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THE STATE OF U.S. SPECTRUM POLICY

HEARING

BEFORE THE

SUBCOMMITTEE ON COMMUNICATIONS,
TECHNOLOGY, INNOVATION AND THE INTERNET

OF THE

COMMITTEE ON COMMERCE,
SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

ONE HUNDRED SIXTEENTH CONGRESS

SECOND SESSION

JULY 23, 2020

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED SIXTEENTH CONGRESS

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THE STATE OF U.S. SPECTRUM POLICY

THURSDAY, JULY 23, 2020

U.S. SENATE,
SUBCOMMITTEE ON COMMUNICATIONS, TECHNOLOGY,
INNOVATION AND THE INTERNET,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Subcommittee met, pursuant to notice, at 9:58 a.m., in room SR–253, Russell Senate Office Building, Hon. John Thune, Chairman of the Subcommittee, presiding.

Present: Senators Thune [presiding], Wicker, Fischer, Moran, Sullivan, Blackburn, Capito, Lee, Schatz, Klobuchar, Blumenthal, Peters, Tester, and Rosen.

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

Senator THUNE. This hearing will come to order. Good morning. Great to have everybody here today, and I will tell you in advance that we are going to be juggling about three votes on the floor of the Senate but we will try and figure out a way to keep everything rolling so we can get everybody's comments and questions in, but we are grateful to have all of you here this morning. This morning we are going to talk about the state of the U.S. spectrum policy. The committee has long recognized the need for a thoughtful approach to spectrum policy and the important role both the FCC and the NTIA have in spectrum management. I appreciate all of you taking the time out of your schedules to discuss this topic.

Spectrum is the lifeblood of wireless communications. Next generation wireless networks require efficient and effective use of low, mid, and high bands of spectrum. If we do not have proper management of this limited resource, we simply won't have enough of the right kinds of spectrum available. And in the global race to deploy next generation networks and services, we have a responsibility to furnish Americans with the spectrum fueled 5G ecosystem that will be needed to maintain our competitive edge. This is particularly important for those of us in more rural parts of the country.

If inadequacy of spectrum resources makes 5G less viable, it will be the rural areas where it no longer makes sense to deploy next generation telecommunication services. Here in the United States, NTIA is responsible for managing the Federal Government spectrum use and the FCC for managing all other uses. Both NTIA and the FCC have taken important steps to make more spectrum available but more work must be done.

The FCC, acting in a bipartisan manner, has moved forward with bold proposal to make thousands of megahertz of spectrum available for license and unlicensed fixed and mobile use, and it has proceedings under way to make even more spectrum available. Importantly, at the end of this year, the FCC is planning an auction to make 280 megahertz of C-band spectrum available for commercial license use, and it is critical that that auction goes forward without any delays. This mid-band spectrum is key to the United States winning the race to 5G.

As more and more Americans are relying on connectivity like Wi-Fi during the coronavirus pandemic, we must also recognize the crucial role that unlicensed spectrum plays in the communications landscape. Unlicensed spectrum is responsible for transmitting a significant amount of the data on our networks and will play a tremendous role in development of the Internet of things. But as I mentioned before, if we do not have proper management of spectrum, we will not have sufficient access to the spectrum for commercial purposes. We all know the demand for spectrum resources will continue to increase with the development of new technologies and the demand will result in Government agencies, businesses, and other groups competing for these resources which is why I have always supported an all of the above approach to make sure we efficiently use the limited spectrum resources.

With respect to commercially licensed spectrum, in my view, it is essential the FCC is allowed to rely on the independent, technical, and legal expertise of its bureaus and staff, and remain the sole expert agency to regulate non-Federal uses of spectrum as directed by the statutory authority through the Communications Act. The reviews of spectrum usage rights undertaken by the FCC are rarely simple.

I appreciate Chairman Pai's efforts to make more spectrum available for licensed and unlicensed use and the entire Commission's focus and trust in the technical analysis of its engineers to make spectrum decisions in the interest of our national and economic security. Commercial spectrum usage rights, whether through FCC issued licenses or FCC adopted rules, provide the certainty necessary to incentivize and enable returns on massive investments in research and development, manufacturing, infrastructure deployment, innovations, and applications dependent upon commercial spectrum.

And when spectrum is made available, successful spectrum policy must establish predictable rights for private entities to use the airwaves from satellite to Wi-Fi and terrestrial wireless to broadcast. Simply put, efficient and effective spectrum management requires clear rules and recognized rights for spectrum users. It is also essential for NTIA working with Federal agencies through the interdepartment Radio Advisory Committee to continue to improve the efficiency of Federal spectrum. Making the spectrum relocation fund a better resource for studying spectrum and relocating Federal incumbents were feasible is essential if we are to continue making Federal spectrum available for commercial use.

Sound spectrum management policies and procedures will keep spectrum in the pipeline and will help retain American leadership in wireless communications. I believe we need to make sure the

interagency process when making these decisions is transparent, and this is only going to be more important as we work to free up additional spectrum for commercial use. We have got a distinguished panel before us today. I look forward to hearing your thoughts on ways to improve the spectrum policymaking process to generate the most value for consumers.

Joining us today, we have Mr. Tom Power from CTIA, the Wireless Association; Dr. Roslyn Layton, a visiting researcher, Aalborg University; Mr. Mark Gibson who serves as the Director of Business Development at CommScope; and Mr. Michael Calabrese from New America's Open Technology Institute. He is going to be appearing with us virtually today. I want to thank you all for being here. I am going to turn to our Ranking Member, Senator Schatz, for his opening remarks and he will be delivering those remotely, virtually.

Senator Schatz.

STATEMENT OF HON. BRIAN SCHATZ,
U.S. SENATOR FROM HAWAII

Senator SCHATZ. Thank you, Chairman Thune, for holding this hearing and I want to thank our witnesses for being here to discuss this important topic. As we enter month six of the coronavirus pandemic, it has never been more clear how important good spectrum policies are for the public and for the economy.

Wireless connectivity has enabled many Americans to remain productive and resilient during this time as historic numbers of workers, parents, and children continue to try to work and learn from home. America's reliance on wireless connectivity today is just one example of why it is so important that Government decisions on spectrum allocation are technically sound and based on good data. Spectrum is a limited but crucial resource necessary for cutting-edge technologies like self-driving vehicles, telemedicine, and public safety networks.

In order for the U.S. to maintain its global leadership in wireless innovation, U.S. spectrum policies need to support spectrum sharing technologies that can use multiple adjacent bands. Spectrum—excuse me, spectrum is an often discussed issue in Congress, but the FCC ultimately has expertise and authority to make important technical decisions on commercial spectrum sharing and allocation. While Congress has retained the right to create laws regarding the deployment of communications technologies including spectrum, it has entrusted the FCC with rulemaking authority to make data-driven technical decisions so that our commercial spectrum is allocated for its best and most efficient use, otherwise our spectrum policies may fall subject to politics rather than be rooted in sound data and engineering analysis.

As the expert technical agency, it is critical that the FCC continues to operate in a non-biased way so that our spectrum resources provide the most benefit to our country. However, when making these decisions, the FCC must weigh the concerns of incumbent users such as utilities, the military, and public safety, and safeguard them from potential impacts of new users. The FCC must not cripple existing vital uses of spectrum in order to free up additional bandwidth.

The FCC must also consider the concerns of local jurisdictions when it adopts rules for the deployment of wireless technologies. Just as localities cannot withhold access to rights of way in their jurisdictions, the Federal Government should not just be allowed to steamroll localities just so that companies can have a faster or cheaper rollout. There needs to be a fair and reasonable balance that respects local control and but also encourages wireless deployment. And when discussing spectrum policies, we cannot forget the important role unlicensed spectrum and Wi-Fi have in our society. Unlicensed spectrum enables a variety of activities in our country such as health care monitoring and smart farming, it enables essential connectivity for military bases, universities, and schools all without the burden of an expensive data plan.

So when we think about equity in broadband adoption, it is important to remember that unlicensed wireless technologies have to be an integral part of our spectrum policies. Which brings me to my final point. Today we will discuss how we can ensure that our spectrum policies are forward looking and support next generation 5G, connected IoT, and wireless technology advancements. However, let's not forget that right now, in the middle of the pandemic, tens of millions of our fellow Americans don't have any access to broadband.

Spectrum is an asset that is owned by the American people including those who don't have connections today. And so when the FCC auctions off this important resource for billions of dollars, it is only fair that those revenues are used to help to close the digital divide in the United States. By ensuring that spectrum auction revenues are used to help Americans, we can ensure that the advances in wireless technology go hand-in-hand with narrowing the digital divide and not toward creating a new class of unconnected persons.

I am sure that today's witnesses and the organizations they represent want to make certain that our spectrum policies ensure that the next generation of wireless technology can be delivered to everyone in America. I appreciate you being here today and I look forward to the hearing. Thank you very much.

Senator THUNE. Thank you, Senator Schatz, and we will get started with our panel. And we will start on my left and your right with Mr. Tom Power who as, I said, is the Senior Vice President General Counsel for CTIA, the Wireless Association. Then proceeded to Mr. Mark Gibson, Director of Business Development at CommScope, to Dr. Roslyn Layton, visiting researcher at Aalborg University, and then we will hear from Mr. Michael Calabrese remotely who is the Director of the Wireless Future Project Open Technology Institute at New America. So, thank you for being here and we will recognize Mr. Power and ask if you could confine your oral remarks to 5 minutes and we will make sure that your entire testimony is a made a part of the written record of the hearing. The first vote is underway and we will figure out how to juggle that but we will try and keep rolling so we can get through and give everybody an opportunity to be heard from and hopefully to respond to some questions. So thanks for being here. Mr. Power, please proceed.

STATEMENT OF TOM POWER, SENIOR VICE PRESIDENT AND GENERAL COUNSEL, CTIA

Mr. POWER. Chairman Thune, Ranking Member Schatz, and members of the Subcommittee, I appreciate the opportunity to testify today and let me start by thanking the Committee and the FCC for the leadership shown during the COVID–19 pandemic. With your encouragement, we have been able to respond dynamically to our customers' needs even as the situation evolves. So thank you for the opportunity to speak today about spectrum policy in the United States and possible improvements that could be made. But let's stop to appreciate what we have got including the AWS–3 auction that closed in 2015.

The FCC has auctioned more spectrum in the last 5 years than any previous such period netting $67 billion for the U.S. Treasury. The FCC conducted the first ever incentive auction and the first ever high band auctions. Thanks to Chairman Pai's 5G fast plan and the oversight of Congress, we are on a pretty good streak. We should talk about ways to make it better. But let's acknowledge that for all its imperfections, the current process has delivered some historic wins for the Nation. We are all aware of how this committee's actions have already facilitated America's fast start in the global 5G marketplace.

Last year, U.S. wireless providers were the first to employ 5G networks and are investing in a projected $275 billion, creating 3 million jobs and adding $500 billion to GDP. These investments and deployments will improve the lives of Americans from South Dakota to Hawaii and throughout the country, through access to connected hospitals, safer and more efficient smart cities, and the life-changing applications that will grow out of our burgeoning 5G ecosystem. The U.S. led the world in 4G, both as the first mover in network deployments and in market transforming innovation by rapidly deploying low band spectrum.

As the industry transitions to 5G, we need to add mid-band spectrum to the equation as it is particularly well suited to combine improved speed and latency with broad coverage. But other countries have gotten ahead of us when it comes to mid band. By year's end, our international rivals like China will have on average five times more licensed mid band spectrum than the U.S. The good news is that the FCC will hold two mid-band spectrum auctions this year.

The CBRS auction is commencing today as it happens and the C-band auction will take off in December as the Chairman recognized. But even taking those into account, by the end of 2022, a number of other countries are expected to have licensed nearly twice as much mid-band spectrums of 5G as the U.S. Now, this committee deserves great credit for identifying the lower 3 gigahertz band currently used by the Defense Department to operate radar systems as suitable for commercial use.

We applaud Chairman Wicker and Ranking Member Schatz for introducing the Spectrum Now Act which would require the auction of 100 megahertz of that band, an auction that can't happen soon enough. There are additional bands that can play a critical role in boosting 5G innovation, but the lower 3 gigahertz band is the next major opportunity to expand critical mid-band 5G capacity. Now putting a band like the lower 3 band to work requires work among

the folks at the Defense Department, NTIA, and the FCC. So let me spend a minute identifying some proposals to make that work flow more efficiently. I mentioned earlier Chairman Wicker and Ranking Member Schatz's efforts to the Spectrum Now Act which would expand Federal agencies' use of the spectrum relocation fund to examine ways to shrink their spectrum footprint.

We also applaud Senator Lee for introducing the Government Spectrum Valuation Act which would give this committee and the Administration better insight into the market value of spectrum and to ensure its being put to its best and highest use. We similarly wish to recognize Senator Markey's work to incentivize agencies to move all spectrum that could otherwise be reallocated to consumer uses.

We also strongly commend Chairman Wicker and Ranking Member Cantwell along with the Senate Armed Services Chairman Inhofe and Ranking Member Reed for their collaboration on the Spectrum IT Modernization Act of 2020. We support this legislation and its effort to make the management of Federal spectrum more efficient.

For many years, this committee has paved the way for U.S. leadership in wireless from the MOBILE NOW Act under the leadership of Chairman Thune and former Ranking Member Nelson, to the AIRWAVES Act thanks to Senator Gardner and Senator Hassan. Now, we look forward to working with you on a new spectrum auction pipeline for the years to come. I look forward to discussing these issues with you this morning and thank you again for the opportunity to testify.

[The prepared statement of Mr. Power follows:]

PREPARED STATEMENT OF TOM POWER, SENIOR VICE PRESIDENT AND GENERAL COUNSEL, CTIA

Chairman Thune, Ranking Member Schatz, and members of the Subcommittee, on behalf of CTIA and the U.S. wireless industry, I appreciate the opportunity to testify today. Let me start by expressing our strong appreciation for the leadership exhibited by this Committee and the FCC in responding to the COVID-19 crisis, which has highlighted the critical role that wireless plays in keeping us connected to our family and friends, our jobs, our schools, and our communities. Your leadership has allowed the wireless industry to dynamically respond to the needs of its customers, even as this situation evolves.

Your leadership will be just as critical to ensuring a strong foundation for our Nation's 5G economy over the next decade. The combined efforts of this Committee, Congress, the FCC, and the Administration have facilitated a historic four years of spectrum successes. In that time, we completed the first ever incentive auction and, under Chairman Pai's 5G FAST Plan, we completed the first ever high-band spectrum auctions. We now have the opportunity to build on this foundation to make more spectrum available for 5G—particularly in the critical mid-band.

I have served at the FCC, NTIA, the White House Office of Science and Technology Policy, and in the private sector, and I know very well the essential role that spectrum management policies play. Indeed, the availability of, and access to, sufficient and appropriate spectrum is *the* key to reaping the full benefits of 5G—not only in terms of economic growth, job creation, and public safety—but also by ensuring we are able to meet unexpected and unprecedented demands when the need arises. So today, I'd like to describe the wireless landscape in the U.S., note the priorities we need to balance as we deploy 5G and in mid-band spectrum, and point out some opportunities to improve the processes government uses to identify and repurpose underutilized spectrum.

The Current Wireless Landscape: Continuing Demand for Wireless Services, the Importance of Investment, and the Work that Remains

This Committee's actions have already facilitated America's fast start in the global 5G marketplace. U.S. wireless providers gained a first mover advantage last year when they were the first to deploy commercial 5G networks.[1] The U.S. wireless industry is projected to invest $275 billion on 5G deployments, create three million jobs, and add $500 billion to GDP. These investments will be made possible by your leadership; the certainty you fostered has driven faster deployment, with residents from South Dakota to Hawaii and beyond already enjoying the benefits of 5G. And with scale, 5G will be even more transformative—improving the lives of all Americans through access to connected hospitals, safer and more efficient smart cities, and the life-changing applications that will grow out of our burgeoning 5G ecosystem.

Unprecedented Growth in Wireless. The U.S. continues to experience unprecedented growth in demand for wireless services, especially since the onset of the pandemic. In 2018 alone, we saw an 82 percent increase in mobile traffic. The increase from 2018 to 2019 was greater than the *total amount* of mobile traffic on U.S. networks just four years ago.[2] And when, in a matter of days, much of the U.S. transitioned to staying at home, we witnessed a dramatic increase in demand for wireless services. Almost overnight, voice traffic jumped 20–40 percent; major providers saw a 25 percent increase in texting; data traffic grew nearly 20 percent, with one nationwide provider reporting an increase in mobile device hotspot usage of nearly 40 percent; and applications that provide telehealth and web/video conferencing services saw huge usage increases—well over 1,000 percent.[3] U.S. wireless carriers handled that increased demand with barely a hitch. In fact, despite these trends, U.S. average mobile download speeds actually went up slightly.[4]

The Importance of Investment. U.S. wireless providers rose to this occasion thanks to continued and massive year-over-year investments. In 2018, the wireless industry made capex investments of $24.7 billion primarily for expanding network capacity and coverage and making upgrades to support 5G.[5] According to a recent NERA study, these investments allowed the industry to meet customer demand while simultaneously delivering better value than carriers in any of 36 other countries studied; U.S. consumers save nearly $10 billion per year by virtue of the superior value that U.S. wireless providers offer.[6]

The Work that Remains: The Need for Mid-band Spectrum. As successful as we have been, the next few years will define our 5G future. The U.S. led the world in 4G—both as the first mover in network deployment and in market-transforming innovation. We rapidly made available a world-leading 752 megahertz of low-band spectrum,[7] the propagation characteristics of which allowed carriers to quickly deploy 4G networks over large geographic areas. Today carriers have been repurposing some of that low-band spectrum to 5G. Carriers have also gained access to significant amounts of high-band spectrum, which is ideal for delivering very high speeds and low latency over discrete geographic areas. But while this progress on low- and high-band spectrum is important, the key to ensuring U.S. leadership will be the availability of mid-band spectrum, which sits at the 5G "sweet spot" offering capacity *and* coverage. Mid-band spectrum is perfectly suited to deliver higher speeds and improved latency, particularly in more rural areas.

There is a growing global consensus that mid-band spectrum should be allocated for 5G. Unfortunately, other nations are beating us to the punch. One study found that 13 other leading countries will have, on average, *five times* more licensed mid-

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[1] CTIA, *2019 Annual Survey Highlights,* at 6 (June 20, 2019), *https://api.ctia.org/wp-content/uploads/2019/06/2019-Annual-Survey-Highlights-FINAL.pdf.*

[2] CTIA Blog, *The Wireless Industry Responds to COVID–19* (Mar. 16, 2020), *https://www.ctia.org/news/blog-wireless-industry-responds-to-covid-19;* CTIA, *How Wireless Kept Americans Connected During COVID–19,* at 3 (June 23, 2020), *https://api.ctia.org/wp-content/uploads/2020/06/How-Wireless-Kept-Americans-Connected-During-COVID-19-2.pdf* (COVID-19 Report).

[3] COVID-19 Report at 2–3.

[4] *Id.* at 3.

[5] *Id.* at 5.

[6] NERA, *U.S. Wireless Consumers Get the Most Value for their Money* (Mar. 2, 2020), *https://www.ctia.org/news/report-united-states-wireless-consumers-get-the-most-value-for-their-money.*

[7] Analysys Mason, *Comparison of Total Mobile Spectrum in Different Markets,* at 1 (June 2020), *https://api.ctia.org/wp-content/uploads/2020/06/Comparison-of-Total-Mobile-Spectrum-in-Different-Markets-Final-Report-290620.pdf* (Spectrum Comparison Report).

band spectrum than the U.S. by the end of this year.[8] And even after the U.S. executes on its current mid-band plans through 2022, five countries are expected to have allocated nearly *twice* that amount of mid-band spectrum by then.[9] As other countries work to seize the mantle of 5G leadership, we need to rapidly employ an "all-of-the-above" spectrum strategy to make as much mid-band spectrum available as possible, with a particular emphasis on repurposing government spectrum.

Balancing Spectrum Allocation Priorities

Spectrum allocation decisions have always required that policymakers balance competing priorities. First, we need to properly allocate spectrum between the Federal government and the commercial sector to reflect current national priorities. Most spectrum is currently in the hands of the Federal government, a function of the varied role that spectrum has long played in supporting government missions—including national defense. But that spectrum is an increasingly critical input to another national priority—a robust and innovative economy that creates jobs and economic growth for all Americans and empowers their full participation in all aspects of American society.

Second, within the commercial sector, spectrum must be reasonably allocated between licensed and unlicensed use. While unlicensed is indispensable, the U.S. has become a global outlier by allocating such a large share of commercial spectrum for unlicensed use—particularly in mid-band. The right strategy must properly balance government and commercial needs and licensed and unlicensed use.

Shifting the Balance to Commercial Use. The Federal government has long been the largest spectrum user in the U.S., and out of the 5,400 megahertz of mid-band spectrum between 3.0 GHz and 8.4 GHz, DoD alone occupies a total of 3,600 megahertz—66.67 percent. Decisions that resulted in this allocation were based on national priorities and the state of radio technologies from 50 years ago. Our spectrum management decisions must reflect the new reality of ever-growing demand for commercial wireless services and significant technological advancements across all radio services.

As I know all too well from my time at NTIA, Federal systems sometimes rely on decades-old technologies that are not spectrally efficient. Without reform and proper funding, these systems could occupy essential spectrum resources inefficiently for years to come. But if we get our policy decisions right, a shift toward commercial use will allow these Federal users to deploy new and more spectrally efficient technologies that can help them better achieve their missions—a spectrum management "win-win." There is certainly precedent: the AWS–3 auction gave the U.S. the lead in making spectrum available for 4G while simultaneously allowing DoD to upgrade legacy radios, the Department of Energy to transition microwave systems to more reliable fiber, and the Department of Housing and Urban Development to upgrade to Internet Protocol-based systems.[10]

Three bands represent our next "win-win" opportunities:

The Lower 3 GHz Band. This Committee deserves great credit for identifying the Lower 3 GHz band (3.1–3.55 GHz), currently used by DoD to operate high-powered radar systems and by some non-federal secondary users, as suitable for transition to commercial use. We also applaud Chairman Wicker and Ranking Member Schatz for introducing the Supplementing the Pipeline for Efficient Control of The Resources for Users Making New Opportunities for Wireless (SPECTRUM NOW) Act, which will lead to the auction of the 3.45–3.55 GHz band for commercial use. CTIA supports the FCC's plan to prepare the Lower 3 GHz band for expanded commercial wireless use by removing existing non-federal secondary allocations in 3.3–3.55 GHz and relocating incumbent non-federal operations. NTIA's recent report sought to evaluate whether commercial and government operators can share this band, but we urge NTIA to examine the potential to clear—rather than share—as much of this band as possible. The Lower 3 GHz band is *the* next major opportunity to expand critical mid-band 5G capacity.

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[8] Analysys Mason, *5G Mid-Band Spectrum Global Update,* at 1 (Mar. 2020), *https://api.ctia.org/wp-content/uploads/2020/03/5G-mid-band-spectrum-global-update-march-2020.pdf* (Mid-Band Global Update).

[9] *Id.*

[10] DoD, Releasable Information, DOD/N 1755–1780 (Rev. 4) (Sufficient), at 37 (Aug. 20, 2019), *https://www.ntia.doc.gov/files/ntia/publications/releasable_dod_n_1755-1780_rev-4_sufficient_11_13_2019.pdf;* Dept. of Energy, Releasable Information, DOE/BPA 1755–1780 (Rev. 1) (Sufficient), at 7 (Mar. 11, 2019), *https://www.ntia.doc.gov/files/ntia/publications/releasable_doe_bpa_1755-1780_rev-1_sufficient_11_13_2019.pdf;* HUD, Releasable Information, HUD/HUD 1755–1780 (Rev. 2) (Sufficient), at 8 (Mar. 12, 2018), *https://www.ntia.doc.gov/files/ntia/publications/releasable_hud_hud_1755-1780_rev-2_sufficient_10_26_2018.pdf.*

Internationally, our 5G competitors have already made an average of nearly 200 megahertz available for commercial use between 3.3 and 3.6 GHz—compared to 0 megahertz in the U.S. (albeit with the 3.5 GHz auction underway that includes 3.55–3.6 GHz).[11] The 3.1–3.55 GHz band is a crucial near-term opportunity for the U.S. to make licensed mid-band spectrum available, and if the U.S. moves quickly, it has the opportunity to be a key benchmark band for U.S. leadership. Unlocking this band will also allow U.S. device and network equipment manufacturers to build to globally harmonized international specifications, creating economies of scale and driving down the cost of wireless equipment and services for U.S. companies and consumers. But there is much work to do, and time is not a luxury we have.

1.3 GHz and 1.7 GHz bands. Two low-band opportunities will be key to meeting Congress's requirement in the Spectrum Pipeline Act of 2015 that NTIA identify and reallocate at least 30 megahertz of spectrum below 3 GHz for commercial use.[12] The potential for repurposing spectrum in the 1.3 GHz band is being studied by a pioneering cross-agency program, and could provide up to 50 megahertz—while helping the Federal Aviation Administration and other incumbent users modernize legacy radar and related systems. Similarly, the 1.7 GHz band could offer 50 megahertz directly adjacent to AWS–3 spectrum, presenting great synergies with existing wireless offerings. We all need to stay committed to these efforts.

Balancing Licensed and Unlicensed Use. Sound policy also requires us to balance the amount of commercial spectrum available between licensed and unlicensed use, in the mid-band in particular. With the FCC's recent decision [13] to commit all 1200 megahertz of the 6 GHz band to unlicensed use, there are now 1,860 megahertz of mid-band spectrum available for unlicensed operations. By contrast, today's 3.5 GHz auction represents the very first opportunity for carriers to access *licensed* mid-band spectrum—and it is only 70 megahertz. While thanks to the leadership of the FCC, the C-band auction in December will make another 280 megahertz available that will bring the total amount of licensed mid-band spectrum to only 350 megahertz.[14]

In contrast, five leading nations in the 5G race are each expected to bring 660 megahertz of licensed mid-band spectrum to market by 2022. That's nearly *double* the licensed U.S. spectrum. A total of 350 megahertz is simply not enough licensed spectrum to stay competitive, especially in 5G. Access to more licensed mid-band spectrum is the key to U.S. 5G leadership.

Opportunities to Improve U.S. Spectrum Management Policies

There are also real opportunities for the U.S. to improve its spectrum management practices as we lean into 5G.

Repurposing Federal Spectrum. The U.S. has an ever-improving track record when it comes to creating "win-win" outcomes through repurposing Federal spectrum—in large part because of the leadership of this Committee. In 2004, Congress passed the Commercial Spectrum Enhancement Act ("CSEA"). The CSEA created the innovative Spectrum Relocation Fund ("SRF"), which incented agencies to relocate by providing certainty that they would receive sufficient funding to maintain their Federal missions. The SRF funds Federal agency efforts to identify spectrum available for commercial use, guarantees that they will be reimbursed for their relocation costs and, critically, then replenishes the monies with the auction revenue made possible by the relocation. The SRF has already transferred nearly $4.6 billion to Federal agencies to upgrade their systems—and there has been remarkable progress.

The 2006 AWS–1 auction was the first time the U.S. government applied the CSEA. That auction, and a follow-on auction in 2008, generated a total of $13.7 billion in winning bids, at a Federal relocation cost of $1.55 billion.[15] I am no economist, but 775 percent is a pretty solid ROI, and doesn't even include the value of the resulting new jobs and increased GDP. And it's worth noting that the complexity of the process did not prevent its success; this transition required the relocation of 1,990 NTIA-issued Federal frequency assignments from 12 Federal agencies. These incumbents ranged from fixed microwave systems used to transmit voice and data

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[11] Spectrum Comparison Report at 1.

