy aspects.

The CHAIR. And what do you do, because I want to ask Mr. Johnson a question. So quickly, what do you do about the national security element? Do we figure out how to get more collaborative dialog with people who have national security clearances? You know, how do we solve that problem?

Dr. GHOSH. I think that—I mean, I have a security clearance. A lot of academics at Notre Dame do. We are involved in, you know, DARPA projects, DOD projects. I think getting those connections done better would definitely help take what is happening in the research labs and getting them into the hands of the military, of the science agencies, of even commercial industry.

The CHAIR. Mr. Johnson, your artery analogy is so apt. And so, what is it that you think that we need to do now that would help unleash that? Even though we have had this, you know, report on dynamic spectrum sharing, is there some artery unclogging that we could do today?

Mr. JOHNSON. Absolutely. And the great thing is that I think all Senators and Representatives, all of the leaders of Article—of the Article I branch know that we need a pipeline.

And that is—it needs to be concrete. It needs to provide a pipeline of additional commercial spectrum, with the screaming need being the wide area coverage where we are two and a half times behind China.

The CHAIR. And how important is that to get started now?

Mr. JOHNSON. Absolutely crucial. Every day we are falling behind. So, we need a statute to make that happen.

The CHAIR. Thank you. Senator Cruz.

Senator CRUZ. Thank you, Madam Chair. Mr. Johnson let's follow up on what you were just saying. You stated in your testimony that, "we are in danger of falling far behind China in mid-band licensed spectrum that can support wide area coverage."

I very much agree, and I am worried that this gap will have repercussions beyond 5G and 6G and will harm our leadership in the industries built on top of wireless networks, from advanced manufacturing to AI, to next generation app development.

Mr. Johnson, in your judgment, why is legislation like the Spectrum Pipeline Act, with defined timelines for auctions, so critical to preventing our adversaries from overtaking U.S. wireless leadership?

Mr. JOHNSON. Thank you, Senator. We have a national spectrum strategy. We have an implementation plan. We have studies. What we need is a pipeline. All of those things lead to a pipeline, but we can't get to a pipeline without a statute.

And so, we need a statute that gives the FCC the authority that it has had—it had for 30 years until a year ago, and so that they can—so we can have a new pipeline, particularly for where we are so far behind in the wide area coverage licensed mid-band.

Senator CRUZ. And expand on that for a moment. Why is licensed wide area, full power coverage such a critical part of America's spectrum pipeline?

Mr. JOHNSON. I would say for two reasons. One negative—one is it is the only part of our ecosystem where we are behind. We have the best weapons and defense systems in the world. As Mary articulated, we have the best unlicensed and Wi-Fi capabilities in the world.

We are falling—we presently have the best network infrastructure in the world, but we are in danger of falling behind. And it is that network infrastructure that will be a crucial component of the future 5G infrastructure.

That is what is built by Huawei and ZTE and others. So, we have to secure that as is evidenced by the Rip and Replace need. So, we have to secure the infrastructure and that is where the arteries, so to speak, come into play.

Senator CRUZ. Thank you. Dr. Furchtgott-Roth, you are a well-respected economist and a former FCC Commissioner. I have to say, I am concerned by your assessment of the paralyzed state of our domestic spectrum policy. Do we need more studies and deliberation, or do we need real action to restore our wireless leadership?

Dr. FURCHTGOTT-ROTH. Senator, we need action. We don't need more studies. We don't need more committees or bureaucracies. We need action.

Senator CRUZ. And speaking as an economist, how important are strong property rights in promoting an efficient spectrum marketplace? If licenses are shared either with Federal users or among commercial users, how would that limit the ability of licenses to maximize their spectrum resources?

Dr. FURCHTGOTT-ROTH. Property rights are extraordinarily important for efficient markets and for economic growth. There can be property rights in all different types of spectrum, and different usage arrangements, but we need to clarify those.

And the Nation that leads in defining better property rights in spectrum is the nation, I believe, that will dominate the 21st century.

Senator CRUZ. Thank you. Ms. Rinaldo, you have stressed the importance of a spectrum pipeline to broaden the supply chain for next generation wireless networks. Putting on your hat as the former acting head of NTIA, can pipeline legislation and incentives for agencies to move out of certain bands help to break the bureaucratic logjam in getting licensed spectrum into the marketplace?

Ms. RINALDO. Absolutely. I think that is the one thing that we have consistently seen across the board. Money is not a motivating factor for the agency, so we need to re-imagine incentives that are going to allow them to move in and upgrade their technologies.

Senator CRUZ. And in your judgment, how will the Spectrum Pipeline Act of 2024 open the door for U.S. manufacturers like Mavenir, a homegrown Texas company, Nvidia, and Broadcom to compete against Huawei and ZTE, and to encourage foreign companies to manufacture more equipment in the U.S., as Samsung has done recently in Texas.

Ms. RINALDO. Yes, it might sound cliché, but first movers' advantage, and we have seen that already, especially in your backyard at Telecom Corridor in Dallas with Fujitsu, who moved their networking business here about 2 years ago.

Senator CRUZ. And Ms. Brown, I also believe the United States needs to maintain its leadership in Wi-Fi, which is why the Spectrum Pipeline Act of 2024 requires the FCC to allocate at least 125 MHz for unlicensed use, and potentially up to 1,250 MHz. How would the unlicensed allocation and the Spectrum Pipeline Act help us counter Huawei and ZTE's influence abroad?

Ms. BROWN. Well, first of all, thank you for that part of your bill. That would be an extremely helpful addition to the unlicensed portfolio, particularly if we can position it contiguous to the existing 6 Gigahertz band for which there are already standards and for which we could ship equipment tomorrow.

So, that would be a tremendous show of American leadership as the world continues to look at this part of the spectrum. If we learned anything from the World Radio Conference, if we stick together as a country, we can get done what we need to get done. And that would be a great asset to the Wi-Fi community.

Senator CRUZ. Thank you.

The CHAIR. Senator Welch.

**STATEMENT OF HON. PETER WELCH,
U.S. SENATOR FROM VERMONT**

Senator WELCH. Thank you very much. Madam Chair and Ranking Member, I want to thank you for this hearing. And I want to thank the witnesses too.

I am new to this committee, but this has been extremely informative, and I really appreciate getting the context and how urgent it is that we resolve these problems so that we do have the best situation in the world. I am going to take my opportunity to talk about something a little bit different because it is so urgent and that is the Affordable Connectivity Program.

It is about to expire, and that is really literally at the other end of what we are discussing now. It is for lower income folks around the country to be able to connect to the internet. In this Congress, bipartisan support, we have done an enormous amount, especially as a result of COVID where there was a recognition that being on the internet, having access to that was really critical for the well-being of our—all of our families, where folks, couldn't go to school unless they had the internet. They couldn't get a doctor's point without the internet.

And we have built out the internet, but that—it is no good if you can't afford to get on it. If you are that family who makes \$15,000 a year, has two kids, and you are trying to figure out how you can pay your bills and afford food.

So, the Affordable Connectivity Program is \$30 bucks a month help to these families all around the country, millions. In Vermont, it is like 25,000 families and it is expiring. And one of the big challenges we have—because there is broad support for the program.

It affects all of our communities, whether we are in a red state or a blue state. And it is evidenced by the bipartisan support we have for the efforts to do it. Ben Ray Lujan has been doing an immense amount of work on that. But we have many colleagues on this committee, Senators Vance and Rosen, Senator Cramer, have been very supportive.

And one of the challenges is how are we going to pay, it is about \$7 billion, in order to keep that going. So, Madam Chair, I have mentioned this to you, I know others have, and I know there is enormous demands. Whenever there is any money that may be available, the spectrum auction is one of the sources that may possibly be able to allow us to continue this program.

But it really, really is urgent. And along the way, as we are re-considering how to do it and keep it going, if there is reforms that make it more efficient, deal with improvements. I know, Senator Capito, you have mentioned some concerns that you have had.

And Senator Wicker, I know you have as well. Let's do it. You know, let's make it better. Let's make it more efficient. But the bottom line, I think, is that we really have to continue the Affordable Connectivity Program.

Otherwise, folks who are, fairly dependent on their 30 bucks in order to maintain connectivity are going to fall off. And surveys have indicated they really will. And will they get back on? Probably not. So, this is a real setback for kids and especially in rural America, and families in rural America that are absolutely the same as the rest of us.

They need access to the internet, just like folks in rural America needed access to electricity back in the 30s. And we made a decision that it was worth it socially, for the benefit of our country, to electrify America. We have made that same decision here, but we have got to keep it affordable.

So, Madam Chair, thank you for your indulgence in letting me make my case to fund the Affordable Connectivity Program. Thank you. I yield back.

The CHAIR. Well heard. Well heard. Senator Wicker.

**STATEMENT OF HON. ROGER WICKER,
U.S. SENATOR FROM MISSISSIPPI**

Senator WICKER. Thank you very much. Let's see, so much talent and brainpower at the table. Where to start? Back a few years ago, we passed a bill called the Beat China to 5G Act. Led to the successful auction of 3.45 to 3.55 Gigahertz band.

This auction required DOD to compress its systems—let's go to you, Mr. Johnson. You may have even been with us then. To compress its systems into the lower part of the 3 Gigahertz band.

Now, NTIA is studying whether we should do that again. Is this an option? It is—will compression work again as an option for DOD and other incumbent Federal users? If not, what is the way forward there?

Mr. JOHNSON. Thank you, Senator, and thanks for your leadership on that bill and so many other of these bipartisan initiatives. I think that is a great example because it shows we can do this. We are actually better than any—

Senator WICKER. Can we do it again?

Mr. JOHNSON. We can do it, and we can do it again. And the better that we get at doing it is, as Mr. Furchtgott-Roth and Monisha have said, the better we get at doing it, the stronger we will be and the stronger we will be in the 21st century.

Senator WICKER. OK. Who disagrees with that? Ms. Brown.

Ms. BROWN. I think when we look at new bands today, we need to evaluate them from three perspectives.

Senator WICKER. Oh, OK. Well, let's see, I have only got a moment or two. But you fundamentally don't agree with——

Ms. BROWN. Right.

Senator WICKER.—and I think Dr. Ghosh, you don't either. OK, would you supplement your answers for the record so that I can proceed?

Ms. BROWN. We will.

Senator WICKER. Let me ask you this, Dr. Furchtgott-Roth about proposed Biden Administration policies. Digital discrimination rules. Will that make it more costly for broadband providers to connect unserved and underserved Americans that Senator Welch is concerned about?

Dr. FURCHTGOTT-ROTH. Senator, depends on how they are implemented. But there is a great risk that the rules will make it more costly for providers to provide broadband services to all——

Senator WICKER. What might the rules contain that we need to avoid?

Dr. FURCHTGOTT-ROTH. I wouldn't want to prejudge what the Commission will come up with, but if they impose any requirements that lead to greater costs of service, those costs will be shared by all Americans.

Senator WICKER. And the Biden FCC, predictably, has begun laying the groundwork to reinstate 1930s regulations. What about that?

Dr. FURCHTGOTT-ROTH. I assume you may be referring to network neutrality——

Senator WICKER. I don't like net neutrality because I think it is a misnomer.

Dr. FURCHTGOTT-ROTH. It sounds like a Swiss railway company, but yes I don't like the term either. But I don't think Title 2 should apply to——

Senator WICKER. How would that affect investment?

Dr. FURCHTGOTT-ROTH. Very negatively.

Senator WICKER. When the ox was in the ditch here in the United States during COVID, we didn't have the so-called net neutrality, as compared to Europe. Europe kind of shut down, didn't they?

Dr. FURCHTGOTT-ROTH. That is right. They——

Senator WICKER. We didn't have—we really didn't really have a problem, did we?

Dr. FURCHTGOTT-ROTH. No, sir, we did not.

Senator WICKER. The talk is we did not distinguish ourselves as a country at the World Radio Communications Conference in December, and we kept relying on other countries and asking them what they thought. Have you heard that?

Dr. FURCHTGOTT-ROTH. Yes, sir.

Senator WICKER. Do you agree with that?

Dr. FURCHTGOTT-ROTH. Yes.

Senator WICKER. Well, does that give you concern?

Dr. FURCHTGOTT-ROTH. I have been concerned about the stature of the United States internationally, in international conferences, and in standard setting bodies for more than a decade now.

Senator WICKER. OK. And then we you know, we have talked about Rip and Replace and these Chinese companies, but Chinese equipment remains in the networks of small rural providers and there is no auction authority. Is this a matter of concern?

Dr. FURCHTGOTT-ROTH. Yes, sir, it is.

Senator WICKER. And is it just a matter of not funding the Rip and Replace?

Dr. FURCHTGOTT-ROTH. No, it is all of the above. That is—there is a lot of work to be done.

Senator WICKER. All right. Thank you. Thank you, Madam Chair.

The CHAIR. Thank you, Senator Wicker. Senator Capito.

**STATEMENT OF HON. SHELLEY MOORE CAPITO,
U.S. SENATOR FROM WEST VIRGINIA**

Senator CAPITO. Thank you, Madam Chair. I thank all of you for being here today. Professor Ghosh, did I say your name correctly? Yes. Thank you. West Virginia needs—I am from West Virginia.

We need more connectivity. But to close that digital divide, I have been technology neutral because we have a lot of mountains. Not every technology works in our state. And fixed wireless has shown some promise.

So how do you see the role of fixed wireless after future auctions playing out in the rural areas?

Dr. GHOSH. Thank you for that question. I think that rural connectivity is about more than just spectrum. It is about having deployments.

So, you can have all the spectrum in the world, but if base stations are not deployed, you are not going to get coverage.

And there are—we have done a lot of work with rural areas in Illinois where we have the same problem, where farms are not connected.

So, I think we have to be more creative in getting rural and isolated communities connected. CBRS is actually proving to be a great alternative to doing that at, shared spectrum. But, if you have a satellite back—

Senator CAPITO. Could you say, what is that, CB—

Dr. GHOSH. CBRS. That is the Citizens Broadband Radio Service. Senator CAPITO. OK.

Dr. GHOSH. That is shared spectrum 3.55 to 3.7 Gigahertz. It is shared with Navy radar, but the U.S. has led and coming up with a system of sharing that is very effective.

Senator CAPITO. Would that be affected by an auction?

Dr. GHOSH. It has already been auctioned. So that band is already available.

Senator CAPITO. OK. That is already on, OK.

Dr. GHOSH. It is already available. There are three ways that you can get to it. You can either have bought licenses at the auction that happened in 2021, I believe. Or you can also use it like an unlicensed—in an unlicensed mode called General Authorized Access, which gives you all of the benefits of having paid for auction.

And the real benefits that you get with CBRS as compared to either Wi-Fi or cellular is it is a frequency band that propagates very

far, much further than Wi-Fi does. And in terms of cellular, it—you don't have to pay to access that spectrum.

So, this is working very well. Many communities, even in, South Bend, we have a deployment with CBRS, was deployed by the City of South Bend to serve its lower income students. It is not an underserved area.

There are other options, but you know, talking about the ACP and looking for ways to get it more affordable, CBRS is offering that option for communities to take control of their connectivity needs.

Senator CAPITO. OK. Ms. Brown, we have a—the national radio quiet zone is in West Virginia.

And, we have half of that, but it restricts transmissions to allow for—so that it allows for advanced scientific research and other sensitive technology operates without interference. And we are—a very remote part of our state, but we are running into problems here is it also conflicts with the 9–1–1 service and the ability to deliver service.

So, when you have a conflict like that, how in those sensitive areas can we continue to work so that you can you do the innovation that you need to do on the—in the quiet zone area, but you can still serve your citizens on the 9–1–1? Does anybody have an answer for that?

Ms. BROWN. That is a difficult question when you have quiet zones.

And that requires a lot of technical analysis to look at, are there wireless signals that could be propagated at low power, at a low level in order to deliver the 9–1–1 technology that you need while not interfering with the radio astronomy.

Radio astronomy also has a number of bands available to it. And it may be that you have to ascertain which of those bands is going to be best if you are concerned about having 9–1–1 connectivity at that facility.

Senator CAPITO. OK.

Ms. BROWN. It is an engineering problem, yes.

Senator CAPITO. Yes, well, I mean, I am thinking about the folks out in Pocahontas County where this is located.

They are going to need some technical expertise. Obviously, the state can help, but this has been a chronic issue out there. So, I am going to ask just a general question.

I don't have all that much time left, like 35 seconds, but if a regular citizen is sitting here listening about, we are going to auction spectrum, what does that mean to them? So, who wants to take that? We will give it to one person. Yes.

Ms. RINALDO. So, I think when you bring additional spectrum online, it is going to improve the user's experience. What we have seen across the networks is that we are at capacity. And so, if we are able to bring more spectrum, you are going to be able to get stronger, faster, more resilient signal.

Senator CAPITO. So, what I think of somebody who maybe is in an unserved and underserved area who has gotten—who has been promised and hopefully through the IIJA we are going to be able to deliver this, I think what they hear is we are going to improve

all of the things that have already been improved upon and you are still going to be left behind.

Ms. RINALDO. You know, no, it is absolutely, it is incumbent upon us to articulate how we can get more coverage out to our rural communities and that is a big part of this as well. And we are exactly where the spectrum bands are coming into play. And then the carriers are able to build out in your area.

Senator CAPITO. All right. Thank you.

The CHAIR. Thank you. Senator Rosen. Hold on a second, we have a sound issue with you.

Senator ROSEN. OK.

The CHAIR. There you go.

Senator ROSEN. Can you hear me now?

The CHAIR. Yes, we can.

**STATEMENT OF HON. JACKY ROSEN,
U.S. SENATOR FROM NEVADA**

Senator ROSEN. Oh, perfect. Well, I was just thanking you, and thanking you for holding this really important hearing because all of the spectrum issues, it really makes a huge difference. And last week, I was proud to lead 33 Senators in calling on Congressional leadership to fully fund both the FCC's Rip and Replace program and the Affordable Connectivity Program. In 2020, Congress created a Rip and Replace program, which requires companies to remove untrusted, untrusted network equipment.

While critical to our national security, the program has only been funded at 40 percent, so this is forcing our small and our rural providers to eliminate coverage, absolutely just eliminate across our networks. In Nevada, one company stated, they are going to have to reduce service to about 26,000 mi² as a result.

And this is cutting off wireless access and emergency services to Nevadans in rural areas. And likewise, the ACP program has been pivotal for helping close that digital divide, and nearly 9 percent of Nevadans use this benefit to lower their cost of Internet bill each month. But without additional funding, this program is going to lapse by the end of April.

So, I recognize that reauthorizing the FCC spectrum authority, auction authority opens up a lot of revenue, which could be used for funding these vital programs and others, and I remain committed to working across the aisle to find a path forward for both Rip and Replace and ACP to ensure that our networks remain secure, and that Nevadans can get coverage.

And so, with Rip and Replace, we have seen the real world impacts of failing to lead in innovation and provide meaningful, innovative alternatives for untrusted foreign equipment. The U.S. has made progress, some progress in removing high risk Chinese equipment like Huawei and ZTE.

But we must lead the way—we have to also lead the way in offering alternatives. And so, Professor Ghosh, how can U.S. spectrum policy contribute to growing an ecosystem that provides meaningful alternatives to untrusted network equipment manufacturers?

Dr. GHOSH. Thank you for that question.

As I have said before, I think by having well-thought-out, rounded spectrum policy that is not exclusively focused on exclusively licensed spectrum but also looks at other ways of getting spectrum into the hands of people so they can manage their own connectivity better is absolutely crucial.

So, especially when we are looking at the spectrum congestion that we face, especially in the mid-bands, it is absolutely essential that we do this better than we are doing it now. Just having more spectrum does not equate to better connectivity if the actual infrastructure is not deployed.

Senator ROSEN. Thank you. And I appreciate that.

And I am going to ask Mr. Johnson, you know, if we don't have a clear and unified domestic spectrum policy, as you are hearing about spectrum congestion and somehow some of these things are being used, is there a risk that the U.S. becomes a spectrum island?

And what does that mean for our national security if we don't have a good policy that addresses some of these issues going forward?

Mr. JOHNSON. Thank you, Senator. I think what it means, specifically, if we are—if the United States is a spectrum island, we and our, the global technology ecosystem will be surrounded by Chinese technology.

So, if we think Huawei and ZTE and TikTok and other Chinese national champions are a problem, and I certainly do, then if we are an island, we will be surrounded by that problem.

And in that case, I don't think there—I am concerned, as a former Army officer, that there are no weapons systems or defense systems that can secure our national interests in that setting.

Senator ROSEN. Thank you. Thank you for sharing that. I am going to move now to talk about Open RAN, which is one of the ways that U.S. is leading by advancing a new—a new communications framework through, like I said, Open RAN.

After launching the first 5G Open RAN network in Las Vegas in 2021, Dish has expanded their network to over 70 percent of the country. And so, I was very proud to support the CHIPS and Science Act, which included \$1.5 billion for the Wireless Innovation Fund, which just announced funding for an Open RAN lab to talk about this new innovation, things we have to do, to allow carriers to test their equipment on the Open RAN network.

So, Ms. Rinaldo, what more can Congress do to support the Open RAN model and other types of wireless innovation?

Ms. RINALDO. Thank you, Senator. There is so much that still can be done. Encourage NTIA to disperse the additional \$1.4 billion that they have. It needs to go out in the next two to three years. International assistance programs haven't worked for the telecom industry.

We need to take the tools that we have and make them work better for us. We are dealing with Chinese Communist Party market distortions around the world. So how can we take the XM Bank, the DFC, make it more usable for our industry?

I would also say to the Senators, as you travel and talk to your counterparts around the world, ask them where they are in the

build, who they are using in their networks. I think the additional education and inattention really does make a global difference.

And then, just we have had a great working relationship with Congress, with the Administration, so it is good to have everyone on the same page on this one. And it has made a tremendous difference in the last 4 years in bringing Open RAN from just a concept to over 100 global deployments.

Senator ROSEN. Well, thank you for that. I have some questions for the record. I know my time is up. I am very interested in discussing the dynamic spectrum sharing and will be submitting that for the record. Thank you, Madam Chair.

The CHAIR. Thank you. Senator Fischer.

**STATEMENT OF HON. DEB FISCHER,
U.S. SENATOR FROM NEBRASKA**

Senator FISCHER. Thank you, Madam Chair, and also thanks to our Ranking Member for holding this hearing today. The defense of U.S. networks is critical as foreign threats grow, particularly those in China. For this reason, removing high risk Chinese equipment from our communication networks should be paramount to this committee's work.

Congress cannot simply watch as networks go dark. My bipartisan bill, the Defend Our Networks Act, would tackle this problem head on. This program shortfall needs our attention, and it needs it now. To that end, I would like to enter into the record this letter from impacted carriers.

The CHAIR. Without objection.

[The information referred to follows:]

COMPETITIVE CARRIERS ASSOCIATION
March 6, 2024

Hon. MIKE JOHNSON,
Speaker of the House,
U.S. House of Representatives,
Washington, DC.

Hon. HAKEEM JEFFRIES,
Minority Leader,
U.S. House of Representatives,
Washington, DC.

Hon. CHARLES E. SCHUMER,
Majority Leader,
U.S. Senate,
Washington, DC.

Hon. MITCH MCCONNELL,
Minority Leader,
U.S. Senate,
Washington, DC.

Dear Speaker Johnson, Majority Leader Schumer, Minority Leader Jeffries, and Minority Leader McConnell:

In 2020, Congress took steps to address a growing threat to our national security: telecommunications equipment and services that pose a national security risk to the United States. Congress created the Secure and Trusted Communications Networks Reimbursement Program (Program) at the Federal Communications Commission (FCC) to fund the removal of such equipment and services, including equipment produced by Huawei, ZTE, and other Chinese companies, and its replacement with equipment and services from trusted vendors.¹ To date, Congress has provided less than 40 percent of the approved cost estimates needed to fulfill this national security mandate. The Program cannot succeed until Congress funds the \$3.08 billion shortfall² so that Program participants can complete their projects and eliminate

¹See Secure and Trusted Communications Networks Act of 2019, Pub. L. No. 116–124, 134 Stat. 158 (2020), <https://www.congress.gov/116/plaws/publ124/PLAW-116publ124.pdf>.

²See Letter from Jessica Rosenworcel, Chairwoman, Federal Communications Commission, “Update to Members of Congress Regarding the Secure and Trusted Communications Networks Reimbursement Program” (May 3, 2023), <https://docs.fcc.gov/public/attachments/DOC-393206A1.pdf>.

this threat, while also ensuring that American consumers and businesses can continue to access communications services, including 9–1–1 and emergency services.