[12] Bipartisan Budget Act of 2015, Pub. L. No. 114–74, § 1004.

[13] *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz,* Report and Order and Further Notice of Proposed Rulemaking, FCC 20–51 (rel. Apr. 24, 2020).

[14] Mid-Band Global Update at 1.

[15] Wilbur L. Ross and Douglas W. Kinkoph, U.S. Dept. of Commerce and NTIA, *CSEA Annual Progress Report for 2019,* at I–1 (June 2020), *https://www.ntia.doc.gov/files/ntia/publications/ntia_2019_csea_report_june_2020.pdf* (2019 CSEA Report).

signals to more specialized law enforcement video and surveillance systems and mobile aeronautical systems.[16]

The CSEA also played a key role in the highest grossing spectrum auction in U.S. history, the AWS–3 auction in 2015. There, the FCC auctioned two Federal spectrum bands that contained more than 200 systems or programs that qualified for CSEA transition funding, ranging from National Oceanic and Atmospheric Administration microwave operations to DoD air combat training.[17] All told, the AWS–3 auction brought in $41.3 billion, with total Federal relocation costs of $5.1 billion[18]—another ROI of more than 700 percent.

Increasing the Flexibility of the SRF. Policymakers should consider upgrading the SRF to fund Federal incumbent efforts to enhance their spectrum efficiency. Since 2010, U.S. wireless providers have increased their spectral efficiency 42 times—a rate that Federal users cannot match under the current regime.[19] While Congress made targeted SRF modifications in 2012, 2015, and 2017 to increase the program's flexibility by allowing it to support critical research and development, more needs to be done to incentivize Federal agencies to more efficiently use scarce spectrum assets. We therefore again wish to praise Chairman Wicker's and Ranking Member Schatz's efforts through the SPECTRUM NOW Act, as well as the leadership exhibited by Senators Moran and Udall on this important issue.

Improved Transparency and Incentives. Unlike commercial uses, the lost opportunity costs of underutilized Federal spectrum are rarely transparent. We therefore applaud Senator Lee for introducing the Government Spectrum Valuation Act, which would better equip this Committee and the Administration to determine the market value of spectrum and to ensure it is being put to its best and highest use. We similarly wish to recognize Senator Markey's work to incentivize agencies to move off spectrum that could otherwise be reallocated to consumer uses. We hope these important legislative efforts move forward this Congress.

Enhancing the Federal Spectrum Framework. We also strongly commend Chairman Wicker and Ranking Member Cantwell, along with Senate Armed Services Chairman Inhofe and Ranking Member Reed, for their collaboration on the Spectrum IT Modernization Act of 2020. We support this legislation and its effort to make the management of Federal spectrum more efficient. It often takes well over a decade for Federal bands to be identified, reallocated, and deployed by commercial wireless providers. This legislation will allow NTIA, through modernization and forward-thinking planning, to be better-positioned to unlock win-win opportunities more expeditiously. This is certainly a tool I wish we had when I served at NTIA, and I hope this legislation will pass swiftly.

Increasing Industry/Government Collaboration. The feasibility of reallocating Federal spectrum must be based on the actual operating characteristics of Federal systems—which of course requires the exchange of information that is often deemed classified. Collaboration and trust between government and industry can be challenging to achieve but yields results that benefit Federal users, the wireless industry, and consumers alike. For example, the successful AWS–3 information sharing process was driven through a Federal advisory committee structure. That process, in turn, was built on the foundation laid by AWS–1.[20] Enhanced "Trusted Agent" models could facilitate the exchange of information between Federal agencies and industry to drive identification and analysis of Federal spectrum uses, protect sensitive government and commercial information, and serve as an impartial clearinghouse for stakeholders to address issues, but create the potential for delay. Policymakers must continue to explore ways to streamline and expedite this process to drive more efficient spectrum management.

Maximizing Intergovernmental Cooperation. We are pleased that Congress continues to recognize the respective allocation of responsibilities between the FCC, NTIA, and Federal spectrum users. Commercial spectrum has never been—and should not be—governed by DoD if we want the technological advances and produc-

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[16] Wilbur L. Ross and Diane Rinaldo, U.S. Dept. of Commerce and NTIA, *Commercial Spectrum Enhancement Act (CSEA) Annual Progress Report for 2018,* at I–1 (Oct. 2019), *https://www.ntia.doc.gov/files/ntia/publications/3397-ntia_2018_csea_report102819final.pdf.*

[17] *Id.*

[18] 2019 CSEA Report at II–1. The total estimated relocation and sharing costs for the 1695–1710 MHz band were $527.1 million and the total estimated relocation and sharing costs for the 1755–1780 MHz band were $4.576 billion.

[19] CTIA, *Smarter and More Efficient: How America's Wireless Industry Maximizes Its Spectrum,* (July 2019), *https://www.ctia.org/news/wireless-providers-increased-spectrum-efficiency-by-42-times-since-2010-new-paper-shows.*

[20] Lawrence E. Strickling and Alexander MacGillivray, *AWS–3 Auction Highlights New Approach to Spectrum Policy* (Jan. 29, 2015), *https://obamawhitehouse.archives.gov/blog/2015/01/29/aws-3-auction-highlights-new-approach-spectrum-policy.*

tivity gains that are stimulated by private sector investment. Any consideration of spectrum sharing policy decisions, technologies, or reports involving Federal and non-federal spectrum should be led by the FCC and/or NTIA. But as a veteran of both agencies, I know first-hand the challenges posed by the interagency process and shared spectrum jurisdiction. There are very few formal structures to guide the agencies; a fairly general 2003 Memorandum of Understanding between the FCC and NTIA is the primary guidance document. But as this hearing makes clear, spectrum policy has only become more important over the past two decades, and the existing processes are no longer working as effectively. Stakeholders on all sides agree that the process that preceded the auction of the 24 GHz band—which didn't happen until five years after the FCC identified the band as a candidate for 5G use, and over a year after the FCC put rules in place—was not constructive. I applaud this Committee's commitment to identifying the appropriate structures and processes for the race to 5G and beyond. Our common national interest in sound spectrum management underscores the importance of coordinated spectrum policy decision-making.

Creating a Spectrum Pipeline. This Committee has always been a leader in spectrum policy and we encourage you once again to take up that mantle with a spectrum pipeline bill that charts the course for our country's 5G goals. Chairman Thune and then-Ranking Member Nelson brought us the MOBILE NOW Act, and Sens. Gardner and Hassan followed up with the introduction of the AIRWAVES Act. We are hopeful we can work again with this Committee on the next generation of spectrum pipeline legislation.

* * *

Thank you for the opportunity to testify today. CTIA appreciates this Committee's leadership in promoting 5G through sound spectrum management processes and results. We look forward to continuing to work with all of you to advance our ability to identify and reallocate critical mid-band spectrum that will allow us to maintain our global leadership.

Senator THUNE. Thank you, Mr. Power. now recognize Mr. Mark Gibson.

STATEMENT OF H. MARK GIBSON, DIRECTOR, BUSINESS DEVELOPMENT AND SPECTRUM SHARING POLICY, COMMSCOPE, INC.

Mr. GIBSON. Thank you, Chairman Thune and Ranking Member Schatz, and members of the Subcommittee, and thank you also for the opportunity to testify on the state of U.S. spectrum policy today. It is truly an honor and pleasure to be here. CommScope is a leading U.S. developer and a manufacturer of wireless network equipment. Our products and services provide the critical building blocks that U.S. carriers and enterprises need to deploy and operate their next generation wireless networks.

Our customers range from small rural wireless carriers to large global wireless Internet service providers, from local telecom providers to Nationwide cable companies and many other Americans in virtually every sector of the economy. Our customers operate in every state of the United States and lately we have also been working with nonprofit organizations plus our partners and employees to provide much-needed assistance during the COVID–19 pandemic. For example, by equipping school buses with Wi-Fi and LTE backhaul and parking them in neighborhoods were families lack Internet access.

I would also like to note as Mr. Power suggested and identified that today is the beginning of the CBRS auction, the Citizens Broadband Radio Service auction of priority access licenses. This culminates more than 8 years of challenging yet highly productive work among many stakeholders, including our Federal partners at

the FCC and NTIA. CBRS is an example of what has worked well in U.S. spectrum policy, while also highlighting some areas where we can improve upon spectrum management processes and interactions among stakeholders both within Government and industry. One mission of CommScope is to help make spectrum available as fast as possible for the broadest uses as possible. We strongly believe that U.S. leadership and wireless technology relies on quick access to spectrum. The U.S. has long been the world leader in wireless technologies and innovative ways to maximize the use of a spectrum allocation.

Some of the recent innovations around dynamic spectrum sharing have been critical in introducing new wireless services. However, 8 years to commercialize a band like CBRS is simply too long. While we are improving on that timeline, there is still much work to be done. To be sure, each spectrum allocation proceeds at its own pace. For example, while access to the 6 gigahertz spectrum appears to be progressing rather quickly, the lower mid-band 3100 to 3550 megahertz spectrum will likely take longer to be available for commercial use. We need to shorten the spectrum availability pipeline.

One significant factor that contributes to the extended length of many of these spectrum proceedings is the reality that because we are a leader in wireless technologies, we have allocated almost all of the low and mid-band frequencies. Efforts to repurpose or share those bands for next generation services inherently involve incumbent users and discussions on the impacts to existing services. And many of these incumbents are also Federal spectrum users.

CommScope supports a comprehensive long-term National spectrum policy that addresses the Nation's anticipated needs for new allocations of licensed and unlicensed frequencies. Our spectrum policy should also incorporate newer, dynamically coordinated sharing regimes where feasible, building upon the innovative approaches in CBRS and 6 gigahertz. These newer coordinated sharing regimes should accommodate a range of access types including quasi-licensed and quasi-unlicensed. And they are able to rebalance how bands are allocated over time in response to demand. This provides a complement to their traditional allocation types and offers regulators and policymakers a new tool in their spectrum management toolkit.

Reallocation spectrum for clearing shared-use brings up the issue of how to work with incumbents. Our experience indicates that a good way to address incumbent issues is to establish a framework for collaboration among stakeholders early in the process. Examples of successful collaboration include AWS–3, CBRS, and the ongoing collaborations in the 3.7 and 6 gigahertz bands.

We must leverage and strengthen these collaborations among all spectrum stakeholders in order to maintain and extend America's leadership in wireless technologies and services. NTIA and DOD have highlighted the critical role of industry in areas of national interests such as 5G services for Federal users and modernization of the spectrum management systems. CommScope continues to engage in these activities along with other critical public, private collaborations such as Federal support of next-generation Open RAN architectures, which will help accelerate America's 5G build out.

So again, Chairman Thune and Ranking Member Schatz, and members of the Subcommittee, thank you again for holding this hearing and I look forward to answering your questions.

[The prepared statement of Mr. Gibson follows:]

PREPARED STATEMENT OF H. MARK GIBSON, DIRECTOR, BUSINESS DEVELOPMENT AND SPECTRUM SHARING POLICY, COMMSCOPE, INC.

Chairman Thune, Ranking Member Schatz, Chairman Wicker, Ranking Member Cantwell and members of the Subcommittee, thank you for the opportunity to testify today on the state of U.S. Spectrum Policy; it is truly an honor and pleasure to be here today.

The timing of this hearing is particularly significant as today is also the beginning of the long-awaited Citizens Broadband Radio Service (CBRS) auction of Priority Access Licenses (PALs). This culminates more than eight years of challenging, yet highly-productive work among many stakeholders including our Federal partners, the FCC and NTIA. I think CBRS is an example of what has worked well in U.S. spectrum policy, while also highlighting some areas where we can improve upon the spectrum management processes and interactions among stakeholders within both government and industry.

Spectrum is the lifeblood that our Nation needs in order to realize the economic and social benefits of new technologies and myriad resulting wireless services such as the mobile cellular networks, Land Mobile Radio, broadcast, satellite, microwave, CBRS, Wi-Fi and millions of innovative unlicensed devices, and many more.

The U.S. has long been the world leader in wireless technologies and innovative ways to wring every hertz out of a spectrum allocation. Some of the recent innovations around dynamic spectrum sharing have been critical to introducing new wireless services. We will be building on dynamic sharing as we investigate new spectrum opportunities.

We must also look for ways to use spectrum more efficiently and to make spectrum available more quickly. Eight years to commercialize a band like CBRS is too long. While we are improving on that timeline, there is still work to be done. To be sure, each spectrum allocation proceeding moves at its own pace. For example, while access to the 6 GHz spectrum appears to be progressing rather quickly at this time, the lower mid-band (3100–3550 MHz) will likely take longer to be available for commercial use. We must shorten the spectrum availability pipeline—the period from when spectrum is identified to when it is put into service.

One significant contributing factor to the extended length of many of these spectrum proceedings is the simple reality that because we are a leader in wireless technologies (for both commercial and government uses), we have allocated virtually all of the low and mid-band frequencies. Efforts to repurpose or share those bands for next-generation services inherently involve incumbent users and discussions on the impacts to existing services. Many of these incumbents are Federal spectrum users.

CommScope supports a comprehensive, long-term national spectrum policy that addresses the Nation's anticipated needs for new allocations of licensed and unlicensed frequencies, the time-tested allocation types upon which we have established our existing wireless leadership. In addition, our spectrum policy should incorporate newer, dynamically-coordinated sharing regimes, building upon the innovative approaches in CBRS and 6 GHz. These newer coordinated sharing regimes should accommodate a range of access types, including "quasi-licensed" and "quasi-unlicensed," and are able to rebalance how bands are allocated over time in response to demand, thus providing a complement to the traditional allocations and offering regulators and policymakers a new tool in their spectrum management toolkit.

Reallocating spectrum for clearing or shared use brings up the issue of how to address incumbents. Our experience is that one of the best ways to address incumbent issues is to establish a framework for collaboration among stakeholders early in the process. Examples of such successful collaboration include AWS–3, CBRS, and the recent and ongoing collaborations in the 3.7 GHz and 6 GHz bands.

As a nation we must leverage and strengthen these collaborations among all spectrum stakeholders in order to maintain and extend America's leadership in wireless technologies and services. NTIA and DoD have highlighted the critical role of industry in areas of national interest such as 5G services for Federal users and spectrum management systems modernization. CommScope continues to engage in these activities, along with other critical public/private collaborations such as Federal support for next generation Open RAN architectures which will help accelerate America's 5G buildout.

Finally, some of the work of the Commerce Spectrum Management Advisory Committee (CSMAC) at NTIA is worth considering. One of their working groups will be suggesting an implementation structure and governance model in consideration of the pending National Spectrum Strategy.

Overview of CommScope

CommScope is a leading U.S. developer and manufacturer of wireless network equipment. Our portfolio of products includes the critical building blocks that U.S. carriers and enterprises need to deploy and operationalize their next generation wireless networks—for each and every part of those networks, including fiber infrastructure and backhaul, macro cellular sites, outdoor small cells, in-building and venue wireless (Wi-Fi and cellular), and spectrum management solutions. More broadly, our company is also a key provider of broadband solutions, ranging from innovative technologies which increase the speed and expand the deployment of broadband networks to the customer equipment needed to access these broadband services. Our customers range from small rural wireless Internet service providers to large global wireless operators; from local telecom providers to nationwide cable operators and American companies in virtually every sector of the economy. CommScope's customers operate in every state of the U.S.

CommScope has been, and continues to be, an active and leading participant in numerous spectrum-related proceedings. We are active in nearly 100 Standards Development Organizations, including 3GPP and IEEE. CommScope was a founding member of the CBRS Alliance and fills its Presidency. We also serve on the Board of the Wireless Innovation Forum. CommScope was one of the first authorized CBRS Spectrum Access System (SAS) operators and has been a TV White Space database administrator. CommScope also has over 40 years of spectrum management experience and expertise.

One mission of CommScope is to help make spectrum available for the broadest uses and applications as fast as possible. Our leadership in wireless and spectrum issues has been key in bringing new spectrum bands online for 5G, including:

- Licensed, unlicensed, and shared spectrum solutions and services across the low/mid/high bands,
- Dynamic spectrum sharing (TVWS, CBRS, 6 GHz AFC); both on the RAN and spectrum management systems and supporting services. For instance, CommScope is an FCC-designated SAS/ESC administrator,
- FCC-designated frequency administration for services such as the 70/80/90 GHz service and Wireless Medical Telemetry Service,[1]
- Open RAN development, standardization, and advocacy,
- Close collaboration with various Federal agencies, including the FCC, NTIA, DoD, FAA, DoE, etc. on spectrum initiatives such as AWS–3, CBRS, 3.1–3.55 GHz, 7–8 GHz, 70/80/90 GHz, etc. CommScope is also a charter member of the National Spectrum Consortium.

In particular, CommScope is a demonstrated leader in Open RAN initiatives. CommScope has contributed to standardization efforts by the O–RAN Alliance, a consortium of mobile network operators and vendor companies, since it was founded in February 2019 and has actively participated in Open RAN demonstrations with other O–RAN Alliance members. In addition, CommScope is a founding member of the Open RAN Policy Coalition, which promotes policies that will advance Open RAN solutions.

U.S. Leadership in Wireless Technology Relies on Quick Access to Spectrum

In a 2015 report,[2] CTIA indicated that it takes about 13 years to make spectrum available to consumers. We are improving on that timeline thanks in part to your leadership on advancing legislation such as the MOBILE NOW Act. However, we still have much to do. It has taken eight years to commercialize CBRS. And while 6 GHz spectrum may come online in record time, the lower mid-band (3100–3550 MHz) will likely take many years to be realized for commercial use. The C-Band will have taken over six years from the time of the FCC's initial Mid-Band NOI to the time when nationwide wireless services can be deployed.

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[1] CommScope is the technical partner to the American Society for Healthcare Engineering of the American Hospital Association who are the FCC-designated frequency coordinator for the WMTS.

[2] *https://api.ctia.org/docs/default-source/default-document-library/072015-spectrum-timelines-white-paper.pdf.*

CommScope commends Chairman Pai and the FCC for their actions under the 5G FAST Plan to identify and accelerate new allocations of licensed, unlicensed, and shared spectrum in the low, mid, and high bands. Collectively, we must seek ways to decrease the time from pipeline identification to commercial use.

We are encouraged by the Committee's leadership in the bipartisan approval of S. 3717, the Spectrum IT Modernization Act, in the Fiscal Year 2021 National Defense Authorization Act (NDAA). As the Nation's demands for spectrum continue to increase rapidly and we seek efficiencies in Federal and commercial spectrum utilization, it is critical that the spectrum management technologies, tools, and infrastructures of NTIA be improved and modernized. Industry relies heavily on NTIA to perform complex engineering analyses of spectrum usage, spectrum-sharing feasibility and signal coverage. NTIA was invaluable in providing engineering support for AWS–3 and CBRS. We expect that modernizing and improving the capabilities of NTIA and other Federal agencies will improve spectrum utilization efficiencies for all U.S. spectrum users.

The U.S. needs to expedite ongoing research, development, testing, and evaluation to develop advanced technologies, innovative spectrum-utilization methods, and spectrum-sharing tools and techniques that increase spectrum access, efficiency, and effectiveness.

A comprehensive, long-term national spectrum policy should incorporate traditionally licensed and unlicensed approaches.

We have interests, business, and customers in practically every corner of the spectrum-scape. From traditional and non-traditional wireless operators who use spectrum across the low, mid, and high band ranges to provide 5G services; to enterprises and customers who rely on Wi-Fi devices; to rural wireless Internet service providers who are providing critical communications to rural Americans during COVID; to utilities managing the Nation's energy supply, we are acutely aware of the need to have flexible approaches to spectrum allocation and assignment.

The MOBILE NOW Act is a great example of this flexibility. Calling for 500 MHz of spectrum to be allocated to several uses including spectrum below 6 GHz for mobile and fixed wireless broadband use and spectrum for commercial mobile and unlicensed use, there is something for everyone.

Similarly, the FCC's "Mid-band Notice of Inquiry" resulted in rulemakings that will repurpose 1480 MHz for licensed and unlicensed use in the 4 GHz and 6 GHz bands. This will have profound effects on new technologies and capabilities to support America's increasing need for broadband.

We need to work together to create flexible models for spectrum management, including standards, incentives, and enforcement mechanisms that promote efficient and effective spectrum use, including flexible-use spectrum allocations or licenses, while accounting for critical safety and security concerns.

Spectrum policy should consider and promote spectrum-sharing approaches where appropriate.

Virtually all the spectrum in the low, mid, and high bands has some degree of incumbent use. For example, according to the NTIA, the 3100–3550 MHz bands contain over 330 frequency assignments.[3] In the CBRS band, there are over 7800 grandfathered sites licensed for use by wireless Internet service providers and utilities, there are over 90 fixed satellite earth station sites plus an unknown number of DoD radar locations.[4] According to the FCC, the 6 GHz bands (5925–7125 MHz) contain almost 47,700 assignments.[5] In the C-Band, there are 66 satellites and over 18,000 earth stations.[6]

Relocation is often not feasible or takes a long time and ends up delaying the introduction of new wireless services. The recent NTIA analyses on the feasibility of commercial wireless sharing with Federal systems in 3100–3550 MHz bands were generally predicated on the assumption that there would be no changes to incum-

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[3] NTIA Spectrum Compendium data provided in the following segments: *https://www.ntia.doc.gov/files/ntia/publications/compendium/3100.00-3300.00_01DEC15.pdf, https://www.ntia.doc.gov/files/ntia/publications/compendium/3300.00-3500.00_01DEC15.pdf,* and *https://www.ntia.doc.gov/files/ntia/publications/compendium/3500.00-3650.00_01DEC15.pdf.*

[4] FCC Public Access to 3650 grandfathered wireless protection zone filings: *https://opendata.fcc.gov/Wireless/ULS-3650-Locations-Default-View/dpvg-tvcx/data* FCC Public access to protected FSS Earth Station Registrations: *https://opendata.fcc.gov/Wireless/Protected-FSS-Earth-Station-Registration-Complete-/acbv-jbb4/data;*

[5] FCC 6GHz Notice of Proposed Rulemaking, FCC 18–147, ET 18–295.

[6] FCC C-Band Report & Order, FCC 20–22, GN 18–122.

bent operations.[7] In the 6 GHz bands, relocation was not considered.[8] And in the C-Band, *accelerated* relocation will take almost four years to clear the band for mobile use.

Sharing generally obviates relocation or can be used where relocation is not feasible. Sharing systems can be brought online before incumbent operations can be relocated. In cases where the incumbent situation is not complex, good, old-fashioned frequency coordination is a proven sharing solution.

There are several new and existing spectrum-sharing technologies that should be recalled when identifying bands to repurpose or open to shared use. The CBRS SAS and new 6 GHz AFC are examples of spectrum-sharing systems that will allow for deployment and operation of new devices and services without having to relocate incumbent operations.

Spectrum policy must balance the costs, complexities and time frames for making spectrum available on a shared or exclusive basis. We note that sharing is not applicable in all cases and we absolutely support exclusive licensing.

Establish frameworks for collaboration and cooperation among stakeholders

The concept of sharing spectrum sets up a potentially adversarial relationship between incumbents and new entrants. Incumbents might be hesitant to work with new entrants on establishing sharing frameworks particularly at the end of lengthy, complex, and possibly contentious rulemakings. We have found that intentionally establishing a collaborative framework for cooperation among all stakeholders has been quite successful in arriving at mutually-agreeable solutions.

In 2012, NTIA used the CSMAC process to establish a collaboration framework between commercial interests and Federal spectrum users in the AWS–3 bands (1695–1710 MHz and 1755–1850 MHz). The plan was to create working groups that would consider ways to facilitate the implementation of commercial wireless broadband into erstwhile Federal bands. The working groups produced recommendations to the CSMAC concerning approaches to sharing, transition, and/or relocation of the band that determined the steps that were ultimately taken and any factors that could reduce the projected costs, or limitations or restrictions on spectrum availability. These recommendations also helped to inform the FCC's AWS–3 rulemaking. This AWS–3 collaboration under CSMAC proved to be very successful in helping to craft rules with a clearer mutual understanding of how commercial mobile systems can coexist with a host of Federal and DoD systems.

Another direct benefit of this collaboration was the establishment of key relationships with Federal spectrum management and policy leaders and counterparts. Working with key individuals such as Mr. Fred Moorefield, Deputy Chief Information Officer for Command, Control, Communications and Computers and Information Infrastructure Capabilities, Office of the Secretary of Defense, Chief Information Officer and Mr. Tom Taylor, Deputy Director, EMS Operations at DoD CIO, and many others, we were able to identify and creatively resolve issues in close collaboration with individuals empowered to find solutions.

Industry collaboration on CBRS among all stakeholders helped identify and address issues relatively quickly. These engagements build upon the AWS–3 collaboration to the extent that there was good familiarity among stakeholders, there was mutual understanding of issues and how to collectively address them, and general willingness to work through issues together. Again, the relationships we had previously established with Mr. Moorefield, Mr. Taylor, and others were critical in working through many challenging issues. The FCC concluded in a November 2018 report to Congress on the status of CBRS that, "[c]ollaboration among all of the stakeholders is excellent."[9] CommScope agrees with that assessment and has seen that excellent collaboration continue to this day.

FCC-endorsed multi-stakeholder group (MSG) collaboration on C-Band and 6 GHz is relatively new, yet shows promise as a framework to coordinate technical discussions among industry stakeholders to achieve mutually-agreeable solutions to several difficult technical questions. For the C-Band, there are currently four technical working groups comprised of some of the industry's best technical experts who are addressing potential in-band and adjacent-band coexistence and sharing issues. For

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[7] "Technical Feasibility of Sharing Federal Spectrum with Future Commercial Operations in the 3450–3550 MHz Band", NTIA Technical Report 20–546, January 2020. "Feasibility of Commercial Wireless Services Sharing with Federal Operations in the 3100–3550 MHz Band", July 2020.

[8] 6 GHz R&O at para 1.

[9] Federal Communications Commission, Report to Congress Pursuant to Section 1008 of the Spectrum Pipeline Act of 2015, As Amended by the Ray Baum's Act of 2018, November 2, 2018 at 25.

the 6 GHz band, the FCC encouraged the formation of an MSG to study and make recommendations on how to operationalize the AFC and address interference issues.

In order to achieve the spectral efficiency and time to market benefits of shared-spectrum regimes and repurposing efforts, collaboration among all stakeholders is required.

Consider CSMAC's recommendations, primarily on the National Spectrum Strategy, when examining the respective roles of the FCC and NTIA in spectrum management and policymaking

CSMAC has been organized since 2004 under the Federal Advisory Committee Act. CSMAC advises the Assistant Secretary for Communications and Information at NTIA on a broad range of spectrum policy issues. CSMAC typically functions through working groups who deliberate on specific tasks or questions provided by the NTIA and makes recommendations to the Assistant Secretary. CSMAC members are spectrum policy experts from outside the Federal government. Committee members offer expertise and perspective on reforms to enable new technologies and services, including reforms that expedite the American public's access to broadband services, public safety, and long-range spectrum planning. Members are selected based on their technical background and expertise. The current CSMAC charter was renewed in October 2019 and expires in September 2021.[10]

In August 2019, the Assistant Secretary provided CSMAC with the following question that is directly related to U.S. spectrum policy:

> What should be the United States implementation structure or governance model for the National Spectrum Strategy (NSpcS)? Consider whether the U.S. spectrum management approach is optimized for the implementation of a 21st century national spectrum strategy, and if not, whether there is value in establishing a new approach or structure to accomplish this. If there is value in a new approach or structure, what are its characteristics? [11]

This working group has been deliberating on this question since October 2019. In January 2020, the working group provided a public update on their deliberations:

> There is general agreement among the working group that our country's current approach for managing the use of spectrum is no longer effectively serving the needs of the entire stakeholder community and would benefit from reform. Moreover, with the increased use of spectrum by all stakeholders, we agree that issues around spectrum sharing and band adjacencies will need to be handled with both speed and skill to ensure that the U.S. is making the most of its critical national resources.[12]

The deliberations of the working group are ongoing and not yet public. However, the working group is planning to provide a full report on their findings to the Assistant Secretary in the coming months.