The situation is dire. Due to the lack of full funding, many Program participants, especially in Western states, are forced to decide where to remove covered equipment but not replace it, eliminating service available today both to their subscribers as well to anyone that roams into their network coverage. Due to lack of Program funding and challenges providing service in sparsely populated areas with extremely tight margins, carriers, including those that are the only wireless provider serving much of their market, will go out of business altogether. This critical work cannot be completed with only forty cents on the dollar, and costs incurred to date are reaching or surpassing the funding currently available.³

Real-world impacts and consequences will result from a lack of full funding for the Program:

- A Program participant will be forced to reduce its coverage area by over 67 percent (over 31,000 square miles) in Arizona and nearly 64 percent (over 26,000 square miles) in Nevada. The impacted areas include key military and national security installations. That same carrier would have a nearly 90 percent reduction in service in Utah.
- A Program participant in New Mexico will lose 70.2 percent of its current coverage area (over 19,000 square miles) leaving customers unserved absent immediate funding.
- A Program participant in Colorado will be forced to reduce its coverage area by 73.8 percent (13,766 square miles) absent full funding.
- A Program participant in Wyoming will be forced to reduce coverage by over 80 percent (nearly 4,000 square miles).
- A Program participant in Montana will be forced to reduce service by over 62 percent (over 1,500 square miles).
- A Program participant that serves the Navajo Nation will likely reduce coverage in that area by 20–40 percent, in certain areas eliminating the only service available to communities highly dependent on the Affordable Connectivity Program.
- A Program participant covering 122,000 square miles in the Rocky Mountains is deciding what portions of its network to terminate because of the funding failure. Absent additional funding, its coverage area will be reduced by over 70,000 square miles, eliminating the only coverage roamers have available. This coverage area includes 40 military installations, 32 of which are in areas that will not retain service without full funding, including a strategic missile base. Absent full funding, only 91 healthcare facilities out of 456 will remain covered, and only 415 schools or other educational facilities out of 1,897 will be able to retain coverage. Over half of this provider's approximately 40,000 subscribers will be affected, as well as the 13–14 million roamers that use the network each year.
- A Program participant in Western states that connects approximately 20 million annual roaming customers, in addition to its own customers, would see service degraded or lost.
- A Program participant serving a large rural area in the upper plains cannot transition to 5G because it does not have full funding to remove untrusted equipment. The network, and the communities it serves, will degrade over time and the area will go from served to unserved.
- Another Program participant in the South faces financial obligations beyond its prorated Program funding and faces dire implications in the absence of full funding even if they do not rip and replace.

These examples are just some of the negative outcomes facing Americans across the country. To be clear, this issue does not only affect impacted carriers' own subscribers. Tens of millions of customers from nationwide wireless networks roam onto these networks while travelling to and through impacted areas and will have their connectivity and access to emergency services and 9–1–1 reduced as well.

Failure to act immediately will be catastrophic for large swaths of the country. Millions of Americans, particularly in rural areas and on Tribal Lands, could lose basic connectivity. It also means that untrusted equipment remains in service, in-

³Katie DiRico, *Rip & Replace Data Understates Participants Incurred Spending Costs*, SUMMIT RIDGE GROUP (Feb. 16, 2024), <https://summitridgegroup.com/rip-replace-data-understates-participants-incurred-spending-costs/>.

cluding some near military bases, airports, and other areas of strategic importance. Every day that passes increases the risk of catastrophic network failures as this untrusted equipment remains in networks and cannot be maintained.⁴ Carriers participating in the Program take national security and network security seriously, and they are working diligently to remove all equipment determined to pose a security threat, but they need Congress to provide adequate funding to complete this work.

The Program is a national security mandate created by Congress; success demands Congress provides adequate funding. While the United States has taken a leadership role internationally on the risks of untrusted communications equipment and services from companies connected to the Chinese government, work remains to eliminate that risk in our own heartland. Congress must immediately prioritize this national security emergency and fully fund the Secure and Trusted Communications Networks Reimbursement Program.

Sincerely,

TIM DONOVAN,
President & CEO.

cc:

The Honorable Maria Cantwell, Chair, Senate Committee on Commerce, Science and Transportation

The Honorable Ted Cruz, Ranking Member, Senate Committee on Commerce, Science and Transportation

The Honorable Cathy McMorris Rodgers, Chair, House Committee on Energy & Commerce

The Honorable Frank Pallone, Jr., Ranking Member, House Committee on Energy & Commerce

The Honorable Mike Gallagher, Chair, House Select Committee on the Chinese Communist Party

The Honorable Raja Krishnamoorthi, Ranking Member, House Select Committee on the Chinese Communist Party

Senator FISCHER. Looking at our Nation's management of spectrum, we all know that we must be efficient and innovative. This is true for Federal agencies and for non-Federal entities that use spectrum.

Economically, we face a global race for leadership and technologies these airwaves fuel. But boosting spectrum efficiency cannot come at the cost of harming systems our Department of Defense depends on to keep this country safe.

Vital missile defense radar systems operate in Alaska and in Hawaii using the same key mid-band spectrum that many corporations seek to obtain. We cannot deter or defeat China if our radar systems cannot reliably detect, identify, and track an ICBM missile or other incoming threat.

And while this committee often hears about China's ambitions to dominate certain global industries, we must not forget China's focus on expanding and modernizing their military forces.

For example, the breathtaking expansion of their nuclear triad. If we—it would be very reckless to sacrifice current and future military capabilities solely for economic gain, and we should not continue to see DOD only as the pot of spectrum gold at the end of the rainbow. I am also a senior member on the Armed Services Committee.

We are hearing today far from our INDOPACOM Combatant Commander, as well as our Commander on the Korean Peninsula,

⁴See *Protecting Against National Security Threats to the Communications Supply Chain through FCC Programs*, Report and Order, Order, and Further Notice of Proposed Rulemaking, FCC 19–121 (rel. Nov. 26, 2019) (prohibiting use of Universal Service Funds for maintenance of untrusted equipment).

both in classified and unclassified briefings. The information presented to SAS today only serves to reinforce my commitment to the duty, the first duty of Congress, and continuing to be sure our military has what it needs in regard to spectrum to protect this Nation.

The Administration's new National Spectrum Strategy and Implementation Plan further highlight the disjointed communications on spectrum management. Throughout drafting, DOD's work and feedback were heavily omitted and outright rejected.

The study that NTIA, our Federal spectrum coordinator, co-led with DOD on critical lower 3 spectrum continues to be dismissed by this Administration. That study still hasn't been released publicly to inform this discussion we are having. Senators King, Hirono, and I wrote a letter to the Administration about these concerns over a month ago.

We still haven't heard back, and I can't say that I am surprised by that. Dr. Ghosh, DOD has stated that it would undermine our national defense if we displaced its systems, especially those in the lower 3 band.

We also know that spectrum sharing systems today use the same trusted 5G supply chain as exclusive spectrum systems, supporting the same supply chain. When dealing with DOD spectrum, can American innovations in spectrum sharing help resolve these intense fights over moving systems to clear bands?

Dr. GHOSH. Thank you very much for that question. Absolutely, and we have proof of that. CBRS is already doing that. There has been, as far as I am aware, no documented evidence of interference to any Navy radar from commercial deployments since CBRS.

The way we have done that in CBRS is to move away from the high power exclusively licensing option and investigate low to medium power, perhaps indoors sharing options. I will point out that even China has said that the 3.3 to 3.4 Gigahertz band is for shared indoor use.

I don't know whether they have military operations in that band, but clearly the rest of the world is also looking at different ways of using spectrum so that you can layer on more than one application in the same band.

So dynamic spectrum sharing at low, medium, perhaps indoor power is a great way to protect the DOD, not having them leave the band, but add on other services on top of it.

Senator FISCHER. In your briefings, have you had detailed explanations from DOD on current systems that many are classified—on current systems and the effect it would have on them? Radars, F-35s?

Dr. GHOSH. Yes, yes. I was actually participated in the Path SS effort between NTIA and DOD, the one that you just referred to. I think that collaboration worked exceedingly well. There was academia in the room. There was industry, the Government agencies.

I agree with you, it would be nice to see the public report come out of the work that went into doing that. But we are continuing some of those efforts within academia. We are still engaged in looking at how 5G can coexist at different power levels with DOD operations.

Senator FISCHER. Thank you. Thank you, Madam Chair.

The CHAIR. Thank you. Senator Peters is next. And then, Senator Blackburn, I have seen her on the remote a couple of times, but she would be after that. So, if you are ready.

**STATEMENT OF HON. GARY PETERS,
U.S. SENATOR FROM MICHIGAN**

Senator PETERS. I am ready.

The CHAIR. If not, we will go to Senator Hickenlooper.

Senator PETERS. Thank you, Madam Chair. Thank you. Ms. Ghosh, one use of spectrum that I have long advocated for is transportation safety technology, like a cellular vehicle to everything technology.

This type of technology helps connect vehicles to each other, to other road users as well as infrastructure. It dramatically could improve safety and efficiency, as you well know. The applications include collision avoidance, school bus safety, first responder signal priority, and the list goes on.

My question for you is, as you know, these technologies are reserved in the 5.9 GHz band. And in 2020, the FCC acted to reduce the amount of spectrum available in that band for these applications.

So, from your perspective, what are the particular challenges or opportunities created by reserving 30 MHz of spectrum for the transportation safety technologies? And second, what are the strategies we can use to ensure that we are maximizing safety applications in this band, in the future?

Dr. GHOSH. Thank you for that question. I was at the FCC, actually, when that decision to remove 30 MHz was made. So, I think one of the things I would like to point out is that the ideas, band had been allocated for 20 years prior to 2020. It was in late 1999.

I think that band was allocated for ITS and there has been very little deployments. So, I think now that we have C-V2X, which is a newer way to do this, I agree that it would be good to have 75, but 30 is also a sizable portion of spectrum. I think what we need to have is deployments.

The thing with vehicular communications is that you need a critical mass of vehicles out there. If I am the only car on the highway that has this technology, you have nobody to talk to.

So, we need that infrastructure, if you are going to do vehicle to infrastructure, we need a critical mass of vehicles, so you can do vehicle to vehicle, and that needs to get started as soon as possible. I think 20 years has been a long wait for this technology to really come into play.

Senator PETERS. But the question is, it is coming into play. So, it is, you are seeing especially as we move toward autonomous vehicles. It is a big aspect of that.

So, the technology may not have been developed for a while, but then right when we are actually developing it all and we know there are going to be major increases over safety, to try to take spectrum away so someone can download a movie quicker—I think I would rather save people's lives in automobiles.

And let's think about where that technology is today and where it is going. Not think about, well, they didn't develop this 20 years ago. You can say that about airplanes. Hey, we reserved things for

airplanes, but they weren't developed till the Wright brothers did it.

You know, that is not the way to look at it. So, I would hope we are looking at the future.

Dr. GHOSH. I agree. And I think, I will be—you know, there are concerns about interference from adjacent bands into C-V2X, and all of those are concerns that we need to study more.

Senator PETERS. Right. Absolutely need to do that, but hopefully safety is always number one, not quicker videos. Mr. Johnson, I have appreciated the testimony that you gave today on the threat posed to our national security by Chinese telecommunications firms like Huawei and ZTE.

And I agree that we must actively address this threat, which is why I strongly support shortfalls in the—to fund those shortfalls in the Rip and Replace funds that rural broadband needs for these networks. Northern Michigan University, for example, provides broadband service to over 16,000 households in Michigan's Upper Peninsula and has been facing a \$27 million shortfall in Rip and Replace of their Huawei systems since 2021.

This is not just a national security issue. It is a rural broadband access issue, which is critical. So, if you could speak to coverage and quality issues that rural broadband networks face that are reliant on Huawei and ZTE equipment. And if they don't receive the funding and are unable to upgrade, what is that going to mean for them?

Mr. JOHNSON. Thank you, Senator. I speak as a rural American citizen, live in rural Northeast Georgia, so it is personal to me and my family. This is the easy part, frankly, that we have to—we know where the gear is, we know how much it costs, and we just need to get rid of it.

And I think that the harder part is if we let China lead on spectrum, all of the connected vehicles and autonomous vehicles, and essentially any mobile technology that we have has the danger of being produced by China for autocratic means, that will be something that we can't rip and replace.

So, this part is the easy part, and we have to do it. Those 16,000 people need to be able to make 9-1-1 calls.

Senator PETERS. Appreciate it. Thank you. Thank you, Madam Chair.

The CHAIR. Thank you. Senator Blackburn.

**STATEMENT OF HON. MARSHA BLACKBURN,
U.S. SENATOR FROM TENNESSEE**

Senator BLACKBURN. Thank each of you for being there this morning. Ms. Rinaldo, I want to come to you first. Spectrum is a scarce resource, and I appreciate that you all are here talking about it this morning. I have long called for an inventory of spectrum assets that the Federal Government is holding.

And I know when you were the Acting NTIA Administrator, that you asked the Federal agencies to review their frequency assignment and to quantify their spectrum utilization. And the goal was to ultimately estimate the extent to which each system used its assigned spectrum.

Make certain we didn't have spectrum squatting. So, talk a little bit about how these assessments might help us as we look to more efficiently use our scarce spectrum resources, particularly as we are drafting spectrum pipeline legislation?

Ms. RINALDO. Thank you, Senator. Yes, so incredibly important to have a better understanding of who is doing what and where. And while I sent that in 2019, it needs to be done every couple of years. I think as part of us moving forward, we need to ensure that our process is in place. And so, things like this are done periodically without being directed to do so.

Senator BLACKBURN. Great. One of the things that I have put some work in, Senator Warner and I introduced the Promoting U.S. Leadership and Standards Act, which improves, would improve our Nation's ability to advance its agenda at meetings, particularly, meetings around emerging technologies, and would help bolster our leadership on the global stage.

And I was disappointed with how we were represented at the World Radio Conference and the lack of leadership that was there. And the U.S. at the last minute was forced to change personnel, wrestle with domestic policy disputes, and proceed with unclear objectives.

In other countries, especially our adversaries, do not conduct themselves in this way. They are organized and they dominate on the world stage. As a result, countries like China, Iran, Russia are leading these discussions. Huawei had a significant presence at WRC 2023, and they were one of the loudest voices represented there.

So, Mr. Johnson, you said in your written testimony that the U.S. is a, and I am quoting you, "mid-band licensed spectrum island that operates largely outside of core, globally harmonized spectrum bands."

So, what impact does this have on U.S. leadership in mid-band spectrum, and how does it affect our economic and our security interest?

Mr. JOHNSON. Thank you, Senator. And I think our economic and security interests are identical. They are completely aligned. What it does is it undercuts, the long standing U.S. leadership that has characterized almost all of, post-World War II history, including in spectrum and, and we are in danger of losing it.

And China knows they have a—they have a strategy, a plan, and they are taking action. And that is why, I think the number I heard was there were 45 Huawei representatives in Dubai, not to mention all the other China based representatives.

They know where the future lies and they know where they are ahead and we are behind, and we need to—if we just let this happen, we will be seeding the future of the technology supply chain to China, which will have drastic impacts.

Senator BLACKBURN. Thank you for that. Mr. Furchtgott-Roth, you will weigh in on this? What do you see as the impact? How do we fix it?

Dr. FURCHTGOTT-ROTH. Senator, your bill with Senator Warner is very important. These international fora, both through the ITU and through standard setting bodies are extraordinarily important.

And, you are right, the United States, frankly for many years, has not taken these as seriously as we should.

In part, it is that decades ago, certainly the 1990s—1980s and 1990s, the United States was offered a great deal of deference because we were the undisputed world leader in a lot of these technologies.

We no longer are. We don't get the deference. And we need to restore America to a position of strength in which other countries looked to us for leadership.

Senator BLACKBURN. Thank you. Thank you, Madam Chair.

The CHAIR. Thank you. Senator Klobuchar.

**STATEMENT OF HON. AMY KLOBUCHAR,
U.S. SENATOR FROM MINNESOTA**

Senator KLOBUCHAR. Very good. Thank you very much, Senator Cantwell, Chair, and thank you for allowing, some of us to have this capability to do this by video as well. I have 100 things this morning, so I appreciate it.

An estimated 240 million calls, as you all know, are made to 9–1–1 centers annually, yet there is still outdated technology for 9–1–1 centers. For example, in many places, it doesn't even still support text messages, which is pretty outrageous in this day and age.

As co-chair of the Senate Generation 9–1–1 Caucus—Next Generation Caucus, I lead legislation with Senator Cortez Masto to modernize our 9–1–1 systems. Professor Ghosh, do you support using spectrum auction proceeds to modernize our 9–1–1 infrastructure?

Dr. GHOSH. Yes, absolutely. The 9–1–1 infrastructure needs all the financial support it can get.

Senator KLOBUCHAR. And I want to enter in the record a letter to Chair Cantwell and Ranking Member Cruz from a number of organizations supporting public safety that support this position. If I could, Chair.

The CHAIR. Without objection.

[The information referred to follows:]

March 19, 2024

Hon. MARIA CANTWELL,
Chair, Senate Committee on Commerce,
Science, and Transportation.

Hon. TED CRUZ,
Ranking Member, Senate Committee on
Commerce, Science, and Transportation.

Chair Cantwell and Ranking Member Cruz:

On behalf of the Public Safety Next Generation 9–1–1 Coalition, we respectfully submit this letter for the record concerning the imperative of modernizing our Nation's 50+ year-old 9–1–1 infrastructure to Next Generation 9–1–1 (NG9–1–1). As you consider the national security implications of spectrum policy at the hearing entitled "Spectrum and National Security," we highlight the national security imperative of NG9–1–1 and opportunity to fund NG9–1–1 with spectrum auction revenue.

Our coalition was honored to collaborate in a bipartisan fashion with the House and Senate, as well as industry stakeholders, to draft legislation that would create an NG9–1–1 grant program. This legislation would provide the funding needed to deploy NG9–1–1 in a fully interoperable, comprehensive, secure, innovative, and reliable manner throughout urban and rural areas, ensuring no community is left behind.

In late 2022, the NG9–1–1 bill was included in a legislative package that would have directed the revenue from spectrum auctions managed by the Federal Communications Commission to fund NG9–1–1 implementation. That approach received strong bipartisan and bicameral support and nearly passed into law. More recently, the NG9–1–1 legislation was included in H.R. 3565 (the Spectrum Auction Reau-

thorization Act), which passed the House Energy and Commerce Committee with unanimous support last year.

Federal support for NG9-1-1 remains an urgent need. The cyberthreats are outpacing our public safety agencies' defenses. Every day that passes means 9-1-1 professionals and emergency responders lack the advanced communications tools and cybersecurity resources they need to best protect life and property. NG9-1-1 will begin saving lives in our communities the moment it is deployed.

Achieving NG9-1-1 as soon as possible is a national security imperative, for the following reasons:

1. Enhanced Response to Disasters and National-level Threats

During natural disasters or terrorist attacks, time is of the essence and critical decisions need to be made with the best information available. The current 9-1-1 system is limited to voice calls and basic text messages, preventing citizens from sharing multimedia content and other information that could provide real-time actionable intelligence to emergency responders. Upgrading 9-1-1 systems to allow for the exchange of data, photos, and videos will provide local, state, and national officials with improved situational awareness, resulting in faster and more effective responses and better outcomes for the public and first responders.

2. Protection Against Cyberattacks, Including State-Sponsored Attacks

The current 9-1-1 system already suffers cyberattacks, which disrupt emergency response capabilities and put lives at risk. In most cases, a single 9-1-1 emergency communications center serves numerous responding agencies. Thus, an attack on a 9-1-1 center has a cascading effect on multiple emergency response chains, making it a prime target for cybercriminals and state-sponsored attacks. NG9-1-1 requires a modern cybersecurity architecture that provides end-to-end IP-based intrusion detection and prevention capabilities. Federal funding is needed to implement this upgrade on a national scale and ensure that emergency services are available when they are needed most.

3. Support for National Defense Efforts

The 9-1-1 system is an important part of the Nation's defense infrastructure. In the event of a national emergency or attack, the first line of defense is 9-1-1. Multiple civilian and defense agencies and departments would be involved in the response effort. The capabilities of a fully implemented NG9-1-1 network would be vital to improving coordination and ensuring clear, secure, and resilient communications capabilities for national security and defense.

We look forward to continuing to work with you and the committee to finish the job and enact this needed legislation.

Respectfully,

MEL MAIER,
Spokesman,

Public Safety Next Generation 9-1-1 Coalition

Coalition Members:

Association of Public-Safety Communications Officials, International
Fraternal Order of Police
International Association of Fire Chiefs
International Association of Chiefs of Police
Major Cities Chiefs Association
Major County Sheriffs of America
Metropolitan Fire Chiefs Association
National Association of State EMS Officials
National Organization of Black Law Enforcement Executives
National Sheriffs' Association

Senator KLOBUCHAR. Thank you. Let we continue on this vain. Professor Ghosh, about how to use technology in a better way so it serves everyone. One of those issues is bringing broadband to every corner of the State. And we know to do that and of the country, you need to get accurate maps.

Not just to know where the coverage is still needed, but to make sure that no one's overstating their coverage. I led an effort back in 2020 to improve the accuracy of the FCC broadband availability maps.

We have seen some improvements, but there is more to do. Professor, I understand you worked on broadband mapping during your time at the FCC and led a pilot project to retrofit postal service vehicles and garbage trucks to door to door and test maps which I love the idea of actually testing what we see on paper or on the internet. How effective have these pilots been?

Dr. GHOSH. Thank you very much. I—that was one of the most fun things I have done at the FCC. So, while at the FCC, we did the postal vehicles. And then when I came to the University of Notre Dame, we did the same thing with garbage trucks.

This is a very easy, actually, way of collecting network coverage information without going out of your way to do drive tests like a lot of operators do. We are doing a very similar thing within Spectrum X.

Our center, which we call broadband map us, is a project where we have involved students and we have given them phones that they then go out and collect data for on the phone.

So today we have very easy ways to collect signal strength information from our phones, and they are doing very innovative things like mapping—you know, sort of correlating the network coverage with the socioeconomics of the places that they are collecting the data in.

So, I think there are many inventive ways we can do this.

Senator KLOBUCHAR. Very good. And I just think just having that accountability and knowing that we are checking on things can lead to more accurate outcomes, because no one wants to be found that they actually weren't telling the truth of the coverage.

Mr. Johnson, you note in your testimony, changing topics, that foreign companies were the only suppliers that built radios for the spectrum bands where many small carriers operate. Can you discuss how coordinating spectrum use with our allies can help ensure carriers have competitive options when buying equipment?

Mr. JOHNSON. Thank you, Senator. Yes, ma'am, the basic answer is that if we have harmonized spectrum bands, we have global scale, and that means that our trusted suppliers have a scaled market to design to and to sell to.

Often and I think in most cases in this arena, design and development start with spectrum band, with the spectrum band. It goes all the way down to the chips and the software. So, it is literally the beginning of the technology development.

Certainly, Huawei and ZTE know that which is I think probably why they designed those radios for those sort of bespoke smaller spectrum bands.

Senator KLOBUCHAR. OK. Along the lines of competition, Ms. Rinaldo, prior to Open RAN, there were only a handful of telecommunications equipment vendors serving wireless network operators.

Can you explain how these Open RAN vendors are bringing more competition to the market and helping lower costs for network deployment?

Ms. RINALDO. Yes. So, there are 127 companies participating from 21 different countries around the world. And what we have seen that—why Open RAN has been so successful is that because

we give companies and countries something to run to, as opposed to run away from.

Senator KLOBUCHAR. Well said.

Ms. RINALDO. When I was at NTI—I am sorry?

Senator KLOBUCHAR. I said, well said.

Ms. RINALDO. Thank you. So, just when I was at NTIA, we would go around the world, people didn't want to go to Huawei, but they just didn't see any alternative. So, I think that is why there has been such a huge interest in Open RAN not only here in the U.S., but globally.

Senator KLOBUCHAR. All right. Thank you very much. Appreciate it. Thank you, Senator Cantwell.

The CHAIR. Thank you, Senator Klobuchar. Next is, Senator Vance, if he is ready. If not, I am sure Senator Lummis would be.

**STATEMENT OF HON. J. D. VANCE,
U.S. SENATOR FROM OHIO**

Senator VANCE. I appreciate it. Thanks to the Chair for hosting this hearing. And I think, like a lot of my colleagues here, you know, I am relatively new to the spectrum issue, and I am just trying to understand everything.

And, you know, obviously sort of the one of the big debates in the spectrum question is sort of, well, you know, the DOD wants this mid-band spectrum. It is obviously very valuable. And you also have a lot of commercial users who want it too.

And so, I am sort of mindful of Cruz—Senator Cruz's and Thune's efforts on this. But I maybe just want to ask each of you for kind of your perspective on this and how you think about the balancing of factors that we are thinking of.

And, you know, I will just go down the line, if I can and, you know, maybe try to answer relatively briefly because I am just curious in everybody's sort of perspective on this. But like, you know, imagine you are a Senator for a day, and you are trying to figure out how to balance the national security implications of mid-band spectrum with the commercial concerns.

Like, how would you guys do it? And how do you think about sort of these tradeoffs? That is a relatively open ended question, but by design. So, maybe we will just start with, and I am terribly—I am going to butcher his name, but Dr. Furchtgott-Roth.

Dr. FURCHTGOTT-ROTH. That was very good, Senator.

Senator VANCE. Well, OK. Great. It is the best thing I will do all day.

Dr. FURCHTGOTT-ROTH. I would—I think you hit it on—hit the nail when you said balance. And I think it is a question of balance and certainly want to take national security interests into—we want to take this, balance those against the incredible commercial value in the spectrum.

And I would like to see a study that kind of sort of goes maybe 25 MHz, by 25 MHz, by 25 MHz, and sort of say, if you took off 25 MHz, how much would that cost DOD, if you took a 50 MHz, how much would it cost DOD, and come up with some numbers and figure it out from there.

Senator VANCE. OK. That is helpful. Ms. Brown.

Ms. BROWN. Thank you for the question. I think we have to now start evaluating Federal spectrum from three perspectives. One, could it be compressed? Could it be—could Federal spectrum be compressed, or could those systems be cleared?

Two, could they be shared with commercial users, as we have done in CBRS, the very successful CBRS model? And three, should we consider putting unlicensed technologies in as an underlay and could that be a successful model? Unless we have the information for all three, we can't make an informed decision.

Senator VANCE. OK. Thank you, Ms. Brown. Ms. Ghosh.

Dr. GHOSH. I think we should look at our needs, not another country's. China is four times our population. And if they have more spectrum, it doesn't mean that we need more spectrum.

We need to look at what our defense needs are, what our consumer needs are, and what our science needs are. We often forget that we need spectrum for things like weather satellites as well. And I agree with Mary's assessment, we should look at all options before we decide that one is the best.

Senator VANCE. OK. Thank you. And Ms. Rinaldo.

Ms. RINALDO. I would say that none of us want to degrade the capabilities of our defense. I was at the House Intelligence Committee, and I worked on these issues. I have a tremendous respect for what our armed service are doing.

What we are discussing is there a possibility to move, and not only move, but to increase capabilities. And I think that is why it is so important to relook at how we incentivize the agencies that—could we give them increased technologies with funding from the Spectrum Relocation Fund?

I also think we need to remove the personalities and the emotion from this conversation and have it be data driven.

Senator VANCE. Just want to follow up on that. I mean, how much of the debate is a scientific debate about, you know, what happens when you move 25 MHz this direction or that direction, and how much of this is, we understand the scientific implications, we are just sort of having a turf war over interest from there. Maybe, Mr. Johnson, I will give you that one.

Mr. JOHNSON. Thank you, Senator. And I will answer as a former Army logistics officer, I have spent my entire career at the intersection of national security and commercial security.

Senator VANCE. Sure.

Mr. JOHNSON. And I think in this case, it is the same. These interests are the same. And so, I would borrow a lot of the—sort of the ideas that have been said by my four fellow panelists and just add that I would shift the whole posture.

I actually don't think it is about tradeoffs. I think it is about optimizing. And if we look at how do we make the best use of the available spectrum, that is a different discussion from who is taking from whom. If we do that, the best in the world, which we can and we have, I think we can do it better.

But this mix that Mary talked about and some of the advances that Harold and Monisha discussed, we can lead the world and it will benefit our defense systems and it will benefit our commercial security, all of which benefits U.S. national security.

Senator VANCE. Sure. And I am sure my staff and I will follow up just to try to better understand some of these answers in detail. But I appreciate your time and appreciate you being here today. Thanks.

The Chair: Thank you, Senator Vance. Senator Hickenlooper.

**STATEMENT OF HON. JOHN HICKENLOOPER,
U.S. SENATOR FROM COLORADO**

Senator HICKENLOOPER. Thank you, Madam Chair. And thanks to all of you for being here today. I think this is almost like the, you know, the 1927 Yankees. I am not sure we have had this much horsepower at one table since I have been here.

There is a lot of talk these days about, TikTok and ByteDance, but I want to come back again to the issues around Rip and Replace. And I think that it is worth discussing from all perspectives.

You go back to 2020, when Congress authorized the FCC to financially reimburse rural wireless carriers for the costs of ripping and replacing network equipment that have been made by Huawei and other companies that posed a national security threat.

The program currently faces a \$3 billion funding shortfall, as we have heard. Small carriers are bearing the financial burden of repairing their networks and disposing of their equipment without being reimbursed, as was promised.

In Colorado, this is a big risk. Some reports indicate a wireless carrier in Colorado could soon be forced to reduce its coverage by 70 percent without full reimbursement for the program. That is nearly 13,000 mi².

Simply put, small wireless carriers across the country serving rural communities are at risk of shutting down parts of their network in places where they are, in many cases, most needed. And Colorado is not alone.

We have our little heat map that demonstrates that the lack of funding is affecting states across the country. And it is not just a threat to national security. It is a threat to our goal of bridging the digital divide, maintaining access to telehealth, and public safety.

So, I guess I would ask each of you, and just go down and start with Dr. Ghosh, do you believe closing the gap in Rip and Replace funding is critical to both national security and public interest?

Dr. GHOSH. Yes.

Ms. BROWN. Yes.

Mr. JOHNSON. Yes.

Ms. RINALDO. Yes.

Dr. FURCHTGOTT-ROTH. Yes.

Senator HICKENLOOPER. Really nothing better than rhetorical questions where you are sort of guiding. Switching a little bit back to Open RAN, which I think again is a fascinating but critical issue.

Ms. Rinaldo, thank you for your testimony today and all your work on this. Open radio access networks really can revolutionize how we build communications networks, how successfully we can interoperate. Is that a real word?

Ms. RINALDO. Exactly.

Senator HICKENLOOPER. Make them more interoperable, and it allows us to build networks with components that are from trusted

U.S. vendors. Not ZTE, not Huawei, not any of the companies from our rivals.

In Colorado, we have Dish. They have taken a lead and developed the first, I think the largest standalone Open RAN 5G wireless network, and they are launching service now across the country.

Ms. Rinaldo, how can we accelerate Open RAN adoption and lower barriers to the entry of new vendors in the Open RAN ecosystem?

Ms. RINALDO. Thank you, Senator. And thank you for your leadership at ITS. Absolutely, Dish has been a leader on Open RAN.

And I think how we get additional operators to participate in the Open RAN ecosystem is Spectrum Auction Authority. The more spectrum that we can auction, the more bands we are bringing online, the more opportunities for Open RAN. I would also say that standards is such a critical part of this conversation.

We need to incentivize companies to go to standards. We need to ensure that we are working beforehand. That we have, again, right, this talk about the chaos—that we have a good, unified position as we enter in these standards body. So, I would also say that's incredibly important.

And then just NTIA, encourage them to get the additional funding out the door as soon as possible. If we are going to bring Open RAN to scale, we need that money to be out the next two to three years.

Senator HICKENLOOPER. Absolutely. And I think that sense of urgency is something that we haven't seen—we haven't seen the level of urgency that I think we would all agree we need. Dr. Ghosh, let me ask you, you know, we lead the world in private R&D, you know, investments in terms of telecommunications.

We get top flight researchers from around the world. Also, entrepreneurs from around the world that come here to set up businesses and do their research. But we actually have all that talent, you know, right here already in many cases.

And American companies are developing these exciting new, you know, the dynamic spectrum sharing abilities to maximize our range that we have. I think that is—it should be another priority to make efficient use of these—of this potential, and these efficiency gains could be critical in reducing energy consumption, meeting climate goals, we can go down the list.

So, how can this DSS, this dynamic sharing, dynamic spectrum sharing, help us achieve more energy efficient networks?

Dr. GHOSH. Thank you for that. I think there are two ways that DSS can really help in reducing the footprint of ICT, as it is called, which is growing. So 5G was supposed to be more energy efficient than 4G, and it turns out that the total energy expenditure of 5G is actually growing. The—one of the key ways the DSS dynamic spectrum sharing can help is by sharing spectrum with the Federal users, but at a much lower power.

So, to get into this building from a base station outside, you have got to overcome about 20DB, which is 100 times of signal loss. If instead of that, you could have a dynamic—a CBRs kind of shared network deployed in the building that your phone connected to, you would have just reduced the amount of power you transmit.

So, I think, you know, keeping that goal. It is a goal of a lot of the next generation, standardization activities, and I hope to see that we will make progress on that.

Senator HICKENLOOPER. Right. And I feel—I am out of time, but Ms. Brown and Mr. Johnson, I will submit my questions for you into the record. But I appreciate all of you taking the time—taking the time to come and testify.

The CHAIR. Senator Thune.

**STATEMENT OF HON. JOHN THUNE,
U.S. SENATOR FROM SOUTH DAKOTA**

Senator THUNE. Thank you, Madam Chair. Let me just start by saying that spectrum decisions are often driven by the amount of proceeds that a particular bill might raise rather than policy, which concerns me.

When I authored MOBILE NOW and in working with Ranking Member Cruz on this Spectrum Pipeline Act of 2024, I have always focused on getting the policy right, not on how much money the bill would raise.

And so, I would just ask each of the panelists and a simple yes or no, should spectrum policy be driven by the dollar sign certain legislation could raise? Dr. Ghosh.

Dr. GHOSH. No, it should be for the user's capabilities.

Ms. BROWN. No.

Mr. JOHNSON. No for security.

Ms. RINALDO. No.

Dr. FURCHTGOTT-ROTH. No. All the proceeds should go to the U.S. Treasury.

Senator THUNE. So, Mr. Furchtgott-Roth, could you elaborate on the specific harms that allowing spending priorities to dictate spectrum policy?

Dr. FURCHTGOTT-ROTH. Yes, Senator. The important thing about spectrum policy that we have been discussing today is to get spectrum from the Federal Government to the private sector, or to protect spectrum that is in the Federal user.

But the auctions are all about getting spectrum to commercial users as quickly and expeditiously as possible. And the spectrum policy shouldn't be focused on how much we can get to some specific activity. I think Congress does that through the Appropriations Committee. And that should be the way it should operate.

If you think about it, today, we have—approaching a \$36 trillion deficit. If you could find \$100 billion a day, \$100 billion a day, you could not pay off the Federal debt in a year. We just have this massive debt. How are we going to close it?

Senator THUNE. Well, let me just—that is a subject that I am interested in but probably not for this conversation. But in my view, the United States needs to make more mid-band spectrum available both for commercial licensed and unlicensed uses to maintain our global competitiveness.

It is clear to me that the Biden Administration is not taking our mid-band spectrum deficit seriously, while China and our rivals are freeing up this crucial spectrum. The President's national spectrum strategy commits to freeing up zero Megahertz of spectrum, not a single Megahertz.

Mr. Furchtgott-Roth, is there any urgency that you see from this Administration to make more spectrum available for commercial use? And then just as a follow up to that, how important is it then for Congress to act to provide a real spectrum implementation plan?

Dr. FURCHTGOTT-ROTH. Senator, I think the two can work together. I think there are some positive elements in the Biden Administration spectrum policy. But it—the timelines are much too broad.

They need to be tightened up and there needs to be some identification of spectrum that is going to be in the pipeline by a date certain.

And that is why I think that the bill you have co-sponsored on the Spectrum Pipeline Act of 2024 has—it is an excellent bill and moves everything in the right direction.

Senator THUNE. Ms. Brown, I was supportive of and pushed the Pai FCC to make the 6 Gigahertz band available for unlicensed use. This order fulfilled an important mandate of the MOBILE NOW Act, which recognized rural both licensed and unlicensed spectrum play in the communications landscape.

During the most recent World Radio Communications Conference, it was reported that China and Huawei are working against the United States to reverse the progress made on 6 Gigahertz. Could you elaborate on how this played out and how moving forward—or I should say, and moving forward, what steps should the United States take to ensure we are leading the world in wireless advancements?

Ms. BROWN. Well, thank you, and thank you for all your support of unlicensed through the years, including the most recent Spectrum Pipeline Act and your discussion of advanced Wi-Fi. China has been opposing U.S. industry efforts to open the upper 6 Gigahertz band from the day the FCC made its decision in April 2020.

We have encountered Huawei and Chinese interest in every country, in every proceeding that has looked at the 6 Gigahertz case. That culminated in November and December of this past year WRC, where China attempted a spectrum grab. They tried to use the WRC decisionmaking process to basically tell the world, you will not use the upper part of the 6 Gigahertz band for unlicensed.

You will not even have that discussion. You will only use it for exclusive licensed mobile use. That is not what happened. Thanks to U.S. leadership at the conference, we ended up with a resolution whereby the countries of the world could decide for themselves based on their own strategic objectives what they wanted to do with the upper 6 Gigahertz band.

And that means that U.S. industry can continue to go country by country to try to influence national regulation and come up with a harmonized approach to the 6 Gigahertz band. Going forward, we are going to need help from the Administration.

And we work very closely with the trade organizations within the USG to try to use those levers to help us as we go around the world.

Senator THUNE. Well, thank you all very much. And I would just argue, Madam Chair, that it is time to reload the pipeline, and I

think you all have testified to that today and how important that is for—on so many levels.

So, I hope we can get moving on legislation that would bring some certainty and clarity to the issue. Thank you.

The CHAIR. Thank you, Senator Thune. Senator Lummis.

**STATEMENT OF HON. CYNTHIA LUMMIS,
U.S. SENATOR FROM WYOMING**

Senator LUMMIS. Thank you, Madam Chair. And I want to thank my colleague from Colorado who has allowed me to use his map to illustrate the issue of Rip and Replace—

The CHAIR. Senator Lummis, I wanted collaboration so much and I am glad we have it.

Senator LUMMIS. You definitely have it on Rip and Replace. This is a huge problem for the three States in brown, Nebraska, Wyoming, and Colorado.

Because the Congress only provided enough money to cover 40 percent of the costs of eliminating the Chinese made equipment from their networks, and the three states that are the most at risk, are the three in brown, including my own. [Map displayed.]

So, one wireless provider in my state is deciding now what parts of their network they will need to shut down soon. I mean, really soon because they don't have the funds to replace the equipment that Congress ordered them to remove.

So, this provider covers 122,000 mi² of land. It contains 450 health care facilities, 1,900 schools, 40 military installations, and a significant part of that includes segments of Interstate 80.

Now I-80 runs, of course, from coast to coast. It runs through Central Nebraska and Southern Wyoming. The area of coverage that is going to get lost is this area of coverage, and it covers a large part of Interstate 80, so all of those truckers—and it is a huge commercial trucking route across our country, and they are going to lose coverage.

And so, if we have spectrum, great. But if there is nobody to access the spectrum on the ground, what good is it? So, for Wyoming, and of course, my colleagues in Nebraska and Colorado, this is a huge risk. And time is running out. They are going to shrink their coverage because of the huge geographic area that they need to coverage.

So, I definitely share the goal of identifying additional spectrum for the rollout of 5G and 6G, but truly, it won't be much use if no wireless providers are around to use it because Rip and Replace was inadequately funded.

So, I want to make an urgent call, along with my colleagues from Nebraska and Wyoming, and a couple other States, even the ones in the more orangy, the deeper orange, are in tremendous risk of losing coverage. So, and we have funding sources. There is two bills that have funding sources.

One is, Senator Fischer's from Nebraska, and she is using extra COVID money. Senator Daines has another source of funding to fully pay for this Rip and Replace. But the fact that it hasn't been done and it has put these providers at a place where they are just going to have to cut coverage.

And it has been a long time since you could drive down Interstate 80, and just all of a sudden drop the call for extended mileage, before you can pick it back up. And this is critical because our blizzards are epic, and trucks are left by the roadside in a moment's notice when a blizzard hits.

And this is dangerous to allow Rip and Replace to be underfunded. I urgently make the pitch to fund Rip and Replace, not only for my state, but every other state that did not benefit from the funding that was inadequately provided for Rip and Replace. So, off my soapbox for a few minutes.

I would like to ask a question about Open RAN. Ms. Rinaldo, could you tell me how these advancements in Open RAN contribute to making connectivity more affordable and accessible for rural communities?

Ms. RINALDO. Absolutely. And I 100 percent agree, we need to rip Huawei out and have a strong supply chain to ensure this doesn't happen again. So, I think that some of the great benefits of Open RAN is the competition. 127 players in the ecosystem is going to help bring prices down.

We are also moving to virtualization in software defined networks, which is going to shrink our footprint and keep things in check. I think bringing AI into the ecosystem is going to help with spectrum efficiency. After you have your radio equipment in place, energy is the next largest cost that the carriers face.

So, if you are able to do sensing capabilities, will also help bring down costs. And then just innovation. It is going to allow for updates to occur much easier and much simpler, so you don't have to wait for the next 10 year life cycle to occur.

So, I think there is a lot of excitement, and it is well deserved.

Senator LUMMIS. Thank you. And Madam Chairman, I know I am out of time, but I may want to submit some additional questions for the record, particularly with regard to Open RAN and concerns that Rip and Replace causes rationing, the remaining parts that they need to repair equipment.

And as I said, we are only one bad snowstorm away from the network going down. Hey, thank you all. This has been a wonderful panel. Appreciate you all. Thanks, Madam Chair.

The CHAIR. Senator Lummis, do you have a number associated with your region on Rip and Replace? Do you know?

Senator LUMMIS. Yes. These three brown states, the unreimbursed costs are greater than \$200 million. Now, on the more orange states, the more vibrant orange, it is between \$100 million and \$200 million.

And there is a number of those as well. And then those that are the more pastel orange, between \$10 million and \$100 million. So, I think it is what, about \$3 billion to fund the whole shebang? And everybody should—they were required to rip it out.

And to not fund the replacement for these small rural providers just puts them out of business.

The CHAIR. Well, how does this affect your technology development? You know, part of CHIPS and Science with the EPSCoR legislation was trying to unfold more places because you can't just do all the technology in very expensive places, so we want to unfold more technology. So, how does that affect your ability to attract

some of these technology companies with your additional EPSCoR funding?

Senator LUMMIS. Yes, you can—as you can imagine, it is absolutely huge. Now, we have dark fiber that was put across Southern Wyoming, kind of along the I-80 corridor some years ago. Some of it is still dark simply because the technology needs to be built to utilize that capability. But again, without Rip and Replace, we are struggling to provide the important components of a fully integrated system. I want to add one more thing, since you have been so kind to ask this question. In Cheyenne, there is kind of a lead development of standards in the architecture. It is a really promising innovation that can help lower costs for deploying wireless networks. And it is Open RAN Center for Integration and Deployment. But the problem is many of these networks were built with Huawei and ZTE equipment using legacy radio access network architectures. So, providers in my state have been unable to replace their Huawei and ZTE equipment because of the delays in funding Rip and Replace. So, now they are rationing the remaining parts they need to repair their equipment, and they tell me that it is just constantly at rip—at risk. It is what we used to call, you know, you are baling wire things together and it is really problematic. Thanks for asking.

The CHAIR. Well, thank you. I don't know if Ms. Rinaldo, you want to add anything? We are waiting for a couple of colleagues.

I mean, I have other questions, but we are waiting for Senator Schmitt and Luján to join us momentarily. So, but did you have a comment on that, on this legacy network? My concern here is that, you know, we are talking about these big issues. I loved the optimization repositioning by Mr. Johnson because that is truly what we are talking about. We are talking about how do we optimize?

And sure, you can be a top down Government like China and dictate things. It doesn't mean it is the right thing. Clearly, interoperability is the key, and us figuring that out and then leading on it and in articulation internationally also the key.

It is challenging to go to various places and explain to them why they might have bought something that is not going to be the standard of the future, because no one is going to let a government backdoor be the standard of the future. It is unfortunate that that has been someone's international policy to try to go and deploy that.

But nonetheless, I do think that collaboration is the key, because that is what we have to do to get the implementation of the next generation technology. We have to collaborate. And as you can see, this is a subject where not everybody has wanted to collaborate. So, I am glad—I am glad we are getting some collaboration this morning.

But did you want to say anything about this legacy network, from a geographic perspective, of what that does to put people behind? Because I think that is really what my two colleagues from the Central West were describing.

And I think of them as two powerhouses. We have some investors from our state that are trying to build next generation modular reactors in Wyoming. And obviously, Boulder is already an epicenter of next generation energy technology.

What does that do to put a region behind if they are sitting there with a legacy technology squarely not dealt with?

Ms. RINALDO. Yes. So, I would say I worked at the House Intelligence Committee for the authors of the Huawei Report. We have been studying this since 2012 and it just confounds me that it has taking this long to see movement in this space.

But it just shows how important it is for Government to collaborate with industry and to be able to pass that information. And my old boss, the one that wrote the report, said he had his first briefing and realized that this needs to get out in the public sector, hence they wrote the classified and the unclassified.

Through Open RAN, I would say that there has been a lot of change. There has been a lot of information sharing to the public sector since then, so we need to make sure that continues going forward to collaborate. We are all in this together. So again, I think—

The CHAIR. How far does it put a region behind if it still is one of these regions that has a legacy problem? I mean, are people just going to say, I am going to go somewhere else? And here we are trying to expand more development in more places.

There is a lot of innovation to take place in the United States of America, and I personally believe you got to have a few things like airports, but you certainly also have to have networks that are free of any kind of government backdoors.

Ms. RINALDO. No, absolutely, right and connectivity is the base of the entire foundation of our economic ecosystem. If we can't get that right, then we struggle having other things fall in place, like the airports, our transportation networks. So, it is critical that we do this. We do it right.

The CHAIR. So, do you think people are looking at those regions now and raising questions?

Ms. RINALDO. Yes, absolutely.

The CHAIR. Interesting. OK, Senator Luján.

**STATEMENT OF HON. BEN RAY LUJÁN,
U.S. SENATOR FROM NEW MEXICO**

Senator LUJÁN. Thank you, Chair Cantwell, and thank you for convening this important hearing today. As we know, Congress faces many challenges in telecom, and I am worried that we don't have the tools needed to face all the challenges in front of us.

The House just sent the Senate legislation to address foreign ownership and interference in social media. Section 230 and its liability waiver are under intense scrutiny. Our communications networks and online platforms remain vulnerable to nearly daily privacy violations.

The Universal Service Fund is facing unprecedented legal challenges, and at the end of April, the Affordable Connectivity Program will run out of money. The CHIPS and Science Act remains underfunded. Wireless providers face a mandate to remove Chinese manufactured equipment from cell towers and replace it with secure, trusted hardware. And Congress has so far failed to agree on national spectrum policy.

One common factor of all of these, besides that they all fall under the jurisdiction of this committee and the communications sub-

committee, one common factor is these are all highly technical problems.

I am worried that the Legislative Branch underinvested in the tools and institutions that we need to address these challenges. Congress, and the Senate, and this committee have a duty to explore the evidence and establish facts. So, I am grateful that this committee and our chair are exercising its jurisdiction to explore this complex problem. But for over a year, we have continued to disagree on the facts.

When it comes to certain spectrum bands, NTIA and the FCC often say one thing, and other agencies, or staff within the agency come to the Hill and say something else. Debate is essential, but different Federal agencies even disagree on what is technically feasible, and it is simply unacceptable.

So, to the panel, my question is this, yes or no, should Congress pass legislation that improves interagency coordination such that the Executive Branch has a unified voice when it comes to spectrum policy? Mr. Johnson.

Mr. JOHNSON. Absolutely, Senator. And not to—there is. It can't be a Pollyanna. There will always be turf wars. There will always be disagreements.

But if we don't—if we are not able to come to a unified position, then the United States will fall behind specifically China. And that, if we do that, the future is China's. So, it starts with having a unified U.S. position, and we can do this. We have done it before, we need to do it again.

Senator LUJÁN. Sounds like a resounding yes. Ms. Rinaldo.

Ms. RINALDO. Yes, absolutely. And I would love to work with you on that.

Senator LUJÁN. Dr. Ghosh.

Dr. GHOSH. Yes, absolutely. Fact based is what we should be going after.