Open RAN also will play a significant role in accelerating the rollout of 5G in the U.S. by enabling 5G equipment interoperability.

In contrast to the existing "closed" systems where networks are locked to a single vendor, Open RAN (O–RAN) architectures are a new model where cellular radio networks are comprised of hardware and software components from multiple vendors operating over "open and interoperable" network interfaces. Although CommScope and other industry stakeholders are making significant strides towards O–RAN solutions for 5G wireless networks, ongoing standardization and implementation research and development must still be done. Given the critical role Open RAN can play in advancing 5G, government/industry collaboration, including Federal funding, is needed to ensure American leadership in O–RAN research and development efforts.

Summary

Thank you again for the opportunity to testify before the Subcommittee and thank you for your leadership in driving discussion on U.S. spectrum policy.

U.S. spectrum policy is at the nexus of increased demand for spectrum; advanced methods and tools for extracting the maximum use, efficiency, and value of spectrum and a blurring of the lines between spectrum allocations. Indeed, this is perhaps one of the most transitional times in the history of spectrum management.

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[10] *https://www.ntia.doc.gov/files/ntia/publications/csmac_charter_10.1.19.pdf.*

[11] *https://www.ntia.doc.gov/files/ntia/publications/spectrum_strategy_governance_briefing_012820.pdf.*

[12] *https://www.ntia.doc.gov/files/ntia/publications/csmac_sc1_presentation_april_22_2020.pdf.*

I think we all have a role in:

- Assuring quick access to spectrum,
- Incorporation of licensed and unlicensed approaches to spectrum allocation,
- Use of spectrum-sharing approaches where appropriate,
- Ensuring collaboration and cooperation among stakeholders,
- Supporting NTIA's recommendations on the National Spectrum Strategy, and
- Support of Open RAN in the rollout of 5G.

We look forward to working together to advance U.S. spectrum policy.

Senator THUNE. Thank you, Mr. Gibson. Next up is Dr. Layton. Welcome.

STATEMENT OF ROSLYN LAYTON, PH.D., VISITING RESEARCHER, AALBORG UNIVERSITY

Ms. LAYTON. Thank you for this honor and privilege to testify on the state of U.S. spectrum policy. The Commerce committee has driven reforms to liberalize commercial spectrum allocations at the FCC. These practices have become models for countries around the world. Reforms include flexible use, competitive bidding, spectrum repackaging, and dynamic sharing. Without these reforms, our trillion-dollar wireless economy and the millions of jobs it powers would not be possible. As this committee has improved outcomes for commercial spectrum the same can likely be done for the Government. Today, Federal spectrum is managed by NTIA and IRAC, the latter founded in 1922. The management of Federal spectrum is essentially unchanged for 98 years and it is time to review it. In the 1920s, free market common law property rights were alive and well for radio spectrum.

The purpose of the 1927 Radio Act was to end free enterprise and enshrine bureaucratic control of the airwaves. The practical effect was to make spectrum allocation a political decision and to reward favored constituents. By the time Nobel Prize economist Ronald Coase wrote his seminal articles on the FCC and IRAC, the U.S. had some 40 years of administrative allocation. Coase laid the theoretical foundation for the market-based spectrum management we know today. He described how the prevailing central planning of spectrum was wasteful and costly. He debunked the premise that Government is needed to limit interference when the same function can be done more effectively through pricing.

Coase's proposals were mocked in his day but experience has proven him right. The FCC has helped some 100 spectrum auctions and raised over $100 billion for the treasury. There are millions of spectrum licenses today, tens of thousands of licensees, and an ever-increasing number of uses and there is a robust secondary market. However, this optimization only occurs on one-third of the relevant spectrum. The rights to the other two thirds are held by the Government and this spectrum has a limited set of uses and users.

Spectrum is no different than any other resource. It is subject to supply and demand, it can be packaged and priced like any other good or service, and moreover, there is no reason why Federal agencies which purchase their inputs from the market should not pay for their use of spectrum. The first best realization of Coase's recommendation is to liberalize the underlying resource, privatize

the spectrum itself. This would entail sunsetting administrative allocation. Privatizing Federal spectrum would be worth at least half a trillion dollars, maybe more to the U.S. Treasury. Like the incentive auction, proceeds from the sale of Federal spectrum could be returned to the agencies to help them fund their equipment upgrades.

Today we will hear about a lot of ongoing spectrum conflicts within and between industries and Federal agencies. This will likely continue. Even though we have liberalized allocation within certain spectrum bands, the overall designation of these bands is still a bureaucratic decision. Second best would be the introduction of a pricing system for Federal spectrum. This can be done without dismantling the regulatory authorities. For example, FCC licenses commercial spectrum. NTIA could do this for Federal spectrum.

Now while pricing is ideal, it may not be politically tenable at this time, but there are ways to bring greater discipline and accountability. Chairman Wicker and Senators Schatz, Moran, and Udall have this in mind with the SPECTRUM NOW Act. This bill addresses the critical lack of mid-band spectrum for 5G with the feasibility study of Federal efficiency relocation and sharing with commercial users.

Chairman Wicker's hearing on broadband during the pandemic highlighted that networks performed admirably under the crisis, but these networks are needed even more. 100 million school children face the prospect of distance learning this fall and yet policy struggles to allow the purchase of mid-band spectrum rights to serve these children with 5G, the quickest and most cost effective way to bring connectivity to all, particularly rural areas. It is a valid policy question whether the Federal Government requires 2500 megahertz or 3600 megahertz of beachfront spectrum for radar navigation when we have critical civilian needs at stake.

The record shows that, when under crisis, the military has adjusted its uses to accommodate other uses. In any event, Federal agencies have been reluctant to share much less relinquish their little use frequencies. They have resisted Congress's reasonable request for transparency. Maybe market actors will have more success. Seven firms have signed up as spectrum access system administrators for the 3.5 proceedings. One or more of these firms should make a public dashboard so that we can see for ourselves how little Federal spectrum is used.

The Federal agencies could be graded on their spectrum efficiency and these report cards should be part of the Appropriations and agency authorization process. And further, this can be helped by the Spectrum Modernization Act sponsored by Chairman Wicker and Senators Cantwell, Inhofe, and Reed. This bill allows for the modernizing of IT infrastructure for Federal spectrum. Thank you, Commerce Committee, for your leadership on this issue. I look forward to your questions.

[The prepared statement of Ms. Layton follows:]

PREPARED STATEMENT OF ROSLYN LAYTON, PH.D., VISITING RESEARCHER, AALBORG UNIVERSITY

Thank you, Senator Thune, Ranking Member Schatz, and members of the committee. It is an honor and a privilege to testify on the State of U.S. Spectrum Policy.

This issue which is arguably the most important in telecom policy. I hope to highlight some key findings from the academic field of spectrum management and policy and preliminary policy recommendations maximize the outcomes for the American people. I am an American and have enjoyed affiliation with Denmark's Aalborg University since 2012 where I earned my PhD and continue my research.[1] Our university hosts doctoral students from around the world who wish to make multidisciplinary and international comparisons of telecom policy. Our university is ranked by U.S. News and World Report as 4th in the world for its overall engineering program and 2nd for Electrical and Electronic Engineering.[2] In addition to my department of Communication, Media and Information Technologies, our research and educational domains include Antennas, Propagation and Millimeter-wave Systems; Automation and Control; Connectivity: Wireless Communication Networks; and Signal and Information Processing. We use "problem-based learning" to examine, teach, and learn about complex, real world problems. Spectrum management is a textbook example of a complex real-world problem for both for the engineering and political requirements. My comments reflect my own views.

Aalborg University has been strengthened with public-private partnerships for innovation and the frameworks of the country's industrial PhD program, soon celebrating its 50th year. My participation has been enabled by Strand Consult where I serve as Senior Vice President. Strand Consult is an independent company developing strategic research on critical topics in mobile telecommunications. Its most recent report details the percentage of Huawei and ZTE equipment in 103 European mobile operators' 4G networks.[3] This report is used by European governments to identify problem areas for rip and replace efforts. Strand Consult founded China Tech Threat to bring attention the larger issue of technological threats from firms owned and affiliated with the Chinese government.[4] While it is not the precise theme of this hearing, spectrum management has geopolitical implications. Not only does China influence global organizations where spectrum decisions are much such at the International Telecommunication Union and various technical standards organizations, it commands and controls its spectrum policy in a way to align military and industrial interests to promote its national champions in space/satellite technologies, network equipment, wireless devices, software platforms, and emerging technologies such as smart cities solutions, artificial intelligence, and quantum computing. Sometimes U.S. policy appears to pit Federal and commercial interests against each other, rather than adopt the market-based approach which will put the U.S. on the best technological footing to challenge China both economically and militarily.

The gap between the U.S. and China on mid-band spectrum has been noted. Mid-band frequencies, also called the Goldilocks band, are prized for their technological capabilities to send large amount of data over long distances. China and even Canada are on track to have some 500 MHz of mid-band spectrum deployed (and Japan with 1000 MHz), whereas the U.S. has a scant 350 MHz. As such, *S. 1986, SPECTRUM NOW Act* sponsored by Chairman Wicker, Ranking Member Schatz, and Senators Moran and Udall has critical importance. Using the Spectrum Relocation Fund, this bill would support Federal entities operating on mid-band spectrum to study the feasibility of increasing spectrum efficiency and relocating federally held spectrum or sharing it with commercial users to facilitate the deployment of 5G.[5]

To put the numbers into perspective, consider that the Federal government sits on 70 percent of the so-called spectrum "beachfront", some 2500 MHz, used primarily for radar and radio navigation. The government's holdings amount to more than four times what America's five major wireless carriers (T-Mobile, AT&T, Verizon, Dish, and U.S. Cellular) have in mid-band frequencies for 5G. The U.S. is in an existential battle with China for 5G, and it trying to do it on scraps of mid-band spectrum.

5G is the quickest way to equalize the digital divide between urban and rural America, providing the same, if not, superior connectivity than wireline fiber net-

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[1] "Profile for Roslyn Mae Layton," Aalborg University's Research Portal, accessed July 17, 2020, *https://vbn.aau.dk/en/persons/roslyn-mae-layton*

[2] "Top Electrical and Electronic Engineering Schools in the World—US News Education," accessed July 17, 2020, *https://www.usnews.com/education/best-global-universities/electrical-electronic-engineering.*

[3] "Understanding the Market for 4G RAN in Europe: Share of Chinese and Non-Chinese Vendors in 102 Mobile Networks." Strand Consult. July 2020 *http://www.strandreports.com/sw8772.asp*

[4] "Our Mission." *https://chinatechthreat.com/about-us/#Our-Mission* Accessed July 21, 2020

[5] "Supplementing the Pipeline for Efficient Control of The Resources for Users Making New Opportunities for Wireless Act." S. 1986, SPECTRUM NOW Act, 116th Congress. *https://www.congress.gov/bill/116th-congress/senate-bill/1968/text*

works. While there is a promise of some more mid-band spectrum in the future, the allocation process for these frequencies, which by rights should be have been a quick, speedy private transaction, was seized by political actors protecting incumbent firms.[6]

In any event, if there was a market-based process to allocate Federal spectrum, there would be no need to quibble about the 3.7 to 4.2 MHz, as private actors would have the opportunity to buy, sell, lease, trade, or share the most valuable swath of the airwaves. Simply put, the Federal spectrum holders are insulated to the pain caused by the spectrum imbalance. Policymakers have made a choice to prioritize certain Federal (notably military) applications above civilian wants and needs. This is not to say military applications are unimportant, but it is a valid policy research question of whether all 2500 MHz is best deployed for radar and radio navigation when some measure of this spectrum could enable over 100 million school children to participate in distance learning during the pandemic.

While no country's spectrum policy is perfect, the U.S. has driven important successes over the last century. This Committee has been the driving force behind the FCC reforms to liberalize the allocation of commercial spectrum, which has become a model for telecom regulators around the world. Reforms include a liberalized allocation process for commercial spectrum, flexible use, competitive bidding to make rights assignments more efficient, and tools and processes to make spectrum use more efficient whether repacking spectrum (a result of the broadcast incentive auction, for example) or dynamic sharing such as in the 3.5 GHz Citizens Broadband Radio Service proceeding. As a result of these and other efforts, the FCC has improved the access, availability, and efficiency of commercial spectrum, without which our wireless economy would not be possible. Over 90 commercial spectrum auctions in the U.S. have delivered over $116 billion to the U.S. Treasury.[7] Wireless spectrum enables the trillion-dollar wireless economy. We now accept the premise that spectrum is a finite resource for which prices and markets can improve their allocation.

If such reforms have improved the outcomes for commercial spectrum, it stands to reason that similar improvements could be driven for Federal spectrum. At the very least this would include improving access and availability for Federal users, but more largely, better outcomes for the American people. Presently Federal spectrum is managed the National Telecommunications and Information Administration (NTIA) and more specifically, the Interdepartment Radio Advisory Committee (IRAC), which was founded in 1922. While commercial spectrum allocation has been reformed, the management of Federal spectrum is essentially unchanged for almost 100 years. It is timely and appropriate to review it.

Leading telecom economist and former FCC chief economist Thomas Hazlett observes, "The FCC had no idea that mobile would become a mass market (not a luxury niche), that handsets would become pocket (not car) phones, that texting and data (not just voice) would become standard, or that digital was superior to the analog standard it mandated. And that was after vast input from scientists, management consultants, broadcasters, Motorola, and AT&T."[8] Spectrum markets had to be liberalized before innovation and adoption took hold.

To facilitate the buying, selling, and leasing of spectrum, the FCC operates a Universal Licensing System (ULS). Indicative of the demand for spectrum, has been the increased use of the system. The FCC reports some remarkable statistics from the ULS platform, for example the thousands of licenses holders (including individuals), the many uses of spectrum, and the number of licenses issued annually (more than 150,000 per year for almost a decade).[9] The FCC has responded to exploding demand for commercial spectrum by modernizing the ULS over a multi-year upgrade.

Indeed, this Committee has already taken important steps to bring the IT system for America's Federal users spectrum up to speed. While some have observed that having a single system for both Federal and commercial spectrum, there are some important differences in the law and policy which creates some challenges to run an integrated system. For example, some Federal uses may be classified for national security reasons and there are not suitable for commercial viewing. On the other hand, there are additional levels of data (*e.g.,* precise location of infrastructure tow-

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[6] "A Government 5G Coup." *Wall Street Journal.* Editorial Board. November 19, 2019. *https://www.wsj.com/articles/a-government-5g-coup-11574208133*

[7] "REMARKS OF FCC CHAIRMAN AJIT PAI AT THE INFORMATION TECHNOLOGY AND INNOVATION FOUNDATION." February 6, 2020 *https://docs.fcc.gov/public/attachments/DOC-362334A1.pdf*

[8] "Commentary: The Best Way for the FCC to Enable a 5G Future," *Reuters,* January 17, 2018, *https://www.reuters.com/article/us-hazlett-5g-commentary-idUSKBN1F6253.*

[9] "FCC Licenses at a Glance." Accessed July 21, 2020. *http://reboot.fcc.gov/license-view/*

ers), which are collected for the Federal system but are not collected for commercial spectrum (perhaps for competitive reasons).

In any event, there need not be a single system but make a systemic improvement in spectrum management. Indeed, there is much that Federal users can learn from the FCC's ULS system. I applaud Chairman Wicker and Senators Cantwell, Inhofe, and Reed for introducing *S. 3717, the Spectrum IT Modernization Act* which requires NTIA and other Federal agencies to outline a plan for modernizing the information technology infrastructure used for the management of Federal spectrum, to define the parameters of interoperability, and for the Department of Defense to report on their challenges of management and utilization.[10]

Following the Federal Radio Act, it took U.S. policymakers 67 years to try a market-based spectrum allocation for commercial spectrum, but now it's considered a standard.[11] We should be rushing to bring these benefits of market based allocation to Federal spectrum holdings. But old habits, or incumbent interests as it were, die hard.

Ronald Coase laid the theoretical foundations for market-based regimes and challenged the prevailing regulatory wisdom of administrative allocation of radio frequencies. His 1959 *Federal Communications Commission*[12] exposed the fallacy of administrative allocation which justified restricting spectrum use to limit interference. Coase showed that same function can be performed more efficiently through a "price system." In his day, Coase's proposals were mocked by policymakers. The first auction for spectrum rights was delayed until 1994.[13]

Today, however, spectrum auctions are practiced around the world and are considered *de riguer* for telecom regulators and spectrum authorities. Coase is not alive today, but his Nobel prize and the legacy of his work (including the fact that he remains among the most cited Nobel prize winners, in law, and in economics[14]) attest that he was correct on pricing and radio spectrum. Hazlett, Porter and Smith argue that Coase's work on radio spectrum is on par of that of Adam Smith's *Wealth of Nations* for its bringing "disruptive clarities to system dynamics."[15] They note that Coase dispensed with Pigou's notions of externality and spillover, showing that central planning was not costless. Moreover, Coase demonstrated the destructive fallacy of assigning rights by government fiat, noting that how the airwaves were used and who used them were not one in the same.[16] The existence of secondary markets prove that the creation of rights and its assignment are separable.[17] An additional irony and inequality is that the Federal government is primary holder of spectrum rights, but is not the primary user. This suggests that additional optimization is possible.

Coase discussed the IRAC at length in his 1962 article.[18] This testimony highlights some of his observations which are still highly relevant.

The "First Best" realization of Coase's recommendation is to liberalize the underlying resource—privatizing the spectrum itself—not just the use and licensing regime. This would entail sunsetting administrative allocation, also called command and control. A 1996 policy proposal suggested that the sale of Federal spectrum holdings could generate as much as $300 billion (almost half a trillion in today's dol-

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[10] S. 3717, the Spectrum IT Modernization Act. 116th Congress. *https://www.congress.gov/bill/116th-congress/senate-bill/3717/text*

[11] Coase, R. H. "Comment on Thomas W. Hazlett: Assigning Property Rights to Radio Spectrum Users: Why Did FCC License Auctions Take 67 Years?" *The Journal of Law & Economics,* vol. 41, no. S2, 1998, pp. 577–580. *JSTOR, www.jstor.org/stable/10.1086/467403.* Accessed 16 July 2020.

[12] Coase, R. H. "The Federal Communications Commission." *The Journal of Law & Economics,* vol. 2, 1959, pp. 1–40. *JSTOR, www.jstor.org/stable/724927.* Accessed 9 July 2020.

[13] Coase, R. H. "Comment on Thomas W. Hazlett: Assigning Property Rights to Radio Spectrum Users: Why Did FCC License Auctions Take 67 Years?" *The Journal of Law & Economics,* vol. 41, no. S2, 1998, pp. 577–580. *JSTOR, www.jstor.org/stable/10.1086/467403.* Accessed 16 July 2020.

[14] Landes, William M., and Sonia Lahr-Pastor. "Measuring Coase's Influence." *The Journal of Law & Economics,* vol. 54, no. 4, 2011, pp. S383–S401. *JSTOR, www.jstor.org/stable/10.1086/666478.* Accessed 21 July 2020.

[15] Thomas Hazlett, David Porter, and Vernon Smith, "Radio Spectrum and the Disruptive Clarity of Ronald Coase," *Journal of Law and Economics* 54 (November 1, 2011), *https://doi.org/10.1086/662992.*

[16] Ibid

[17] Ibid

[18] Coase, R. H. "The Interdepartment Radio Advisory Committee." *The Journal of Law & Economics,* vol. 5, 1962, pp. 17–47. *JSTOR, www.jstor.org/stable/725004.* Accessed 16 July 2020.

lars) to pay down the national debt and transition the administrative allocation regime to privatization within a decade.[19]

Indeed, a common law property rights regime for spectrum had already emerged before the Federal Radio Act of 1927. I review this briefly, but as it is outside today's scope, I will describe "Second Best" options, notably spectrum fees. I provide additional suggestions for transparency, accountability, and IRAC reforms.

In recent years Congress has had success to reform Executive Branch agencies, most recently with the Foreign Investment Risk Review Modernization Act of 2018 (FIRRMA) for the Committee on Foreign Investment in the US. (CFIUS). This reform was achieved within a single session of Congress and was overwhelmingly bipartisan. It represents one of the most significant Congressional efforts to improve national security by requiring that CFIUS screen foreign investment for cybersecurity and privacy implications. Already it resulted in the halting, if not reversal, of foreign acquisitions of MoneyGram, PatientsLikeMe, Grindr, and StayNTouch because of concerns that that Americans' personal data would fall into the hands of the Chinese government. Importantly, FIRRMA requires greater accountability of CFIUS to Congress, as it was observed that Congress' concerns about security threats had been discounted by the Executive Branch in the past in an effort to effect quick transactions.[20] It is entirely appropriate that Congress and the Commerce Committee assert greater authority over Federal spectrum, which after all, is what the Constitution prescribes.

Common law property rights for spectrum

Spectrum markets were already working before the creation of the 1927 Federal Radio Act. The government created a solution that the market didn't need, but it did serve to cement Federal power over the radio spectrum and protect politically favored incumbents. Up to that time, hundreds of radio stations flourished under common law tenets, and a secondary market emerged with transferring rights with equipment. Parties met annually under the auspices of the Department of Commerce to make trades.

Thomas Hazlett details this little-known spectrum history in a recent article, showing that a common law property rights regime was well-established before the implementation of the Act.[21] Hazlett challenges the conventional view that policymakers of the day didn't have information of how a spectrum rights market could work and therefore opted for administrative allocation. Hazlett shows that Senator Clarence Dill (D–WA) and the bill's supporters knew exactly what they were doing. Moreover, Hazlett uses market data from the 1920s to demonstrate how the National Association of Broadcasters (NAB) and Radio Corporation of America (RCA) benefitted from the new regime, which limited competitive entry into the market, secured licenses to existing broadcasters, and ensured a stream of revenue for radio receivers. Indeed, Hazlett observers how the term "public interest" was coined by private actors to protect their market position.

The U.S. Department of Commerce had powers granted under the 1912 Radio Act to "minimize interference." It used a common law method to recognize first-in-time emission rights and to protect against encroachment. Stations that strayed from their registered frequencies were closed with the Department of Commerce's police powers. Commerce convened an annual conference where emergent players organized. Hazlett describes,

> Commerce had designated an AM radio band, collaborating with radio manufacturers and broadcast stations in annual Radio Conferences that were convened by the Commerce Department from 1922 through 1925 (Benjamin 1998). Entrants that requested new rights were assigned vacant AM channels. Where none were available, applicants were told to strike a time-sharing agreement with an existing licensee or to buy a station, in which case the transmission rights would be transferred (with the broadcasting facility) to the new owner. The chief sponsor of the 1927 Radio Act, Sen. Clarence C. Dill (D–WA), explained that the legal institution employed by Commerce was well known as "property by right of user," "squatter sovereignty," or "adverse possession" (Dill

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[19] David Colton. "Spectrum Privatization: Removing the Barriers to Telecommunications Competition." Reason Foundation, July 1, 1996. *https://reason.org/policy-study/spectrum-privatization/*

[20] Roslyn Layton and Robert Pittenger, "CFIUS' Growing Power to Protect American Security from China Tech Threats: Examining TikTok and Lenovo" (China Tech Threat, June 26, 2020), *https://chinatechthreat.com/wp-content/uploads/2020/06/CFIUS-Paper-062420_.pdf.*

[21] Thomas W. Hazlett, 2020. "The 1927 Radio Act as Pre-emption of Common Law Property Rights," Review of Industrial Organization, Springer; The Industrial Organization Society, vol. 56(1), pages 17–35, February. *https://ideas.repec.org/s/kap/revind.html*

1938, p. 78). Under this regime, over 500 radio stations were broadcasting—which created a new mass media market—with substantial investments of private capital. In early 1926, a trade union in Chicago, intent on launching radio station WCFL, had the option to buy the broadcasting rights of three different local stations, including that of WHT, which was asking $285 000 (Godfried 1997, p. 33). In September 1926, AT&T sold its New York City radio station, WEAF, for $1 million to the Radio Corporation of America (RCA), of which $800,000 was for the value of spectrum rights (Barnouw 1966, pp. 185–186)."[22]

Data from the period shows that the common law regime worked such that consumers purchased radios (which amounted to $1000 in today's money) at a brisk pace. However, to create the needed "chaos" in the airwaves which would support the bill, then Commerce Secretary Herbert Hoover cancelled the annual conference and stopped enforcing rights. The subsequent interference "chaos" that ensued was seized by the press and policymakers as justification for the new law.

Hazlett notes that 1927 Act was decidedly against property rights. The statute states that while it will consider the "use" of spectrum, its purpose is to "pre-empt the assertion of private property rights in radio spectrum." The law further prescribes that "No station or license shall be granted . . . until the applicant therefore shall have signed a waiver of any claim to the use of any particular frequency or wave length or of the ether as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise." The 1927 Radio Act did not "stumble" into administrative allocation of frequencies but sought a regime change. The prospect of property rights in frequencies was not a foreign concept. Indeed, a system of priority-in-use rights for radio broadcasts was in play since the first radio station, KDKA in Pittsburgh in 1920.

The Act launched the regime of administrative licensing or command and control spectrum management. The government served as the clearing house for spectrum, its proffered benefit being the control of interference by exclusivity to protect the licensee's signals. To get a license, the applicant would participate in a "beauty contest" to show why its service did a better job to realize the "public interest" than another. There was no fee based on an estimated value of the spectrum. Such a model emphasizes the political rewards of spectrum assignment which accrue to the licensing body and the licensee. Moreover, it incentivizes the application to overpromise to win the application but underdeliver once received.

Naturally, command and control offers some marginal economic benefits (some use of the spectrum is better than none at all), but it is not optimal. Some countries have attempted to rectify perceived political bias through spectrum lottery, but this also fails to rationally reflect the economic contest by competing actors for a scarce resource. The command and control regime was further legitimized by the 1943 Supreme Court decision *NBC v. FCC* asserting that there is not enough spectrum for everyone and that there is a finite natural limit of radio stations that can operate without interference.

Hazlett offers further history and analysis *The Political Spectrum: The Tumultuous Liberation of Wireless Technology, from Herbert Hoover to the Smartphone.*[23] He documents systematic deterrence of new technology by bureaucracy. He blames not the regulators themselves, individuals who want new technologies, but the "administrative apparatus" and "regulatory gridlock" to access unused spectrum, requiring potential licensee to file an application, detail the business plan, and demonstrate the technology before it is ever tried. Moreover, the applicant must prove that the technology will serve the "public interest, convenience, and necessity." Incumbents can nix technologies they believe to be threatening. It can take a decade or more to bring a new technology to market. Most innovators fail, and many pass away unrecognized, bankrupted, and demoralized.

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[22] "Two major interests sought a new regime that would grant regulators greater discretion: On the one hand, successful commercial stations sought to limit competitive entry. In the 1925 formation of the National Association of Broadcasters—a trade group that represented incumbent broadcasting stations—the industry created a novel standard for rights assignment. "An interesting fact," wrote Senator Dill, is that the broadcasters themselves suggested the inclusion of the words "public interest" in the law as a basis for granting licenses" (Dill 1938, p. 89). On the other hand, policy makers—such as Hoover, Dill, and other members of Congress—desired to assert political authority over what they recognized as an influential new medium of public opinion. License awards were said to be mandated as a consequence of nature, and licensing authority was then leveraged to include administrative oversight of speech and the press; this skirted constitutional limits that were binding elsewhere (Hazlett 1998)."