Senator LUJÁN. Appreciate that. Ms. Brown.

Ms. BROWN. Yes. We—absolutely need a transparent process where all stakeholder voices get heard. And more than that, even more than one decision, we need finality in that decision, as we have seen before. Thank you.

Senator LUJÁN. Dr. Furchtgott-Roth

Dr. FURCHTGOTT-ROTH. Yes, Senator. And my understanding is actually under current law, NTIA actually has this responsibility. And somehow, anything you can do to reinforce that so that the Administration speaks with one voice and not alternate voices.

Senator LUJÁN. Appreciate that. Dr. Furchtgott-Roth, in your testimony, you stated that the United States was unquestionably at the forefront of commercial spectrum policy. In 1993, Congress gave the FCC authority to auction spectrum.

Other countries emulated us, establishing independent regulatory agencies, allowing unlicensed devices, commencing spectrum auctions, and promoting competition in wireless services.

In your history as a Congressional staffer, a former FCC Commissioner, and in your work and research since then, has spectrum ever been a partisan issue?

Dr. FURCHTGOTT-ROTH. No, Senator. It hasn't been and it never should be.

Senator LUJÁN. I agree with that, and we can retake our leadership position. To do so, we must lead the world in developing the next generation of not only spectrum technology, but spectrum policy.

So, I am hopeful that Congress can find agreement in getting the job done here. Dr. Ghosh, I believe the United States can lead the world in developing technology and policy for dynamic spectrum sharing. In my subcommittee hearing last Congress, we focused on the lessons learned from the CBRs band.

Now, Dr. Ghosh, as you said in your testimony, CBRs demonstrated conclusively that spectrum can be shared successfully between mission critical applications, such as Navy radar, and commercial applications.

Should the Federal Government not only enact policy but also invest resources in the development of dynamic spectrum policy?

Dr. GHOSH. Absolutely, yes. And I think when we are talking about dynamic spectrum sharing, all systems that are going to be sharing should be designed from day one to operate robustly in a shared spectrum environment. So that includes both Federal systems, as well as commercial systems.

Senator LUJÁN. I appreciate that. And Madam Chair, I would like to ask unanimous consent to submit into the record a letter signed by 25 organizations that are writing to renew the Federal Communications Commission's auction authority and use \$7 billion of the projected revenue to fund the Affordable Connectivity Program.

The CHAIR. Without objection.

[The information referred to follows:]

March 21, 2024

Hon. MARIA CANTWELL,
Chairwoman,
Senate Commerce, Science, and
Transportation Committee,
Washington, DC.

Hon. TED CRUZ,
Ranking Member,
Senate Commerce, Science, and
Transportation Committee,
Washington, DC.

Dear Chairwoman Cantwell and Ranking Member Cruz,

The undersigned 25 organizations write to urge you to act expeditiously to renew the Federal Communications Commission's auction authority and use \$7 billion of the projected revenue to fund the Affordable Connectivity Program (ACP.) The ACP serves as a critical lifeline for millions of low-income households in America, ensuring that families across the country can afford access to the high-speed Internet necessary to participate in today's society. Unfortunately, the Federal Communications Commission projects that the program will run out of funds in little over a month. Without this funding, tens of millions of people will either struggle to maintain access to the Internet or lose access entirely. We will revert to a situation where children must do their homework in McDonald's parking lots, where job seekers cannot look for work opportunities, and where the sick and elderly will lose access to critical telehealth services. Congress can prevent these outcomes and continue our progress towards affordable, universal Internet access by renewing the FCC's spectrum auction authority.

The ACP targets the affordability component of the digital divide by offering a monthly Internet discount to qualifying low-income households, households in high-cost areas, and households on tribal lands. While the program was created in response to the unique conditions posed by COVID-19, enrollment has continued to

grow in the years following the pandemic—from 1.5 million households enrolled in May of 2021 to its current size of 23 million households.¹

As the program’s enduring popularity indicates, Americans’ increasing connectivity needs were not transitory, they are the new normal—and Americans’ use of the Internet and perspectives about the Internet have evolved accordingly. An October 2023 Consumer Reports study revealed that the percentage of people who rely on the Internet seven days a week increased by ten percentage points—from 75 percent to 85 percent—from February 2021 to October 2023. The same survey found that 78 percent of Americans believe the Internet is as important as other basic household utilities.² It is critical that Congress continues to acknowledge what is already evident to the majority of Americans: Internet access is essential and generates real, material benefits.

In opening the doors to myriad commercial, professional, and social opportunities, the ACP allows communities that are traditionally left behind to share in the economic and communal benefits of our digital world. Almost half of the ACP’s 23 million enrollees are over the age of 50.³ For many seniors living on a fixed income, losing the ACP means returning to a world of hard choices; such as the choice between Internet access and prescription medications, other utilities, or food. Equally importantly, the ACP allows demographics with mobility challenges, including elderly and disabled populations, a meaningful avenue for social inclusion. The ACP’s capacity to build community also extends beyond *interpersonal* isolation and counters *historic* forms of exclusion. One in four enrolled households are Black, and another one in four households are Hispanic and Latino—populations which are historically disproportionately likely to lack home broadband connectivity.⁴ And for the over 300,000 ACP-enrolled households who reside on tribal lands, where broadband bills frequently exceed \$120 a month, these dollars are a necessary measure to ensure that tribal communities share in America’s prosperity.⁵

Due to the interconnected nature of the internet, the ACP offers a host of direct and indirect social and economic benefits. Research analysis from the Benton Institute has shown that for every dollar of ACP subsidy, there are nearly two dollars in financial returns to those using the program, including gains in professional productivity and opportunities as well as time saved from access to online commerce.⁶ This research is corroborated by the FCC’s surveys, which indicate that nearly 50 percent of ACP subscribers use their service to apply for jobs or to work, shoring up local labor markets.⁷ These opportunities translate to real financial returns—households using a discounted Internet offer see average annual income boosts of about \$2,200. This dynamic not only matters within the microcosm of a household, but within the broader economic landscape of the broadband industry.

The \$42.5 billion dollars deployed through the Broadband Equity, Access, and Deployment (BEAD) program mark another critical investment in underserved broadband communities—in particular, rural and tribal communities. However, we will struggle to unlock the full potential of those benefits without an ACP-backed user base. The BEAD and ACP funds were designed to approach the digital divide in a complementary fashion, by building out the supply of broadband infrastructure and a corresponding, stable base of subsidized demand so carriers can operate in that area economically. Therefore, to lose investment in one half of this equation is to jeopardize the gains in the other—and conversely, when we invest in broadband, we create ripple effects of prosperity felt by the broader community.

One year out from the lapse of the FCC’s auction authority, Congress has a unique opportunity to advance our national spectrum goals while simultaneously generating sufficient revenue to support the connectivity needs of millions of Americans. We urge you to take swift action to protect these gains in connectivity by passing legislation to renew the FCC’s auction authority and fund the ACP. In doing so, we can realize the ambitions of our infrastructure investments, close the digital

¹ ACP and EBB Enrollment and Claims Tracker. *The Universal Service Administrative Company*. Accessed March 2024.

² American Experiences Survey Report. *Consumer Reports*. November 2023.

³ ACP Enrollment and Claims Tracker (Enrollment by Age). *Universal Service Administrative Company*. Accessed March 2024.

⁴ Home Broadband Adoption, Computer Ownership vary by Race, Ethnicity in the U.S. *Pew Research*. July 2021.

⁵ The Cost of Connectivity in the Navajo Nation. *The Open Technology Institute*. October 2020.

⁶ The Affordable Connectivity Program Creates Benefits that Far Outweigh the Program’s Costs. *The Benton Institute*. March 2024.

⁷ ACP Consumer Survey. *The Federal Communications Commission*. February 2024.

divide, and ensure that every American has access to the social, economic, and professional benefits connectivity has to offer.

Sincerely,

Access Humboldt
American Association of People with
Disabilities
American Association for Public
Broadband
American Library Association
The Benton Institute for Broadband &
Society
Center for Rural Strategies
Common Cause
Common Sense
Connected Nation
Demand Progress
EducationSuperHighway
Fight for the Future
Free Press Action
The Greenlining Institute

Institute for Local Self-Reliance
Mississippi Broadband Association
National Consumer Law Center
National Digital Inclusion Alliance
(NDIA)
National Disability Rights Network
(NDRN)
Native Public Media
NETWORK Lobby for Catholic Social
Justice
Open Technology Institute
Public Knowledge
Schools, Health & Libraries Broadband
(SHLB) Coalition
United Church of Christ Media Justice
Ministry

Senator LUJÁN. I yield back.

The CHAIR. Thank you so much, Senator Luján, for your leadership here and for your hearings and sharing various focuses on this issue to bring more light into how we can collaborate. Senator Schmitt.

**STATEMENT OF HON. ERIC SCHMITT,
U.S. SENATOR FROM MISSOURI**

Senator SCHMITT. Thank you, Madam Chair. Over the last three years, the U.S. has ceded leadership both domestically and internationally as it relates to spectrum management and 5G innovation.

The responsibility for this deviation from America's supremacy almost exclusively lies at the feet of the current President and this Administration for the lack of focus, attention, or direction on these critical issues.

We have seen almost zero action from the Biden White House in heading off China, whether it is in Rip and Replace and addressing the presence of Chinese telecom companies such as Huawei and ZTE in our networks, freeing up more spectrum for commercial use, or asserting leadership abroad in international forums like the World Radio Conference or on spectrum standards. The list goes on and on and on.

But what is clear is this Administration's effort to address the China threat and assert U.S. spectrum leadership has fallen flat on its face. Instead, this White House has prioritized injecting woke politics into our Nation's telecommunications policies. Some examples include the Commerce Department coercing Internet providers to combat climate change, or prioritizing hiring past criminals as a condition for Federal broadband program funding.

Additionally, we have seen them engage in Government power grab antics like Internet rate regulation in combating so-called "digital discrimination practices." None of these actions address the urgent and critical issues of network security, spectrum leadership, and our strategic competition with China.

This current Administration's initiatives stand in stark contrast with the proactive leadership of President Trump. Under the

Trump Administration, the FCC released record amounts of spectrum for licensed 5G use and thousands of Megahertz for unlicensed use.

Thanks to that—to the Trump Administration, America went from standing still to leading the globe in 5G innovation. Additionally, President Trump took the China threat head on by working with Congress to pass the Secure and Trusted Networks Act, taking important actions to protect our networks from Huawei and ZTE and asserting U.S. leadership in international forums to secure 5G networks.

Late last year, President Biden released his long awaited national spectrum strategy. While some—while many were expecting a strategy that lays out a timeline for making specific spectrum bands available for a variety of licensed, shared, or unlicensed commercial use, Biden’s strategy did none of that.

Instead, the current Administration strategy, and I use that term loosely, failed to make a single Megahertz or spectrum available. Let’s be clear, this failure of strategy by the Biden Administration puts our Nation further behind the eight ball as China continues to push forward with 5G innovation.

There are plenty of proposals offered here in Congress, including my Launch Communications Act to help modernize our Nation’s spectrum policies and strengthen America’s efforts domestically, abroad, and in space. While many will differ over how to best position our Nation spectrum strategy, it is important that any approach maximizes America’s innovation and promotes the diverse supplier base of our Internet ecosystem.

However, thanks to the Biden Administration, our Nation has a strategy of stagnation at a time when technological leadership is more crucial than ever. America is not just falling behind, it is faltering as a direct consequence of this Administration’s tactics, while China is nearing the final turn of the race on 5G.

We cannot allow that to happen, and I remain committed to working with members of this committee to ensure our Nation does not fall behind. Madam chair, I yield back.

The CHAIR. Thank you, Senator Schmitt. I think that concludes our hearing for today, at least for members who are planning on making it over.

So, I want to thank again our witnesses for this illumination about really how much you actually agree on moving forward on some policies, and how much these efforts to optimize, and integrate, and collaborate mean something for our future. So, hopefully we can demonstrate that and do that.

You will have—Senators will have until the end of business on Thursday, April 4 to submit questions for the record, and we will have to the end of business on April 18 to submit your responses for our committee record.

So, thank you again, and we are adjourned.

[Whereupon, at 12:19 p.m., the hearing was adjourned.]

A P P E N D I X

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARIA CANTWELL TO
MONISHA GHOSH

Smart Spectrum Policy

We have seen firsthand how a fractured domestic approach to spectrum management threatens domestic and national security. The former Administration's hands-off policies resulted in interagency disputes.

We can avoid this by creating a unified approach to domestic spectrum policy, where agencies with critical missions such as the FAA and DoD work together with NTIA—cooperatively—on spectrum. The Biden Administration's framework outlined in the Presidential Memorandum on Modernizing United States Spectrum Policy does this.

We are at our best when we work together. Facilitating a collaborative approach to domestic spectrum policy will ensure a unified front on the world stage. A smart approach to spectrum will allow the U.S. to lead on international policies and advance our national security interests.

Question 1. Dr. Ghosh, how in your view have the interagency spectrum disputes of the past harmed national security, and why is it so important to restore order to the process?

Answer. Interagency spectrum disagreements should be addressed in a scientific manner based on analysis and data. Airing such disputes publicly in the media detracts from the authority of all involved agencies and projects to the international community that the U.S. has internal divisions that are not being resolved in a fair and balanced manner: this reduces our credibility and can endanger national security by inadvertently signaling weaknesses in our policies. It is thus extremely important to restore order to the process so that possible spectrum disputes are addressed well ahead of any allocations that may be controversial. The process laid out in the National Spectrum Strategy and Implementation Plan sets the right tone in managing sometimes contentious spectrum differences. In order to meet the spectrum needs of all applications, commercial Federal and scientific, it is also important that the relevant agencies are open and transparent about their actual spectrum uses and needs. Spectrum hoarding by any entity does not benefit society since it results in spectrum inefficiencies and hurts innovation by limiting access to spectrum.

Timely resolution of potential interference issues when new allocations are being considered, either co-channel or adjacent channel, requires research to be done well in advance of potential changes in spectrum allocations. Since stakeholders will naturally be biased towards their applications, there needs to be independent evaluation of potential interference scenarios. Here, the academic research community can play a critical role. For example, the National Science Foundation funded my research in 6 GHz which was based on unbiased measurements and presented to the FCC¹ as an independent analysis of the probability of interference to incumbent fixed microwave links. With adequate funding, SpectrumX² and other academics with the required expertise can work alongside the spectrum regulatory agencies, NTIA and FCC, in critically evaluating potential interference scenarios before any allocation decisions are made.

¹Ex-parte submission on 6 GHz measurements to FCC OET Docket 18–295, Unlicensed Use of the 6 GHz Band, July 21, 2023, <https://www.fcc.gov/ecfs/document/107211592305290/1>

²SpectrumX, an NSF Spectrum Innovation Center, <https://www.spectrumx.org/>

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. KYRSTEN SINEMA TO
MONISHA GHOSH

Question 1. What have been the key shortcomings of previous spectrum policy determinations, and how have commercial entities both failed and succeeded in the past to effectively take into account the need for national security access and use of the spectrum?

Answer. In my opinion, while past spectrum policy determinations could have proceeded more efficiently, there have not been any major shortcomings. Admittedly, the 5G/altimeter issue in the C-band and the 5G/weather-radar issue at 24 GHz should have been better handled, and could have been, with more in-depth, unbiased research in advance of the spectrum allocations. Both new commercial entrants and incumbent, perhaps federal, users will tend to protect their needs and advocate for their stakeholders, and hence there is an urgent need for more unbiased and fair studies of possible interference before new allocations are made. Here is where increased funding for unbiased academic research can help the agencies, NTIA and FCC, in their task.

In most cases, protection of national security needs has been front and center when new spectrum has been allocated, such as the CBRS band where Navy radars have been protected by a sensing and database approach that has, as far as we know, never caused interference to the Federal incumbent. In 3.45–3.55 GHz, industry worked with NTIA and FCC to protect areas of the country where critical Federal operations needed to continue. In order to develop these techniques however, all sides need to be open and transparent, to the extent possible, about actual spectrum use and need.

Question 2. Are there adequate policies and procedures in place as we modernize and optimize our spectrum use and infrastructure to balance future national defense needs of and access to spectrum with the commercial and scientific stakeholders?

a. If not, what needs to be added?

Answer. As mentioned above, in my opinion, there needs to be more thorough, unbiased research studies into optimizing spectrum use between defense, commercial and scientific needs. Today, there is not enough information about actual use to perform these studies in a timely fashion. It can be challenging, since many Federal uses are classified, but we need to have a process to address this. The National Spectrum Strategy and Implementation Plan suggests some possible approaches, but more can be done, especially by leveraging the expertise that resides in academia.

b. Recognizing that future technological development may be difficult to anticipate, do those policies and procedures account for access and use of the spectrum by the Department of Defense (DoD) in the future as they respond to developments of spectrum use by our adversaries, which may be within spectrum bands the DoD no longer has access to?

Answer. Spectrum use and allocations are changing, worldwide, with every country facing similar challenges as the U.S. in balancing the needs of federal, commercial and scientific uses. The U.S. leads the world today in the use of Dynamic Spectrum Sharing (DSS) technologies, such as those used in CBRS, 6 GHz and TV White Spaces. These were all innovations that were conceived of and implemented domestically and maturing and growing DSS is the only way that one can build systems for uncertain spectrum environments of the future. ALL future wireless systems, commercial, Federal and even scientific, need to be “frequency agile”, a core requirement of DSS, *i.e.*, be able to respond to interference and move operations to other frequency bands. This capability will ensure that DoD will always have access to the bands they operate in now because these will not be taken away, since bands are shared: Navy radars always have priority access in CBRS even though the band is shared by commercial users. AI and ML techniques for detecting interference and managing spectrum in a dynamic manner have been studied in academia for a few years now and our spectrum policy should seek ways of accelerating this research so that they can be applied to future spectrum challenges. By not moving fast, we leave the door open for other nations, including adversaries, to wrest the lead we have today in developing DSS. As pointed out in the Joint White House Statement³, “6G technologies that use spectrum efficiently and incorporate spectrum sharing mechanisms by design to coexist with incumbent service providers” should be a goal.

³Joint Statement Endorsing Principles for 6G, <https://www.whitehouse.gov/briefing-room/statements-releases/2024/02/26/joint-statement-endorsing-principles-for-6g-secure-open-and-resilient-by-design/>

c. What do we need to consider in spectrum optimization to account for the agility certain adversaries have in spectrum allocation and their ability to prioritize their own security considerations over commercial interests?

Answer. As explained above, we need to leverage advanced spectrum management technologies to keep our lead in the federal, commercial and scientific applications that depend on spectrum, all of which contribute to national security. In my opinion, long term research funding is required to accomplish these goals, in collaboration with academia, industry and government agencies. Spectrum can be shared quite effectively amongst various stakeholders by designing suitable strategies. For example, with the increase in commercial requirements for wireless communications indoors (*e.g.*, factory automation), one can reuse spectrum that is used by incumbents outdoors, using lower power indoors. This is the sharing mechanism used in the 6 GHz band with outdoor fixed links and could be reused in other Federal bands such as 7–8 GHz, without requiring the Federal incumbents to discontinue operations in the band. High power, exclusively licensed spectrum as used in cellular deployments today do not serve the needs of indoor wireless very well, especially at these frequencies. Extending the sharing model pioneered in CBRN to newer bands should be pursued.

d. What is the feedback you have received from the DoD and other national security stakeholders on the Dynamic Spectrum Sharing concept referenced in testimony to optimize spectrum use?

Answer. My limited interactions with the DoD lead me to believe that they are open to sharing if their priority status is maintained and exposure to harmful interference is limited. I believe these objectives can be met, but we have to be more innovative on how we accomplish this. True sharing, *i.e.*, DoD and commercial use co-existing in the same spectrum, over the same geography and at the same time, is extremely difficult if the commercial use requires high-power, outdoor operation from base-stations installed on tall towers, which is the case for a mobile cellular network. However, if we consider other deployment scenarios, such as medium-power, lower-height, small-cell deployments, or indoor deployments, true sharing may be possible. I believe that prior investigations into the 3.1–3.45 GHz band, for instance, did not fully evaluate all these alternatives. I hope that future investigations will do so since there are many ways of meeting the connectivity needs of homes and businesses other than high powered cellular systems.

Question 3. Again, recognizing that we can never fully anticipate what areas of the spectrum our adversaries may be utilizing or researching for their own weapons systems development, is it possible to identify certain geographic areas within the Nation to exclude from the sale of exclusive access of the spectrum in order to preserve DoD access and flexibility in testing and training within such limited geographic area(s)?

a. Would such an area for test and evaluation be of value to the commercial and scientific stakeholders as well? If so, how?

Answer. Yes, I believe that selective geographic areas for exclusive access can be preserved for test and evaluation by the DoD, similar to the National Radio Quiet Zone at Greenbank⁴ for radioastronomy. However, since our adversaries could be using spectrum bands that we do not know about, I believe that DoD systems should be built to withstand interference in any band and detect adversaries in any band. Dynamic Spectrum Sharing (DSS) can allow both DoD and commercial systems to be built with this resilience: this also increases spectrum efficiency without compromising performance.

b. Would there be any anticipated concerns from commercial or scientific stakeholders that you are aware of?

Answer. Reserving certain geographical areas for DoD test and evaluation may be of concern to commercial and scientific stakeholders if these areas were significantly large or affected the deployment or capability of the commercial and scientific uses. If located in remote areas, then there should be minimal concerns.

Question 4. The U.S. Army's Buffalo Soldier Electronic Testing and Training Range at Fort Huachuca, Arizona currently serves as a technical demonstration platform that is critical to the DoD by enabling research and development, driving technological advancement, bolstering national security, informing effective policies, and advancing scientific discovery.

a. As part of the National Spectrum Strategy and the need to develop a national testbed for dynamic spectrum sharing (DSS), is it possible to co-locate the DSS

⁴National Radio Quiet Zone, Greenbank Observatory, <https://greenbankobservatory.org/about/national-radio-quiet-zone/>

testbed with the Buffalo Soldier Electronic Testing and Training Range at Fort Huachuca and the Western Regional Range Complex concept in general to enable DoD, Federal agencies, and national policymakers to work cooperatively with industry, researchers, and academia to objectively identify optimization opportunities and examine new technologies?

Answer. If Fort Huachuca meets the conditions needed by the DSS testbed as described in the National Spectrum Strategy Implementation plan, then it is certainly possible to locate it there. A DSS testbed needs an incumbent and the new entrant to be both available at the test-site. For example, a 3.1–3.45 GHz DSS testbed would require a 5G network (at that frequency) and the airborne radars that are the incumbents to be deployed along with the sharing mechanism. Industry, government and academia could collaboratively develop such a testbed with adequate funding to deploy the required elements.

b. Would co-locating these activities reduce or eliminate duplication of other efforts and synchronize other relevant research and engineering activities already under way across the government with respect to AI/ML, zero-trust networks, data-source management, autonomy and autonomous systems, and advanced radar technologies?

Answer. Without specific knowledge of the activities already underway elsewhere across the government, I cannot determine if duplication will be reduced or eliminated. The intent of the implementation plan is to test and evaluate DSS in various scenarios. According to the Implementation Plan, “A National DSS Testbed will be created for dynamic sharing technology, consisting of a federated network of sites providing complementary capabilities.”⁵ Fort Huachuca could offer an outdoor sharing environment whereas other sites could offer a different sharing environment, for example indoor commercial systems sharing spectrum with airborne radars in 3.1–3.45 GHz. It is important to have a diversity of testing environments to ensure that DSS is robust.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BEN RAY LUJÁN TO
MONISHA GHOSH

Emerging Mid-Band Radar Spectrum Sharing (EMBRSS) Feasibility Assessment Report

As I said in-person in the hearing, the United States can retake our leadership position on spectrum. To do so, we must lead the world in developing the next generation of not only spectrum technology, but spectrum policy. The U.S. Department of Defense recently released an unclassified version of the Emerging Mid-Band Radar Spectrum Sharing (EMBRSS) Feasibility Assessment Report as required by the Infrastructure Investment and Jobs Act (IIJA). The assessment found “a [Dynamic Spectrum Management System] DSMS, that evolves the CBRS framework in the 3550–3700 MHz band, with advanced interference mitigation features which can address the needs of all systems, including the unique needs of airborne systems, provides a *feasible path forward for spectrum sharing* between the Federal and commercial systems in the 3100–3450 MHz band [emphasis added]” (Page 220; U.S. Department of Defense, EMBRSS Feasibility Assessment Report; released September 2023, unclassified report released April 3, 2024).

Question 1. Now that the EMBRSS Report is public, does it provide a roadmap for future public and private investment into the regulations and technology necessary to open up spectrum availability through dynamic spectrum sharing? If it does not provide a roadmap, what other steps are necessary?

Answer. Yes, it does. The EMBRSS Report encouraged investigating dynamic spectrum sharing as a solution for the 3.1–3.45 GHz band. In my opinion, this is the correct way forward. However, future investigations should include all types of sharing, not just with high-power exclusively licensed uses, but also, for example, with medium-power uses, like in CBRS and indoor deployments that leverage the national isolation provided by buildings. The shared spectrum model established in CBRS has not only protected incumbent DoD services (Navy radars) but also resulted in a multitude of innovative applications⁶ that are not well served by either high-power exclusive licensed spectrum (cellular) or low-power unlicensed (Wi-Fi): these include community networks to serve underserved areas, factory automation

⁵The National Spectrum Strategy Implementation Plan, <https://www.ntia.gov/sites/default/files/publications/national-spectrum-strategy-implementation-plan.pdf>

⁶Bridging the Digital Divide in South Bend, <https://www.nd.edu/stories/bridging-the-digital-divide/>

and remote oil-field monitoring⁷. However, the CBRS model needs to be enhanced to accommodate the different types of incumbents in 3.1–3.45 GHz and the collaborative process announced by the National Spectrum Consortium (NSC) on April 9, 2024⁸ will bring together academia, industry and government to develop appropriate solutions. In order to be successful in developing unique dynamic spectrum sharing mechanisms, this process needs collaboration from all stakeholders as well as a neutral evaluation which academia can provide.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN HICKENLOOPER TO
MONISHA GHOSH

Spectrum Relocation Fund

The Spectrum Relocation Fund (SRF) has been effective in providing compensation for Federal agencies who are willing to share or reallocate their spectrum for non-federal purposes. However, the current statute limits reimbursements for agencies to modify their systems to adapt to a sharing or reallocation arrangement only up to a “comparable capability”.

Question 1. Do you agree the “comparable capability” threshold under the current Spectrum Relocation Fund statute is limiting? What effect do you believe proposals would have by amending this threshold to allow for reimbursements, subject to review by the Technical Panel (including the Office of Management and Budget) to support “enhanced capability” or achieve a “state of the art”?

Answer. In my opinion, incumbent systems are often decades old, and it would definitely improve spectrum efficiency if the SRF could be used to upgrade these systems to state-of-the-art, to include spectrum sharing functionalities that most likely did not exist when these systems were developed. Additionally, any systems being designed today for future use should also incorporate frequency agility and the “hooks” to enable spectrum sharing in the future, and, if appropriate, SRF should enable such capability.

Under 47 U.S.C. 923(j), the Spectrum Relocation Fund establishes a preference that “NTIA shall give priority to options involving reallocation of the band for exclusive non-federal use.” Spectrum bands that are not occupied by a Federal agency are becoming increasingly scarce, which increases the necessity to finding coexistence regimes that protect Federal missions and also foster innovation in non-federal, commercial applications.

Question 2. Do you believe these provisions establishing an SRF preference for exclusive non-federal users should be modernized to better reflect the current spectrum environment? Why or why not?

Answer. Yes, I believe that all types of allocations should be considered, not just exclusive use. The current spectrum environment, and use cases, have changed considerably from when there were only two types of connectivity options available: cellular or Wi-Fi. Most wireless data usage has moved indoors⁹; these use cases can be better served by private 5G cellular networks deployed over shared spectrum using lower power than exclusively licensed spectrum, like we see today in the CBRS band using neutral hosts¹⁰. There will always be a need for high-power, exclusive spectrum to provide ubiquitous connectivity outdoors, however we need to evaluate the bandwidth needs of such spectrum versus shared spectrum. Today, there is only 150 MHz of shared spectrum compared to almost 2 GHz of unlicensed spectrum and 600 MHz of exclusively licensed spectrum. In my opinion, it is less disruptive to Federal operations if a Federal band were to be shared with a non-federal system (like in CBRS) compared to exclusive use which would require clearing of the band. Moreover, low-cost access to shared spectrum leads to more innovations¹¹.

⁷ Celona Case Studies in oil-refinery monitoring, industrial control etc., <https://www.celona.io/case-studies>

⁸ National Spectrum Consortium Re-Launches PATHSS to Develop New Spectrum Solutions, <https://www.nationalspectrumconsortium.org/news-detail/national-spectrum-consortium-re-launches-pathss>

⁹ Energy Efficiency and Sustainability in Mobile Communications Networks, Dec 2023, <https://www.5gamericas.org/wp-content/uploads/2023/12/Energy-Efficiency-and-Sustainability-in-Mobile-Communications-Networks-WP.pdf>

¹⁰ Celona in-building private network solution, https://uploads-ssl.webflow.com/5e3277d251fd9e4b90615367/65fcea399a036b3da883885_28490%20Celona%20-%20T-mobile%20Infographic%2007.pdf

¹¹ OnGo Alliance Use Cases for CBRS, <https://ongoalliance.org/ongo-solutions/>

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. RAPHAEL WARNOCK TO
MONISHA GHOSH

Spectrum Authority

Extending the Federal Communications Commission's (FCC) spectrum authority could enable greater funding for a variety of Federal programs, including the Affordable Connectivity Program.¹² The Affordable Connectivity Program has helped over 700,000 Georgia families access the internet¹³ and is expected to run out of funding in April 2024.¹⁴

Question 1. How do programs such as the Affordable Connectivity Program promote connectivity for low-income, rural, and tribal communities?

Answer. Programs such as the ACP enable all Americans access to broadband at speeds that are essential for many of the web applications that are commonly used today. This is especially true for many underserved communities in low-income regions. In South Bend, the ACP was instrumental in connecting 10,000 households to the internet: these households now face disruption in their service as the ACP ends.

National Spectrum Strategy

In March 2024, the National Telecommunications and Information Administration (NTIA) released the National Spectrum Strategy (NSS) Implementation Plan.¹⁵ A major goal of the NSS is to train a spectrum workforce with the necessary skills to innovate across current and emerging technologies and meet the needs of an evolving wireless environment.¹⁶ To achieve this goal, NTIA outlined strategic outcomes to attract, train, and grow the current and next-generation spectrum workforce, such as developing a National Spectrum Workforce Plan and directing Federal agencies to proactively recruit talent at Minority-Serving Institutions (MSIs) and Historically Black Colleges and Universities (HBCUs).¹⁷

Question 1. What barriers currently exist for colleges and universities with respect to training the future spectrum workforce?

Answer. A future spectrum workforce needs to be well educated on a variety of topics, ranging from a fundamental understanding of the physics of propagation and knowledge of wireless systems to the latest AI/ML techniques that can be employed in Dynamic Spectrum Sharing and policy aspects. The technical expertise in these areas is usually spread across different departments such as Electrical Engineering and Computer Science, and spectrum policy issues usually reside in Law, Economics and Public Policy Schools, making it extremely challenging to train students to develop a well-rounded appreciation of the issues. Hence, there is a need to develop curricula that specifically addresses the skill set required for understanding how spectrum should be managed optimally, which is lacking in most universities today.

Question 2. What steps can Congress take to ensure that HBCUs and MSIs are prepared to train the next generation spectrum workforce, and how do they address any unique barriers that HBCUs and MSIs face?

Answer. The National Science Foundation funded SpectrumX as the Nation's first Spectrum Innovation Institute. One of the primary goals is to develop spectrum training, starting from increasing awareness in K-12¹⁸, with a specific emphasis on broadening participation to include students and faculty from HBCUs and MSIs to engage in the research activities which are focused on many areas of spectrum: spectrum measurements, developing coexistence and sharing methods, building spectrum testbeds and impacting spectrum policy. There are about 14 such institu-

¹²See Nicol Turner Lee and Jack Malamud, *Reinstating the FCC's auction authority could save the Affordable Connectivity Program*, Brookings Institution (Aug. 31, 2023), <https://www.brookings.edu/articles/reinstating-the-fccs-auction-authority-could-save-the-affordable-connectivity-program>.

¹³See *ACP Enrollment and Claims Tracker*, Universal Service Administrative Company, <https://www.usac.org/about/affordable-connectivity-program/acp-enrollment-and-claims-tracker>.

¹⁴See *Affordable Connectivity Program*, Federal Communications Commission (Mar. 20, 2024), <https://www.fcc.gov/acp>.

¹⁵Alan Davidson, *National Spectrum Strategy Implementation Plan*, National Telecommunications and Information Administration (Mar. 12, 2024), <https://www.ntia.gov/sites/default/files/publications/national-spectrum-strategy-implementation-plan.pdf>.

¹⁶*Id.* at 22.

¹⁷*Id.* at 22-23.

¹⁸SpectrumX Education and Workforce Development, <https://www.spectrumx.org/research-and-education/education/>

tions affiliated with SpectrumX, with more being invited to join. SpectrumX is working closely with the NTIA in these efforts.

Congress can ensure that such initiatives continue to receive steady funding since such efforts take decades to mature, while NSF funding is usually limited to 5 years.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. TED CRUZ TO
MONISHA GHOSH

Citizens Broadband Radio Service

In response to a question from Sen. Capito during the hearing, you stated that Citizens Broadband Radio Service (CBRS) is proving to be “a great alternative to [getting rural and isolated communities connected].” You went on to say, “[CBRS is] shared spectrum but if you have a satellite backhaul . . .” but were unable to complete the thought.

Question 1. Please complete your thought.

Answer. Often, lack of connectivity in rural areas is due to a lack of backhaul. In such cases, one can provide connectivity using satellite backhaul and a CBRS private network for local access. Such solutions are only possible if the spectrum needed for local access is made available for use with low barriers to entry. Wide-area connectivity, especially outdoors, cannot be delivered efficiently over unlicensed spectrum using Wi-Fi, and hence the only option in remote and rural areas that are unserved by cellular carriers using exclusively licensed spectrum, is private networks over shared spectrum, such as CBRS, along with satellite backhaul if fiber or microwave backhaul are not available. Here are some example of real deployments where satellite is used as a backhaul with local access provided over CBRS:

- Celona on Starlink Satellite Internet: <https://docs.celona.io/en/articles/5936816-celona-on-starlink-satellite-internet>
- CBRS and Starlink, Private LTE in the wild, <https://markhoutz.com/2022/07/19/cbrs-and-starlink-private-lte-in-the-wild/>

Other applications that are enabled by such deployments include Precision Agriculture: most farms are hundreds of acres, and it is not cost effective to provide cellular connectivity at a level that is required for high-data rate applications. With the satellite + CBRS approach, one can deploy connectivity when and where it is needed: many precision agriculture applications are seasonal, for example, robots used in sowing in spring, or robots used in undercover crop planting in late fall and winter. Here are some links that may be helpful:

- Connecting Farms With Private Networks, OnGO Alliance, https://ongoalliance.org/up-content/uploads/2024/02/Connecting-Farms-with-Private-Networks_IG_Final.pdf
- Report from the FCC’s Task Force on Precision Agriculture, November 2023, <https://www.fcc.gov/sites/default/files/2023-Report-FCC-Precision-Ag-Task-Force.pdf>

Question 2. Would it be faster to deploy and/or less expensive to use CBRS sharing and satellite backhaul than to install a satellite dish at each user’s residence and connect them to the Internet that way? If so, how?

Answer. This would depend on many factors, primarily, the number of households needing connectivity and their proximity to each other. Far flung users in remote areas would be better served by individual satellite connections, but for other use cases, such as connectivity to schools and community centers, it may be more economical to have a single satellite backhaul with distribution over a 4G or 5G network deployed in the CBRS spectrum. While not using satellite backhaul, since fiber was available, the City of South Bend, in collaboration with the University of Notre Dame, deployed a CBRS network to serve hundreds of low-income households with free internet, and many other school districts around the country are deploying similar networks. Once again, low barrier to entry in terms of access to spectrum on a shared basis permits these types of innovative uses of 5G networks deployed in CBRS spectrum. However, the current availability of such spectrum, only 150 MHz, may not be enough to meet the growing needs of private networks which are being used for applications such as remote oil-field monitoring, warehouse connectivity and factory automation.

- Bridging the Digital Divide in South Bend, <https://www.nd.edu/stories/bridging-the-digital-divide/>

- Kansas City and South Bend Utilize CBRS to Build Affordable Wireless Broadband Networks, <https://www.kcdigitaldrive.org/article/kansas-city-and-south-bend-indiana-utilize-cbrs-to-build-affordable-wireless-broadband-networks/>
- Celona Case Studies in oil-refinery monitoring, industrial control etc., <https://www.celona.io/case-studies>

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARIA CANTWELL TO
MARY L. BROWN

Smart Spectrum Policy

We have seen firsthand how a fractured domestic approach to spectrum management threatens domestic and national security. The former Administration's hands-off policies resulted in interagency disputes.

We can avoid this by creating a unified approach to domestic spectrum policy, where agencies with critical missions such as the FAA and DoD work together with NTIA—cooperatively—on spectrum. The Biden Administration's framework outlined in the Presidential Memorandum on Modernizing United States Spectrum Policy does this.

We are at our best when we work together. Facilitating a collaborative approach to domestic spectrum policy will ensure a unified front on the world stage. A smart approach to spectrum will allow the U.S. to lead on international policies and advance our national security interests.

Question 1. How in your view have the interagency spectrum disputes of the past harmed national security, and why is it so important to restore order to the process?

Answer. Interagency disputes over spectrum matters are not new. However, recent disputes have not been resolved through an orderly interagency process. The resulting disorganization has illustrated the challenges to the process of reaching consensus and making final decisions in an era where spectrum stakeholders feel empowered to challenge the notion that the public can rely on what has been decided. This is true not only in the interagency process, but also by commercial stakeholders—particularly those publicly (and unfortunately) calling on the FCC to make changes to the established decision to allocate the 6 GHz band for unlicensed services.

To our adversaries keeping tabs on these fights and observing decisional disarray, it undermines U.S. spectrum leadership and calls into question our government's commitment to its global spectrum partners.

Restoring order requires leadership. The Federal Communications Commission and the National Telecommunications and Information Administration—on behalf of the entire Executive Branch—are tasked with working to create optimal spectrum outcomes. Unfortunately, the era of easy spectrum leadership is over. In order to continue to lead and to ensure the U.S. position as the most innovative spectrum market in the world, agencies must accept two new realities:

First, the old playbook of “clear and auction” isn't going to be the path of the future. As with nearly all technology matters, the path to continued innovation is rarely “just keep doing what you're doing.” Iterative, challenging, innovative technologies have been developed and deployed and represent an innovative and sensible best path forward for the U.S. to make even greater use of spectrum for all stakeholders.

Second, agencies must participate in and embrace a comprehensive and inclusive process where a wide range of commercial industry and public interest opinions can be discussed along with Federal views. Each stakeholder agency in the process plays an important role—whether it's to articulate its mission parameters or to reconcile Administration positions—and accept that once an Administration has done the hard work of making sure that a wide range of stakeholders' views are heard and reconciled through the Executive Branch process, that the matter is decided. The Memorandum of Understanding (MOU) signed by the FCC and NTIA on spectrum matters ensures that conversations begin as early as possible to avoid conflicts between those two agencies and is a good start. Other Federal agencies should be held to the same standard—pay attention and engage early through the NTIA.

However, the work does not end there. Foundational to a healthy dialogue is the willingness to admit another's expertise and a concomitant willingness to learn or to trust those willing to learn on their behalf. We should not expect agencies to be experts in technologies they do not design, but openness to learning and new ways of thinking—such as the Dynamic Spectrum Sharing ideas being explored by the Defense Department—need to be recognized for setting the right tone as all of us look toward a more crowded, and less siloed, Table of Allocations.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BEN RAY LUJÁN TO
MARY L. BROWN

Wi-Fi Benefit to Internet Service Providers

Ms. Brown, in past spectrum debates different parties often come to the Hill with competing proposals. That has especially true in debates over spectrum pipelines, where the wireless industry argues for more spectrum to be made available through auction for exclusive use, and device manufacturers argue for more Wi-Fi. That dynamic has changed recently, where today you can see wireless and wireline providers offloading traffic on to Wi-Fi.

Question 1. How do you see Wi-Fi's relationship with different players in the ecosystem, whether it be mobile network operators, satellite providers, telecommunications companies, cable providers, or fixed wireless Internet service providers?

Answer. As the "Swiss Army knife" of wireless, Wi-Fi plays a critical and multifaceted role in the wireless ecosystem. At its core, Wi-Fi provides ubiquitous connectivity in our homes, businesses, schools, and anchor institutions serving as our key connection to the internet. Thanks to Wi-Fi, broadband connections to the home and business are maximized and made available to a wide swath of devices and users at any premises served by broadband. For the bulk of consumers, Wi-Fi is the internet. However, Wi-Fi's benefits are not limited to just broadband networks. Wi-Fi can be used to build and/or supplement a Wireless Internet Service Provider (WISP) network, by carrying traffic to rural homes and then distributing the traffic to devices inside the home. It is a complement to mobile networks, offloading traffic that would otherwise use mobile infrastructure (*e.g.*, cell towers and fiber backhaul). One mobile operator states that the amount of smartphone mobile traffic offloaded to broadband is as high as 87 percent—the lion's share of device traffic. That's good for mobile operators who do not need to manage extreme demand spikes, and good for consumers who care little about how a device connects, only that it does.

Wi-Fi is used at the edge of every broadband connection—whether that connection is based on fiber, cable technology (DOCSIS), satellite, or even fixed 5G. Any broadband connection to your home or business ends in Wi-Fi because it is Wi-Fi that delivers traffic to and from your devices. Moreover, the number of devices with Wi-Fi connectivity (also called "smart" devices) just keeps growing in number and by category—the Wi-Fi Alliance reports 19.5 billion Wi-Fi devices in the global marketplace consisting of 80,000 unique products at last count. From this perspective, Wi-Fi reaches deeply into the consumer technology sector providing connectivity to appliances of all types, plumbing, security, hearing and electrical, athletic equipment, home health devices, and more.

Emerging Mid-Band Radar Spectrum Sharing (EMBRSS) Feasibility Assessment Report

As I said in-person in the hearing, the United States can retake our leadership position on spectrum. To do so, we must lead the world in developing the next generation of not only spectrum technology, but spectrum policy. The U.S. Department of Defense recently released an unclassified version of the Emerging Mid-Band Radar Spectrum Sharing (EMBRSS) Feasibility Assessment Report as required by the Infrastructure Investment and Jobs Act (IIJA). The assessment found "a [Dynamic Spectrum Management System] DSMS, that evolves the CBRS framework in the 3550–3700 MHz band, with advanced interference mitigation features which can address the needs of all systems, including the unique needs of airborne systems, provides a feasible path forward for spectrum sharing between the Federal and commercial systems in the 3100–3450 MHz band [emphasis added]" (Page 220; U.S. Department of Defense, EMBRSS Feasibility Assessment Report; released September 2023, unclassified report released April 3, 2024).

Question 1. Now that the EMBRSS Report is public, does it provide a roadmap for future public and private investment into the regulations and technology necessary to open up spectrum availability through dynamic spectrum sharing? If it does not provide a roadmap, what other steps are necessary?

Answer. The EMBRSS roadmap is quite clear: develop an evolved implementation of Citizens Broadband Radio Service (CBRS) sharing approach that meets a set of conditions spelled out in the document, and then test it to make certain it works.

The conditions are straightforward: DoD's systems are and must continue to be treated as "primary" in the band for regulatory purposes; the band must be preemptable for national security purposes; development of new capability and equipment must address informational, operational and cyber security dimensions; the band needs to be open for testing and experimentation by defense vendors; the band must accommodate evolving Federal usage, including new and expanded sys-

tems; and the band must be operationalized with established interference safeguards. Two non-technical needs must also be addressed—(1) the Federal government needs to be exempted from liability for damages to commercial systems (2) Federal resource requirements must be addressed to allow this activity to be developed. None of this is surprising or unreasonable.

U.S. industry interests that have been involved in the CBRS band have responded quite positively to the release of the redacted EMBRSS report and look forward to collaborating with DoD as the conversation toward Dynamic Spectrum Sharing in lower 3 GHz continues. NTIA’s activities around its National Spectrum Strategy should not slow down the work that needs to be done to commercialize the lower 3 GHz spectrum but instead build upon (and not ignore) the significant work already accomplished in the EMBRSS report. We look forward to working with NTIA to quickly advance the interests of Federal and commercial users in this spectrum.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN HICKENLOOPER TO
MARY L. BROWN

Spectrum Relocation Fund

The Spectrum Relocation Fund (SRF) has been effective in providing compensation for Federal agencies who are willing to share or reallocate their spectrum for non-federal purposes. However, the current statute limits reimbursements for agencies to modify their systems to adapt to a sharing or reallocation arrangement only up to a “comparable capability”.

Question 1. Do you agree the “comparable capability” threshold under the current Spectrum Relocation Fund statute is limiting? What effect do you believe proposals would have by amending this threshold to allow for reimbursements, subject to review by the Technical Panel (including the Office of Management and Budget) to support “enhanced capability” or achieve a “state of the art”?

Answer. Enhanced capabilities should be available to Federal procurement. Viewed from a commercial perspective, there is no radio systems manager who—confronted with a need to replace a radio system—would choose to source one of “comparable capability.” Developments in radio science are simply moving too fast. At a high level, Federal spectrum-based systems (including transmitters and receivers) should be evaluated as follows:—(1) does the system satisfy its mission and purpose; and (2) does the system promote spectral efficiency within the band of operation and adjacent to it, as well as demonstrate cost effectiveness measured over the system lifecycle.

Under 47 U.S.C. 923(j), the Spectrum Relocation Fund establishes a preference that “NTIA shall give priority to options involving reallocation of the band for exclusive non-federal use.” Spectrum bands that are not occupied by a Federal agency are becoming increasingly scarce, which increases the necessity to finding coexistence regimes that protect Federal missions and also foster innovation in non-federal, commercial applications.

Question 2. Do you believe these provisions establishing an SRF preference for exclusive non-federal users should be modernized to better reflect the current spectrum environment? Why or why not?

Answer. Yes. Today the United States is in a leadership position on sharing and unlicensed spectrum and our Federal law should reflect that leadership by placing sharing and unlicensed technologies at least on equal footing with legacy exclusive use models.

This provision of the Spectrum Relocation Fund, to prioritize the SRF for exclusive non-federal use, was adopted in 2012, and today has become obsolete and needs to be updated to reflect today’s wireless ecosystem. First, in the past 12 years since this language was adopted, we have generated valuable knowledge about sharing and coexistence—not just the development of technological capability, but actual market-based proof that sharing spectrum supports real business cases. Statutory language needs to reflect this reality.

Here are just a few examples of developments since this language became law:

- In 2015, the FCC released its ground-breaking service rules for the CBRS band, calling out how tiers of users with different sets of spectrum rights would utilize the band.
- The WINNForum begins that same year to develop a standards-based approach to layering database-driven sharing on mobile networks and technologies. New versions of its standards continue to be updated and released.
- The “On-Go Alliance” forms to promote use of the CBRS band in 2017.

- In 2018, the FCC released its auction approach and emissions limits on end devices.
- January 2020: FCC authorizes full use of the CBRS band with six Spectrum Access System (SAS) providers.
- Auctions for CBRS PALS licenses net \$4.6 billion in revenue in 2020 and more than 200 auction winners.
- In April 2020, the FCC releases rules for the operation of Automated Frequency Control (AFC) systems for 6 GHz, kicking off a substantial industry effort to develop and test the database systems.
- The NTIA releases its review in May 2023 of CBRS band performance in the 2021–23 timeframe, finding surprisingly fast uptake against a backdrop of no interference issues:
 - CBRS deployments grew at a steady rate with a mean quarterly increase of 12.0 percent and a total increase of 121 percent over the 21-month analysis period.
 - On January 1, 2023, there were 128,351 active CBSDs in DPA-impacted counties with a total population of 232,348,897 residents.
 - The number of CBSDs with Priority Access License (PAL) grants grew consistently with a mean increase of 17 percent per quarter, but General Authorized Access (GAA) CBSDs dominated deployments. On January 1, 2023, four out of five active CBSDs were GAA-only, 85 percent of the active grants were GAA, and two-thirds of active CBSDs with a PAL grant had at least one active GAA grant.
 - More than 70 percent of all active CBSDs were deployed in rural census blocks on January 1, 2023.
- February 2024 inaugurates the first commercial AFC systems for Wi-Fi in the 6 GHz band, when the FCC authorizes seven such providers. This enables Wi-Fi to be used at “standard power” levels because the databases prohibit Wi-Fi transmissions near microwave link.
- April 2024 the Department of Defense convenes a process to evaluate the development of Dynamic Spectrum Sharing with its spectrum-based systems.