[23] Thomas W. Hazlett, 2020. "The 1927 Radio Act as Pre-emption of Common Law Property Rights," Review of Industrial Organization, Springer; *https://ideas.repec.org/s/kap/revind.html.* The Industrial Organization Society, vol. 56(1), pages 17–35, February.

Problems with Administrative Allocation

Coase critiqued IRAC or what he termed "governmental administrative machinery", the "complex process of bargaining and accommodation," and the "widespread feeling of dissatisfaction with the way the present arrangements are working."[24] He noted that IRAC allocates too much spectrum to government departments and too little to private users. Coase took issue with IRAC's policy of "first come, first served," calling it a system in which "those who are first granted the use of a radio frequency are not easily displaced by a newcomer" (p. 37). Coase noted that IRAC's assignments are rarely disturbed. "What this implies is that radio frequencies are used by Government departments for purposes which have a relatively low value as compared with what are the same frequencies would be worth if they could be made available to a private user," says Coase. By contrast, we can see that since the FCC adopted market-based reforms, assignments are frequently changing as license holders trade up for better uses.

Coase ascribed the challenge for IRAC in part to the downsides of central planning, observing,

> The experience in the United States with the administrative structure which has been devised to handle the allocation of radio frequencies illustrates very vividly one of the dilemmas of planning. The attempt to control everything from the center is liable to lead to paralysis. The delegation of control leads to inconsistency of action. If central control is instituted, the necessity of referring all questions to the center involves expense in compiling and transmitting information and delay before decisions can be made. Nor are the decisions necessarily better when they are made. The remoteness of the center from the areas affected by the decision may lead to a failure to understand the significance of the issues under consideration . . . The division of control of the allocation of radio frequencies between the FCC and IRAC has no doubt led to misuse of radio frequencies. It may well have resulted in too great an allocation of radio frequencies in total for the use of Government departments. But there is every reason to suppose that an attempt to avoid such misallocation by extending the powers of the FCC to cover Government stations or by establishing a new Board to supervise the allocation of frequencies to Government departments (using procedures similar to those of the FCC) or by setting up a single super Board to control the allocation of all frequencies in the United States, would impose additional expense and delay and would bring about new misallocation. It is no doubt desirable to realize the inefficiencies inherent in the present system. (p. 39)

It is interesting to note that there have been multiple attempts to improve allocation of government spectrum, even an idea from the 1930s that the FCC would allocate the government frequencies. "But this move was resisted by the Government departments, particularly the military departments, and the final result of success reorganization was to place the FCC, if anything, in a subordinate rather than dominant position," notes Coase (p. 38). Moreover, in the realpolitik of spectrum among Federal agencies, there are political payoffs which never appear on the balance sheet. Spectrum can be a valuable token when budgets and other assets are limited. As such keeping some spectrum issues unresolved allows them to used for later trades.

The Case for Spectrum Fees

Coase thought that private and government users should pay for spectrum. He described the simplicity and superiority of a pricing system over administration allocation, how it eliminates waste and misuse, and how it would deliver better outcomes in the national interest. He described, quite plainly in 1962, that the demand for the scarce resource of spectrum exceeds supply:

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[24] Coase quotes Dr. Irvin Stewart, then Chairman of the Communications Policy Board (xx of IRAC) and was to become Director of Telecommunications Management: "It is a body composed of users. The situation is one in which naturally there is a desire to accommodate the wishes of the users who participate. There is nobody sitting in the position of arbiter. There is nobody who can ask too many hard questions. There is nobody who has an overriding task of requiring that the necessity for a particular new assignment be established in light of all the assignments that have been made in the past. . . . It is natural for each Government department to emphasize the importance of its role; and there isn't inherent in the situation any necessary motivation to conserve frequencies in order that they might be available for only-Government use. In many cases in the assignment of frequencies, security considerations must be taken into account, and that means that justifications for the assignments cannot be made a matter of record. And then when you have no public record, you have another fertile ground for suspicion" (Hearings on Spectrum Allocation p. 33–34).

> In the case of radio frequencies, as the price that is charged at the present time is, of course, zero, it is hardly surprising that we find a situation in which there is an excess of demand over supply and there is need for some governmental administrative machinery to decide who among the many claimants shall be granted this valuable resource. Those in positions of authority who deal with the problems of allocating the radio spectrum act as if they were unaware that the rest of the American economic system largely works on different principles. (p. 42)

Coase then described why a pricing system is superior to administrative allocation, noting that,

> . . . resources are obtained by those who will pay the most for them. Since the amount which a user will pay for a resource reflects the value of that resource in whatever employment he is contemplating using it, the pricing system tends to result in that allocation of a resource between its various uses which maximizes the value of production. If a price had to be paid for radio frequencies, government departments would not use them unless they felt that, by spending their money in this way, it would serve the purposes of the department better than by spending that money in any other way. And if the price was made sufficiently high so as to bring the demand for radio frequencies into equality with the supply, this would both eliminate the need for an administrative allocation and ensure radio frequencies were used for those governmental purposes which justified the greatest monetary sacrifice (p. 41).

Coase understood the economics of information and observed that government users

> would be naturally reluctant to disclose information which might result in their having to relinquish any radio frequencies. It is one of the advantages of the pricing system that, for its efficient working, the only person who needs to know about how any given user would use radio frequencies is the user himself. He has to decide how much it is worth his while to offer for a certain radio frequency: whether he obtains it depends on what others are willing to offer. (p. 43) . . . The absence of a market price (which measure the value of a frequency to another user in another use) means that a user has little idea of when he is using a frequency "wastefully" and no financial inducement to find out. Obviously, a frequency should not be used for a particular purpose if it prevents the accomplishment of some other purpose of greater value or if the same purpose could be achieved by the use of another resource which would mean a smaller fall in the value of production than the use of the frequency. It is clear that such wasteful use must be very common with the existing system. Any user with the existing system will not willingly surrender frequencies that he has been allocated so long as their use (or potential use) has a value greater than zero and this even though there may be others to whom the frequency has higher value (p 45).

Coase described that a pricing system for spectrum would benefit the military and the Nation. "The introduction of a market would tend to bring the interest of the military departments and the national interest into a closer conformity," he wrote (p.44) Coase noted that spectrum usage fees could be made available for short or long terms and that this did not preclude the addition of other regulation.

Accessing fees on government agencies is logical and rational. Just as agencies procure resources from the market (labor, building rental, electricity), they should also pay for spectrum. A fee regime can be implemented without requiring the government to divest its spectrum ownership. Though it still requires some administration, it is an improvement because it brings pricing discipline. Spectrum regulator Ofcom in the United Kingdom implemented a fee regime in 2007.[25] The goal was to nudge agencies to return their lightly used spectrum. While the agencies ended up requesting the funds to purchase the frequencies outright, the regime brings greater attention and accountability to resource management and forces the agencies to acknowledge the value of spectrum.

Some might resist a fee regime for spectrum on the ground that the U.S. military has been rendered less effective by the bureaucratic "accountability police".[26] How-

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[25] Ofcom. "Modifications to Spectrum Pricing." January 10, 2007. *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/287994/UK_Spectrum_Strategy_FINAL.pdf*

[26] Christian Browse. *The Kill Chain: Defending America in the Future of High-Tech Warfare. Hachette Books,* 2020.

ever it is not logical nor rational that the military (or any Federal agency) acquire all of its inputs (land, labor, weapons etc.) through a market process, but not a problem. The bureaucratization of the military is a separate problem, but it is no excuse to a continue the command and control regime that diminishes the effectiveness of spectrum policy and discourages the military from being a responsible spectrum user.

IRAC and Reform

Conflict within and between NTIA/IRAC and FCC is not new. Over the decades there have been a series of political struggles. This will likely continue as long as spectrum is allocated by administrators, not the market. Policymakers should not invest hope that there is some magical institutional design that can resolve the conflicts. It is natural and predictable that incumbent industrial and government interests will use institutions to maintain the status quo and protect their position, which appears to be the case with the proposals under development by Commerce Spectrum Management Advisory Committee (CSMAC) for "new" versions of NTIA, FCC, or a unified spectrum authority.[27]

Indeed, leaders have been well aware of the consequences of the IRAC policy choice. Reflecting on his role leading the organization, E.M. Webster described IRAC in 1945 noting,

> The IRAC is unique among government agencies in that it came into being, not as the result of action by either the executive or legislative branches of the government, but spontaneously through a demand of the interested government agencies . . . These people represent their respective agencies whenever frequencies are involved, but it should be emphasized that, while each is acting to some extent as an individual, he is primarily the medium of policy expression for his organization.[28]

This statement dispels the view that IRAC acts collectively on behalf of the American people. Rather it is designed to further the interest of vested Federal agencies. Today's members include the Air Force, Army, Navy, Coast Guard, Broadcasting Board of Governors, Federal Aviation Administration; the Postal Service, the National Science Foundation, the National Aeronautics and Space Administration, and the Departments of Commerce, Energy, Homeland Security, Interior, Justice, State, Transportation, Treasury, and Veterans Affairs. The FCC is only a liaison. Observers include the Department of Defense, the Food and Drug Administration, and the National Security Agency.

Webster recounts the debate on the need for trials on vacuum tubes versus arc transmitters and how the government would dispose of obsolete radio equipment from World War II (lest it continued to be used and cause interference.) He observed how the agency spent significant time regulating small pieces of spectrum, which in retrospect was a waste as new technology from the private sector made government choices obsolete. He recognized that Federal spectrum holders needed to be more tolerant of interference and that receivers needed to be improved.

Webster observed that the conduct of war is not for the military alone. Many actors which need to use the spectrum when the Nation is at war, especially domestic and international broadcasters. He noted that the government's use of spectrum must by necessity be constrained. If the use of spectrum is limited for government during war, it must certainly be limited during times of peace, and it must be shared for communications, aviation, navigation, public safety, forestry, channels for allies, and so on. He noted how during wartime that government users had to shuffle and relinquish rights and accept higher levels of interference. Given limited frequencies, a set of priority use was established. This is an important lesson for today's pandemic. Households and business are economizing during a financial crisis. There is no reason why the Department of Defense should not examine how to make better use of its $800 billion budget. Indeed, pricing could help NTIA and IRAC make better decisions and reduce internal conflict among competing agencies.

Webster described IRAC's decision guidelines as the protocols of priority use, freedom from harmful interference, and precedence. He described detailed decision making at the agency which requires it to assess many factors when making spectrum allocation including

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[27] "Report on the Presidential Memorandum on Developing a Sustainable Spectrum Strategy for America's Future: Governance" (CSMAC Working Group 1, April 22, 2020), *https://www.ntia.gov/files/ntia/publications/csmac_sc1_presentation_april_22_2020.pdf.*

[28] E. M. Webster, "The Interdepartment Radio Advisory Committee," in *Proceedings of the IRE,* vol. 33, no. 8, pp. 495–499, Aug. 1945, doi: 10.1109/JRPROC.1945.230506.

a. Rule of law as defined by agreements and records, Executive Orders, IRAC minutes and records, international and interagency agreements;
b. National interest, where in consideration is given to relative need for the frequency in question and to the degree of utilization by the agencies involved;
c. Necessity for using radio, taking into consideration the availability of other means of communication;
d. Expansion. Here, in the interest of planned and orderly utilization of the radio spectrum, the Committee recognizes the desirability of providing for normal expansion of a service where it is shown by the applicant that expansion will occur, and where its trend and magnitude can be estimated;
e. Geographical priority, which, as applied to mobile stations, is construed to extend only to the geographical area specified at the time the frequency was assigned; as applied to a fixed station, it extends only to the geographic allocation of the points of communication designated in the authorization;
f. Dates of assignment and first use, where other considerations are substantially equal, establish the priority as between stations unless by the terms of an agreement it is specifically provided otherwise. To the end that there be most efficient utilization of the radio spectrum, acceptance of a radio-frequency assignment imposes definite obligations on the assignee with respect both to equipment and to use. Some of these are specified in treaties and laws.

Additionally, the organization was obligated to

a. To use the best and most selective radio apparatus the state of the art and service operating requirements permit;
b. To use frequencies economically by avoiding unnecessary emissions and conducting operations on a minimum number of frequencies;
c. To share frequencies between agencies as a recognized and necessary expedient for the fullest utilization of the radio spectrum.

These requirements are interesting in light of today's interagency conflicts. For one, the pricing mechanism would eliminate much of the "administrative machinery" Coase described, but also, it is not evident that Federal agencies even follow IRAC's rules. For example, the former Under Secretary of Defense for Research and Engineering Michael D. Griffin in the Department of Defense noted that the military's GPS receivers will not fulfil military grade expectations until 2035.[29] Government agencies have made technological choices which are not emissions-efficient, and rather than using a "minimum" number of frequencies, they claim to need more than they have, even challenging private rights' holders. Moreover, the notion that agencies need to share the scarce spectrum resources is belied by government behavior which challenges new uses.

While Congress has vested authority in NTIA and IRAC, there could be an issue in the violation of the nondelegation doctrine in that Congress has devolved too much power and function to the Executive Branch on an issue which it is constitutionally bound to exercise itself.[30] Spectrum is at the heart of interstate commerce, which is clearly an Article I responsibility, and one of critical importance to the people of the United States.

Aside from public choice and rule of law questions about IRAC, its governance today consists of some 20 Federal agencies whereas the "public" (purportedly consumers) is represented only by the FCC, which does not enjoy the same standing or power as the other agencies. IRAC's proceedings are not fully public, and it appears to be subject only to limited Congressional oversight and judicial review (other than the oversight of the individual member agencies). As such, most spectrum remains under legacy rules and is unavailable to satisfy the highest-valued demands of consumers.

It is not even clear that NTIA and IRAC are fulfilling their duty to inform the White House of their activities. The requirement to develop a Sustainable Spectrum

[29] "Department of Defense Spectrum Policy and the Impact of the Federal Communications Commission's Ligado Decision on National Security," Armed Services, May 6, 2020, *https://www.armed-services.senate.gov/hearings/20-05-06-department-of-defense-spectrum-policy-and-the-impact-of-the-federal-communications-commissions-ligado-decision-on-national-security.*

[30] Kelley, William K. "Justice Scalia, the nondelegation doctrine, and constitutional argument." *Notre Dame L. Rev.* 92 (2016): 2107.

Strategy is one of many requests from the President which has not been delivered, or at least not made public.[31]

Congress should consider the introduction of a pricing system for Federal users which reflects the market value of the spectrum. Failing this, Congress should consider reforms so that the American people are duly represented in IRAC, or at least to bring more accountability to its decisions. The recommendations in the subsequent section begin to address this problem. Simply put, having more spectrum in use by private actors makes our country richer, increases gross domestic product, and provides valuable services to consumers and producers.

Second Best Options

Transparency of spectrum use

Senator Mike Lee's (R–UT) proposed the Government Spectrum Valuation Act which would task NTIA, the Office of Management and Budget, and the FCC to estimate the value of relative spectrum for licensed or unlicensed and report what is assigned and allocated to each agency.[32] Coase explained why government users will resist such an effort, and unsurprisingly this common-sense bill has not moved forward. However, such a study need not be stymied by lack of legislative support. The National Science Foundation (NSF), for example, could conduct the study, though without access to NTIA's underlying information, NSF would only be able to provide estimates.

Market actors could help bring transparency to opaque government spectrum usage. The FCC has approved seven Spectrum Access System Administrators (SAS) for the 3.5 GHz band.[33] One or more of these administrators could create a public dashboard of frequencies to show how little Federal spectrum is used. This promises to show the opportunity cost of leaving spectrum fallow when so many actors are willing to use it more efficiently and pay for the right to do so. Some 350 firms have signed up to participate in the forthcoming 3.5 GHz auction in which the FCC offers three payment tiers to access 70 MHz of valuable but little used Federal spectrum.[34] Given the plethora of firms willing to pay significantly for spectrum access, the FCC should consider implementing a similar tiered framework for the 6 GHz band, which otherwise is a giveaway to America's richest software companies during a time of national financial crisis.

Report Cards

The Congressional Budget Office could play a role not only to estimate the opportunity cost of little used Federal spectrum but could issue report cards on agencies for their efficiency of spectrum use. Spectrum stewardship could be included as part of the review criteria for appropriations and authorization. Reports cards need not be developed by government actors. Private and academic actors could contribute on this instrument.

Examination of interference studies

Recent spectrum conflicts offer a valuable policy research opportunity to test the purported claims of interference. Many agencies have portended Y2K-like disaster scenarios from FCC decisions on commercial spectrum.[35] As some time has elapsed since these proceedings and services have been deployed, it is valuable to see whether the predictions proved true, were mitigated as the FCC described, or never come to pass. This is also a legitimate area of study for the FCC's Office of Economics and Analytics and NTIA's Institute for Telecommunications Sciences.

Spectrum policy choices have economic and national security consequences. While market reforms have helped correct misguided historical choices for spectrum decisions, many features of command and control administrative allocation remain.

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[31] "Presidential Memorandum on Developing a Sustainable Spectrum Strategy for America's Future," The White House, October 25, 2018, *https://www.whitehouse.gov/presidential-actions/presidential-memorandum-developing-sustainable-spectrum-strategy-americas-future/*.

[32] "Sen. Lee Introduces Government Spectrum Valuation Act," Mike Lee, May 23, 2019, *https://www.lee.senate.gov/public/index.cfm/2019/5/sen-lee-introduces-government-spectrum-valuation-act*.

[33] "3.5 GHz SAS Conditional Approval Public Notice," Federal Communications Commission, December 21, 2016, *https://www.fcc.gov/document/35-ghz-sas-conditional-approval-public-notice*.

[34] Mike Dano, "The Full List: Here Are the Actual Bidders in the CBRS Auction," Light Reading, June 19, 2020, *https://www.lightreading.com/5g/the-full-list-here-are-the-actual-bidders-in-the-cbrs-auction/d/d-id/761602*.

[35] Roslyn Layton, "GPS Interference Fears Are Today's Y2K, Says Former UK Spectrum Director," Forbes, May 8, 2020, *https://www.forbes.com/sites/roslynlayton/2020/05/08/gps-interference-fears-are-todays-y2k-says-former-uk-spectrum-director/*.

Today, many parties are unsatisfied. Nearly every industry and Federal agency would like more spectrum but can't get it. Inefficient use is encouraged; new technologies are deterred; and Americans are denied new jobs and services in the wireless domain.

The most cited academic literature and experience shows the value of market-based allocations of spectrum. The first best policy choice for consumers is to privatize the spectrum itself and sunset administrative allocation. However, the second-best policy choice of the introduction of a market-based pricing system while regulators remain has been a success in the commercial domain.

The template for Federal spectrum allocation is essentially unchanged for a century. Bringing pricing discipline to Federal users would be a quantum leap from the status quo and would improve outcomes for Federal users and Americans. It could be implemented without having to reboot existing agencies.

With the SPECTRUM Now Act and the Spectrum IT Modernization Act, this Committee is taking important steps to bring Federal spectrum allocation into the 21st century and building on proven success of improved management and efficiency of commercial spectrum. A feasibility study of increasing Federal spectrum efficiency and relocating federally held spectrum and/or sharing it with commercial users to facilitate the deployment of 5G is much needed. Similarly, modernizing the IT infrastructure for Federal spectrum can also help to bring transparency and improved decision-making.

Thank you for the opportunity to testify today. I look forward to your questions.

Sincerely,

ROSLYN LAYTON, PH.D.,
Visiting Researcher,
Communication, Media and Information Technologies,
Technical Faculty of IT and Design,
Department of Electronic Systems,
Aalborg University.

Senator THUNE. Thank you, Dr. Layton. And last we have Mr. Michael Calabrese who will be joining us virtually. Mr. Calabrese, you are recognized for your statement.

STATEMENT OF MICHAEL CALABRESE, DIRECTOR, WIRELESS FUTURE PROJECT, OPEN TECHNOLOGY INSTITUTE AT NEW AMERICA

Mr. CALABRESE. Thank you and good morning Chairman Thune, Ranking Member Schatz, and members of the Subcommittee. The Subcommittee's focus today on spectrum policy comes at a critical time. The pandemic has only reinforced both high capacity and affordable broadband connectivity are essential for working, learning, and living well at home.

As the world goes wireless, the demand for mobile connectivity and spectrum is surging. While this suggests that spectrum capacity is scarce, the reality is that smart spectrum policy can unlock an abundance of bandwidth by authorizing dynamic spectrum sharing in a larger number of underutilized bands. In recent years, the FCC has made enormous progress in opening Federal and commercial bands for more intensive shared use through policy innovations that have put the U.S. on a path to the world's most robust 5G wireless ecosystem. A leading example is a new citizens broadband radio service.

CBRS uses sensing and a geolocation database to coordinate the sharing of Federal spectrum with U.S. Navy radar which continues undisturbed. In addition, the database also facilitates a use it or share it rule that authorizes the temporary use of unused priority access licensed spectrum by any other operator both now and indefinitely following the PAL auctions that began today. This use it or share it approach should be applied to other underutilized

bands. As a default rule, it can put vacant spectrum to use in rural, tribal, and other underserved areas where it is needed most.

Another world leading example of the FCC's innovative leadership is its unanimous vote in April to authorize unlicensed use of unused spectrum across the entire 6 gigahertz band, a total of 1200 megahertz. Chairman Pai and his colleagues deserve enormous credit for recognizing that with shared access to the entire 6 gigahertz band, next generation Wi-Fi can accelerate the availability and affordability of innovative new 5G applications and services such as telehealth and augmented reality. Enabling gigabit fast Wi-Fi 6 will quickly benefit all homes, businesses, and schools, including in rural small town and less affluent areas that are unlikely to see mobile carrier 5G build-out for many years.

Two issues remain pending on 6 gigahertz that are central to the value of Wi-Fi 6 for consumers. One is power levels. A modest increase is needed for indoor only use so that gigabit fast Wi-Fi routers can continue to cover the typical home and small business reliably and at a reasonable cost. The other is the authorization of very low power devices such as connected glasses and other wearables that consumers can use indoors and outdoors unburdened by a requirement to be under the control of the geolocation database. Because sharing and reorganizing spectrum bands have become the new normal, it is crucial that the FCC and NTIA cooperate more closely than ever to unlock unused spectrum. An example is the nearly vacant 5.9 gigahertz band allocated 20 years ago for auto safety but still idling empty.

We strongly support the FCC's proposal to reallocate at least the lower portion of the band for unlicensed use. The FCC should also consider relocating auto safety applications to the nearly vacant public safety band at 4.9 gigahertz, thereby removing the roadblock to a contiguous Wi-Fi superhighway. As the 5.9 and 6 gigahertz debates demonstrate, because all very useful spectrum is occupied, the FCC faces the adamant opposition of incumbents in every proceeding aimed at opening up unused spectrum.

These spectrum turf wars, intentions are particularly discouraging on the Federal side for two key reasons. First, because the FCC is the expert agency in the best position to evaluate competing technical studies related to the risk of truly harmful interference. And second, the number and intensity of recent disputes suggest a lack of effective consultation and coordination. My written testimony suggest four changes that can greatly improve the functioning of our Nation's split system for governing spectrum.

And finally, the FCC or Congress should immediately extend the tribal priority window for access to vacant 2.5 gigahertz spectrum set to expire August 3. Thank you for inviting me to testify today.

[The prepared statement of Mr. Calabrese follows:]

PREPARED STATEMENT OF MICHAEL CALABRESE, DIRECTOR, WIRELESS FUTURE PROJECT, OPEN TECHNOLOGY INSTITUTE AT NEW AMERICA

Introduction

Good morning Chairmen Wicker and Thune, Ranking Members Cantwell and Schatz, and members of the Subcommittee. My name is Michael Calabrese. I direct the Wireless Future Project at New America's Open Technology Institute (OTI), a nonprofit policy institute based here in Washington, D.C. I have also served since 2009 on the Department of Commerce Spectrum Management Advisory Committee

(CSMAC). My organization develops and advocates for policies to promote universal, faster and more affordable wireless broadband connectivity, broadband competition, and more efficient spectrum use with a focus on expanding unlicensed access and dynamic spectrum sharing. OTI is also a member of the broad-based Public Interest Spectrum Coalition (PISC) that includes national consumer, civil rights, education, rural broadband and social justice organizations.

The Subcommittee's focus on spectrum management comes at a critical time. The pandemic has highlighted how vital it is for every household to have an affordable fixed broadband connection, as well as the higher-capacity Wi-Fi needed to distribute that connectivity to the workers, students and others sharing those connections. At the same time, the Nation is beginning a transition to 5G mobile networks and a broader, complementary 5G wireless ecosystem that will include millions of high-capacity and customized networks deployed by individual business firms and households to meet their particular needs at a lower cost.

As the world goes wireless, the demand for wireless connectivity and spectrum continues to increase rapidly. Cisco's annual report on Internet usage projects that mobile data traffic in North America will continue to grow at a compound annual growth rate exceeding 36 percent through 2022.[1] Wi-Fi data consumption on mobile devices is growing at an even faster 45 percent annual rate.[2] The demand for spectrum capacity will grow further as the Internet of Things (IoT) emerges and machine-to-machine (M2M) data transfers require more and more capacity. Cisco estimates that as M2M applications develop and grow—through operations including "smart meters, video surveillance, healthcare monitoring, transportation, and package or asset tracking."[3] By 2023, M2M connections are expected to represent 50 percent of all devices and connections.

This surging demand and several contentious FCC proceedings to allocate more spectrum for 5G has created an impression that spectrum is scarce. It is true that the low- and mid-band spectrum most valuable for wide-area mobile services has become more and more difficult to clear and repurpose for exclusive licensing, as we saw recently with the protracted debate over clearing and auctioning unused C-band spectrum. However, contrary to assumptions of scarcity, smart and forward-looking spectrum policy can unlock an abundance of wireless bandwidth in a larger number of underutilized bands through dynamic spectrum sharing.

The President's Council of Advisors on Science and Technology (PCAST) forecast this new reality in 2012, concluding that a new paradigm can "unlock the data-carrying capacity of spectrum in an unprecedented way."[4] The PCAST report concluded: "The essential element of this new Federal spectrum architecture is that the norm for spectrum use should be sharing, not exclusivity."[5] This "new normal," as the PCAST report saw it, is a reason the FCC, NTIA and Federal users need to collaborate more than ever to unlock unused spectrum capacity in more frequency bands. Their close cooperation is needed to support the Nation's progress in deploying mobile 5G services, high-capacity fixed wireless connections, and next generation Wi-Fi 6 networks that all together will consume exponentially more data over the years ahead.

The FCC's World-Leading Innovation in Spectrum Sharing

In recent years the FCC has made enormous progress in unleashing underutilized spectrum in occupied bands for both licensed and unlicensed use. Both Federal and commercial bands have been opened for more intensive shared use through policy innovations that have put the U.S. on a path to the world's most robust 5G wireless ecosystem. A leading example is the new Citizens Broadband Radio Service, which began commercial operations earlier this year.

CBRS is doubly innovative as a framework that can be tailored to additional occupied but underutilized bands to unlock low-cost capacity. CBRS authorizes both li-

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[1] Cisco also projects a global annual compound growth rate of 46 percent. "Cisco Visual Networking Index (VNI): Global and Americas/EMEAR Mobile Data Traffic Forecast, 2017–2022," Cisco Knowledge Network Session, at 9 (March 2019). Available: *https://www.cisco.com/c/dam/m/en_us/network-intelligence/service-provider/digital-transformation/knowledge-network-webinars/pdfs/190320-mobility-ckn.pdf.*

[2] *Id.* at 104.

[3] Cisco Annual Internet Report (2018–2023), Cisco Systems Inc. (March 2020). Available: *https://www.cisco.com/c/en/us/solutions/collateral/executive-perspectives/annual-internet-report/white-paper-c11-741490.pdf.*

[4] *Report to the President Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth,* President's Council of Advisors on Science and Technology (July 2012), at 11. Available: *https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf.*

[5] *Id.* at vi.

censed and opportunistic (lightly-licensed) access to unused spectrum in the 3550–3700 MHz band long used for U.S. Navy radar systems. The CBRS rules authorize the certification of multiple frequency coordination systems—called Spectrum Access Systems (SAS)—to govern a dynamic framework for spectrum sharing among a three-tier hierarchy of users: incumbent licensees (primarily U.S. Navy radar), Priority Access Licenses (PALs), and opportunistic (effectively unlicensed) General Authorized Access (GAA) users. Multiple, competing SASs are responsible for ensuring incumbent services are fully protected from harmful interference and that PAL operators are protected from each other and from GAA users.

In addition, the rules for CBRS include a use-it-or-share-it provision that authorize any operator to coordinate access to unused PAL spectrum on an opportunistic basis—both now and indefinitely following the PAL auctions that began today. The automated frequency coordinator (SAS) ensures that opportunistic GAA use of unused PAL spectrum in a local area will not interfere with the priority access licensee. The SAS database thereby facilitates—on an automated basis at low cost—intensive spectrum sharing that both protects U.S. Navy systems and ensures that all the spectrum in the 3.5 GHz band is available for use. In short, spectrum not actually being used by the U.S. Navy or by the post-auction PAL licensee is available to enhance the capacity of other operators on an opportunistic, use-it-or-share-it basis. One sign of the band's success is that tens of thousands of CBRS base stations have been deployed since the band opened up just a few months ago, pre-auction and despite the pandemic.

Another world-leading example of the FCC's innovative leadership in spectrum policy is the Commission's unanimous vote in April to authorize unlicensed use of unused spectrum capacity across the entire 6 GHz band—a total of 1,200 megahertz that begins just above the portion of the 5 GHz band most used today for Wi-Fi, but which is increasingly congested. Chairman Pai and his colleagues deserve enormous credit for recognizing that with access to the 6 GHz band, next generation Wi-Fi 6 can almost immediately support 5G-quality applications and services in any home, business, school or library that has access to a high-capacity fixed broadband connection. With access to the 6 GHz band, Wi-Fi 6 will accelerate mobile 5G services both by providing complementary offload capacity indoors and by facilitating early adoption of 5G-quality applications, such as augmented and virtual reality.

Indoor-only use is authorized across all 1,200 megahertz at a low power level that the FCC's Office of Engineering and Technology determined will not cause harmful interference to band incumbents. This decision will both secure U.S. dominance in Wi-Fi and fuel innovation in augmented reality and other applications. While Europe is far along in authorizing the lower portion of the band for indoor-only use, the FCC's experience with spectrum sharing coordinated by geolocation databases led it to "go big" and authorize standard-power operations outdoors in 850 megahertz of the band where incumbent point-to-point links can be protected by an Automated Frequency Coordination (AFC) system. This will prove hugely beneficial to rural, tribal, small town, and other less-densely populated areas that may not see true 5G mobile carrier services for many years.

OTI believes that a general authorization for opportunistic access on a use-it-or-share-it basis should be a central piece of any effort aimed at expanding spectrum access for small and non-traditional ISPs in rural, tribal and other underserved areas, as well as for enterprise and institutional use. A version of the CBRS framework should be tailored to promote more efficient and intensive use of both Federal and commercially licensed bands with substantial unused capacity. Opportunistic access policed by an automated AFC database could empower a wide variety of small and alternative providers to use fallow spectrum in local areas to provide high-speed broadband and other services, while retaining the licensee's right to exclusive use of that spectrum whenever the carrier commences service. Unleashing opportunistic, shared access to fallow spectrum creates a general incentive for licensees to build out services more quickly, or to make greater efforts to partition or lease their spectrum. This will reduce spectrum warehousing and increase access to operators ready to deploy, but who lack spectrum access in a local area.

Reforming the Governance of Spectrum

Not surprisingly, the FCC's efforts to open underutilized bands for sharing and to reallocate bands to facilitate emerging services, particularly mobile 5G, has met with stiff resistance from incumbent users. Whether incumbents are commercial licensees or Federal agencies, they inevitably resist on the grounds that authorizing new or more efficient use of a band will create an unacceptable risk of harmful interference. Because every valuable band of frequencies is occupied by some set of incumbents, the FCC now faces the obstacle of rampant NIMBYism in virtually every proceeding aimed at opening the spectrum capacity needed to facilitate new

technologies and services. On the commercial side, we see this in the 6 GHz band, where incumbent licensees are mounting or threatening litigation. And we see it on the Federal side as agencies oppose FCC proposals and even seek to overturn or undermine final orders through legislation.

These spectrum "turf wars" and tensions are particularly discouraging on the Federal side for two key reasons:

First, and most importantly, the FCC is the expert agency in the best position to evaluate competing technical studies related to the risk of truly harmful interference. The FCC has accumulated unparalleled engineering expertise in wireless technologies. All decisions follow not only public notice and comment, but also a separate consultation process with NTIA and any impacted Federal agency. It's also crucial that the FCC determine and follow consistent definitions and standards concerning what is or isn't an unacceptable risk of harmful interference. In my experience, which covers nearly two decades of spectrum proceedings, the FCC and its Office of Engineering and Technology are objective, thorough and, if anything, decidedly on the conservative side when it comes to minimizing the risk of interference or disruption to incumbents, particularly Federal users. Deference to the FCC as the expert agency should be beyond dispute concerning non-federal bands in particular, since Congress gave the FCC exclusive jurisdiction over commercial spectrum decisions.

Second, the number and intensity of recent disputes between Federal agencies and the FCC suggest a lack of effective consultation and coordination. I'm not in a position to know where the process is breaking down, although it seems likely that the combination of a very activist FCC and the lack of a coherent Federal spectrum policy mediated by White House oversight has proven to be a toxic combination. As I explain further below, because the NTIA is primarily an advocate for Federal spectrum users, and the FCC is focused primarily on promoting private industry and the economy, in our split system of spectrum governance it is imperative that White House officials play a guiding and mediating role in defining the balance that best serves the broader national interest.

Spectrum "turf wars" and conflicts between the FCC and incumbent users of spectrum, both private licensees and Federal users, are likely to worsen as sharing or consolidating long-occupied bands becomes the "new normal." On the Federal side, this has created a recognition that our split system for spectrum allocation will require reform. Last fall NTIA asked the CSMAC, on which I've served since 2009, to study whether a new approach or structure for spectrum governance would better optimize U.S. spectrum management "for the implementation of a 21st century national spectrum strategy." After discussions that involved most members, the Working Group reported at CSMAC's January public meeting that:

> There is general agreement among [CSMAC] members that the United States' current approach for managing the use of spectrum is no longer effectively serving the needs of the entire stakeholder community and would benefit from reform. Moreover, with the increased use of spectrum by all stakeholders, we agree that issues around allocations, spectrum-sharing and band adjacencies will need to be handled with both speed and skill to ensure that the U.S. is making the most of its critical national resources.

The divided responsibility for spectrum governance might ultimately be an issue only this Committee can resolve, since the origins are statutory. Long before the FCC's creation, the Radio Act of 1912 provided that certain frequencies belong exclusively to the government as a matter of national security. A decade later, the Inter-Departmental Radio Advisory Committee (IRAC) was established as a coordinating body for Federal departments and agencies with an interest in radio communications. The Radio Act of 1927, followed by the Communications Act of 1934, formalized the dual structure, giving the FCC exclusive authority to license non-governmental spectrum, but exempting radio operations owned by the Federal Government.[6]

At its April public meeting, the CSMAC Working Group previewed a range of options for alternative spectrum governance models. One general option is to integrate all authority over spectrum allocation into one existing agency or the other, creating a "new" FCC or a "new" NTIA. Another general option is to create a new independent agency to assume this role, either as a "full service spectrum agency" that assumes all spectrum-related functions, or possibly as a more limited "spectrum resource agency" that assumes responsibility for all "top-level spectrum governance

[6] Communications Act of 1934, 47 U.S.C. § 151. *See* GAO, *Information on Management and Use of the Radio Frequency Spectrum—A Little-Understood Resource,* B–159895 (1974).

and policy decisions" while leaving implementation to the FCC and NTIA. A final category described more incremental changes, including, most notably, updating and enhancing the current Memorandum of Understanding (MOU) between NTIA and the FCC, signed in 2003, to expedite and strengthen coordination and decision-making.[7]

The CSMAC's work on this topic is ongoing. A more detailed report on these alternatives will be discussed at the July 30 public meeting, so I will not venture an opinion now. However, I do believe a few changes can and should be made that do not require legislation:

First, the White House needs to drive and finalize a National Spectrum Strategy that outlines a coherent set of priorities and strategies that can help shape a consensus among the FCC, NTIA, and Federal users represented on the IRAC. As President Trump set forth in his 2017 Presidential Memorandum, "the Nation requires a balanced, forward-looking, flexible, and sustainable approach to spectrum management."[8] Building on the PCAST recommendations, President Obama set his administration on a new path that favored unlocking exclusive but underutilized Federal bands, such as the 3.5 GHz band where CBRS now operates, but the current path and plan are not clearly in sight.

Second, the current MOU that governs coordination on spectrum matters between the NTIA and FCC should be updated and enhanced. As the CSMAC Working Group reported at its April public meeting, the 15-day coordination period for routine items leaves gaps and potential discord on non-routine items. The group suggested that for "non-routine FCC items, [the MOU should] create an agreed escalation process and include specific time frames for resolution." The two agencies should strive to agree on a common set of metrics and methodologies to determine when a band is underutilized and, critically, to predict potentially harmful interference. A joint test bed and annual joint workshop could "explore novel spectrum sharing, management techniques, and approaches." The MOU should also provide for an annual report to Congress that describes the agencies' "joint spectrum planning activities, future spectrum requirements, spectrum allocation actions necessary to accommodate those uses," including any significant areas of disagreement.

Third, the coordination and consultation process itself needs to be more transparent to stakeholders. It is typically not clear outside the FCC and NTIA to what degree there are concerns about a proposed policy or what technical information is being exchanged. As part of this, the MOU should require that Federal agencies—or NTIA on their behalf—monitor and file comments and technical studies in the FCC's notice and comment docket in a timely manner (in redacted form, if necessary). Too often Federal agency concerns come to light at the 11th hour, after the FCC and the private sector have finished building a public record. While these early filings should not replace the requirement for consultation with NTIA after the FCC evaluates the record and reaches a tentative conclusion, it does ensure that agencies, industry and other stakeholders are not blindsided by last-minute objections never fully or publicly documented.

Fourth, and most importantly, the Executive Office of the President needs to engage directly in guiding and mediating disputes that arise when the FCC and NTIA cannot reach a consensus. As noted above, while both the FCC and NTIA are to a significant degree 'captured' by their role as advocates for the private sector and Federal spectrum users, respectively, the right combination of officials in the White House should be in the best position to discern the overall national interest. The "Spectrum Management Team" recommended in the PCAST Report is an example.[9] Only the EOP has the clout to enforce a government-wide strategic direction and to push back against individual departments or agencies that diverge. A deeper engagement in spectrum policy by at least OSTP and NEC can also assist the FCC at critical times when it faces opposition to proposals for spectrum sharing (*e.g.,* 6

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[7] "Memorandum of Understanding between the Federal Communications Commission and the National Telecommunications and Information Administration." Available: *https://docs.fcc.gov/public/attachments/DOC-230835A2.pdf.*

[8] White House, "Presidential Memorandum on Developing a Sustainable Spectrum Strategy for America's Future," 25 October 2018. Available: *https://www.whitehouse.gov/presidential-actions/presidential-memorandum-developing-sustainable-spectrum-strategy-americas-future/.*

[9] The *PCAST Report* made a specific recommendation along these lines. *See PCAST Report* at ix ("Specifically, we recommend that the White House Chief Technology Officer (CTO), with equivalent level representatives from the National Security Staff (NSS), the Office of Management and Budget (OMB), and National Economic Council (NEC) formalize a Spectrum Management Team (SMT) to work with the NTIA to carry out the President's directive.").

GHz) or consolidation and clearing (*e.g.,* C-band) from powerful incumbent licensees in commercial bands.

Next Generation Wi-Fi: Accelerating Affordable 5G Services for All Americans

The 5.9 and 6 GHz proceedings pending at the FCC exemplify both the promise and peril of the current imperative to share or reallocate spectrum to advance America's 5G future. Unlicensed spectrum is what ultimately makes both mobile and fixed broadband service more available, fast and affordable to consumers and businesses nationwide. Far more unlicensed spectrum is needed to distribute a gigabit or more of bandwidth to all the users and devices in our Nation's homes, offices, schools and other venues. But because every band of very useful spectrum is occupied by one or more incumbent uses, adding even a very low power "underlay" of unlicensed use on vacant portions of underutilized bands—such as the 6 GHz band—entails overcoming the inevitable opposition of incumbent users and their NIMBY claims of imminent disruption. Our public interest coalition believes that Chairman Pai and his colleagues displayed both remarkable vision and care in crafting balanced and innovative proposals for 5.9 and 6 GHz that will ultimately fuel not only the world's most robust 5G wireless ecosystem, but one that is more available and affordable in rural, small town and low-income areas across the entire nation.

Wi-Fi is the workhorse of the Internet because low-cost, off-the-shelf routers and devices easily and affordably offer access to unlicensed spectrum that provides high-capacity connectivity in homes, at work, at school, in libraries, restaurants, retailers, and virtually every public place. The vast majority of data consumed on smartphones and other mobile devices flows over Wi-Fi networks, never touching mobile carrier spectrum or infrastructure. The share of data traffic offloaded via Wi-Fi is expected to increase sharply as mobile technology upgrades from 4G to 5G, since high-bandwidth applications are typically used at home, work and other indoor locations. Cisco projects that 76 percent of all data traffic on smartphone and other mobile devices will be offloaded onto Wi-Fi in North America by 2022.[10] The U.S. alone will have an estimated 77 million Wi-Fi hotspots by then.[11] Providers acknowledge Wi-Fi's central role. For example, Verizon's Executive VP and Consumer Group CEO told an investor conference in January that between 70 percent and 75 percent of mobile device data traffic is offloaded onto Wi-Fi.[12]

6 GHz Band: Unlicensed Sharing Across 1200 MHz Will Benefit All Americans

Unlicensed Access 1200 contiguous megahertz at 6 GHz—from 5925 to 7125 MHz—is the fuel necessary to power gigabit-fast and affordable Wi-Fi 6 and other unlicensed innovations of greatest benefit to consumers and the overall economy. Consumer and digital inclusion advocates strongly supported the FCC's decision to authorize low-power and indoor-only use of unlicensed devices across all four band segments (a total of 1200 megahertz). We likewise supported the FCC's proposal to allow outdoor unlicensed operations at a higher ("standard") power in two band segments that total 850 megahertz subject to registration and recurring authorization by an Automated Frequency Coordination (AFC) system.

While consumer and digital inclusion advocates celebrated he FCC's April Order, the still-pending Further Notice of Proposed Rulemaking addresses two critical shortcomings that threaten to diminish the value of Wi-Fi 6 for the vast majority of Americans at home and at work.

First, the enormous consumer benefits of authorizing low-power, indoor-only ("LPI") devices across the entire 6 GHz band will be undermined if the power levels are restricted to a level below what's needed to protect high-power fixed links outdoors. The maximum power adopted in April (5 dBm/MHz power spectral density) might be justified as a "compromise" with powerful incumbents, but in practice it makes Wi-Fi routers far more costly, complex, and less useful for the average household or small business. In the context of the current pandemic, because Wi-Fi 6 routers and devices can come to market as soon as the end of this year, OTI believes it is critical that consumers and businesses have the indoor coverage they need to function reliably and affordably. The Commission should not pull the technical rug out from under ordinary consumers, schools, and small businesses unless the engineering evidence in the record clearly establishes that LPI at up to 8 dBm/MHz PSD will measurably and substantially increase the risk of harmful interference to in-

[10] *Cisco 2019 VNI Report* at 104.
[11] *Id.* at 111.
[12] Verizon, Citi 2020 Global TMT West Conference, Webcast (Jan. 7, 2020). Available: *https://www.verizon.com/about/investors/citi-2020-global-tmt-west-conference.*

cumbent users. As the Commission acknowledged in its April Order, reliable engineering studies in the record show that this modest power increase is extremely unlikely to cause actual harmful interference to any band incumbents.

Second, to its credit the FCC recognizes in the FNPRM that Wi-Fi 6 and other unlicensed technologies will not deliver the potential benefits of new applications, such as augmented and virtual reality, without authorizing an additional class of Very Low Power (VLP) devices. OTI and PISC strongly support the Commission's proposal to authorize VLP devices to operate both indoors and outdoors across the band's entire 1200 megahertz unburdened by any requirement to be under the control of an Automated Frequency Control ("AFC") system. It is crucial that the Commission authorize VLP devices to operate at power levels up to 14 dBm EIRP, which is the minimum power level needed to achieve the enormous potential consumer and economic benefits of VLP, while also fully protecting band incumbents from harmful interference.

The Vacant 5.9 GHz Band is a Roadblock to a Potential Wi-Fi Superhighway

OTI strongly supports the Commission's pending proposal to reallocate *at least* 45 megahertz of the virtually unused 5.9 GHz band for unlicensed use. The 5.9 GHz band lies directly between the upper portion of the 5 GHz band, currently the most heavily-used Wi-Fi spectrum, and the 6 GHz band that will soon become the go-to band for next generation Wi-Fi 6. As Commissioner Mike O'Rielly so aptly put it, the 5.9 GHz band is "the missing link between the 5 GHz and 6 GHz bands." Reallocating the 5.9 GHz band for unlicensed use would create an immensely productive Wi-Fi Superhighway, enabling contiguous channels of multi-gigabit-fast connectivity in every home and business. Contiguous wide channels of unlicensed spectrum with mid-band propagation is essential for accelerating the next-generation of 5G-capable Wi-Fi services nationwide, including for fixed wireless broadband in rural areas.

Back in 1999, the FCC allocated this 75 megahertz (5850 to 5925 MHz) for auto safety signaling using a specific technology called Dedicated Short-Range Communications ("DSRC"). For two decades the band has gone almost completely unused, making the 5.9 GHz band a telling experiment in market forces and innovation. Wi-Fi also emerged in 1999. Over that time, unlicensed innovation and Wi-Fi use has surged, saturating both the 2.4 GHz band and two segments of the 5 GHz band with intensive spectrum re-use that generates hundreds of billions of dollars annually in consumer surplus.[13] The 'car band,' meanwhile, sits idling and empty. The band is so empty that the FCC recently authorized more than 100 rural wireless Internet providers (WISPs) to use it to enhance the capacity of fixed wireless networks in rural areas.

Currently the auto and mobile industries are developing Cellular V2X as an alternative to DSRC. Since C–V2X is in its infancy and is likely to thrive, if at all, as an application on general purpose mobile 5G networks, OTI believes it would be a "win-win" for consumers to relocate V2X safety signaling. We believe Congress should urge the FCC and DOT to work together to explore all alternatives, including whether an alternative band, such as the nearly vacant 4.9 GHz public safety band, could be equally or *more* useful for vehicle safety applications that are integrated with 5G mobile networks. We recently released a paper making the case for relocating at least the future Cellular V2X safety applications to 4.9 GHz, or to another dedicated band that is not wedged between what will be the two most intensively used Wi-Fi bands.[14] The Dynamic Spectrum Alliance, a high-tech industry coalition, recently made a similar proposal.[15] Consumers will benefit most if the allocations for both auto safety and next generation Wi-Fi are optimized.

The Lower 3 GHz band: Expedite Shared Access to Unused Military Radar Spectrum

As requested by Congress, earlier this month NTIA released a report on the military radar bands at 3100–3550 MHz that "focuses on creating opportunities for commercial use by sharing rather than by clearing the spectrum" and "under the assumption of no changes in incumbent operations." The report concludes that "the 3450–3550 MHz portion of this band is a good candidate for potential spectrum

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[13] *See* Diana Gehlhaus Carew, *et al.*, "The Potential Economic Value of Unlicensed Spectrum in the 5.9 GHz Frequency Band," RAND Corporation (2018). Available: *https://www.rand.org/news/press/2018/11/29.html.*

[14] Michael Calabrese and Amir Nasr, "The 5.9 GHz Band: Removing the Roadblock to Gigabit Wi-Fi," Open Technology Institute at New America (July 2020). Available: *https://d1y8sb8igg2f8e.cloudfront.net/documents/The_5.9_GHz_Band_.pdf.*

[15] Ex Parte Filing of the Dynamic Spectrum Alliance, Amendment of Part 90 of the Commission's Rules, WP Docket No. 07–100, ET Docket No. 19–138 (June 11, 2020).

sharing" and that "ultimately some sharing of spectrum below 3450 MHz may be possible as well."[16]

OTI encourages this Committee to examine whether the 3 GHz spectrum immediately below the CBRS band—and currently used extensively for Department of Defense radar systems—could, like the 3550–3650 MHz band, be opened for dynamic sharing under the control of a Spectrum Access System (SAS) and as an expansion of CBRS. Like the grossly underutilized 3.5 GHz band, there is every indication that the 3300–3550 MHz band can be successfully shared with military radar systems that currently occupy the band.

The NTIA's separate technical report on the 3450–3550 MHz sub-band found that a dynamic, time-based sharing mechanism "present[s] a potentially attractive approach to both protecting Federal systems and providing viable commercial operations."[17] Such a dynamic sharing arrangement could be enabled by having Federal incumbents dynamically inform a SAS when and where they are operating rather than having Spectrum Access Systems rely on spectrum sensing systems, which can be problematic for a number of reasons. Conversely, NTIA's technical report concluded that the static geographic- and/or frequency-based approaches more conducive to exclusive, very wide-area licensing is problematic. Such a static sharing approach would "result in significant restrictions on commercial services, in terms of emitter power limits and exclusion zones, making sufficient access for viable commercial applications unlikely."[18]

The 2012 PCAST report concluded that often the "clearing and reallocation of Federal spectrum is not a sustainable basis for spectrum policy due to the high cost, lengthy time to implement, and disruption to the Federal mission." DoD's Defense Innovation Board (DIB) report last year similarly concluded that within a reasonable time frame, dynamic sharing would be far more feasible and acceptable from the military's perspective.[19] OTI fully agrees with the DIB. The report's co-authors wrote separately that clearing DoD spectrum for exclusive-use licensing is "impractical" given the need to find and clear substitute bands for military radar.[20] Even if possible, the delay would be self-defeating if the goal is to win a global race to 5G. OTI agrees that shared access can open the 3450–3550 MHz band for 5G-quality networks years sooner by leveraging the coordination capabilities of FCC-certified SAS databases.

The 12 GHz Band can Provide Shared Spectrum for 5G and Rural Broadband

The 12 GHz Band provides an opportunity to adopt a sharing framework that greatly expands the availability of spectrum for both fixed and mobile broadband deployments with mid-band propagation characteristics significantly better than the millimeter wave bands at 24 GHz and beyond. By adding the 12 GHz Band to the Commission's 5G FAST Plan, the FCC can make an additional 500 megahertz of contiguous spectrum available for two-way fixed and mobile 5G wireless broadband services, while protecting incumbent satellite uses (including satellite broadband) from harmful interference. This will promote competition, innovation and improve services to underserved communities.

OTI, as well as the Competitive Carriers Association, INCOMPAS and other parties have urged the FCC to launch a NPRM to consider the petition filed four years ago by DISH and other terrestrial licensees in the 12 GHz band who are currently restricted to one-way and very low-power transmissions under outdated rules. Although OTI and most consumer advocates opposed the merger of Sprint and T-Mobile, now that there are only three national mobile broadband providers it is imperative that the FCC ensure that DISH has access to sufficient spectrum to compete aggressively with the incumbent providers. In doing so, we also have urged the FCC to protect the operations of Space-X and other potential satellite broadband competitors that have co-primary rights in the 12 GHz band.

In addition, OTI, Public Knowledge and other public interest groups have urged the FCC to seek comment on the authorization of coordinated, shared use of the

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[16] U.S. Department of Commerce, *Feasibility of Commercial Wireless Services Sharing with Federal Operations in the 3100–3550 MHz Band,* at 1 (July 2020).

[17] Edward Drocella, Robert Sole, Nickolas LaSorte, *Technical Feasibility of Sharing Federal Spectrum with Future Commercial Operations in the 3450–3550 MHz Band,* NTIA Technical Report 20–546, at ix (rel. Jan. 2020).

[18] *Id.* at ix.

[19] *See* Defense Innovation Board, *The 5G Ecosystem: Risks and Opportunities for DoD,* Recommendation #1, at 28 (April 2019). Available at *https://media.defense.gov/2019/Apr/04/2002109654/-1/-1/0/DIB_5G_STUDY_04.04.19.PDF.*

[20] Milo Medin and Gilman Louie, "Clearing the Air on 5G," *Texas National Security Review* (March 13, 2020). Available at *https://warontherocks.com/2020/03/clearing-the-air-on-5g/.*

band for high-capacity fixed wireless services on an opportunistic unlicensed or licensed-by-rule basis. Authorizing coordinated access to vacant 12 GHz spectrum on a secondary basis would be particularly beneficial for rural, tribal and other underserved communities.

If the FCC grants terrestrial MVDDS licensees more flexible use rights, the shared nature of the band makes it likely that power limits will be lower than in bands that mobile operators will rely upon for wide-area 5G coverage. As a result, mobile 5G deployments are likely to be limited for years to urban, inner-suburban and other higher-traffic areas where an investment in greater capacity justifies the cost. Rather than leave as much as 500 megahertz in the band fallow in underserved rural and other less-densely-populated areas, the Commission—and this Subcommittee—should consider a "use it or share it" approach that allows at least secondary, coordinated access for fixed broadband uses.

Unused C-band Spectrum Can Spur Rural Wireless Broadband

OTI and multiple public interest, high-tech and rural broadband provider coalitions supported two proposals that would put *all 500 megahertz* of today's grossly underutilized C-band to work to fuel America's 5G future and to close the rural broadband divide. First, we strongly supported the FCC's pivot late last year to a public auction for 280 megahertz in the lower portion of C-band. Although OTI and our broader Public Interest Spectrum Coalition continue to oppose the $9.7 billion giveaway to foreign satellite companies adopted by the FCC as unlawful and unnecessary, we do believe that consolidating fixed satellite services and reallocating 280 megahertz for public auction will hasten a more widespread deployment of mobile 5G services.

In addition, those same rural broadband, high-tech and public interest coalitions supported a proposal to authorize coordinated, shared access to unused spectrum across the entire C-band to the extent it would not cause harmful interference to registered earth stations or to future licensed mobile services. A study by wireless engineers at Virginia Tech showed that even after incumbent earth stations are consolidated into the upper 200 megahertz of the band, every megahertz could be used in roughly 80 percent of the U.S. to provide gigabit-fast fixed wireless broadband service to more than 80 million Americans, mostly in rural and underserved areas.[21] By requiring rural ISPs and other operators to rely on an automated coordination system, the FCC can fully protect earth stations (and thereby TV and radio consumers) in the same way that FCC-certified Spectrum Access Systems are now protecting the U.S. Navy and satellite earth stations in the immediately adjacent 3550–3700 MHz band.

Unfortunately, although the FCC included this proposal in its Notice of Proposed Rulemaking, it did not adopt it. We believe that any Congressional action on C-band should require the FCC to authorize coordinated, shared access to unused spectrum across the entire band to the extent it does not cause harmful interference to registered earth stations or to future licensed mobile services. Spectrum itself is public infrastructure that can be used to help close the digital divide. OTI strongly supports the SMART Act, which would minimize the unnecessary pay-off to band incumbents and designate a substantial share of auction proceeds for a Digital Divide Trust Fund. We urge the leadership of this Committee to prioritize a compromise that both earmarks proceeds to promote broadband access in rural, tribal, low-income and other underserved areas and also requires the FCC to authorize coordinated, shared access to unused spectrum across the entire 500 megahertz conditioned on protecting the primary licensees from harmful interference.