These achievements are unprecedented and give the United States options that other countries do not have. Given that there is a desire to add new and varied uses to mid-band-spectrum, we should ensure that NTIA’s processes can take full advantage of the technological capabilities that we have been working on for decades. 47 U.S.C. 923(j) needs to be updated and revised to give NTIA this needed flexibility to pursue sharing and unlicensed spectrum models.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. TED CRUZ TO
MARY L. BROWN

Unlicensed Spectrum

America has the best unlicensed and Wi-Fi capabilities in the world. As Americans continue to use Wi-Fi more and more each year, it is essential that we have a plan in place to protect U.S. leadership and preserve our competitive advantage over China.

Question 1. How could S.3909, the Spectrum Pipeline Act of 2024, promote Wi-Fi technology?

Answer. I would encourage reconsideration of the balance of spectrum set forth in the bill. Given the importance of Wi-Fi to consumers and our economy, unlicensed spectrum should be given greater emphasis in any spectrum pipeline legislation. As currently set forth in the legislation, exclusive high-power spectrum is guaranteed 10 times the amount of spectrum as compared to unlicensed spectrum. This imbalance does not reflect how consumers use spectrum on a daily basis or the spectrum needs of the future, as Wi-Fi is projected to handle more and more data traffic every year.

Moreover, the provision that identifies 125 MHz of new unlicensed spectrum is a beneficial first step, assuming the additional spectrum is the 7125–7250 MHz band as it is contiguous to existing unlicensed spectrum and already part of the Wi-Fi 7 specification. Contiguous spectrum provides the needed bandwidth to complete the 6 GHz channel plan for Wi-Fi, addressing the need for a stranded 320 MHz channel left incomplete by the FCC’s 2020 decision (due to jurisdictional limits above 7125 MHz). Channel diversity in dense Wi-Fi deployments, Wi-Fi demand

growth, and new types of devices (*e.g.*, AR/VR) will exhaust the available channels in 6 GHz, and 7125–7250 MHz helps alleviate that. However, to be clear, 125 MHz of additional unlicensed spectrum will not be sufficient to satisfy the exponentially growing needs and demands of Wi-Fi into the future so the bill should be adjusted to devote substantially more spectrum to unlicensed uses.

Question 2. Are further steps needed to ensure Wi-Fi's continued success and prevent our adversaries from dominating foreign telecom markets?

Answer. Yes. Understanding the unqualified success of Wi-Fi is the first step in understanding how to keep it successful. The U.S.-led Wi-Fi equipment industry historically is one that is characterized by large volumes—volumes that are multiple times those of licensed mobile technology. In 2023, the Wi-Fi industry shipped around the world 3.8 billion chipsets—a number that continues to grow each year. In addition, application and device manufacturers design their products utilizing the latest Wi-Fi capabilities and spectrum availability, further compounding the U.S. vested interest and investment in global Wi-Fi.

In order to ensure this market remains healthy, the U.S.-led Wi-Fi industry needs help and support from all branches of the U.S. government to convince countries to follow the U.S. lead on 6 GHz and unlicensed spectrum more generally. While we have worked closely with the current Administration over the past four years, including before and during the recent World Radio Conference, our industry continues to need senior engagement from the Commerce and State Departments, and the White House, if we are to continue the success of Wi-Fi into the future. While company officials are out in the world talking about Wi-Fi spectrum every day, other countries need to hear that the U.S. government recognizes the necessity and value of Wi-Fi and unlicensed spectrum. In sharp contrast, China has made its support of the China-dominated 5G equipment industry a priority for their senior foreign policy and commercial officers on behalf of its domestic manufacturers. We need to do the same for Wi-Fi which remains a vital link to the Internet for so many Americans.

Moreover, it is critical that we continue to pursue a spectrum pipeline for unlicensed spectrum given that as much as 87 percent of mobile traffic is offloaded onto Wi-Fi. As mentioned above, your bill has the potential to complete a fourth Wi-Fi 7 channel in the 7125–7250 MHz band. Unfortunately, that additional unlicensed spectrum will not be sufficient. As broadband pipes into the home get bigger and bigger, Wi-Fi 7 will need multiple 320 MHz channels to ensure Wi-Fi does not become the bottleneck to gigabit broadband speeds for consumers. We encourage you to consider directing the FCC to prioritize opening up a reasonable balance of licensed *and* unlicensed spectrum in a way that recognizes the full wireless ecosystem.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. JOHN THUNE TO
MARY L. BROWN

Question. In your written testimony, you provide critical detail on how the People's Republic of China sought to undermine U.S. policy preferences at the World Radio Conference, particularly regarding supporting Wi-Fi technology. Simply put, why does China oppose Wi-Fi?

Answer. China acts in its self-interest. Unlike the United States, China is characterized by centrally controlled broadband infrastructure and connectivity, limited and controlled “competition,” highly regulated content, a larger population concentrated in large cities, and an approach to security that emphasizes centralized governmental control, surveillance, and adherence to Communist Party beliefs. Once China has settled on an approach to a spectrum band that meets its domestic needs, it then turns its attention to the rest of world and attempts to impose its domestic vision on global economies and political structures in order to provide market opportunities to Chinese vendors.

Mobile networks operated by Chinese providers or supplied with Chinese equipment can be used more easily to facilitate surveillance. In contrast with Wi-Fi, a user could roam through multiple networks in the course of a day—home, coffee shop, work, restaurant, grocery store, etc.—without being tracked by a central network operator. Limiting the availability of Wi-Fi in China encourages a consumer to utilize the licensed mobile network.

Further, the intellectual property of Wi-Fi is very different than that of mobile technology—as a result, Wi-Fi is far less expensive to manufacture. Wi-Fi intellectual property is largely U.S.-based and is made available on reasonable and non-discriminatory terms that enable Wi-Fi to be offered as a lower-cost networking alternative. As China seeks to continue to resuscitate Huawei and its other tightly

controlled mobile network equipment vendors revenue matters, and Chinese vendors can make more money selling licensed mobile technology based on outsized licensing terms favoring the vendor.

In addition, mobile network technology is often sold “as a service” or with corresponding service packages. This means that a network equipment sale to a network operator is not a one-time sale, but rather generates recurring revenue and opportunities to continue to make changes to the equipment’s software. While the same can be said about enterprise Wi-Fi, Wi-Fi services are much less expensive as described above.

For the few mobile network vendors still in business outside of China, lining up behind China’s Huawei and ZTE in a global campaign for spectrum becomes a low-cost way to open potential future markets. China encourages European vendors in this effort because it gives its spectrum campaigns an “international” imprimatur. This is exactly what is happening in the global fight (still ongoing) over the upper 6 GHz band as U.S. interests attempt to get the full 6 GHz band opened for Wi-Fi and China opposes.

If China proves successful, the U.S. loses. First, at a global level spectrum becomes de facto labelled “for mobile network operators only” whether those economies and populations need it for mobile or not. As a blunt comparison, the 5G needs of China’s 4+ billion population are very different than the 6.8 million who live in Paraguay. But China’s goal in Paraguay is to take spectrum that could be used for Wi-Fi today off the table permanently. By convincing foreign governments to block out spectrum for the future benefit of Chinese mobile equipment vendors, China prevents that spectrum from being used beneficially today. Across Africa in 2023, China convinced virtually all countries that the upper 6 GHz band should be set aside for “5G” even though no operator in Africa was ready to build “5G” in the upper 6 GHz band, and few were building “5G” in any band. The sad reality is that it is doubtful that this spectrum will be used for decades, if ever, unless China builds these countries a “free” network comprised of Chinese equipment of dubious security. Wi-Fi, which could have immediately been deployed on the continent to benefit Africa’s growing fixed and satellite broadband networks, has been locked out of more than half the spectrum in the 6 GHz band. While the final chapter on 6 GHz in Africa has not been written, and countries could still choose unlicensed, the continent’s unified call at the WRC for a “mobile network only” approach is troubling.

For those foreign markets that decide to open the upper 6 GHz band to mobile network operator use, Huawei and ZTE will step forward as the “low-cost” option, given the subsidies they enjoy from the Chinese government. And once Chinese vendors are successful in winning the bids, the network technology that they will use is Chinese—with the same capabilities that China uses to track its own population. Moreover, because many foreign economies are mobile-centric, China has unique control over foreign governments, as China can control the operational status of its core network. Indeed, in many economies that lack adequately trained personnel, it is Chinese nationals who actually operate mobile networks in these countries. U.S. corporate interests operating in these countries, as well as U.S. citizens living or traveling there, are at risk when roaming on Chinese-built networks.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. JERRY MORAN TO
MARY L. BROWN

U.S. Technological Leadership

China is attempting to influence spectrum allocations worldwide, including most recently at the World Radio Conference where they challenged the U.S. position on the 6GHz band, which the U.S. has allocated for unlicensed use.

I understand that, on the surface, these efforts represent attempts to boost Huawei and ZTE internationally.

Question . What are some specific national and economic security implications of China challenging U.S. wireless policies, and how can the U.S. combat China’s behavior?

Answer. The first and most important tenant of understanding the national security impact of China on global spectrum policy is that China acts in its own self-interest. Unlike the United States, China is characterized by centrally controlled broadband infrastructure and connectivity, limited and controlled “competition,” highly regulated content, larger population concentrated in large cities, and an approach to security that emphasizes governmental control, surveillance, and adherence to Communist Party beliefs. Once China has settled on an approach to a spectrum band that meets its domestic needs, it then turns its attention to the rest of

world and attempts to impose its domestic vision on global economies and political structures in order to provide market opportunities to Chinese vendors.

For the few mobile network vendors still in business outside of China, lining up behind China's Huawei and ZTE in a global campaign for spectrum becomes a low-cost way to open potential future markets. China encourages European equipment vendors in this effort because it gives its spectrum campaigns an "international" imprimatur. This kind of China campaign is exactly what is happening in the global fight (still ongoing) over upper 6 GHz as U.S. interests attempted to get the full 6 GHz band opened for Wi-Fi.

If China proves successful, the U.S. loses. First, at a global level spectrum becomes de facto labelled "for mobile network operators only" whether those economies and populations need it for mobile or not. As a blunt comparison, the 5G needs of China's 4+ billion population are very different than the 6.8 million who live in Paraguay. But China's goal in Paraguay is to take spectrum that could be used for Wi-Fi today off the table permanently. By convincing foreign governments to block out spectrum for the future benefit of Chinese mobile equipment vendors, China prevents that spectrum from being used beneficially today. Across Africa in 2023, China convinced virtually all countries that the upper 6 GHz band should be set aside for "5G" even though no operator in Africa was ready to build "5G" in the upper 6 GHz band, and few were building "5G" in any band. The sad reality is that it is doubtful that this spectrum will be used for decades, if ever, unless China builds these countries a "free" network comprised of Chinese equipment of dubious security. Wi-Fi, which could have immediately been deployed on the continent to benefit Africa's growing fixed and satellite broadband networks, has been locked out of more than half the spectrum in the 6 GHz band. While the final chapter on 6 GHz in Africa has not been written, and countries could still choose unlicensed, the continent's unified call at the WRC for a "mobile network only" approach is troubling.

For those foreign markets that decide to open the upper 6 GHz band to mobile network operator use, Huawei and ZTE will step forward as the "low-cost" option, given the subsidies they enjoy from the Chinese government. And once Chinese vendors are successful in winning the bids, the network technology that they will use is Chinese—with the same capabilities that China uses to track its own population. Moreover, because many foreign economies are mobile-centric, China has unique control over foreign governments, as China can control the operational status of its core network. Indeed, in many economies that lack adequately trained personnel, it is Chinese nationals who actually operate mobile networks in these countries. U.S. corporate interests operating in these countries, as well as U.S. citizens living or traveling there, are at risk when roaming on Chinese-built networks.

Finally, if within our domestic policy-making process U.S. policymakers simply "follow" China's lead on spectrum allocations in the name of "harmonization," our country will lose. The 7 GHz band throws this problem into stark relief. China wants the 7 GHz band for mobile networks. The United States and its NATO allies use this band heavily for defense systems. By accepting China's will in this band, our country would need to disrupt our own defense systems, and likely disrupt the defense systems on which NATO relies. Yet the U.S. has the opportunity to enable further unlicensed Wi-Fi in the 7 GHz band that can coexist with our DoD and other agencies' incumbent uses, given Wi-Fi's significantly lower power levels and indoor use. This would prevent any significant disruptions to the United States and NATO allies' defense systems.

Combatting China's strategy requires U.S. leadership. The U.S. needs to make spectrum decisions that are in its strategic interests, including with one eye on our allies' interests, and champion those. Moreover, the U.S. vision should include spectrum sharing and unlicensed coexistence capabilities that have been developed in the United States over the past 20 years, of which Wi-Fi and CBRS are examples. The U.S. cannot let China set the spectrum agenda here in the U.S. or globally.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. MARSHA BLACKBURN TO
MARY L. BROWN

At the World Radiocommunications Conference last year, China and Huawei were almost successful in rallying other countries to identify the 6GHz band for licensed use. This could have stranded the billions of dollars invested in engineering and manufacturing 6 GHz Wi-Fi devices for the global market. This also would have given Huawei a significant advantage in the market as they are the only company building licensed wireless equipment for 6 GHz. Despite our lack of preparedness,

the U.S. delegation was able to block these attempts. However, I am concerned this may be the new normal in international venues.

Question. Do you expect China to try something like this again, and what can the United States do to be better prepared in the future to pushback and deter similar China actions?

Answer. Given our experiences at the WRC-19 and the WRC-23, it is clear that China's priorities for spectrum allocations support its commercial and foreign policy goals to the disadvantage of ours. China plans its work at the WRC years in advance of the conference—first working with individual countries, then sub-regional groups, and finally regional organizations, to drive its preferred approach. Moreover, China did not hesitate to escalate discussions to very senior government officials not involved in spectrum policymaking, but who understood Chinese investment in their national economy, in order to secure a favorable outcome. For example, the U.S. industry successfully cultivated the support of regulators in a number of African countries on identifying the upper 6 GHz band for unlicensed, only to see those same regulators silenced in subregional and regional meetings, or even changing their view to support licensed mobile, once China's Huawei had the opportunity to demand a different result from a Minister or the President's office.

For the U.S. to blunt the impact of China's willingness to "purchase" their way to policy wins, we need to rely on the United States' strongest asset: technology leadership. The U.S. opened the 6 GHz band to Wi-Fi in 2020 and therefore had a leadership position in discussing this band with countries around the world. This decision also served to unite the U.S. delegation early in the WRC process. That enabled all parts of the Executive Branch, together with the FCC, to convey one consistent message for 6 GHz to foreign countries—keep the band open for unlicensed use on the ITU stage, and domestically, open the band to unlicensed use. The U.S. view prevailed.

We already know China intends to pursue a similar plan to ensure that the 7 GHz band is made available for Huawei and ZTE. China was able to get the WRC to agree to evaluate the 7 GHz band for exclusive high powered mobile use, knowing that in the U.S. and NATO countries, there will need to be significant disruptions to national security systems if the U.S. and Europe follow China's approach. The band is better utilized for unlicensed in the United States, because Wi-Fi can coexist without disruption to defense systems. In our view, the question the U.S. needs to ask and answer is this: "What is the best use for this spectrum in the United States?" and not "how do we follow the ambitions of China?"

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. SHELLEY MOORE CAPITO TO
MARY L. BROWN

Uncertainty about future spectrum access can inhibit new technology development and can have broad downstream impacts far beyond communications networks. The Biden Administration has acknowledged that spectrum access is essential for the next generation of aviation, identifying the 5030–5091 MHz band to support command non-payload communications (CNPC) in the National Spectrum Strategy. However, the Implementation Plan envisions a study of this band, which does not need to be reallocated, that will not be complete until 2026. Meanwhile, billions of dollars in new capital investment is flowing into the development of Unmanned Aircraft Systems (UAS) and Advanced Air Mobility (AAM), which the Administration has also identified as a national competitive priority.

Question. Can you please discuss the economic and commensurate safety and security risks that uncertainty and unpredictability about access to this band creates for the development of the necessary technologies, networks, and services to provide CNPC to UAS and AAM operations?

Answer. From the text of the NTIA Implementation Plan, it appears that NTIA is projecting that it will take one year from the start of creating a working group to the completion of its analysis for CNPC in the 5030–5091 MHz band. Once the NTIA-led analysis is done in 2026, the FCC will likely need to conduct a rulemaking to implement the resolution in its rules, which is likely to take additional months or up to a year. The FCC does appear to be advancing on its interim goal of allowing some sharing of the band by UAS and AAM, although the initial operations would appear to be less than what a more fulsome sharing mechanism would allow. The FCC has announced it is circulating a Report and Order for adoption that will address first a manual form of sharing, and then one that will allow temporary assignments using dynamic frequency management systems.

With that as factual predicate, there are a couple of generic observations that can be made about this band, but that apply to all the specific bands of interest. First,

if NTIA is to be the vehicle to spark Federal consensus on use of Federal spectrum, then NTIA's capacity to engage in negotiation and technical investigation becomes determinative of the timeline for decision. NTIA should be encouraged to leverage work that has already been completed to speed its consideration of bands to make them available as soon as practicable. For example, the EMBRSS report should be the starting point for further action on the lower 3 GHz band. Second, in general, Federal policymakers should strive to open a new band using rules that will remain in place as a baseline. While FCC rules for commercial equipment can and do evolve, the threat of significant future changes in a band's operational requirements tends to stifle capital investment, especially when a band is new. For example, today, Wi-Fi equipment is technically capable of operating up to 7250 MHz and is standardized to do so. Chipset capability exists that could permit its operation up to 7625 MHz. But Wi-Fi developers do not know whether to invest because the NTIA analysis will not be completed until the end of 2026 due to the decision to consider the full 7125–8400 MHz band as a single issue. As in the case of UAS and AAM, this delay creates an opportunity cost, and because it is Wi-Fi, the opportunity cost directly impacts consumers. Finally, there is not yet clarity on what happens when the NTIA process runs its course, and it is time to hand off a resolution to the FCC. The FCC has independent requirements under its statute and the Administrative Procedure Act to examine issues. Policymakers should be looking now for ways to ensure the FCC process does not become yet another opportunity for parties to erect years-long obstacles to much-needed spectrum reform.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARIA CANTWELL TO
CLETE D. JOHNSON

Smart Spectrum Policy

We have seen firsthand how a fractured domestic approach to spectrum management threatens domestic and national security. The former Administration's hands-off policies resulted in interagency disputes.

We can avoid this by creating a unified approach to domestic spectrum policy, where agencies with critical missions such as the FAA and DoD work together with NTIA—cooperatively—on spectrum. The Biden Administration's framework outlined in the Presidential Memorandum on Modernizing United States Spectrum Policy does this.

We are at our best when we work together. Facilitating a collaborative approach to domestic spectrum policy will ensure a unified front on the world stage. A smart approach to spectrum will allow the U.S. to lead on international policies and advance our national security interests.

Question 1. How in your view have the interagency spectrum disputes of the past harmed national security, and why is it so important to restore order to the process?

Answer. The United States needs coherent government processes for reallocation to ensure that spectrum is used to best advance U.S. economic and national security interests. It is important for the U.S. government's two spectrum regulators—the Federal Communications Commission (FCC) for commercial spectrum and NTIA for Federal spectrum—to be the ultimate decisionmakers, and NTIA should serve as the central agency to represent Federal government interests. When different government agencies are not on the same page, deployment can be delayed, government and private resources can be unnecessarily spent, and allocation decisions that impact U.S. economic and national security can be hindered.

As the Federal government's halting process in C-band showed, a fragmented process can cause confusion and delay the deployment of 5G services. The C-band auction raised record numbers, with wireless providers collectively paying over \$80 billion for licenses. However, divides within the Federal government—including approval from the FCC and NTIA but questions about safety issues from the Federal Aviation Administration—delayed the launch of 5G. The Interdepartment Radio Advisory Committee (IRAC), composed of representatives from Federal agencies with spectrum interests that help NTIA manage Federal use of spectrum, is an essential tool to develop a coherent and unified government spectrum policy. The IRAC plays an important role in advising NTIA of government interests and distributing information across affected agencies in the context of FCC proceedings on commercial use of spectrum. These interagency processes are critical to U.S. leadership in 5G. After years of engagement across the agencies and their regulated industries, wireless companies are now expected to operate with temporary and minimal restrictions while the aviation industry addresses its concerns regarding older aircraft equipment. Still, these delays reinforce the importance of NTIA serving as the voice of the Executive Branch in its recommendations to the FCC on commercial spec-

trum. The Presidential Memorandum on Modernizing United States Spectrum Policy provides a solid framework to make this happen.

More generally, stakeholders should work together collaboratively to make spectrum reallocation work. In a wireless world, spectrum allocations need to have room to take advantage of technological innovations. Reallocation can be a win-win when incumbent users are provided the resources to succeed, and new users are provided the certainty and spectrum necessary for technological innovation and to implement new uses. The process should not be rigid, as every reallocation, band, and system is different. Reallocation can be guided and organized to benefit all parties, so long as all parties come to the table transparently and with an eye to mutual benefit and advancing the interests of the United States, rather than a zero-sum game with distinct losers and winners.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. KYRSTEN SINEMA TO
CLETE D. JOHNSON

Question 1. What have been the key shortcomings of previous spectrum policy determinations, and how have commercial entities both failed and succeeded in the past to effectively take into account the need for national security access and use of the spectrum?

Answer. As the Federal government's halting process in C-band showed, a fragmented process can cause confusion and delay the deployment of 5G services. The C-band auction raised record numbers, with wireless providers collectively paying over \$80 billion for licenses. However, divides within the Federal government—including approval from the FCC and NTIA but questions about safety issues from the Federal Aviation Administration—delayed the launch of 5G. The Interdepartment Radio Advisory Committee (IRAC), composed of representatives from Federal agencies with spectrum interests that help NTIA manage Federal use of spectrum, is an essential tool to develop a coherent and unified government spectrum policy. The IRAC plays an important role in advising NTIA of government interests and distributing information across affected agencies in the context of FCC proceedings on commercial use of spectrum. These interagency processes are critical to U.S. leadership in 5G. After years of engagement across the agencies and their regulated industries, wireless companies are now expected to operate with temporary and minimal restrictions while the aviation industry addresses its concerns regarding older aircraft equipment. Still, these delays reinforce the importance of NTIA serving as the voice of the Executive Branch in its recommendations to the FCC on commercial spectrum. The Presidential Memorandum on Modernizing United States Spectrum Policy provides a solid framework to make this happen.

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Question 2. Are there adequate policies and procedures in place as we modernize and optimize our spectrum use and infrastructure to balance future national defense needs of and access to spectrum with the commercial and scientific stakeholders?

a. If not, what needs to be added?

b. Recognizing that future technological development may be difficult to anticipate, do those policies and procedures account for access and use of the spectrum by the Department of Defense (DoD) in the future as they respond to developments of spectrum use by our adversaries, which may be within spectrum bands the DoD no longer has access to?

c. What do we need to consider in spectrum optimization to account for the agility certain adversaries have in spectrum allocation and their ability to prioritize their own security considerations over commercial interests?

d. What is the feedback you have received from the DoD and other national security stakeholders on the Dynamic Spectrum Sharing concept referenced in testimony to optimize spectrum use?

Answer. As I said in my testimony, I believe government and industry should collaborate on initiatives to maximize spectrum use in any given band. Most im-

diately, we must advance presently viable spectrum sharing regimes; when fully clearing a spectrum band for new uses is not practical, coordinated sharing through proven methods can be a solution. Government and industry should collaborate to advance “static” sharing, in which parties benefit from predictable spectrum access by coordinating their use over geography, time, or frequency. These sharing methods provide coordinated access and certainty, and technological developments are increasing the precision of these sharing methods. We should focus immediately on these proven models of sharing to advance our national interest in maintaining 5G leadership globally.

In parallel over the long term, we should also seek breakthroughs in “dynamic” spectrum sharing—in which each party’s use of frequencies changes dynamically according to real-time needs—to overcome existing practical impediments to real-world implementation. Such breakthroughs will likely take years to become practically and economically viable at scale, and U.S. global leadership and collaboration with allies will be required to address the need for global harmonization and scale sufficient to support diverse and competitive trusted suppliers in such a sharing environment. Absent strategic leadership, bespoke U.S.-only sharing frameworks could mean we deploy more slowly than other countries that simply implement globally harmonized, standardized frameworks, and the custom sharing solutions would be so circumstance-specific that they would have no global market.