Thank you for this opportunity to share our views with the Committee on these critical spectrum management issues and proceedings.

Senator THUNE. Thank you, Mr. Calabrese. We will jump right into questions and I would like to start by getting to the subject of interagency spectrum process. Despite Congress delegating authority over Federal spectrum management to NTIA, there have been cases where other Federal agencies have questioned NTIA's decisions and authority.

Along those same lines, NTIA is supposed to speak for the entire Executive Branch on Federal spectrum issues yet there have been

[21] Monica Alleven,"Google, WISPA Tout Results of Study on Sharing in C-band," *Fierce Wireless* (July 2, 2019). Available: *https://www.fiercewireless.com/wireless/google-wispa-tout-results-study-sharing-c-band.*

multiple examples of Federal agencies communicating directly with the FCC rather than collectively through NTIA. And I will just open this up to anybody who wants to comment, do you all believe that the interagency spectrum process as designed by Congress is working effectively as it was intended?

Mr. POWER. Thank you, Mr. Chairman. I think the structure is right. We have had some stumbles the last couple of years as you referenced. I think what is needed is just greater collaboration between NTIA and FCC at all levels. And certainly, we have seen some turnover at the top of NTIA which probably hasn't helped. There are a lot of good people at NTIA and they are doing a good job, but I think in terms of consistent representation of the agencies and consistent collaboration with the FCC, some stability there would be of assistance.

But more importantly I think it is just a commitment to getting, the smart folks in the room, getting all the engineers in the room to tackle these issues and to have a shared vision of what we are really trying to achieve as between NTIA and the FCC, OMB usually has a view on this stuff, help from OSTP or NEC in the White House, and just a continued, sustained, and collaborative effort to get to our common goals.

Senator THUNE. Yes. Mr. Gibson.

Mr. GIBSON. Thank you, Chairman Thune, for the question. It is an interesting question. You basically quoted from a from a memo from the Chairman Pallone of the Energy and Commerce Committee on the House side to the GAO to conduct an investigation of some of these concerns and issues. And at the end, the Committee asked GAO to look into several things. So I don't think we feel that the problem process is broken. It may be suffering from growing pains.

The process, as Dr. Layton said, is between 94 and 86 years old depending upon when you think it started. If you take the Communications Act of 1934, it is 86 years old and a lot has happened since then. Quite a bit has happened since then. And so the phase we are in now, the age where now is an age where there is a lot more shared-use. And so we wonder whether the process might lend itself to revisiting that in the context of more shared spectrum use.

Senator THUNE. Dr. Layton.

Ms. LAYTON. Well, again, thank you for the question and of course this hearing, Senator Thune, and your leadership to look at this issue. What was created with the 1927 Radio Act, that is what we have today and it is acting as what was intended at the time which was to make spectrum as a political decision. So I think we get what was put in place then and if you also read the minutes of IRAC over the years, there have always been disputes.

We forget about them now, but they have always been going on amongst the agencies, between the FCC, with the other Federal departments. It is nothing new. What I would encourage and I encourage this committee, I think there could be more Congressional oversight of this particular function. This committee does a lot of work to oversee the FCC. I think it could do more work to oversee NTIA and IRAC, and I encourage you to look at that.

Senator THUNE. OK. Mr. Calabrese, anything to add before we move on? OK, I will direct this question to Dr. Layton. In your testimony you state that, and I quote, "5G is the quickest way to equalize the digital divide between urban and rural America." How can we improve the Federal spectrum allocation process to provide more equitable benefits to Americans and should the process be more transparent?

Ms. LAYTON. So what I think you can see, if you look at the FCC's spectrum, the ULS, the Universal Licensing System, is that what a market-based system does is it allows more participation in the spectrum: this number of licenses, the number of users, the number of uses. It is tremendous. With regard to 5G, because the overall decision around which bands are to be used is still an administrative decision, the industries, who are going to be disrupted by 5G, want to hijack the political process to slow the rollout of 5G.

I find it very unfortunate. People suffer today because 5G has been delayed by at least 2 years. We can look at what's going on with C-band for example. Nevertheless, I think Chairman Pai, the FCC Commissioner O'Reilly, Commissioner Carr, they have been very forthright to continue to push for 5G of course and with the help of this committee. It is extremely important. All of America wants to have the next generation networks. They all need it today, school children, health, telemedicine. We know that through the pandemic.

For a longer term, I hope that we would look at bringing pricing to this picture. That is something that is missing. I know it is not something in this particular term, but a medium to long-term plan should include pricing for Federal spectrum. That would reduce the squabbling significantly.

Senator THUNE. I am going to run and vote and return. Senator Schatz I think is available. Senator Wicker is up. The Chairman—we will yield to the Chairman of the Full Committee for questions.

The CHAIRMAN. I think we had told Senator Schatz he could be next so if he is available——

Senator SCHATZ. I am available but I defer to you, Mr. Chairman.

The CHAIRMAN. Well, then if I might, let me ask, and start with Mr. Power, about mid-band spectrum. As I understand it, if you could—and bear in mind we have a variety of knowledge levels among the viewers today and it is surprising how many people listen to our hearings—give us if you can a little bit of a primer on the advantages of mid band versus high band spectrum and also versus low band spectrum. And then, am I correct in my data that we really rank fifth in the world in mid band spectrum allocation?

Mr. POWER. Thank you, Chairman Wicker. So when we think about spectrum, we do divide it into these three categories: low-band, mid-band, high-band. Low band is what 4G was built on very successfully. It has the advantage of great coverage over miles. It is not as great at the amount of capacity, the amount of data you can carry. High band spectrum is just the opposite. It contains a lot of capacity, very low latency, but the distance it travels isn't as great.

Mid band is as my friend, Dr. Layton, said in her testimony, is the goldilocks because it combines elements of both. You get good

capacity, but you get good coverage too. And that is why it is so important. And to your point, we are behind there. We have zero spectrum in the critical mid band spectrum license today. The CBRS license or auction that is commencing today will give us 70 megahertz of that and start to catch up but other countries are multiples ahead of that.

The CHAIRMAN. Why are we so far behind?

Mr. POWER. Well, I think Chairman Pai deserves credit. In his 5G fast plan, he identified low, mid, and high. I think the high band was kind of the most accessible in the fastest amount of time. The mid band spectrum, as we talked about, has been encumbered by other uses. And so we are doing the best we can on that. But I think that is why the high band came first and the high band has great benefits for us too.

The CHAIRMAN. Dr. Layton or Mr. Gibson, you want to weigh in?

Ms. LAYTON. OK. So what I would say, if you look at other countries that they don't have the military in this band or there is a lot less military. So we have the military taking precedence. That is one part of it. And you know, when we allocated these things however many decades ago, no one realized that there would be such a thing as 5G. So that is part of the importance of having market-based mechanisms because we can trade up all the time.

The CHAIRMAN. What are we not anticipating today in 2020?

Ms. LAYTON. Well, I would say our biggest blind spot is China and that is and you know this. You are deep into the security world and those challenges. To me it is not just the issue of the spectrum deployment, it is the whole ecosystem. Whereas China, in their command-and-control spectrum policy, they align all the national champions. They get the right spectrum, the national champions, and then they want to have all those things together. Now, they don't have the market-based system the way we do, but they are organizing themselves in that way to be able to roll out to the rest of the world.

Now, I want to compliment my friend Mr. Power who has talked about, we don't have to be China to beat China. What I think where we have held ourselves back is we have not let the market play the role that it should because it would quickly resolve these discrepancies and the best would come forward. So in the medium term, we are satisfying—we are doing it in a suboptimal way, but we would move much faster and more quickly if we would allow the market to work.

The CHAIRMAN. Mr. Gibson.

Mr. GIBSON. Chairman Wicker, that is a wonderful question. I would add one thing that my panelist may not have added is that we are probably leaders in the world in sharing spectrum. And so while I am not exactly sure of the motivations behind being fifth. You know, it is certainly a place you don't want to be but I think we have been leaders in sharing. As you heard in Mr. Calabrese's testimony about Citizens Broadband Radio Service and the applications of the brand new spectrum access systems. And in the 6 gigahertz band, we are embarking upon a sharing regime where we are going to be using something similar. So I think we have led the world in the ability to find ways to share spectrum without having to disrupt incumbents by relocating them.

Sharing spectrum is something that starts off difficult but ends up working overtime and you can see for example in the Citizens Broadband Radio Service the way we have been able to find ways to share with the existing incumbents, primarily the radar systems, is by deploying sensor networks. So that is a facile—well I wouldn't say it facile, but it is a way that we have established to share spectrum with systems that are radar systems that are very difficult to share with.

So, I think we've been able to apply United States, American ingenuity and technology to find ways to put spectrum to probably more efficient use and sharing. And so we think that is probably something to think about going forward.

The CHAIRMAN. Thank you very much. Senator Schatz.

Senator SCHATZ. Thank you, Mr. Chairman. I have a question for Mr. Calabrese and Mr. Powers about 5G. And you know, working with Senator Thune, Senator Wicker, Senator Cantwell, we are all trying to make sure that the United States is as successful as possible with 5G, but I just want to have a little bit of straight talk here. If there is not a business case for broadband connectivity in rural areas right now without subsidy, in what world do we think 5G pencils out in rural areas without subsidy? Mr. Calabrese.

Mr. CALABRESE. Yes, Senator. That is absolutely right. It is an important concern that actually we have a, you know, as we are seeing in that context of the pandemic, we have a horrible digital divide currently in a 4G world and there is the risk that as we go to 5G, that that divide just gets even wider. That it leaves some people in less densely populated areas and low income neighborhoods even further behind.

There is no question, I mean that, you know, Wall Street analysts, the recent GAO report that while indicated that the 5G has its promised right with gigabit throughput, a very low latency, connecting hundreds of devices—we don't have that yet but when we do, it is so expensive to deploy that it will only be deployed in the initial years in urban areas, maybe inner suburban, other high traffic venues, but it won't be out there in small towns and rural areas at all. And that is where Wi-Fi, the next generation of Wi-Fi is so critical because thanks to the FCC's recent order allowing shared access to the 6 gigahertz band, this new generation of Wi-Fi can deliver the same services.

The same—in fact, it can accelerate American leadership in 5G applications and services, gigabit fast, low latency, coordinating many devices, higher quality, but to every home, business, school, library that has a fast, fixed broadband connection. It just puts it over the air. It gets that gigabit distributed to every user in range.

Senator SCHATZ. Mr. Power.

Mr. POWER. Thank you. Senator. Without a doubt we need to see the benefits of 5G pushed out throughout the country. We are glad to see that 5G, as it currently exists, covers about two-thirds of the population today. Going forward, we do face the challenge of communities that are just not economically viable to serve. There is no disputing that. We are glad to see Chairman Pai moving ahead with his 5G fund which would allocate about $9 billion to help meet that challenge but we will look to that kind of support, I think, to make this work, and especially in the short term, as we

have seen since COVID, there are so many Americans now who do need a safety net just in the short term and then in the long term as well.

Senator SCHATZ. Thank you, and I will stay with you, Mr. Power. Let's talk a little bit about broadband mapping. How can the FCC and NTIA coordinate their broadband mapping efforts so that the funding is better targeted to people who remain unconnected. How do we get these maps to not just be more accurate but to inform some pretty expensive decisions that are pending?

Mr. POWER. Well, this has, obviously as you know Senator, been the challenge as of late. Congress acted with the help of this committee with the Broadband Data Act which the FCC has now implemented to set the parameters that will guide how these maps are collected.

It is a challenge, particular in the wireless side, given the physics of wireless technology with the signal when you get to the edge of the cell, but we are committed to working with this committee, with the FCC to make those maps as accurate as possible to make sure that the money that we are subsidizing is targeted to the communities most in need.

Senator SCHATZ. OK, thank you very much. Mr. Calabrese, my final question. I think you will agree that the FCC is currently using flawed or incomplete maps and they are about to award $16 billion, about 80 percent of the funds available through the rural digital opportunity fund for build-out in unserved areas, and I am trying to wrap my mind around why we would deploy almost all of the money in this fund before we actually know exactly where it is best spent and I am wondering if you can comment on that.

Mr. CALABRESE. Yes, Senator. I totally agree. I believe Commissioner Rosenworcel put it best when she is in her dissent to the RDOF order. You know, which said—she said we need mapping before money and data before deployment. And that is right. This is most—the lion share of the universal service funding is being committed for a 10-year period when for example U.S. Telecom and others in a mapping pilot found that 38 percent of homes in rural—homes and businesses in rural areas that the FCC had as covered in fact did not have broadband connectivity. And then in addition we are locked——

Senator SCHATZ. Could you say that one more time for the listening public? I think it is a really important fact.

Mr. CALABRESE. Right. Well that—just as one indicator of how flawed the mapping data is we have now U.S. Telecom and its partners in a pilot mapping pilot found that 38 percent of the homes and businesses that the FCC had as covered in rural areas in fact, you know, did not have broadband service. And so we are now in the process of blocking all those homes and businesses out of the Federal subsidy program for the next 10 years by dispensing all this money in a rush and doing it at speeds that are substandard, 25, 3 megabits per second up and down. That is just woefully inadequate for the future. And then it allows data caps. There is all kinds of problems with the RDOF program.

Senator SCHATZ. Yes. You know, my time is up, but I will just make one final comment on this. I know we have bipartisan agreement about the flawed nature of the maps, but the FCC itself has

become so polarized and partisanized under this Chairman that it is very difficult for Members on the other side of the aisle to be overtly critical of the actions of this Commission because it is seen as somehow a proxy for being critical of the President of the United States.

But the fact of the matter is these maps are garbage and we are about to deploy money, and as you said, lock almost 40 percent of rural Americans out of having any access to subsidy which means for the next decade they are not going to get broadband that they are entitled to because the Commissioner wants to push it out and the Congress is unwilling to put the pressure on the Commission to do the right thing. Thank you very much.

The CHAIRMAN. Senator Tester. We understand there are some technical difficulties. Can you hear us and are you ready to go?

STATEMENT OF HON. JON TESTER,
U.S. SENATOR FROM MONTANA

Senator TESTER. I can hear you and I appreciate that, Mr. Chairman. If I am allowed to go next, I would love to do that.

The CHAIRMAN. You are next and you are recognized, sir.

Senator TESTER. You are a gentleman and a scholar and I do not have a good clock in front of you so you could just gavel me down when time, Mr. Chairman.

The CHAIRMAN. You are looking a little pale today, John.

Senator TESTER. Yes, well a little fuzzy you might say. So, Mr. Calabrese, I want to continue on with you if I might and that is that in my neck of the woods, which is pretty damn rural, spectrum issues don't mean a whole lot to folks. What really means a lot to folks is when they pick up their cell phone and it either works or it doesn't work.

And I will tell you that where I am at, I will probably be liberal by saying 50 percent of the time the cell phone works, 50 percent of the time it doesn't. And it changes depending on how you hold your mouth or what direction—so what policy changes, what spectrum policy changes can we do, if any, to help close the digital divide to bring wireless coverage into rural areas? And this is for you, Mike.

Mr. CALABRESE. OK. Right. So one of course is you know, I have mentioned a big increase in unlicensed spectrum. And you know what we all think about and what I emphasized was, you know, indoor use for these new bandwidth hungry apps, you know, distributing that gigabit around the school or the home. But it is also very important in rural areas. All the, you know, more than 1,500 small wireless ISPs, almost all in rural areas, rely on unlicensed spectrum for high capacity fixed wireless, point-to-multipoint. It is about one-fifth to one-tenth the cost of springing fiber and so we can get broadband connectivity out in these rural areas much more quickly, but they rely on unlicensed spectrum. They need more capacity.

So this is—the 6 gigahertz is going to make a huge difference there. Second, there is lots of other underutilized spectrum that is not being used in particularly rural areas. So a whole big coalition of us, rural providers, high-tech consumer groups proposed that the Commission in the C-band allow use of a coordinated sharing of the

vacant C-band spectrum in rural areas, again, for this high-capacity fixed wireless.

And the Commission put it in its proposed rulemaking but did not act on it. And there are other bands, the 12 gigahertz band is another one where if the FCC moves forward with an NPRM, it can include a provision for coordinated sharing. And finally, I mentioned the Senators Schatz and Kennedy and others, the smart app and Chairman Thune has his own version of this, that would require auction, you know, take a share of the auction revenue and put it in a digital divide trust fund so that it could be—so that we could have more funding available to close the gap in these areas.

So—excuse me about the buzzer. So let's carry on then. What percentage of the spectrum from the auction proceeds should we devote to rural communication build out?

Mr. CALABRESE. Right, so, you know, with all respect to Chairman Thune I would say significantly more than 10 percent. Chairman Thune was on the right track, I believe, in making it about broader than just the C-band option. He said, you know, the proceeds from auctions over the next two years until the end of the FCC's auction authority period. So I think Congress should be looking at extending the auction authority and taking a share much larger than 10 percent of all auction revenue.

You know, that is how we—that is how we ceded First Net for example, auction revenue the incentive auction and elsewhere. So yes, I think definitely what we need to do is the monies being paid in these auctions to cover the more profitable, big urban and suburban areas, we need to recycle that money in the industry to cover the low income and particularly rural areas.

Senator TESTER. Do you have any sort of figure in that you'd be comfortable in pulling out as far as what should be dedicated to—and by the way, I don't think Chairman Thune would feel upset with that. He lives in a rural State. I think that he is the kind of guy that would love to see more money go into rural America.

Mr. CALABRESE. Yes, I would hope so. Well, you know, I certainly think at least 50 percent but you know really it is—you know, we see in the current crisis it is such a pressing problem. I mean broadband is a new electricity. And so whatever we need. Whatever it takes.

Senator TESTER. OK. Appreciate that perspective, Michael. Tom Power, I want to ask you the same question. What, do you think, what percentage of spectrum auction funds should be we devote for rural communications roll out? Mr. Tom Power.

Mr. POWER. Thank, Senator. I don't have a number at hand. You know, we certainly defer to you and the members of the Committee in Congress to figure out the best use of these proceeds. It is, as I said, essential if we are going to get out to these economically unviable areas. The industry, you know, invests $25 billion a year as it is, but as you have experienced and as we all have when we are out in rural areas, we need some help from the subsidy system.

And I will say having addressed this 10, 11 years ago when I was at NTIA under the Recovery Act, we found that there were—one of the secrets to success was the local organizations coming together to, you know, the bank, the school, the Mayor, and looking for the resources and then collaborating with the Government here

in Washington to make it happen. And that is what—we just need to double down on those efforts.

Senator TESTER. Well, I appreciate both of your comments on this. I can tell you that I live in an area where there isn't a lot of people and I can tell you the number of times I wanted to throw this thing through the wall is far more than I got fingers and I got less fingers than Wicker—and that is still a lot. It is because it is incredibly frustrating to try to do business when you are in the middle of town telling somebody what kind of part you need for your combine and the damn phone quits working.

And it happens more often than it doesn't. And so I really appreciate you guys' input and I really think that the revenue and doing our best to be able to try to meet the needs, as you guys presented them. So I always want to thank you very, very much. Thank you, Chairman Wicker.

Senator THUNE. Thank you, Senator Tester.

Senator TESTER. Chairman Thune, I stand corrected.

[Laughter.]

Senator THUNE. Sorry.

Senator TESTER. Sorry about that. That was——

[Laughter.]

Senator THUNE. No, but yes, I can hear your frustration and I am glad you are spending time on a combine. It actually probably feels like you are accomplishing something when you are sitting on a combine.

Senator TESTER. That is true.

Senator THUNE. Next up is Senator Blumenthal.

STATEMENT OF HON. RICHARD BLUMENTHAL, U.S. SENATOR FROM CONNECTICUT

Senator BLUMENTHAL. Thank you very, very much, Mr. Chairman, and I want to talk a little bit about Lifeline, about connectivity which for America should be a matter of bipartisan essential work. As you well know after Hurricane Katrina, the FCC took sweeping action to make sure that anybody affected by that disaster was connected. Within 1 month the FCC dedicated more than $200 million to fund connectivity efforts and very aggressively opened up Lifeline and E-Rate programs to new carriers and subscribers.

What I have been hearing in Connecticut and from my colleagues all over the country is that distance learning, efforts of unemployed to connect to jobs, all are hampered by the lack of connectivity. And I held a round table in Hartford with educators, our superintendent of schools, Mayor, parents, community groups, all of them crying out for more connectivity. We need a bold plan and leadership. Senator Wyden and I introduced the Emergency Broadband Connections Act along with 24 colleagues.

I led a letter with 26 of my Senate colleagues writing to Congressional leadership calling for $1 billion right away for Lifeline. I would hope and presume that all the members of this panel agree that Lifeline needs more funding during this crisis. Let me get from each of you an estimate of how much you think ought to be allotted to this program? Beginning with you, Mr. Power.

Mr. POWER. Thank you, Senator. Yes, well, we are very happy to be supportive of Senator Markey's bill. That is our getting $4 billion to augment the E-Rate program and we have also been discussing with members our program which is similar to your proposal. But you are absolutely right. I was happy to be a part of the original implementation of E-Rate twenty years ago and our members certainly support Senator Markey and your efforts to bolster Lifeline.

Senator BLUMENTHAL. Thank you. I will just go down the panel.

Mr. GIBSON. Yes, Senator Blumenthal, thank you for the question. I don't necessarily have the expertise to comment on how much but I suggest that based on your testimony it should be more. I haven't personally experienced, I don't live necessarily in a deep rural area, but I get my Internet through a wireless Internet service provider and while I have the means to pay for it, it is not cheap.

And the situation I have is my local, the local cable company is just as unwilling unless I spend something like $10,000 throwing cable out my way. So I certainly have a feeling and our company, you know, certainly have a feeling we, again as I said in my testimony, have really been trying to support rural broadband in the pandemic with some creative approaches with setting up access points and LTE backhaul. So we think that, I would defer to Mr. Power and others that have expertise in the amount, but I think I would agree it could be more.

Senator BLUMENTHAL. Thank you. Ms. Layton.

Ms. LAYTON. Senator, thank you for your commitment to the people of Connecticut. I think Lifeline actually needs to have major reform. I don't think that the model is working. What I would advocate, however, would be the participation of the Internet content providers, notably the video providers who provide 80 percent of the data that goes across the network. They are not participating today in the process. They make a lot of money. They are getting the benefits of users using the networks and they should be part of the funding.

Senator BLUMENTHAL. And our last panelist, Mr. Calabrese.

Mr. CALABRESE. Yes, Senator. Yes, my organization like the broader public interest community supports these bills, the Accessible Affordable Broadband Act, I believe it is called, and you know in the Senate HR2, in the House, which provide I believe somewhat more than $8 billion in emergency broadband relief, essentially a Lifeline supplement, you know, for the duration of the crisis.

And, you know that is certainly needed now along with, you know, what as Tom mentioned Senator Markey's proposal that I believe is also in that same bill for E-rate. You know, we need both of those and another $4 billion for E-rate. And I would also mention that we should be including both for now and for the long run more flexibility for E-rate so that school districts can decide for themselves the best use of these funds, the most cost-effective way to connect students at home.

Senator BLUMENTHAL. I agree completely on e-rate. I am a strong supporter of the Senator Markey's bill. We have these combined efforts. I am hopeful that the measure that my Republican colleagues will announce shortly for the next corona virus relief package will

include a necessary and robust commitment to broadband, whether it is through Lifeline, E-rate or any of the other programs that connect carriers and subscribers. And yes, there may be a need for reform but right now in all areas, not just rural areas, but all areas, there is a lack of connectivity which leads to the homework gap and the digital divide. So I feel strongly we need to move forward. Thank you very much to all the panelists.

Senator THUNE. Thank you, Senator Blumenthal.

Senator Moran.

STATEMENT OF HON. JERRY MORAN,
U.S. SENATOR FROM KANSAS

Senator MORAN. Mr. Chairman, thank you very much. Thank you to our panelists for being here and being present maybe is a better way of saying that. Let me direct this question to Mr. Power. In my role on this committee, but also is the Appropriations Chairman for CJS, I oversee the formal dispute resolution process stemming from U.S. interagency spectrum policy decisionmaking. It is my understanding that the FCC is the Federal agency with authority for managing all non-Federal Government spectrum while NTIA manages and assign spectrum holdings for the Federal agencies. Is that a fair assessment of the circumstance?

Mr. POWER. That is right, Senator.

Senator MORAN. Is there an existing formal process for agencies like the FCC and NTIA to resolve disputes revolving around spectrum policy determinations?

Mr. POWER. There is a memo of understanding between them. I don't think it is particularly detailed. I think it is more of an informal relationship that helps solve those problems.

Senator MORAN. Are these differences, when in determining U.S. input into international standard setting versus a general domestic spectrum determination, is there a difference?

Mr. POWER. Yes. So, you know on the international stage is the international telecommunication union, which is a subset of the U.N. that helps harmonize spectrum decisions worldwide. And so the State Department steps in to be the U.S. representative there and works within NTIA and the FCC to develop the U.S. position, and with industry, to develop the U.S. positions in advance of those international conferences.

Senator MORAN. So in the case of a dispute between NTIA and FCC, theoretical dispute, who reigns? Is there a third party that then steps in?

Mr. POWER. It is on the international context, it is the State Department that leads and is the convener of that mediation process and ultimately makes the decision when it is on the international stage.

Senator MORAN. Outside of the international setting, who is the dispute resolution authority between the NTIA and the FCC?

Mr. POWER. It is a shared responsibility, Senator. I think it can work well. I think it has worked well. We have obviously seen some challenges in the last couple of years, but I think greater collaboration and getting the engineers, the folks who know this stuff, in the room together and focused on the issues, I think that is the best way——

Senator MORAN. Do Federal agencies file comments? Do they provide testimony in front of the FCC on these kind of issues?

Mr. POWER.—it happens. You know, I am an alum of NTIA and our role, we thought, was to coordinate the agencies and have NTIA and the Administration speak with one voice to the FCC. I think the FCC needs to hear from one voice in a coordinated fashion, but there are exceptions to the rule.

Senator MORAN. Dr. Layton, is there a consequence to economic valuation of spectrum if an agency involved in these dispute resolution process tries to affect the policy changes outside that process? Does it set a precedent for future spectrum policies?

Ms. LAYTON. Yes.

Senator MORAN. Any further thoughts on that topic?

Ms. LAYTON. Well, we know the saying you give them an inch they take a yard. So I mean if you can get away with something——

Senator MORAN. That is—thank you for putting it in a way that I understand.

[Laughter.]

Ms. LAYTON. Obviously, I think pricing would bring a lot of—reduce the level of politics but failing that, I would encourage the Committee to look at the carrots and sticks that it has at its disposal. We talked about things today, the dashboards for the Federal use, report cards to grade the Federal agencies on how well they are using the spectrum, and I would also like my fellow people in the policy community, we can also do more work to look at the past disputes, test them, and see were the concerns actually realized. There is a lot of fights about interference, so we need to do more ex-post analyses. Every agency will come forth with a Y2K-like scenario that never comes to pass and we need to hold them accountable.

Senator MORAN. My assumption is that uncertainty and time delays causes spectrum to have less value or less interest in those who want to bid. Let me again ask Mr. Power, the 600 megahertz incentive auction and the broadcaster repack, I think that probably was a pretty good model. Congress demonstrated strong support for ensuring a smooth and safe transition by appropriating additional funds under their RAY BAUM's Act which I led with Senator Schatz.