Question 3. Again, recognizing that we can never fully anticipate what areas of the spectrum our adversaries may be utilizing or researching for their own weapons systems development, is it possible to identify certain geographic areas within the Nation to exclude from the sale of exclusive access of the spectrum in order to preserve DoD access and flexibility in testing and training within such limited geographic area(s)?

a. Would such an area for test and evaluation be of value to the commercial and scientific stakeholders as well? If so, how?

b. Would there be any anticipated concerns from commercial or scientific stakeholders that you are aware of?

Answer. As noted above, geographic spectrum sharing is one of the presently viable spectrum sharing regimes that we should seek to advance. When fully clearing a spectrum band for new uses is not practical, coordinated sharing through proven methods can be a solution. Government and industry should collaborate to advance “static” sharing, in which parties benefit from predictable spectrum access by coordinating their use over geography, time, or frequency. These sharing methods provide coordinated access and certainty, and technological developments are increasing the precision of these sharing methods. We should focus immediately on these proven models of sharing to advance our national interest in maintaining 5G leadership globally.

Question 4. The U.S. Army’s Buffalo Soldier Electronic Testing and Training Range at Fort Huachuca, Arizona currently serves as a technical demonstration platform that is critical to the DoD by enabling research and development, driving technological advancement, bolstering national security, informing effective policies, and advancing scientific discovery.

a. As part of the National Spectrum Strategy and the need to develop a national testbed for dynamic spectrum sharing (DSS), is it possible to co-locate the DSS testbed with the Buffalo Soldier Electronic Testing and Training Range at Fort Huachuca and the Western Regional Range Complex concept in general to enable DoD, Federal agencies, and national policymakers to work cooperatively with industry, researchers, and academia to objectively identify optimization opportunities and examine new technologies?

b. Would co-locating these activities reduce or eliminate duplication of other efforts and synchronize other relevant research and engineering activities already under way across the government with respect to AI/ML, zero-trust networks, data-source management, autonomy and autonomous systems, and advanced radar technologies?

Answer. As a former Army officer, I am familiar with the excellent capabilities at Fort Huachuca and am eager to learn more about the Buffalo Soldier Electronic Testing and Training Range.

As discussed above, I believe government and industry should collaborate on initiatives to maximize spectrum use in any given band. Most immediately, we must advance presently viable spectrum sharing regimes; when fully clearing a spectrum band for new uses is not practical, coordinated sharing through proven methods can be a solution. Government and industry should collaborate to advance “static” sharing, in which parties benefit from predictable spectrum access by coordinating their

use over geography, time, or frequency. These sharing methods provide coordinated access and certainty, and technological developments are increasing the precision of these sharing methods. We should focus immediately on these proven models of sharing to advance our national interest in maintaining 5G leadership globally.

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The Department of Defense—including the activities at Fort Huachuca—can and should play an important role in these initiatives.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BEN RAY LUJÁN TO
CLETE D. JOHNSON

Emerging Mid-Band Radar Spectrum Sharing (EMBRSS) Feasibility Assessment Report

As I said in-person in the hearing, the United States can retake our leadership position on spectrum. To do so, we must lead the world in developing the next generation of not only spectrum technology, but spectrum policy. The U.S. Department of Defense recently released an unclassified version of the Emerging Mid-Band Radar Spectrum Sharing (EMBRSS) Feasibility Assessment Report as required by the Infrastructure Investment and Jobs Act (IIJA). The assessment found “a [Dynamic Spectrum Management System] DSMS, that evolves the CBRSS framework in the 3550–3700 MHz band, with advanced interference mitigation features which can address the needs of all systems, including the unique needs of airborne systems, provides a *feasible path forward for spectrum sharing* between the Federal and commercial systems in the 3100–3450 MHz band [emphasis added]” (Page 220; U.S. Department of Defense, EMBRSS Feasibility Assessment Report; released September 2023, unclassified report released April 3, 2024).

Question 1. Now that the EMBRSS Report is public, does it provide a roadmap for future public and private investment into the regulations and technology necessary to open up spectrum availability through dynamic spectrum sharing? If it does not provide a roadmap, what other steps are necessary?

Answer. The EMBRSS report was an important first step in exploring new commercial uses of mid-band spectrum, as it identified many of the present challenges in doing so. I expect that the further study of these bands will provide additional insights into possibilities in the future. As I said in my testimony, I believe that government and industry should collaborate on initiatives to maximize spectrum use in any given band. Most immediately, we must advance presently viable spectrum sharing regimes; when fully clearing a spectrum band for new uses is not practical, coordinated sharing through proven methods can be a solution. Government and industry should collaborate to advance “static” sharing, in which parties benefit from predictable spectrum access by coordinating their use over geography, time, or frequency. These sharing methods provide coordinated access and certainty, and technological developments are increasing the precision of these sharing methods. We should focus immediately on these proven models of sharing to advance our national interest in maintaining 5G leadership globally.

In parallel over the long term, we should also seek breakthroughs in “dynamic” spectrum sharing—in which each party’s use of frequencies changes dynamically according to real-time needs—to overcome existing practical impediments to real-world implementation. Such breakthroughs will likely take years to become practically and economically viable at scale, and U.S. global leadership and collaboration with allies will be required to address the need for global harmonization and scale sufficient to support diverse and competitive trusted suppliers in such a sharing environment. Absent strategic leadership, bespoke U.S.-only sharing frameworks could mean we deploy more slowly than other countries that simply implement globally harmonized, standardized frameworks, and the custom sharing solutions would be so circumstance-specific that they would have no global market.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN HICKENLOOPER TO
CLETE D. JOHNSON

Spectrum Relocation Fund

The Spectrum Relocation Fund (SRF) has been effective in providing compensation for Federal agencies who are willing to share or reallocate their spectrum for non-federal purposes. However, the current statute limits reimbursements for agencies to modify their systems to adapt to a sharing or reallocation arrangement only up to a “comparable capability”.

Question 1. Do you agree the “comparable capability” threshold under the current Spectrum Relocation Fund statute is limiting? What effect do you believe proposals would have by amending this threshold to allow for reimbursements, subject to review by the Technical Panel (including the Office of Management and Budget) to support “enhanced capability” or achieve a “state of the art”?

Answer. Congress should increase incentives for reallocating spectrum. Congress should build upon the precedent of the CSEA of 2003 that created the SRF and grant new authorities for the Federal government to compensate users for modernization and reallocation. New legislation can improve the SRF process. The SRF was intended to reimburse Federal agencies’ expenses—including those for R&D, engineering studies, and economic analyses—for relocating from or sharing certain bands. Creating new incentives that could allow agencies to be appropriately reimbursed at higher rates would provide stronger incentives for government users currently located in valuable bands for 5G to update their equipment and move to other appropriate frequencies. Likewise, the SRF should not be restricted to provide for comparable systems. Instead, agencies should have clear incentives to use SRF funds to improve capabilities by upgrading equipment rather than simply replacing existing equipment with comparable capabilities.

Under 47 U.S.C. 923(j), the Spectrum Relocation Fund establishes a preference that “NTIA shall give priority to options involving reallocation of the band for exclusive non-federal use.” Spectrum bands that are not occupied by a Federal agency are becoming increasingly scarce, which increases the necessity to finding coexistence regimes that protect Federal missions and also foster innovation in non-federal, commercial applications.

Question 2. Do you believe these provisions establishing an SRF preference for exclusive non-federal users should be modernized to better reflect the current spectrum environment? Why or why not?

Answer. I believe the preference for exclusive non-federal use is appropriate and even necessary, particularly for mid-band spectrum that is ideal for 5G services, because commercial mid-band is the area in which we are in grave danger of falling behind China. I believe that closing this commercial mid-band spectrum gap is absolutely crucial to the security of the United States and our allies, because spectrum policy is key to the future of the networks and applications on which our societies operate. Those networks and applications will be developed either by us, with the free market principles this Committee has long espoused, or by the deepening autocratic alliance of China, Russia, Iran, and North Korea.

The security of the United States as a free market democracy hangs in the balance. Fortunately, successive Administrations and Congresses have taken meaningful actions to address this threat, and now we have the opportunity to leverage spectrum policy in favor of our principles—dynamism, innovation, and freedom rather than surveillance, control, and oppression.

This will require maximizing all critical uses of spectrum, from weapons and defense systems to commercial 5G and next generation wireless networks, including both local wireless connectivity and wide area coverage. To secure our core national interests, we have to lead the world in all of these areas, and we can. However, right now we are in danger of falling far behind China in mid-band licensed spectrum that can support wide area coverage, which is critical to bringing mobile services and technologies to every part of the country. This is a grave threat to the security of our network infrastructure.

Addressing this severe licensed spectrum shortage while also maintaining our present world-leading position in defense systems and local wireless connectivity will be difficult. But as this Committee well knows, the United States is quite capable of accomplishing difficult technical achievements, particularly at the intersection of military capabilities and commercial strength.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. RAPHAEL WARNOCK TO
CLETE D. JOHNSON

Rip and Replace

The Rip and Replace Program is a critical national security program that reimburses smaller communications services providers for replacing equipment purchased from Chinese telecommunications companies.¹ However, insufficient program funding and logistical difficulties replacing equipment force many rural providers to choose between using unsafe technology and maintaining service.² Without adequate Rip and Replace funding, efforts to increase broadband availability in underserved areas will be negatively impacted as rural carriers struggle to provide safe service.³

Question 1. How does the Rip and Replace Program promote American national security interests?

Answer. Replacing Covered List equipment with trusted supplier equipment is a basic step that we need to complete for network security in the United States. Given China's intelligence capabilities, Covered List equipment and services from suppliers like Huawei and ZTE are inherently not secure, and their security risks are difficult or even impossible to mitigate. It is imperative that we complete the task of replacing this equipment with trusted supplier equipment.

Question 2. How would more Federal funding for the Rip and Replace Program promote connectivity in rural and underserved areas?

Answer. Simply put, the connectivity that rural and underserved communities deserve is secure, reliable connectivity. Reimbursed replacement of Covered List equipment for the network operators that serve these communities will provide this necessary secure, reliable connectivity.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JERRY MORAN TO
CLETE D. JOHNSON

Spectrum Research

The University of Kansas, along with partners including Wichita State University, is conducting research into improving data security over 5G hardware that is potentially compromised.

Question 1. As our Nation addresses increased vulnerabilities that come from the proliferation of advanced wireless technology in major segments of our economy—including transportation, manufacturing and critical infrastructure—what are your opinions on the importance of funding research directed at maintaining national security?

Answer. I commend the University of Kansas and Wichita State for their partnership in this important area of research and development. Basic academic research is indispensable to finding security solutions for future networks.

Question 2. Particularly related to national security and defense, what do you see are top areas of spectrum-related research that we are pursuing or should be prioritized?

Answer. Sharing of spectrum may be increasingly necessary as the next generation of telecommunications emerges, 6G, which will require even more spectrum resources and is already in development, including in China. The government and industry should collaborate on two initiatives to maximize spectrum use in any given band. The first should examine how to advance spectrum sharing regimes; when clearing a spectrum band for commercial use is not practical, coordinated sharing through proven methods can be a solution. Government and industry should collaborate to advance “static” sharing, in which each party is restricted to using the shared spectrum in specific geographic locations. These sharing methods provide coordinated access and certainty, and technological developments are increasing the precision of this geographic spectrum sharing. Such sharing of spectrum may be increasingly necessary as the next generation of telecommunications, 6G, emerges,

¹ *Secure and Trusted Communications Networks Reimbursement Program*, Federal Communications Commission (Feb. 27, 2024), <https://www.fcc.gov/supplychain/reimbursement>.

² See Cecilia Kang, ‘Rip and Replace’: The Tech Cold War Is Upending Wireless Carriers, *New York Times* (May 9, 2023), <https://www.nytimes.com/2023/05/09/technology/cellular-china-us-zte-huawei.html>.

³ Quinn Nghiem, *Lack of Rip and Replace Funding Could Spell Trouble for BEAD Progress*, *Event Hears*, Broadband Breakfast (Aug. 2, 2023), <https://broadbandbreakfast.com/lack-of-rip-and-replace-funding-could-spell-trouble-for-bead-progress-event-hears>.

which will require even more spectrum resources and is already in development, including in China.

Over the long term, testing and experimentation on “dynamic” spectrum sharing—in which each party’s use of frequencies changes dynamically according to real-time needs—may eventually overcome existing practical impediments to real-world implementation (*e.g.*, complexity, uncertainty, and coverage limits) that prevent deployment of promising 5G use cases like autonomous transportation and telehealth applications. The ongoing CBRs experiment has shown the difficulties with dynamic sharing arrangements. For now, sharing initiatives to promote 5G should focus on further advances of static geographic sharing mechanisms that provide proven benefits.

The second collaborative initiative should support R&D efforts to advance spectral efficiency for the benefit of both commercial and government networks. Improving spectral efficiency involves finding technical solutions to increase the amount of data that can be transmitted reliably over given spectrum. As FCC Chairwoman Rosenworcel has said, improving the efficiency of receivers is one possibility to maximize spectrum use. As demonstrated through the delays in C-band due to Federal Aviation Administration concerns about outdated altimeters in aircraft, this evaluation of receiver performance should be done well ahead of a reallocation transition. This should involve not only finding technological improvements for spectral efficiency, but also establishing mechanisms for implementation in existing networks to take advantage of newfound efficiencies.

Finally, policymakers should create a formal mechanism to take advantage of advances in spectral efficiency and sharing into Federal procurement processes. Demand for spectrum will increase significantly in the next decade and creating a formal method for incorporating modern technology to improve spectral efficiency and spectrum sharing would help maximize the capacity of spectrum employed by all users, both Federal and commercial.

Unmanned Aerial Systems

Uncertainty about future spectrum access can inhibit new technology development and can have broad downstream impacts far beyond communications networks. The Administration has acknowledged that spectrum access is essential for the next generation of aviation, identifying the 5030–5091 MHz band to support command and payload communications (CNPC) in the National Spectrum Strategy (NSS). CNPC is fundamental to the safe operation of remotely operated aircraft, including Uncrewed Aircraft Systems (UAS) and Advanced Air Mobility (AAM). The NSS Implementation Plan envisions a study of this band—which is already allocated for non-federal aviation services—that will not be complete until 2026.

Question. Can you please discuss the economic and commensurate safety and security risks that uncertainty regarding access to this band creates for the development of the necessary technologies, networks, and services to provide CNPC to future UAS and AAM operations?

Answer. In all areas of spectrum policy and planning, certainty is indispensable necessary for coherent technology processes, from research and development to testing to deployment. This is especially true in emerging technology deployments that have a public safety considerations, such as UAS and AAM. The expedited study of this band is crucial.

NTIA Appropriations/Spectrum Policy Leadership

As the ranking member on the CJS Appropriations Subcommittee, which has jurisdiction over NTIA, I’ve watched these recent debates around spectrum with great interest. As we know, the NTIA Administrator, by law, is the President’s principal advisor on all telecommunications issues. NTIA also houses the Institute for Telecommunication Sciences (ITS), a world-leading lab that can run robust tests and make unbiased findings.

But over the last few years, other agencies have taken a larger role in spectrum policy.

Question. How can Congress ensure our national security while maintaining NTIA’s role as the Federal government’s spectrum policy lead?

Answer. The United States needs coherent government processes for reallocation to ensure that spectrum is used to best advance U.S. economic and national security interests. It is important for the U.S. government’s two spectrum regulators—the Federal Communications Commission (FCC) for commercial spectrum and NTIA for Federal spectrum—to be the ultimate decisionmakers, and NTIA should serve as the central agency to represent Federal government interests. When different government agencies are not on the same page, deployment can be delayed, government

and private resources can be unnecessarily spent, and allocation decisions that impact U.S. economic and national security can be hindered.

As the Federal government's halting process in C-band showed, a fragmented process can cause confusion and delay the deployment of 5G services. The C-band auction raised record numbers, with wireless providers collectively paying over \$80 billion for licenses. However, divides within the Federal government—including approval from the FCC and NTIA but questions about safety issues from the Federal Aviation Administration—delayed the launch of 5G. The Interdepartment Radio Advisory Committee (IRAC), composed of representatives from Federal agencies with spectrum interests that help NTIA manage Federal use of spectrum, is an essential tool to develop a coherent and unified government spectrum policy. The IRAC plays an important role in advising NTIA of government interests and distributing information across affected agencies in the context of FCC proceedings on commercial use of spectrum. These interagency processes are critical to U.S. leadership in 5G. After years of engagement across the agencies and their regulated industries, wireless companies are now expected to operate with temporary and minimal restrictions while the aviation industry addresses its concerns regarding older aircraft equipment. Still, these delays reinforce the importance of NTIA serving as the voice of the Executive Branch in its recommendations to the FCC on commercial spectrum. The Presidential Memorandum on Modernizing United States Spectrum Policy provides a solid framework to make this happen.

More generally, stakeholders should work together collaboratively to make spectrum reallocation work. In a wireless world, spectrum allocations need to have room to take advantage of technological innovations. Reallocation can be a win-win when incumbent users are provided the resources to succeed, and new users are provided the certainty and spectrum necessary for technological innovation and to implement new uses. The process should not be rigid, as every reallocation, band, and system is different. Reallocation can be guided and organized to benefit all parties, so long as all parties come to the table transparently and with an eye to mutual benefit and advancing the interests of the United States, rather than a zero-sum game with distinct losers and winners.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. MARSHA BLACKBURN TO
CLETE D. JOHNSON

At the World Radiocommunications Conference last year, China and Huawei were almost successful in rallying other countries to identify the 6GHz band for licensed use. This could have stranded the billions of dollars invested in engineering and manufacturing 6 GHz WiFi devices for the global market. This also would have given Huawei a significant advantage in the market as they are the only company building licensed wireless equipment for 6 GHz. Despite our lack of preparedness, the U.S. delegation was able to block these attempts. However, I am concerned this may be the new normal in international venues.

Question. Do you expect China to try something like this again, and what can the United States do to be better prepared in the future to pushback and deter similar China actions?

Answer. Yes, I fully expect China to continue to seek to press its advantage in every spectrum policy arena, particularly for mid-band spectrum that is ideal for 5G services. China has a strategy to dominate the future of technology, and its spectrum strategy derives from that.

Commercial mid-band is the area in which we are in grave danger of falling behind China. I believe that closing this commercial mid-band spectrum gap is absolutely crucial to the security of the United States and our allies, because spectrum policy is key to the future of the networks and applications on which our societies operate. Those networks and applications will be developed either by us, with the free market principles this Committee has long espoused, or by the deepening autocratic alliance of China, Russia, Iran, and North Korea.

The security of the United States as a free market democracy hangs in the balance. Fortunately, successive Administrations and Congresses have taken meaningful actions to address this threat, and now we have the opportunity to leverage spectrum policy in favor of our principles—dynamism, innovation, and freedom rather than surveillance, control, and oppression.

This will require maximizing all critical uses of spectrum, from weapons and defense systems to commercial 5G and next generation wireless networks, including both local wireless connectivity and wide area coverage. To secure our core national interests, we have to lead the world in all of these areas, and we can. However, right now we are in danger of falling far behind China in mid-band licensed spec-

trum that can support wide area coverage, which is critical to bringing mobile services and technologies to every part of the country. This is a grave threat to the security of our network infrastructure.

Addressing this severe licensed spectrum shortage while also maintaining our present world-leading position in defense systems and local wireless connectivity will be difficult. But as this Committee well knows, the United States is quite capable of accomplishing difficult technical achievements, particularly at the intersection of military capabilities and commercial strength.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. SHELLEY MOORE CAPITO TO
CLETE D. JOHNSON

Question. What actions should the FCC take to ensure spectrum is available to help expand new technologies that can assist in emergencies, like small drone delivery of medical supplies and groceries?

Answer. This is a compelling example of the valuable technological breakthroughs that can happen with additional spectrum available for commercial uses, and another reason that it is a national security imperative to free up more spectrum for commercial uses—particularly for mid-band spectrum that is ideal for 5G services, because commercial mid-band is the area in which we are in grave danger of falling behind China. I believe that closing this commercial mid-band spectrum gap is absolutely crucial to the security of the United States and our allies, because spectrum policy is key to the future of the networks and applications on which our societies operate. Those networks and applications—including the emergency services referenced in the question—will be developed either by us, with the free market principles this Committee has long espoused, or by the deepening autocratic alliance of China, Russia, Iran, and North Korea.

The security of the United States as a free market democracy hangs in the balance. Fortunately, successive Administrations and Congresses have taken meaningful actions to address this threat, and now we have the opportunity to leverage spectrum policy in favor of our principles—dynamism, innovation, and freedom rather than surveillance, control, and oppression.

This will require maximizing all critical uses of spectrum, from weapons and defense systems to commercial 5G and next generation wireless networks, including both local wireless connectivity and wide area coverage. To secure our core national interests, we have to lead the world in all of these areas, and we can. However, right now we are in danger of falling far behind China in mid-band licensed spectrum that can support wide area coverage, which is critical to bringing mobile services and technologies to every part of the country. This is a grave threat to the security of our network infrastructure.

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RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARIA CANTWELL TO
DIANE RINALDO

Smart Spectrum Policy

We have seen firsthand how a fractured domestic approach to spectrum management threatens domestic and national security. The former Administration's hands-off policies resulted in interagency disputes.

We can avoid this by creating a unified approach to domestic spectrum policy, where agencies with critical missions such as the FAA and DoD work together with NTIA—cooperatively—on spectrum. The Biden Administration's framework outlined in the Presidential Memorandum on Modernizing United States Spectrum Policy does this.

We are at our best when we work together. Facilitating a collaborative approach to domestic spectrum policy will ensure a unified front on the world stage. A smart approach to spectrum will allow the U.S. to lead on international policies and advance our national security interests.

Question 1. Ms. Rinaldo, how in your view have the interagency spectrum disputes of the past harmed national security, and why is it so important to restore order to the process?

Answer. Continued turf disputes have created havoc in the IRAC process, resulting in some agencies working outside it. Updating the Spectrum Relocation Fund allows for more dynamic uses and potential upgrades of capabilities, thereby encouraging agencies to find common ground.

Spectrum Auction Authority and National Security

Back when the wireless industry had access to new commercial spectrum, wireless providers would need to upgrade their networks with technology compatible with that new spectrum. Sometimes, that meant making small changes to existing network equipment; other times, it even meant transitioning to new equipment entirely.

The network upgrades that followed new spectrum allocations presented an opportunity for new companies to enter the market.

But new entrants no longer have this opportunity, as the FCC's spectrum auction authority expired over a year ago. There's no new spectrum to access.

And that's too bad, because new entrants like those using Open RAN are a secure alternative to Huawei and ZTE that are important to national security.

Question 1. Ms. Rinaldo, why is having FCC auction authority restored as soon as possible so important to the development and adoption of Open RAN-based network elements?

Answer. Providing more spectrum gives Open RAN greater opportunities to be deployed here in the United States. The deployment of Open RAN will lead to scale, thereby helping bring down costs and encourage developing nations to move away from untrusted vendors.

Question 2. How does the development and adoption of Open RAN-based network elements support national security and serve to counter the threats of Huawei and ZTE?

Answer. Open RAN gives countries and mobile operators something to run to. 127 vendors are currently participating in the Open RAN ecosystem, leading to advancements in innovation, a decrease in costs, and more opportunities for homegrown companies to take form.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BEN RAY LUJÁN TO
DIANE RINALDO

Emerging Mid-Band Radar Spectrum Sharing (EMBRSS) Feasibility Assessment Report

As I said in-person in the hearing, the United States can retake our leadership position on spectrum. To do so, we must lead the world in developing the next generation of not only spectrum technology, but spectrum policy. The U.S. Department of Defense recently released an unclassified version of the Emerging Mid-Band Radar Spectrum Sharing (EMBRSS) Feasibility Assessment Report as required by the Infrastructure Investment and Jobs Act (IIJA). The assessment found “a [Dynamic Spectrum Management System] DSMS, that evolves the CBRS framework in the 3550–3700 MHz band, with advanced interference mitigation features which can address the needs of all systems, including the unique needs of airborne systems, provides a *feasible path forward for spectrum sharing* between the Federal and commercial systems in the 3100–3450 MHz band [emphasis added]” (Page 220; U.S. Department of Defense, EMBRSS Feasibility Assessment Report; released September 2023, unclassified report released April 3, 2024).