And your wireless carrier members were also proactive in supporting the reallocation of broadcasters technically and financially. While there are still some broadcast stations that need to finalize their transition to a permanent channel, the effort has largely been a success to date. As such, can you walk us through some of the lessons that private industry and the FCC learned or maybe should have learned from the incentive auction and how those lessons can be applied in the future?

Mr. POWER. It has been a success. I think one of the great lessons from that is the confidence that Chairman Thune and others have expressed in the FCC as being the agency with the experts that can manage these processes. There were a lot of naysayers before that auction and particular with respect to the repacking process. It has proven to be quite successful and kudos to the FCC for that.

Senator MORAN. I found myself, Mr. Chairman, looking at the screen instead of the witnesses. I am sorry. I have been to football games in which I only look at the Jumbotron now, but it is nice to have you here in person and by virtual presence. Thank you.

Senator THUNE. And when you look at your screen, you see yourself.

[Laughter.]

Senator THUNE. Just as a quick follow-up, we are going to go to Senator Rosen next, but to Senator Moran's question on disputes. As policymakers are there areas in the process that we ought to consider changing in that dispute resolution process between commercial and Federal spectrum?

Ms. LAYTON. Can you ask the question one more time?

Senator THUNE. Well, he talked about the FCC and NTIA disputes, how those are resolved, and one deals with commercial loan, another deals with Federal spectrum. And I guess the question is, are there things that we ought to be doing as policymakers to change that process so that there is less confusion and less conflict?

Mr. POWER. I know from the industry side, one of the challenges we face is understanding how the Federal systems work and information sharing so that we can work around their systems and figure out how best to relocate or otherwise accommodate their systems. Oftentimes agencies are reluctant to share information with us and sometimes with good reason given some security concerns. But, if we could enhance the transparency of what is underlying the Federal systems and there are challenges, that could help.

Mr. GIBSON. And I would add to that too that two things, one is that I think so many refer to MOU that talks about how the interactions between the two agencies work. And while that may not be the purview of the Committee, it is 17 years old, so it might be worthwhile to go back and maybe put a process in place that that MOU is reviewed almost by design more frequently so that it is updated. And the other thing is I think the IRAC process as Mr. Power alluded to and Mr. Moran alluded to as well, is a little arcane and murky as well.

And we participated in it quite frequently in the work we do in some of the cross-boundary coordination between commercial and Federal systems. So those are probably two areas that could, as I said in my testimony, merit some revisiting and renewing.

Senator THUNE. I said——

Mr. CALABRESE. If I can, Senator——

Senator THUNE. Mr. Calabrese.

Mr. CALABRESE. I mentioned in my testimony several ways to improve that process and I believe it does begin as we have heard with updating the Memorandum of Understanding. Right now, it is very vague. It provides for a 15-day consultation period which is obviously too short and late. In reality, that does begin much earlier, but it needs to be more specific. There needs to be a specific process for escalating disagreement. So you begin with the engineers but it needs to go all the way up.

And perhaps the most important thing here is there needs to be a guiding and mediating effort at the White House level, a spectrum management team, for example, that was recommended by the President's Council of Advisors on Science and Technologies in

their report back in 2012 so that when these escalates, you have officials who are in the best position to distill what is the broader public interest on these disputes.

And finally the agencies need to be filing data in the FCC proceedings while they were actually happening instead of waiting until after the FCC has come to a tentative conclusion and then at the last minute raising objections and even then often being unwilling to provide engineering data.

Senator THUNE. OK. Great, thank you. And I said Senator Rosen is up next. Actually Senator Klobuchar is back. She was here earlier and she is up next.

Senator Klobuchar.

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

Senator KLOBUCHAR. Thank you very much. I have returned remotely, but it was great to hear all your testimony in person and thanks for holding this hearing Senator Thune and Senator Schatz. I know that there have been some questions from Senator Tester and others about rural areas and as Co-Chair of the Senate Broadband Caucus, I am very focused on this. We have got 42 million Americans lacking access to broadband. We have a real opportunity right now.

Senator Cramer and I have a bipartisan bill to work with our rural providers and we also have a bill that I am leading that has actually passed the House that Representative Clyburn has to invest in broadband. Maybe when I go over this, anything you haven't said yet about this Mr. Calabrese, but funding that should be used to expand broadband access in unserved or underserved communities.

In your testimony, you note that C-band spectrum is grossly underutilized and could be used to deploy more rural broadband. Could you talk about what more can be done as soon as possible given what we are seeing with the pandemic?

Mr. CALABRESE. Yes, so thank you, Senator. I noted earlier in case you didn't hear it that, you know, that Open Technology Institute and the broad public interest communities supports your accessible, affordable legislation, of course, the Emergency Broadband Funding, additional E-rate funding, and so on, specifically on rural what you mentioned about spectrum. Spectrum is a public resource owned by the people and what we need to think about is not just universal service subsidies, you know, money from taxpayers, but also spectrum as infrastructure.

I mentioned earlier there to Senator Tester that there are, for example, as you know, more than 1,500 small, mostly small wireless Internet service providers in rural areas primarily, but also all kinds of other providers increasingly use fixed wireless to reach these areas at much lower cost than fiber. And what they rely on primarily is unlicensed spectrum.

And so the 6 gigahertz Order the Commission adopted in April is critical to that by really expanding the bandwidth, but even beyond that what we need to do is identify these underutilized bands such as C-band, 12 gigahertz, and so on, and allow coordinated shared access where that spectrum is vacant.

Senator KLOBUCHAR. Yes. I see Senator Fischer remotely there and she and I actually got something signed into law in 2018 on this and I just cannot emphasize how much to my colleagues we need to do something. One last quick question on 911. I do a lot of work in that area with law enforcement and the need for upgrades with 911 in light of our whole new system was set up of course before everyone had cell phones and everyone could send pictures of burning buildings to fire department so that they know what the floor plan is before they go in and risk their lives. Can you speak to how funding from spectrum of options can support the deployment of 911?

Mr. CALABRESE. Yes, you know, I believe that what we should be doing for that purpose for rural broadband for adoption in low-income areas is actually capturing the share of auction revenue and dedicating it to a digital divide trust fund that can be used for a number of purposes including that one. And so we have supported the Smart Act, for example, with Senator Schatz and others introduced, you know, that would take C-band auction revenue and I deal with you larger share of it including by reducing the incentive payments and put it to that use and others.

Senator KLOBUCHAR. OK. One last question. You can take this or maybe one of our other witnesses and that is, underserved communities, which of course includes minority communities as rural areas, but it also includes tribes and they have been hit particularly hard by the pandemic and they need equitable access to spectrum.

In May, Senator Heinrich and 16 of us sent a letter urging the FCC to extend the rural tribal priority window period for tribes to complete their applications for spectrum for wireless broadband increase for mobile coverage. Could you or any of the other witnesses talk about why it is important to support this extension period to help tribes access unused spectrum?

Mr. CALABRESE. Yes, I can. I mentioned at the end of my opening Statement that the tribal priority window closes on August 3, and because of the crisis, the tribal areas have not had time to really—have not had the opportunity to make the assessment in the application. And so that definitely needs to be extended. This is for the 2.5 gigahertz spectrum which schools have license for educational broadcast spectrum.

So before there is an option of what remains, we need to give tribal, rural tribal areas a fair opportunity to apply for that spectrum because really they need—their coverage is terrible and they need a lower cost way to build out wireless.

Senator KLOBUCHAR. All right. Thank you very much. And thank you to the rest of the witnesses.

Senator THUNE. Thank you, Senator Klobuchar. Senator Fischer is up next. Also joins us virtually.

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

Senator FISCHER. Thank you, Mr. Chairman. I appreciate you having this important hearing today. Achieving more efficient use of our Federal spectrum is critical. While recognizing the continued importance of exclusive licensing, we must keep in mind certain

spectrum bands that are mission critical and Federal users who cannot vacate a specific band entirely.

Our spectrum policies need to be adaptable to accommodate these circumstances. The Citizens Broadband Radio Service has been a major step forward for spectrum sharing system on this front given the significant partnership among the FCC, the NTIA, DOD, and commercial entities. Mr. Gibson, in terms of the broader implications on U.S. spectrum policy, what do you believe worked particularly well in developing the CBRS framework?

Mr. GIBSON. Thank you, Senator Fischer. That is a very good question. I would say that probably the thing that worked best was collaboration among stakeholders. We went into this and actually we had some experience from AWS–3, which was probably preceded CBRS by about at least 5 years.

And again, that was thanks to the leadership of NTIA and FCC where we got together between commercial users and Federal users and got to know each other, and we weren't so scary and we were able to work things out into AWS–3. So we took that experience into CBRS, and thanks to the leadership of people like Fred Moorefield and Tom Taylor and others in the Department of Defense, we were able to get together and hash through a lot of very complex issues and it was ongoing.

So I would say probably the major thing that we were able to work through that is successful for CBRS is the ability to collect to collaborate among the Federal users. And we think it sets up a framework going forward. Thank you.

Senator FISCHER. If I could follow up with you, thinking of the technologies that have really evolved to support spectrum sharing and new device operations without having to move incumbents, what other examples do you feel are the most promising on this front?

Mr. GIBSON. Thank you. I would say the next thing in the pipeline is the automatic frequency coordinating aspect in 6 gigahertz. That band, and I think you have heard some folks allude to it today, was just reallocated for unlicensed use but there are still about 50,000 microwave systems that operate in those bands that use about four hundred and some odd thousand frequencies.

So the automated frequency coordinating system is a way to allow unlicensed operation around the microwave system so they don't cause interference. And it is built on CBRS and some other things that we have worked on in spectrum sharing paradigms. And so we think that that is sort of a good evolution of how we can take spectrum sharing sort of into the 21st century.

Senator FISCHER. Thank you. Mr. Calabrese, as you noted in your testimony, the demand for spectrum capacity will grow as the Internet of Things continues to develop. Estimates predict there will be over 125 billion devices that will be connected to the Internet by 2030.

And as we all know, we are going to need a robust portfolio of licensed and unlicensed spectrum to support industrial and commercial IoT to develop deployment. Given the private LTE capabilities enabled by the CBRS, how will this create added resources for IoT connectivity, particularly with the spotted coverage in buildings for IoT devices?

Mr. CALABRESE. Yes, actually that was one of the great innovations of CBRS was the notion that our policy for the licensed spectrum previously had been mostly about wide area coverage for cell phones and mobile broadband for consumers, but, as IoT emerges, what is increasingly important is giving building owners, factories, ports, schools, campuses, direct access to the airwaves so that they can connect their own networks and customize their own networks or hire third-party integrators to do so.

So CBRS is part of that effort, I believe, conscious effort by the FCC and now other countries following us, the UK, Germany, to make spectrum, low power spectrum like this available directly to users, enterprise users on a local basis. And so they can choose by doing, you know, something like private LTE on CBRS or now, thanks to the FCC's order on April, there is so much more unlicensed capacity, very high capacity unlicensed that can be used in 6 gigahertz for the same purpose. So this is really going to spur innovation in IoT and private networks.

Senator FISCHER. Thank you. Thank you, Mr. Chairman.

Senator THUNE. Thank you, Senator Fischer. Next up joining us also remotely is Senator Rosen.

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

Senator ROSEN. Thank you, Chairman Thune, Ranking Member Schatz, all the witnesses for being here today. I would like to build upon Senator Klobuchar's question on the tribal window extension.

And so I would like to submit for the record a letter from the National Congress of American Indians, the American Library Association, the National Hispanic Media Coalition, and relevant stakeholders requesting that the FCC extend the 2.5 gigahertz rural tribal priority window deadline.

With tribes dealing with the impact of the current virus pandemic, extending this window gives tribes such as the Duck Valley Indian Colony and Pyramid Lake tribes time and opportunity to access unused spectrum to connect to the internet. We will send that over to you, Mr. Chairman.

Senator THUNE. Without objection.

[The information referred to follows:]

July 23, 2020

Senator JOHN THUNE,
United States Senate SD–511,
Washington, DC.

Senator BRIAN SCHATZ,
722 Hart Senate Office Building,
Washington, DC.

RE: EXTENDING THE 2.5 GHZ RURAL TRIBAL PRIORITY WINDOW

Dear Chairman Thune and Ranking Member Schatz,

Attached please find a letter signed by 48 organizations including Tribal organizations, broadband providers, digital inclusion advocates, and others supporting broadband access for all, in support of the Motion to extend the deadline for the 2.5 GHz Rural Tribal Priority Window, filed by the National Congress of American Indians (NCAI), Southern California Tribal Chairmen's Association (SCTCA), AMERIND Risk Management, and Public Knowledge. The Motion supported by these nearly 50 organizations asks the Federal Communications Commission (FCC)

to extend the deadline for eligible federally-recognized Tribes to file applications for 5G spectrum licenses on Tribal lands.

At the moment, the Tribal Priority Window is scheduled to close on August 3, 2020. Unfortunately, because of the pandemic, hundreds of eligible Tribes will not be able to meet this deadline. Unless the FCC acts to extend the deadline, ***more than 80 percent*** of eligible Tribes will be foreclosed from applying for this one-time opportunity to receive critical spectrum licenses necessary for providing broadband services to Native American reservations, Alaskan Native villages, and Native Hawaiian communities.

As you are both aware, Native American communities have suffered terribly as a result of the pandemic. It would be cruel for eligible Tribes to lose this unique opportunity to receive spectrum licenses that will enable them to provide broadband to their people. As Chairman Pallone observed at the recent hearing on the impact of COVID–19 on Native Americans, "Tribes deserve better."

We therefore ask you to include this letter in the record of this morning's hearing, "The State of U.S. Spectrum Policy." We also ask that you and your colleagues support the request of NCAI, SCTCA, and nearly 50 other organizations to extend the deadline of the 2.5 GHz Rural Tribal Priority Window to February 1, 2021. This will give hundreds of federally-recognized Native Americans, Native Alaskans, and Native Hawaiians a genuine opportunity to provide 5G broadband for themselves, and to exercise sovereignty over their digital future.

Sincerely,

/X/ HAROLD FELD,
Senior Vice President,
Public Knowledge.

July 23, 2020

Marlene H. Dortch,
Secretary, Federal Communications Commission,
Washington, DC.

RE: RURAL TRIBAL PRIORITY WINDOW, TRANSFORMING THE 2.5 GHZ BAND, WT DOCKET 18–120

Dear Secretary Dortch,

The undersigned groups write to express support for the National Congress of American Indians, *et al.,* in urging the Federal Communications Commission to adopt an "Emergency Motion for Stay of the 2.5 GHz Rural Tribal Priority Window." Doing so would extend the application deadline for 182 days due to the significant impact the COVID–19 crisis has had on American Indian Tribes, Native Hawaiian communities, and Alaska Native villages across the Nation.

As the Federal Communications Commission itself has declared, broadband is needed "for every facet of daily life." However, less than half of housing units on rural Tribal lands have access to broadband. In order to ensure "meaningful access" to communications services for underserved Tribes, the FCC created the Rural Tribal Priority Window, which allows Tribes to apply for free spectrum in the 2.5 GHz band in order to deploy wireless broadband on their lands. Unfortunately, approximately 80 percent of eligible Tribes will not be able to take advantage of this spectrum unless the FCC extends the deadline.

Despite the promise of this opportunity for Tribal communities, Tribes have faced significant hurdles to finishing their applications on time due to the COVID–19 crisis. Many Tribes lack the expertise to navigate the FCC application process and the vast majority of application workshops intended to help them were cancelled, as were other forms of in-person outreach. An informal review by MuralNet estimates that 20 percent of applications already submitted will need to be amended or are missing necessary filings. This is particularly troubling as the FCC has made it clear the agency will not allow any major application amendments after the deadline, essentially eliminating a Tribe's opportunity to correct any mistakes.

Moreover, the global pandemic has delayed work on the applications and Tribal decision-making because many people have been incapacitated by the COVID–19 virus. Those able to work must generally do so from home—often *without the very broadband access the application is meant to provide.* We cannot expect Tribes to complete work that requires broadband when they don't have broadband.

By refusing to extend the Rural Tribal Priority Window, the FCC will prevent the vast majority of eligible Tribes from accessing this once-in-a-lifetime opportunity—due to circumstances wholly outside of Tribal control. The FCC will also fail to achieve its own policy goals of promoting Tribal connectivity. Extending the 2.5 GHz

Rural Tribal Priority Window is one small way the FCC can fulfill its commitment to Tribes. Doing so is the first step to addressing the inequities of this underserved population, giving Tribes, Native Hawaiian communities, and Alaska Native villages an actual chance to secure broadband access for their communities.

Sincerely,

Access Humboldt Access Now
Advocates for Indigenous California Language Survival
Alliance for California Traditional Arts
AMERIND Critical Infrastructure
AMERIND Risk
Asian Americans Advancing Justice (AAJC)
Benton Institute for Broadband & Society*
California Center for Rural Policy
Center for Rural Strategies
Common Cause
Common Sense
Community Informatics Lab at Simmons University
Department of Public Transformation
Environmental Defense Fund
Fight for the Future
First Nations Development Institute
Free Press
Friends of Buckingham
Global Force for Healing
Heart of the Rockies Initiative
INCOMPAS
Institute for Local Self-Reliance
Internet Society
Kentucky Resources Council, Inc.
Long Beach Gray Panthers
Media Alliance
Merit Network, Inc.
Mobile Beacon
National Digital Inclusion Alliance
National Hispanic Media Coalition
Native American Finance Officers Association (NAFOA)
Native Public Media
New America's Open Technology Institute
New Mexico Public Education Department
NTEN
Public Knowledge
Reis Foundation
San Gabriel Unitarian Universalist Fellowship
Schools, Health & Libraries Broadband (SHLB) Coalition
TechSoup
The National Tribal Telecommunications Association
Tiwahe Foundation
United Church of Christ, OC Inc.
United Methodist Church
Voqual
Washington State University (WSU) Extension
X-Lab

Senator ROSEN. Thank you. I would like to speak now, my question on the lack of a national 5G strategy. You know, I represent the great State of Nevada and so whether it is the self-driving cars that ride along the Las Vegas strip, the drones that are taking flight over the City of Reno, we host the largest technology show in the world. Of course in Las Vegas as well. Nevada, we are at the forefront of innovation.

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*These comments reflect the institutional view of the Benton Institute for Broadband & Society, and, unless obvious from the text, is not intended to reflect the views of its individual officers, directors, or advisors.

And in order to continue that momentum, bring about advancements in transportation, healthcare, and communications, we need a national 5G strategy just like we know we need a national coronavirus pandemic strategy. But with its low latency and high bandwidth, 5G has the power to transform our national economy and Nevada's economy at a time when we really need it.

Just as 4G ushered in smartphones, 5G will make what we consider futuristic, autonomous vehicles, advanced robotics, remote surgeries a reality. The transition from 4 to 5G will require close coordination and cooperation among Federal agencies tasked with managing our national airwaves, but there has been recent disagreements between Federal agencies and how to proceed on key spectrum decisions and they have left some to question why we lack a unified voice or vision on this issue.

So to everyone on the panel, what benefits would such a strategy provide and why is having a national strategy rather than 51 state strategies important? So let's begin with Mr. Calabrese and we can go down line to Mr. Power, Mr. Gibson, and Dr. Layton, please.

Mr. CALABRESE. OK. Thank you, Senator. That is a very, very important question. So we you know, I would say first that the FCC has a 5G spectrum strategy. If you want to get the 5G fast plan, which is basically about pushing out as much spectrum as possible, mid band and high band for both licensed and unlicensed, but you are correct that beyond the FCC's spectrum strategy for 5G, there is no National 5G policy or strategy that really is looking at, OK, how are we going to get it?

You know, make sure it is available everywhere for what is most important, and also to resolve some of these conflicts between the FCC and different agencies. And one suggestion I have is that really we need—the White House, at the White House level we need to engage. Leadership needs to engage much more directly first putting out a strategy with clear priorities so that all the Federal agencies are going in the same direction and then there needs to be some type of spectrum management team in the Executive Office of the President that resolves these disputes and make sure that they are following a broader National strategy and National interest.

Senator ROSEN. Thank you. Mr. Power, would you like to briefly make a comment how 50-state overarching strategy could help us be more effective here?

Mr. POWER. Certainly. Thank you, Senator. We certainly need this to be handled at the Federal level. That is the role of the FCC when it comes to deploying commercial spectrum and there are a myriad reasons for that but a big one, of course, is that the Federal Government sits on a lot of the spectrum, most of the spectrum, and we need to work with the Defense Department and the other agencies to free that up.

And this committee has done so much historically to ensure the rollout of spectrum. We are going to have the auction starting today, another auction in December, and then there is one more auction scheduled for 2024. But beyond that we don't have a pipeline and this committee could do a great service to the Nation to help with 5G deployment by helping to develop a longer-term spectrum pipeline for the advancement of 5G.

Senator ROSEN. I believe I just about ran out of time. So I thank you for your comments. I will submit questions for the record. I just want to be sure that the U.S. doesn't lose ground in the race to 5G. That is really going to hurt us going forward. Thank you, Mr. Chairman.

Senator THUNE. Thank you, Senator Rosen. And now virtually is Senator Blackburn on. Senator Blackburn. If not, I believe Senator Capito is ready to ask questions.

Senator Capito.

[No response.]

Senator THUNE. All right, Senator Lee.

STATEMENT OF HON. MIKE LEE,
U.S. SENATOR FROM UTAH

Senator LEE. Thank you, Mr. Chairman. I am really glad that we are having this hearing. I am also very glad that the FCC is working to conduct auctions on the C-band and CBRS for 5G networks. This is a good thing. Mr. Power, is our commercial spectrum pipeline nearing depletion, and can we really afford to wait to identify new bands?

Mr. POWER. It is nearing depletion and now is the time to act, Senator. Agree.

Senator LEE. I couldn't agree more. We can't afford to wait. Dr. Layton, the Federal Government owns a lot of spectrum and doesn't necessarily operate everything efficiently. The Federal Government is known for many things, efficiency isn't always one of them. And it is understandable. This is a biggest organization that exists on planet Earth. Can we win our 5G race with China if we refuse to include Federal agency bands in our analysis of our Nation's spectrum inventory as we assess that inventory?

Ms. LAYTON. No.

Senator LEE. We can't do it. It can't be done without evaluating that. So we will lose to China if we don't do that.

Ms. LAYTON. Yes.

Senator LEE. OK. Thank you. I appreciate that. Do you agree that the opportunity cost data would help us identify bands that have inefficiencies in them and that this could help us replenish our spectrum pipeline?

Ms. LAYTON. Yes, and I applaud the bill that you have put forth to get at this information. I think it is critical.

Senator LEE. Thank you. I appreciate that. The bill that she is referring to of course is my bill, the Government Spectrum Evaluation Act, to help us identify the true opportunity costs that are associated with sitting on that and not doing other things with it. It is not the case, it can never be assumed to be the case that the Federal Government is omnipotent and omniscient, that it knows everything it is supposed to do including with broadband. Given how much beachfront property the Government owns, we shouldn't be insulating the Government from that kind of evaluation. Mr. Power, do you agree with Dr. Layton's assessment?

Mr. POWER. I certainly do and I think one of the other advantages of your Act, Senator, is that it could provide incentives to the agencies. Because the way the spectrum relocation fund works is when they give up spectrum, some of that revenue can go back to

the agencies to upgrade their systems. And members of this committee are working on improving that process as well. And so I think with the agencies themselves are educated as to the value of their spectrum, they may actually wake up and see some opportunities.

Senator LEE. That is a fantastic point. I am glad you raised that. Dr. Layton, do you agree that insulating Federal spectrum bands from analysis, in addition to causing other problems in the commercial space, it also probably causes greater inefficiencies and it precludes other opportunities within the Federal bands?

Ms. LAYTON. That is absolutely the case. I think that because the various agencies have not been operating with the same market restraints, that they haven't made the best decisions in their own technology. They are incentivized to make inefficient decisions.

Senator LEE. So all of these things considered, can we afford to wait 10 years to make spectrum decisions?

Ms. LAYTON. No.

Senator LEE. And does waiting longer, sort of, indicate that we have got a broken decisionmaking process?

Ms. LAYTON. Yes. I mean, there should be ways to make the agencies feel the pain of the opportunity cost.

Senator LEE. Dr. Layton, in your testimony you discuss common law property rights related to spectrum and to the emergence of the secondary market. Do you have any recommendations for how Congress could reform our current spectrum secondary market and push an allocation process that is more market-based?

Ms. LAYTON. So, you know, obviously I would like the full privatization, but failing that, to look at a pricing regime. The United Kingdom started pricing for Federal agencies in 2007 where they actually would require police, different Government agencies pay for the rights that they use. So that has been started in some places. It creates accountability and respecting, using the resources better. So what has worked in the FCC, I think it could also work for Federal spectrum.

Senator LEE. And the costs of not doing that would be what?

Ms. LAYTON. Well, I mean if anyone believes that 4G has mattered to the United States, what would our world—what would America be like if we didn't have 4G? So I think it could be catastrophic. We are assuming the future of our Nation will be built upon wireless technologies. So we should be all in on doing this.

Senator LEE. Right. And finally, the jump from 4G to 5G is not just the incremental step that the number would represent, right? Isn't it almost the difference between pong on the original video game consoles?

Ms. LAYTON. Right. It is a stepwise function. What we are talking about is industrial applications not just being able to, you know, get all of your information through the air, all of your video content, but we are talking about entire new industries, right, where we put the, you know, the energy industry online, we put all of the cities online, we put all of our education and health, reinvent all of our industries. So that is what we mean with 5G and it shouldn't be stopping with 5G. I mean we should be going to 6G and so on.

Senator LEE. But to get there we have got to have spectrum. To have spectrum, we have got to evaluate what we have got. And to do that, we have got to review Federal allocations.

Ms. LAYTON. And we need your bill.

Senator LEE. Thank you very much. I appreciate you saying that and it is good to have the Chairman and the Whip here to hear that. Thank you.

[Laughter.]

Senator THUNE. Well played, the Senator from Utah. Senator—I am going to give—Senator Blackburn, are you there?

Senator Blackburn.

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

Senator BLACKBURN. Yes. Yes, I am here.

Senator THUNE. All right. Senator Blackburn, you are up.

Senator BLACKBURN. Yes. Thank you, Mr. Chairman. I appreciate so much that we are having this today and to our witnesses, I want to say thank you so much for being here to talk about spectrum policy. And in our office, we talked a little bit about how appropriate it is that we are having this hearing today as the bidding begins on the Citizens Broadband Radio Service auctioning off priority access licenses to support our 5G infrastructure.

And of course, I appreciate hearing the comments about that. And we all know and appreciate that this CBRS auction is a little bit different of a template than our previous efforts. And I am going to be watching this very closely to see if we can determine if this is the right model that we need to be following. And one thing I will say, having done a virtual town hall meeting with Johnson County, Tennessee this morning is that the pandemic and the need to utilize telehealth and then as children are going back to school, the fact that systems have to have both a policy for remote learning and well as in class learning and shared time learning, they have got to have that in place and we have really seen via the pandemic the digital divide.

And the fact that we still have Tennessee communities that are completely without access to high-speed internet. And our—they are not even able to—they are still on dial-up or they have nothing at all. And in this County I talked to this morning, 58.6 percent of the households have a subscription. They have taken the service and of course it is available to more but still we are looking at lagging and we have to speed up these efforts as we look at and as the developed world looks at 5G spectrum assignment.

So I would like to hear from each of you very quickly. If you just comment on the potential deployment delays or economic implications of the U.S. going our own way with spectrum allocation rather than assigning similar mid band spectrum as our international partners for next-generation mobile broadband? And so just start down the dais there.

Mr. POWER. Thank you, Senator. You know, I can't help but notice, as today is the opening of the CBRS auction, it is also opening day of Major League Baseball and they are playing under different rules and we don't know how it is going to go. And I think the same is true of the CBRS auction. Our members are participating.