Question 1. Now that the EMBRSS Report is public, does it provide a roadmap for future public and private investment into the regulations and technology necessary to open up spectrum availability through dynamic spectrum sharing? If it does not provide a roadmap, what other steps are necessary?

Answer. Earlier this month, DoD announced they would be participating alongside NTIA and industry to study dynamic spectrum sharing and fund prototypes to bring it to life. I was pleased to participate at the event and the Open RAN Policy Coalition members are eager to work alongside DoD, NTIA and other agencies to achieve these goals.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN HICKENLOOPER TO
DIANE RINALDO

Spectrum Relocation Fund

The Spectrum Relocation Fund (SRF) has been effective in providing compensation for Federal agencies who are willing to share or reallocate their spectrum for

non-federal purposes. However, the current statute limits reimbursements for agencies to modify their systems to adapt to a sharing or reallocation arrangement only up to a “comparable capability”.

Question 1. Do you agree the “comparable capability” threshold under the current Spectrum Relocation Fund statute is limiting? What effect do you believe proposals would have by amending this threshold to allow for reimbursements, subject to review by the Technical Panel (including the Office of Management and Budget) to support “enhanced capability” or achieve a “state of the art”?

Answer. The SRF should be updated to accommodate Federal users and better serve their mission. By allowing agencies to increase capabilities, you are creating a positive incentive for relocation.

Under 47 U.S.C. 923(j), the Spectrum Relocation Fund establishes a preference that “NTIA shall give priority to options involving reallocation of the band for exclusive non-federal use.” Spectrum bands that are not occupied by a Federal agency are becoming increasingly scarce, which increases the necessity to finding coexistence regimes that protect Federal missions and also foster innovation in non-federal, commercial applications.

Question 2. Do you believe these provisions establishing an SRF preference for exclusive non-federal users should be modernized to better reflect the current spectrum environment? Why or why not?

Answer. Decisions should be data-driven based on capacity constraints and needs.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. RAPHAEL WARNOCK TO
DIANE RINALDO

Rip and Replace

The Rip and Replace Program is a critical national security program that reimburses smaller communications services providers for replacing equipment purchased from Chinese telecommunications companies.¹ However, insufficient program funding and logistical difficulties replacing equipment force many rural providers to choose between using unsafe technology and maintaining service.² Without adequate Rip and Replace funding, efforts to increase broadband availability in underserved areas will be negatively impacted as rural carriers struggle to provide safe service.³

Question 1. How does the Rip and Replace Program promote American national security interests?

Answer. The United States has long known that it would be unwise to have a foreign adversary in our telecommunication networks. By ripping out Huawei and ZTE and replacing them with trusted networking, we are sending signals to our global partners of the severity of the situation and the need to extricate the threat.

Question 2. How would more Federal funding for the Rip and Replace Program promote connectivity in rural and underserved areas?

Answer. Rip and replace is an opportunity to eliminate a national security threat and help improve connectivity in rural and remote areas. Operators should be allowed to use the funding to update their network to 5G; it is the best use of taxpayer dollars and improves connectivity for rural citizens.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. JERRY MORAN TO
DIANE RINALDO

NTIA Appropriations/Spectrum Policy Leadership

As the ranking member on the CJS Appropriations Subcommittee, which has jurisdiction over NTIA, I’ve watched these recent debates around spectrum with great interest. As we know, the NTIA Administrator, by law, is the President’s principal advisor on all telecommunications issues. NTIA also houses the Institute for Telecommunication Sciences (ITS), a world-leading lab that can run robust tests and make unbiased findings.

¹ *Secure and Trusted Communications Networks Reimbursement Program*, Federal Communications Commission (Feb. 27, 2024), <https://www.fcc.gov/supplychain/reimbursement>.

² See Cecilia Kang, ‘Rip and Replace’: The Tech Cold War Is Upending Wireless Carriers, *New York Times* (May 9, 2023), <https://www.nytimes.com/2023/05/09/technology/cellular-china-us-zte-huawei.html>.

³ Quinn Nghiem, *Lack of Rip and Replace Funding Could Spell Trouble for BEAD Progress*, *Event Hears*, Broadband Breakfast (Aug. 2, 2023), <https://broadbandbreakfast.com/lack-of-rip-and-replace-funding-could-spell-trouble-for-bead-progress-event-hears>.

But over the last few years, other agencies have taken a larger role in spectrum policy.

Question. How can Congress ensure our national security while maintaining NTIA's role as the Federal government's spectrum policy lead?

Answer. As the former acting Administrator of NTIA, I believe there is a false narrative that the Administrator and the dedicated men and women at NTIA do not prioritize the country's national security; but I do agree that Congress plays an important role ensuring the process runs more smoothly, and agencies abide by the process.

Suggestions on how to strengthen the process:

- 1) Properly fund NTIA's ITS lab. The United States should have a world-class telecommunications lab that can work closely with the Federal Communications Commission to adjudicate potential concerns of interference.
- 2) Require and give NTIA the tools to become more data-centric.
- 3) Upgrade the NTIA Administrator to Under Secretary—titles matter in the U.S. government.
- 4) Create shot clocks to force timely decision-making.
- 5) Update the Spectrum Relocation Fund to offer greater incentives.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. MARIA CANTWELL TO
HAROLD FURCHTGOTT-ROTH

Smart Spectrum Policy

We have seen firsthand how a fractured domestic approach to spectrum management threatens domestic and national security. The former Administration's hands-off policies resulted in interagency disputes.

We can avoid this by creating a unified approach to domestic spectrum policy, where agencies with critical missions such as the FAA and DoD work together with NTIA—cooperatively—on spectrum. The Biden Administration's framework outlined in the Presidential Memorandum on Modernizing United States Spectrum Policy does this.

We are at our best when we work together. Facilitating a collaborative approach to domestic spectrum policy will ensure a unified front on the world stage. A smart approach to spectrum will allow the U.S. to lead on international policies and advance our national security interests.

Question 1. How in your view have the interagency spectrum disputes of the past harmed national security, and why is it so important to restore order to the process?

Answer. NTIA has maintained the role of coordinating various Administrations' spectrum policy for decades. The FCC makes many spectrum decisions that do not adversely affect NTIA's spectrum decisions, and vice versa. On a few spectrum decisions, there has been a lack of coordination. NTIA is responsible for coordinating Federal spectrum, and the FCC is responsible for coordinating non-federal spectrum. The FCC makes decisions based on a public record—one usually devoid of classified information. Occasionally, FCC decisions may affect national security, and improved mechanisms should be in place to better coordinate FCC decisions with those national security concerns. It is important that government decisions affecting spectrum not endanger national security.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. KYRSTEN SINEMA TO
HAROLD FURCHTGOTT-ROTH

Question 1. What have been the key shortcomings of previous spectrum policy determinations, and how have commercial entities both failed and succeeded in the past to effectively take into account the need for national security access and use of the spectrum?

Answer. Please see my answer above to Senator Cantwell's question. It is the responsibility of the Federal government, not commercial entities, to consider national security concerns and propose corresponding policies.

Question 2. Are there adequate policies and procedures in place as we modernize and optimize our spectrum use and infrastructure to balance future national defense needs of and access to spectrum with the commercial and scientific stakeholders?

Answer. Please see my answer above to Senator Cantwell's question.

a. If not, what needs to be added?

Answer. Again, please see my answer above to Senator Cantwell's question.

b. Recognizing that future technological development may be difficult to anticipate, do those policies and procedures account for access and use of the spectrum by the Department of Defense (DoD) in the future as they respond to developments of spectrum use by our adversaries, which may be within spectrum bands the DoD no longer has access to?

Answer. DoD develops systems that may use specific bands of spectrum for specific purposes. This question focuses on whether DoD can respond if an adversary develops a weapons system that uses a specific band of spectrum that has been allocated for non-federal use in the United States. This is an important question for electronic warfare and countermeasures that DoD might be able to use against a hostile weapon system.

In such a scenario, the development, testing, and training of countermeasures to a hostile weapon system should still be possible at a military facility that is distant from commercial uses in that band. The actual use of those countermeasures would only occur during a major conflict or war; this would be a time when DoD already has emergency authority over spectrum.

c. What do we need to consider in spectrum optimization to account for the agility certain adversaries have in spectrum allocation and their ability to prioritize their own security considerations over commercial interests?

Answer. Each nation has its own spectrum priorities and policies. Some prioritize national security more than the United States; some prioritize it less. At least one of our global adversaries, China, tends to allocate more spectrum for commercial purposes than the United States does.

d. What is the feedback you have received from the DoD and other national security stakeholders on the Dynamic Spectrum Sharing concept referenced in testimony to optimize spectrum use?

Answer. I have not communicated directly with DoD about Dynamic Spectrum Sharing.

Question 3. Again, recognizing that we can never fully anticipate what areas of the spectrum our adversaries may be utilizing or researching for their own weapons systems development, is it possible to identify certain geographic areas within the Nation to exclude from the sale of exclusive access of the spectrum in order to preserve DoD access and flexibility in testing and training within such limited geographic area(s)?

Answer. Yes; that should be possible. The FCC has a long history of issuing and auctioning off spectrum licenses tied specifically to limited geographic territories. Moreover, certain military reservations in the western United States should be remote enough from commercial activities to allow for development and testing and evaluation of weapons systems.

a. Would such an area for test and evaluation be of value to the commercial and scientific stakeholders as well? If so, how?

Answer. Possibly. However, that is a question better directed to commercial entities and scientific researchers.

b. Would there be any anticipated concerns from commercial or scientific stakeholders that you are aware of?

Answer. Again, that is a question better directed to commercial entities and scientific researchers.

Question 4. The U.S. Army's Buffalo Soldier Electronic Testing and Training Range at Fort Huachuca, Arizona currently serves as a technical demonstration platform that is critical to the DoD by enabling research and development, driving technological advancement, bolstering national security, informing effective policies, and advancing scientific discovery.

a. As part of the National Spectrum Strategy and the need to develop a national testbed for dynamic spectrum sharing (DSS), is it possible to co-locate the DSS testbed with the Buffalo Soldier Electronic Testing and Training Range at Fort Huachuca and the Western Regional Range Complex concept in general to enable DoD, Federal agencies, and national policymakers to work cooperatively with industry, researchers, and academia to objectively identify optimization opportunities and examine new technologies?

Answer. This is a question about specific programs, and it is better directed to the individuals responsible for those programs.

b. Would co-locating these activities reduce or eliminate duplication of other efforts and synchronize other relevant research and engineering activities already under way across the government with respect to AI/ML, zero-trust networks, data-source management, autonomy and autonomous systems, and advanced radar technologies?

Answer. Again, this is a question better directed to the individuals responsible for those programs.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BEN RAY LUJÁN TO
HAROLD FURCHTGOTT-ROTH

Emerging Mid-Band Radar Spectrum Sharing (EMBRSS) Feasibility Assessment Report

As I said in-person in the hearing, the United States can retake our leadership position on spectrum. To do so, we must lead the world in developing the next generation of not only spectrum technology, but spectrum policy. The U.S. Department of Defense recently released an unclassified version of the Emerging Mid-Band Radar Spectrum Sharing (EMBRSS) Feasibility Assessment Report as required by the Infrastructure Investment and Jobs Act (IIJA). The assessment found “a [Dynamic Spectrum Management System] DSMS, that evolves the CBRSS framework in the 3550–3700 MHz band, with advanced interference mitigation features which can address the needs of all systems, including the unique needs of airborne systems, provides a *feasible path forward for spectrum sharing* between the Federal and commercial systems in the 3100–3450 MHz band [emphasis added]” (Page 220; U.S. Department of Defense, EMBRSS Feasibility Assessment Report; released September 2023, unclassified report released April 3, 2024).

Question 1. Now that the EMBRSS Report is public, does it provide a roadmap for future public and private investment into the regulations and technology necessary to open up spectrum availability through dynamic spectrum sharing? If it does not provide a roadmap, what other steps are necessary?

Answer. There are several possible options for managing all or part of the lower 3 GHz band. Dynamic spectrum sharing is one possibility; there are also others. Assuming that Congress does not reallocate the lower 3 GHz band by statute, decisions about whether and how to transfer part or all of the lower 3 GHz band to non-federal use will be made by the Administration, including NTIA and DoD. Those decisions by the Administration will be informed by many considerations, including the possibility of using technologies such as Dynamic Spectrum Sharing.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN HICKENLOOPER TO
HAROLD FURCHTGOTT-ROTH

Spectrum Relocation Fund

The Spectrum Relocation Fund (SRF) has been effective in providing compensation for Federal agencies who are willing to share or reallocate their spectrum for non-federal purposes. However, the current statute limits reimbursements for agencies to modify their systems to adapt to a sharing or reallocation arrangement only up to a “comparable capability”.

Question 1. Do you agree the “comparable capability” threshold under the current Spectrum Relocation Fund statute is limiting? What effect do you believe proposals would have by amending this threshold to allow for reimbursements, subject to review by the Technical Panel (including the Office of Management and Budget) to support “enhanced capability” or achieve a “state of the art”?

Answer. I agree that, for purposes of the Spectrum Relocation Fund, allowing for reimbursement of “enhanced capability” would be an improvement over “comparable capability.” However, I am not convinced that this improvement alone will lead to an efficient allocation of Federal spectrum. Federal agencies will continue to see little benefit in making spectrum available to transfer to, or to share with, non-federal use.

Under 47 U.S.C. 923(j), the Spectrum Relocation Fund establishes a preference that “NTIA shall give priority to options involving reallocation of the band for exclusive non-federal use.” Spectrum bands that are not occupied by a Federal agency are becoming increasingly scarce, which increases the necessity to finding coexistence regimes that protect Federal missions and also foster innovation in non-federal, commercial applications.

Question 2. Do you believe these provisions establishing an SRF preference for exclusive non-federal users should be modernized to better reflect the current spectrum environment? Why or why not?

Answer. Yes, insofar as the Spectrum Relocation Fund can and should apply to instances of sharing as well as complete transfer to non-federal use.

However, the limitations of the Spectrum Relocation Fund are only part of the overall inefficiencies associated with the allocation and use of Federal spectrum. We have no overall valuation of Federal spectrum resources. We also lack an assessment for each agency's use of spectrum, as well as pricing mechanisms that would enable agencies to increase or to decrease their use of an extraordinarily valuable and scarce resource: Federal spectrum.

Federal spectrum likely has a market value of trillions of dollars. Its efficient use benefits America; its inefficient use is a loss of a valuable resource that cannot be recovered. The Federal government monitors and quantifies a Federal agency's use of Federal dollars, of Federal personnel, of the environment effects of the agency's activities, and of other uses of Federal assets. In each instance, agencies have quantifiable budgets that must be met. But there is no Federal budget for Federal spectrum, no incentive to use less of it, no mechanism to obtain more as needed, and no basis to improve the efficient use of spectrum.

Therefore, the Spectrum Relocation Fund can and should be improved, but it is only a partial solution to a much larger problem.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JERRY MORAN TO
HAROLD FURCHTGOTT-ROTH

Spectrum Research

The University of Kansas, along with partners including Wichita State University, is conducting research into improving data security over 5G hardware that is potentially compromised.

Question 1. As our Nation addresses increased vulnerabilities that come from the proliferation of advanced wireless technology in major segments of our economy—including transportation, manufacturing and critical infrastructure—what are your opinions on the importance of funding research directed at maintaining national security?

Answer. National security is a public good that would not ordinarily attract private funding. It is important for the Federal government to support national security, including research for national security as described above. Of course, much private investment and research can be—and is—used subsequently for national defense purposes.

Question 2. Particularly related to national security and defense, what do you see are top areas of spectrum-related research that we are pursuing or should be prioritized?

Answer. Government-funded research should focus on areas that are not otherwise addressed by private research. One area of spectrum research that requires substantial government attention is spectrum used both to support our military drones and to deter hostile drone warfare. Electronic warfare and the coordinated use of spectrum are increasingly important as drone attacks have become a primary form of warfare in Ukraine and the Middle East.

Unmanned Aerial Systems

Uncertainty about future spectrum access can inhibit new technology development and can have broad downstream impacts far beyond communications networks. The Administration has acknowledged that spectrum access is essential for the next generation of aviation, identifying the 5030–5091 MHz band to support command non-payload communications (CNPC) in the National Spectrum Strategy (NSS). CNPC is fundamental to the safe operation of remotely operated aircraft, including Uncrewed Aircraft Systems (UAS) and Advanced Air Mobility (AAM). The NSS Implementation Plan envisions a study of this band—which is already allocated for non-federal aviation services—that will not be complete until 2026.

Question 1. Can you please discuss the economic and commensurate safety and security risks that uncertainty regarding access to this band creates for the development of the necessary technologies, networks, and services to provide CNPC to future UAS and AAM operations?

Answer. Please see my answer above concerning areas of spectrum research. Of course, there are economic, safety, and security risks associated with delayed research for spectrum associated with unmanned aerial systems. The Administration's timelines for NSS are much too slow.

The discussion here is correct, but it focuses narrowly on the use of spectrum to support our unmanned military aerial systems. Just as important is the need to develop countermeasures based on spectrum to defeat hostile unmanned aerial sys-

tems. The Ukraine War has been punctuated by a series of drone attacks by both sides against targets with little or no electronic defenses.

NTIA Appropriations/Spectrum Policy Leadership

As the ranking member on the CJS Appropriations Subcommittee, which has jurisdiction over NTIA, I've watched these recent debates around spectrum with great interest. As we know, the NTIA Administrator, by law, is the President's principal advisor on all telecommunications issues. NTIA also houses the Institute for Telecommunication Sciences (ITS), a world-leading lab that can run robust tests and make unbiased findings.

But over the last few years, other agencies have taken a larger role in spectrum policy.

Question 1. How can Congress ensure our national security while maintaining NTIA's role as the Federal government's spectrum policy lead?

Answer. The Spectrum Pipeline Act is a good starting point. Spectrum policy in the United States is disjointed, with NTIA responsible for Federal spectrum and the FCC responsible for non-federal (primarily commercial) spectrum. Coordination between the FCC and NTIA has waxed and waned over the years. We need both forms of spectrum policy.

Spectrum is worth trillions of dollars and is one of the least developed assets in America. A generation from now, Americans will look back at our primitive use of spectrum today in amazement. Commercial spectrum should be allowed to develop to the benefit of American consumers with clear property rights and with only those rules attached that are necessary to protect those property rights. But spectrum is also vital for non-commercial applications, including aviation safety, meteorology, space research, navigation, national security, and countless other Federal uses. Congress should balance the Federal and non-federal interests in spectrum *and* hold both the FCC and NTIA accountable.

U.S. Technological Leadership

China is attempting to influence spectrum allocations worldwide, including most recently at the World Radio Conference where they challenged the U.S. position on the 6GHz band, which the U.S. has allocated for unlicensed use.

Question 1. What is your assessment of U.S. leadership in international wireless standards, and what can Congress do to ensure China is not effective in diminishing U.S. wireless technology positions internationally?

Answer. International standards-setting bodies are important, and the governments of many other countries spend far more resources trying to influence these bodies than the American government spends. However, there is a delicate balance to consider. On the one hand, it would be unseemly for the Federal government to invest substantial taxpayer resources trying to influence these bodies in a blatant form of rent-seeking. Additionally, we have never been terribly accomplished at government-funded efforts to influence international fora. But on the other hand, other countries have effectively done precisely this.

We should, of course, be better organized for ITU conferences than we have been in recent years. But American government leadership can only go so far. America and American consumers—and consumers around the world—have the best outcomes at these international fora when America leads with better ideas, rather than with more taxpayer funds or arm-twisting.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARSHA BLACKBURN TO HAROLD FURCHTGOTT-ROTH

Senators Cruz, Thune, and I introduced the Spectrum Pipeline Act, which would reauthorize the FCC's spectrum auction authority, modernize the Spectrum Relocation Fund, and establish a pipeline to make 2,500 MHz of spectrum available for commercial use.

Question 1. In your written statement, you highlighted the contribution of wireless services to the creation and development of countless U.S. businesses, estimating that the consumer welfare value of commercial spectrum in the U.S. exceeds \$10 trillion. That's a tremendous number. Could you expand upon this and explain how the Spectrum Pipeline Act's emphasis on additional licensed spectrum would contribute to consumer welfare? What would be the consequences of foregoing this opportunity?

Answer. Writing in 2015, Coleman Bazelon and Giulia McHenry estimated that 645 MHz of licensed mobile wireless spectrum in 2015 was worth approximately

\$500 billion.¹ Bazelon and McHenry also estimated that the net present value of consumer welfare associated with licensed mobile wireless spectrum was from 10 to 20 times the market value: between \$5 trillion and \$10 trillion.²

Substantially more licensed spectrum has entered the U.S. inventory since 2015, including returned broadcast spectrum, 3.45 GHz, CBRS, and 3.7 GHz. In 2022, the FCC estimated that there were 1,123 megahertz of licensed mobile wireless spectrum below 4 GHz³ and 4,950 megahertz of millimeter-wave licensed fixed and mobile spectrum at higher frequencies.⁴ The FCC is considering transferring more spectrum for licensed use. Even assuming, unrealistically, no increase in the value of mobile wireless spectrum on a price per MHz pop basis, the amount of licensed spectrum below 4 GHz increased by 74 percent from 645 MHz to 1,123 GHz. Moreover, the population of the United States increased by about 5 percent between 2015 and 2022. Even assuming the price per MHz pop remained constant ($\$0.775 = \$500 \text{ billion} \div 645 \text{ MHz/population}$), the increase in licensed spectrum below 4 GHz and the increase in population means that the value of licensed spectrum below 4 GHz in 2022 would have been \$914 billion.⁵ Adding even a small value per MHz pop for the 4,950 MHz of millimeter wave results in a total value of licensed spectrum well above \$1 trillion. Using the same ratios from Bazelon and McHenry for the net present value of consumer welfare for licensed spectrum results in values well above \$10 trillion.

This is likely an underestimate of the value of licensed mobile wireless spectrum because many transactions for mobile wireless spectrum below 4 GHz since 2015 occurred at a value above \$0.775 per MHz pop. These transactions include the returned broadcast spectrum auction, the 3.45 GHz auction, and the 3.7 GHz auction. An overall blended average of mobile wireless services of \$1 or \$1.25 per MHz pop for spectrum below 4 GHz in the early 2020s is not unrealistic.

Moreover, American consumers enjoy substantial value from other commercial uses of spectrum outside of mobile wireless applications, including broadcasting, CBRS, unlicensed applications, and specialized services such as navigation and aeronautics. Consequently, today, the total value of commercial spectrum in the United States below 4 GHz is almost certainly in the many trillions of dollars, with the value of commercial spectrum above 4 GHz being a substantial sum as well. The consumer welfare of such commercial applications well exceeds \$10 trillion.

The Spectrum Pipeline Act would instruct NTIA to identify and to transfer to the FCC substantial spectrum resources from the Federal sector by a date certain. Much of this spectrum would be applied to commercial uses, further enhancing consumer welfare in the United States.

At the World Radiocommunications Conference last year, China and Huawei were almost successful in rallying other countries to identify the 6 GHz band for licensed use. This could have stranded the billions of dollars invested in engineering and manufacturing 6 GHz WiFi devices for the global market. This also would have given Huawei a significant advantage in the market as they are the only company building wireless equipment for 6 GHz. Despite our lack of preparedness, the U.S. delegation was able to block these attempts. However, I am concerned this may be the new normal in international venues.

Question 2. Do you expect China to try something like this again, and what can the United States do to be better prepared in the future to pushback and deter similar China actions?

Answer. Please see my answer above to a similar question from Senator Moran.



¹ Coleman Bazelon and Giulia McHenry, *Mobile Broadband Spectrum: A Vital Resource for the American Economy*, The Brattle Group (May 11, 2015), https://www.brattle.com/wp-content/uploads/2017/10/7801_mobile_broadband_spectrum_-_a_valuable_resource_for_the_american_economy_bazelon_mchenry_051115.pdf at 1.

² *Id.*

³ *Communications Marketplace Report*, 37 FCC Rcd 15514, (rel. Jan. 4, 2023), <https://www.fcc.gov/document/2022-communications-marketplace-report> at ¶ 84, Figure II.B.9.

⁴ *Id.* at ¶ 85, Figure II.B.10.

⁵ $\$914 \text{ billion} = (\$600 \text{ billion} * 1123) / (645 \text{ billion} * 1.05)$.