We are going to jump in with both feet, but it is untested and it is not what the rest of the world is doing with this band of spectrum.

And among other things, it limits the power levels of the wireless carriers to about one-seventh of the power that they are used to using in nother bands. And when we talk about trying to build out past the urban areas into the suburban and into the rural areas, that presents a challenge. But we are we participating in it.

We are hopeful that it does bring some successes but it does make us, sort of, the outlier in terms of mid-band and how this committee can really help is to restart the spectrum pipeline that Senator Lee was talking about because with this auction in the C-band auction in December, we will be just about at the end. So we will be happy to work with you and the other members of the Committee to develop the next pipeline to get us through the next few years.

Mr. GIBSON. And thank you, Senator Blackburn. This is Mr. Gibson. I think the question is profound, but I think there are more people that are going to be bidding in this auction than have ever been to an auction before. So that is 271 people. So the likelihood of putting spectrum in the hands of a lot of people are going to put it to use is high here, which is not to say that spectrum changes will follow in auctions, but they are going to be, at the end of the day, some twenty some thousand licenses that will be let.

And so while that may be an outlier on the international stage, the United States, you know is different in some regards and it is important to you know, again have, you know, real connectivity based on what we have been hearing. And you know, we see lots of opportunity in the auction on a countywide basis. Obviously, we have interests in the spectrum access system that we are going to be developing to support that so we don't see any issues.

Senator BLACKBURN. OK.

Ms. LAYTON. I will be quick, Senator Blackburn. And just to thank you for all your leadership. You are such a champion on 5G and so many digital tech policy issues. I am concerned we are too little too late. I mean as Mr. Gibson pointed out, 8 years to get 70 megahertz for CBRS is too long. It is not enough. Even the power levels. It is a question about what we can do. All the same, I am delighted. I think it is symbolic. It is important tons of people will learn a lot from it, but we need a lot more. We have to just add another two zeros to everything we are doing. We are dancing around Federal holdings. We have to take the bull by the horns, and you have been such a champion about that. Thank you.

Senator BLACKBURN. Thank you. Mr. Calabrese.

Mr. CALABRESE. Yes, I would just note that as far as you know 3 gigahertz, this 3 gigahertz spectrum as well as a spectrum just below it, we are just simply in a very different situation in other countries because this is military radar spectrum and the judgment—I am not sure if it was correct but the judgment was that it would be too expensive and take too long for the Navy, for example, to replace its radar systems and move to a different band if another band could be found.

And so the FCC really made the best of it in an incredibly productive way by, although it is lower power, the spectrum will be

available to many new parties, you know, who will be coming in to do private LTE and more localized networks and innovation. So in fact now Europe is copying us in this respect of making spectrum on a more localized basis, small licenses available to more parties directly.

Senator BLACKBURN. Well, I think we all can agree and my time has expired, but I think we can all agree whether we are talking about remote learning or telehealth or transactional lifestyle, remote working, or we are talking about great power competition, we have to get spectrum policy right and we have to get the deployment right and we want to be able to keep the standard setting with us and not have the Chinese take the lead in this. So it is imperative that we do this right. I appreciate each of you sharing your knowledge with us today. Thank you so much. I yield back, Mr. Chairman.

Senator THUNE. Thank you, Senator Blackburn.

Senator Wicker.

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

The CHAIRMAN. Mr. Chairman, I had an Opening Statement prepared and I ask that it be inserted into this morning's record at the appropriate time following other opening statements.

Senator THUNE. Without objection.

[The information referred to was not available at time of printing.]

The CHAIRMAN. Now, let me ask, follow up on something that Senator Schatz mentioned and I will begin with you, Mr. Calabrese, but I want all of the panelists to weigh in on this. It was mentioned that Commissioner Rosenworcel in a previous hearing had decried the inaccuracy of maps with regard to the RDOF. Now, it is my understanding that there are a number of criteria in place to make sure that RDOF funds go only to locations where there is no service at all.

So help me out on this. Our complaint with the maps actually has been that they tended to overstate the coverage and say there was indeed adequate coverage where in fact there is none. Mr. Calabrese, there is no question that the RDOF funds will go where there is no coverage. And second, you are not suggesting or is anybody suggesting that we postpone the RDOF in order to get the maps absolutely right across the country? The complaint I have had is that RDOF is not happening soon enough.

If we could move it earlier than October, people would like for us to do that. So are you suggesting in your answer to Senator Schatz's question that the RDOF should be postponed until we get the maps completely right? And are you suggesting that RDOF money is going to go where there is already coverage?

Mr. CALABRESE. Right. Thank you, Senator. No, I am not suggesting that it should be postponed entirely although it should be phased so that a larger share of the total money available over the next 10 years can be distributed with the knowledge of all the areas that are unserved. So you are correct that in this first round, roughly $16 billion out of the $20 billion over the next 10 years will be prioritized unserved areas.

But as I mentioned earlier, industry mapping pilots have found that on the order of 38 percent of homes and businesses that the FCC marked as covered, do not have coverage and so they won't be considered. And really we need to be considering all the unserved areas before we give out the lion's share of the funds. So, certainly they should go ahead with the first two or three years? worth of funding but if Congress can move quickly to fund better mapping, that a year from now we could be distributing the remainder.

The CHAIRMAN. Well, I think everyone in Congress and on this committee would be in favor of coming up with additional funds because the $16 billion is not going to be nearly enough. But do members of the panel wish to comment? And Dr. Layton, you have your hand up.

Ms. LAYTON. First, I want to thank you. You have worked so hard on this issue to get at what to do about mapping. So thank you for that first of all. I would just say that good data can frequently cost money, but we should also recall, in 2010 I remember NTIA had something on the order of $100 billion to make a national broadband map. That money ran out and 2014.

The map wasn't updated. So some notion that this has been a perennial problem and I am pleased to see that presently under Chairman Pai, we have at least seen industry to try to come forward through U.S. Telecom to try to find a long-term solution.

I know they are still working through that. So it is just to say, it is a challenge, but I think you are correct to describe that this committee is trying to resolve it.

The CHAIRMAN. Other people want to jump in on that? Should we postpone the RDOF or should we go ahead with the RDOF as it is currently constituted and authorized?

Mr. POWER. Yes, folks without broadband need broadband and their COVID environment has exacerbated those challenges so we need to get moving.

Mr. GIBSON. And I would agree. We shouldn't let the perfect be the enemy of the adequate. So I would say get going.

The CHAIRMAN. Let's get started as soon as we can in this build on that. Mr. Calabrese, let me ask you, you have on page 14 of your written testimony, you mention OTI as we as the Competitive Carriers Association, and INCOMPASS and other parties have urged FCC to launch a rulemaking to consider a petition filed four years by that Dish and other terrestrial licensees in the 12 gigahertz band. Why is this important and could you elaborate about why you wanted to include that in your testimony?

Mr. CALABRESE. Thank you, Senator. Yes, we filed, as you said, along with many other parties in support for the Commission to move forward based on a petition filed 4 years ago by Dish and others who won terrestrial licenses at an auction, but they are very limited. They are one way and an extremely low power. They are looking for flexible use right since this is 500 continuous megahertz of spectrum that although it is up to 12 gigahertz, is much, much better propagation than the high band spectrum that begins at 24 gigahertz roughly.

So this is great 5G spectrum, potentially, and so we think the FCC should launch to open a Notice of Rulemaking and not nec-

essarily have, you know a set outcome, but here build a record because there are other considerations here including the fact that some of the small satellite constellation, SpaceX in particular, has rights and is beginning to use this band.

And we also proposed that this will be great for rural areas because since even flexible use rights will probably need to be at a lower power and it will be used primarily at least initially more in urban areas, that the Commission should also allow rural broadband providers to coordinate shared use of this spectrum in less densely populated areas to enhance fixed wireless broadband offerings.

The CHAIRMAN. Thank you very much. And Mr. Chairman, thank you for indulging me on the time. I think this has been a particularly informative subcommittee hearing so thank you, sir.

Senator THUNE. Thank you, Senator Wicker. I am going to, without objection, insert a letter from the Competitive Carriers Association into the hearing record as well and we will wrap it here in just a couple of minutes.

[The information referred to follows:]

COMPETITIVE CARRIERS ASSOCIATION
July 23, 2020, Washington, DC

Hon. JOHN THUNE,
Chairman,
U.S. Senate Committee on Commerce, Science, & Transportation,
Subcommittee on Communications, Technology, Innovation, and the Internet,
Washington, DC.

Hon. BRIAN SCHATZ,
Ranking Member,
U.S. Senate Committee on Commerce, Science, & Transportation,
Subcommittee on Communications, Technology, Innovation, and the Internet,
Washington, DC.

Dear Chairman Thune and Ranking Member Schatz:

Competitive Carriers Association ("CCA")[1] thanks the Subcommittee for holding today's hearing on "The State of U.S. Spectrum Policy" and respectfully requests that this letter be included in the hearing record. Clear and consistent spectrum management policies drive significant economic activity and support an ever-growing array of wireless services. As today's hearing reviews the role of the Federal Communication Commission ("FCC") in spectrum management, CCA strongly supports continued direction from Congress that the FCC remains the agency of jurisdiction in commercial spectrum policy.

For wireless technologies to benefit all consumers across the U.S., regardless of where they live, work, or travel, it is imperative that the Federal government work together to provide commercial access to low-, mid-, and high-band spectrum. These finite resources are key ingredients to fueling innovation and satisfying the ever-surging demand for mobile data and will be even more important as carriers work to deliver the connectivity promised by 5G networks. As our Nation's airwaves grow increasingly crowded, commercial spectrum policies must remain based on science and nonpolitical, and the FCC has been effective at developing and implementing these policies precisely because it has been driven by science rather than politics.

FCC leadership on commercial spectrum management has greatly benefited our Nation. Not only does the United States lead the world in wireless services, but FCC-led spectrum auctions have generated over $120,000,000,000 in net winning bids, to the benefit of taxpayers. Continued success from future spectrum auctions depends on the bidders' trust that they can put licenses won at auction to use based on the service rules and underlying spectrum management policies established by the FCC. Trust in FCC analysis is also critical to meeting the policy goals to use spectrum "as efficiently and effectively as possible to help meet our economic, na-

[1] CCA is the Nation's leading association for competitive wireless providers and stakeholders across the United States. Members range from small, rural carriers serving fewer than 5,000 customers to regional and nationwide providers serving millions of customers, as well as vendors and suppliers that provide products and services throughout the wireless communications ecosystem. Visit *www.ccamobile.org*.

tional security, science, safety, and other Federal mission goals now and in the future," as outlined in the 2018 *Presidential Memorandum on Developing a Sustainable Spectrum Strategy for America's Future.*

Any attempt to encroach on Congressionally-mandated FCC authority regarding commercial spectrum management, or to insert other Executive Branch Departments into the independent agency's process, prevents the FCC from utilizing its technical and engineering expertise in reaching decisions and would set a dangerous precedent. Further, the Committee on Commerce, Science, & Transportation, as well as this Subcommittee, must remain the appropriate committee of jurisdiction with authority over the FCC.

American consumers benefit from digital opportunities and wireless services that result from clear, effective commercial spectrum management from the FCC. CCA commends ongoing leadership from this Subcommittee, and the full Committee, to support these opportunities and provide oversight for such a crucial American resource.

Sincerely,

STEVEN K. BERRY,
President and CEO,
Competitive Carriers Association.

Senator THUNE. I just have a couple of last questions to ask but thank you all.

You have been very indulgent with your time. But as you can tell, a lot of interest in the subject and I think we have aired out a lot of good issues today. Mr. Power, in your testimony you mentioned that increasing the flexibility of the spectrum relocation fund would help spectrum efficiency. Can you elaborate on what potential changes we should consider to the SRF?

Mr. POWER. Certainly, Senator, Mr. Chairman. I think the spectrum relocation fund is obviously very well-intended and has worked to an extent to incentivize agencies to free up spectrum because then the portion of the proceeds of the auction comes back to them. I do think, from talking to some folks at the agencies, they almost see it as sort of status quo that they do the work to relocate their bands and then they get paid and then they are just back where they started from after doing a lot of work, and in their views, perhaps taking some risk.

So I think if we can add to those incentives and make sure that they can use that money to do upgrades to systems and perhaps a little more flexibility in terms of planning. And so that the revenues aren't necessarily tied specifically to a particular auction or a particular band, that they can widen their lens a bit and get more of that revenue to become more efficient overall because that is what will ultimately lead to freeing up spectrum for commercial use.

Senator THUNE. And this has been covered pretty well, but I think it would be worth it just for purposes of kind of getting it—having it on the record. But just maybe you can answer this, you all can answer this, what happens if the United States does not make enough mid band spectrum available for commercial 5G services, and can United States have a vibrant 5G ecosystem without enough mid band commercial spectrum?

Mr. POWER. I would say what is at stake, we can learn from by looking back at 4G. The U.S. led the world in 4G and it meant not just spectrum availability and all the uses of spectrum that we derived from that, but it also created the app economy. That is a U.S. centric ecosystem. The two major operating systems for wireless devices. Those are U.S. dominated industries. It becomes this eco-

system that feeds and grows upon itself and that is the opportunity we have in 5G and that is the opportunity we have with mid band spectrum in particular.

Right now as Chairman Pai and the FCC kick off the CBRS auction and now the C-band auction in December, those are two good moves, but we need this lower 3 gigahertz band spectrum, and we really need the help of the Administration, the Defense Department and this committee to get that band freed up to the greatest extent possible to then start catching up. Even with the auctions we have in place, we would not have caught up to China and many of the other countries. So that lower 3 gigahertz band is really important.

Ms. LAYTON. To piggyback on that and certainly I agree with what Mr. Power said. I would add that spectrum is almost—it is less important than the service development. If you look at 4G, the industries who profited were not necessarily the people who invested. So who really benefited from 4G was the device makers and the software systems, the apps, the platforms. And so similarly with 5G we don't even know yet to some extent will be these new industries that will come in the future.

But to me, what is a really the critical issue is that what 5G will enable in Quantum Computing and Robotics and Artificial Intelligence and so forth. We don't have the patents for those things today. And this is where China and other countries where it is a reset, right? It is a reset.

There is not a particular advantage that we bring now and we need to put all the assets that we have as quickly as possible if we even want a chance at those next generation of things. So I don't think we can overstate how important this is today and thank you again for having this hearing.

Mr. GIBSON. And I would just add that one major aspect of the lower mid band is that it has now become The sweet spot. You know, in the time because of technology, the lower band, the 600 megahertz and below was sweet spot, but technology has caught up to the point where the 3 gigahertz band, the 3100 to 3550 is a beautiful band for coverage.

So we have heard a lot today about rural coverage. You really can't effectuate rural coverage much with millimeter wave or the really high band stuff. It just is not meant for that. So we really think that that lower mid band is just a really good sweet spot for the band. And again, 5G helps give us international competitiveness so we really need to keep pushing that.

Mr. CALABRESE. Yes, I would add that, yes, we very much support more spectrum, more mid-band spectrum for both licensed and unlicensed that is critical in thinking of a broader 5G wireless ecosystem that we have sufficient amount of both licensed and unlicensed in the mid band spectrum for the mobile carriers networks. The more spectrum they have, presumably, the more capacity and the lower the prices for consumers.

So that is a good thing. But I would just note that in the spirit of not letting the perfect be the enemy of the good, in the 3 gigahertz spectrum below CBRS, which is also military radar spectrum today, we really need to press for a clear, technical answer in a sense or budgetary answer perhaps about how much of that

can be cleared, if any, and then we should move to share the rest by extending the CBRS framework because that can be done rapidly and we can be having, you know, additional auctions for PAL licenses and additional general authorized access as well. So that may be the fastest way to make it available and for a wider variety of users as well.

Senator THUNE. All right, just perhaps last question. How do we account for spectrum needs which cannot be made public like those that affect our national security interests?

Ms. LAYTON. So well, first of all, I don't think National Security is a static issue, and frequently, you know, some parties want to say well it is National Security, end of discussion and there is quite a bit of debate about what National Security is. And I think Mr. Power, in his testimony he described well I attempted to as well that our economy is a National Security issue, being able to compete with the next generation technologies is a National Security issue.

The military, our adversaries will use next generation technologies to power their weapons. So we won't be able to compete as a military without the right networks and spectrum and so forth. I would recommend a great new book by Christian Brose called *The Kill Chain,* which is a critique of our military today that they have been incentivized to maybe not make the best technological decisions. They are bought in two platforms for example.

Our adversaries are looking at the different modes of warfare. They may be smarter about how they use spectrum. But in any case, it would simply say that we can't stop our conversation about moving forward for spectrum for an excuse of National Security. It is part of realizing the right spectrum policy. And of course, we want to have a powerful military, they need to have their capabilities, but they also have to be smart about how they use resources.

This is not a new concept. This was going on in World War II. There was a discussion around the broadcasters had to be able to use the spectrum the military wanted. It was important to have broadcasting to the American people during World War II. So this notion that somehow the military will always win and there are other uses is not there. There has always been this question, because we have an administrative allocation, about how do we balance the uses.

Mr. GIBSON. I would add to that that we had some experience in the past with a collaboration in DOD type discussions. When we were talking about this, we were able to sign non-disclosure agreements with the DOD and thereby we were able to share information. It was not necessarily classified. It was for official use only but it began to kind of give us a thinking that there is a way through collaborative process, allowing commercial interest to get involved with discussions on spectrum usage and we were able to actually make some very critical decisions that made the auction happen on time for AWS–3. So there is a framework, in fact, within the commerce spectrum management advisory committee.

Shortly after that, we tried to study, a way that we could institutionalize a method whereby, through some aspects, through the Federal Advisory Committee Act or something, whereby commercial interest could help in these discussions. That never saw the

light of day, but the fact that we were able to get NDAs in place and have these discussions with technical experts and spectrum experts on both sides of the discussion was, I think we called the trusted agent approach.

So I would suggest that that be looked into in more detail and considered because we think that many of us still hold clearances from work we have done before and those clearances, we have gone through the vetting process. So it is possible to put that in place and allow us to continue to collaborate.

Mr. POWER. Mr. Chairman, in the last 10 years, the wireless carriers have become 42 times more efficient in their delivery of data. That is to say for every megahertz allocated to them, they are now carrying 42 times the amount of data as they did 10 years ago. And they have invested hundreds of billions of dollars to achieve that and they do it because of the opportunity cost visited upon them by having owned the spectrum.

I doubt there is anyone who can tell us what the efficiency gains, if any, there have been on the Federal side because they don't face those challenges, they don't face those incentives, they don't face those costs. So I think greater transparency into that issue and finding areas where they might be able to increase that efficiency because I suspect there are opportunities there.

I think Senator Lee's bill would help us start to identify them. And then helping and working with the agencies who get the proceeds from these auctions to achieve those greater efficiencies. That is a win-win for everybody.

Senator THUNE. Well, I couldn't agree more. I just think that we have to figure this out and you know, the stakes are so high and our competitors are not having to delay and sit around dealing with the bureaucratic obstacles that we are having to deal with here.

And I thank you for your advocacy. And I hope you will continue to be loud, strong voices on how important it is to figure these solutions out that enable us to get more of that critical spectrum available for 5G because I just think that the cost of not winning that race or at least not being competitive in that race are incredibly high for our country on many levels. So thanks for your testimony today.

We will keep the hearing record open for a couple of weeks and during that time Senators are going to be asked to submit any questions for the record. And when you receive those questions, if you could submit your written answers to the Committee as soon as possible. They will be included in the permanent record and we would greatly appreciate the timeliness of your response.

So thank you for being here today. And with that, we will adjourn this hearing.

[Whereupon, at 12:05 p.m., the hearing was adjourned.]

A P P E N D I X

GPS INNOVATION ALLIANCE
July 21, 2020

Hon. ROGER WICKER,
Chairman.
Senate Committee on Commerce, Science, and Transportation,
Washington, DC.

Hon. MARIA CANTWELL,
Ranking Member,
Senate Committee on Commerce, Science, and Transportation,
Washington, DC.

Dear Chairman Wicker and Ranking Member Cantwell:

The GPS Innovation Alliance ("GPSIA") thanks the U.S. Senate Committee on Commerce, Science, and Transportation ("Committee") for its continued work overseeing the Federal Communications Commission ("FCC" or "Commission"), including at the Committee's June 24, 2020 hearing.[1] During the hearing, FCC Chairman Pai and the other Commissioners discussed, among other things, the *Ligado Order,* which granted applications submitted by Ligado Networks LLC ("Ligado") to modify its Mobile Satellite Service authorizations to be able to deploy a nationwide terrestrial wireless network in so-called "L-Band" spectrum.[2] While the GPSIA appreciates the Chairman and Commissioners' comments on efforts to expand the deployment of broadband services, we believe certain statements made in response to questions asked by Committee members require additional clarification. The GPSIA therefore submits this letter to correct the record.

The 1 dB Standard is the Appropriate Metric to Guard Against Harmful Interference to GPS Navigation and Timing Services

Chairman Pai testified that the FCC has "never embraced" the 1 dB standard and that the National Telecommunications and Information Administration ("NTIA") itself has rejected that standard.[3] Chairman Pai further stated that utilizing the 1 dB standard would "wipe out wireless communications as we know it." Both statements are inaccurate, and they highlight the fundamental flaws in the *Ligado Order*—the Commission's failure to adequately consider the unique characteristics of Global Positioning System ("GPS") devices, *timing and navigation* devices that are fundamentally different from *communications* devices, and to adopt an interference standard that is appropriate for GPS. Since GPS is different, adopting an appropriate interference standard for GPS does not mean the FCC would be required to extend that same standard to *communications* systems. The FCC can, and should, adopt interference standards that are appropriate for each individual service and has done so in the past. Its failure to do so here threatens the 900 million GPS

[1] *See Oversight of the Federal Communications Commission Before the Senate Comm. on Commerce, Science, and Transp.,* 106th Cong. (2020) ("FCC Oversight Hearing").

[2] *See LightSquared Technical Working Group Report, et al.,* Order and Authorization, 35 FCC Rcd 3772 (2020) ("*Ligado Order*"). The L-band frequency bands covered by the *Ligado Order* are 1526–1536 MHz, 1627.5–1637.5 MHz, and 1646.5–1656.5 MHz.

[3] FCC Oversight Hearing (statement of Chairman Pai); *see also* Letter from the Honorable Ajit Pai, Chairman, FCC, to the Honorable Chris Coons, Mike Lee, Edward J. Markey, Ron Johnson, Brian Schatz, John Thune, and Mark Warner at 4 (dated June 12, 2020). The 1 dB standard measures whether a new service causes a 1 dB degradation in a receiver's Carrier-to-Noise Power Density Ratio ("C/N_0") or a 25 percent increase in the noise floor. *See, e.g.,* Letter from J. David Grossman, Executive Director, GPS Innovation Alliance, to Marlene H. Dortch, Secretary, FCC, IB Docket Nos. 11–109 and 12–340, at 2 (filed Dec. 20, 2019) ("GPSIA Dec. 2019 *Ex Parte* Letter").

receivers in use in the United States[4] and the critical activities and systems that depend on them.

First, the FCC has, in fact, utilized the 1 dB standard, including in cases involving GPS.[5] We note that just two months prior to the adoption of the Ligado decision, the Commission applied the 1 dB standard in order to protect C-band earth stations from terrestrial broadband operations in the adjacent band.[6]

Second, the FCC has previously distinguished, as it did not do here, between different types of services, adopting an interference standard that is appropriate based on the circumstances. For example, in repurposing "H Block" spectrum for mobile communications services, the Commission adopted a less restrictive 3 dB standard to protect mobile communications systems. But in doing so, the Commission acknowledged that the "1 dB desensitization is most commonly used as an interference protection criterion for noise-limited receiver systems." [7]

GPS receivers are precisely the type of "noise-limited receiver systems" that the Commission recognized that the 1 dB standard should be used to protect. As the FCC has explained, "noise limited" systems and services include receivers that are expected to continue to operate even when they receive very weak signals and are limited by the presence of radiofrequency noise that is expected to be present at the same level as the desired signal.[8] A 1 dB adverse change, which represents a 25 percent increase in noise, is a sizable impact on such systems. Unlike typical wireless communications systems, which operate at high power relative to satellite signals and operate *above* the noise floor, wide bandwidth, spread spectrum GPS signals are *below* the thermal noise floor when they are received.[9] Indeed, GPS satellites transmit with no more power than a 50-watt light bulb, and signals arrive on earth with a power of less than a millionth of a billionth of a watt.[10] Therefore,

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[4] *See* National Space-Based Positioning, Navigation, and Timing Advisory Board, *Twenty-Fourth Meeting,* at 14 (Nov. 2019), *https://www.gps.gov/governance/advisory/meetings/2019-11/minutes.pdf.*

[5] *See, e.g., Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems,* Memorandum Opinion and Order, 18 FCC Rcd 3857, ¶¶12, 14 (2003) (utilizing the 1 dB standard when the FCC established emission levels for ultra-wideband transmission systems); *Amendment of Parts 73 and 74 of the Commission's Rules to Establish Rules for Digital Low Power Television, Television Translator, and Television Booster Stations and to Amend Rules for Digital Class A Television Stations,* Report and Order, 19 FCC Rcd 19331, ¶230 (2004) (using the 1 dB standard to establish rules to limit the emissions of low-power television stations into the spectrum band used by GPS); *Allocations and Service Rules for the 71–76 GHz, 81–86 GHz, and 92–95 GHz Bands,* Memorandum Opinion and Order, 20 FCC Rcd 4889, ¶23 (2005) (modifying the interference protection criteria for existing digital and analog facilities by adopting a 1 dB standard).

[6] *See Expanding Flexible Use in the 3.7–4.2 GHz Band,* Report and Order, Order Proposing Modification, 35 FCC Rcd 2343,¶¶366–89 (2020) ("*C-Band Order*"); *id.* ¶382 ("We find that a protection criteria of I/N = -6 dB is appropriate for TT&C links, as we did for the FSS earth stations described above. The 3.7 GHz Service licensee must ensure that the aggregated power from its operations will meet an I/N of -6 dB as received by the TT&C earth station."); *id.* ¶388 ("To protect TT&C earth stations from adjacent channel interference due to out-of-band emissions, we set the same interference protection criteria of -6 dB I/N ratio."). An interference-to-noise ("I/N") ratio of -6 dB is equivalent to a 1 dB rise in the noise floor.

[7] *Service Rules for Advanced Wireless Services H Block—Implementing Section 6401 of the Middle Class Tax Relief and Job Creation Act of 2012 Related to the 1915–1920 MHz and 1995–2000 MHz Bands,* Report and Order, 28 FCC Rcd 9483, ¶144 (2013). In that same decision, the FCC also referenced an Interference Protection Criteria Technical Report released by NTIA on the 1 dB standard, demonstrating that both the FCC and NTIA *have* relied on or utilized the 1 dB standard. *See id.* ¶144, n.440.

[8] *See Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Extension and Reauthorization Act,* Notice of Inquiry, 20 FCC Rcd 9349, ¶6 n.19 (2005); FCC White Paper, *The Public Safety Nationwide Interoperable Broadband Network: A New Model for Capacity, Performance and Cost,* at 15 & n.23 (June 2010), *https://transition.fcc.gov/pshs/docs/releases/DOC-298799A1.pdf* (noting that cellular networks are generally "interference limited rather than noise limited" and that noise-limited networks are "inherently more vulnerable to interference, including adjacent-channel interference, than commercial networks").

[9] *See* GPSIA Dec. 2019 *Ex Parte* Letter at 2; Phillip W. Ward, John W. Betz, and Christopher J. Hegarty, UNDERSTANDING GPS PRINCIPLES AND PRACTICE 247 (Elliot D. Kaplan and Christopher J. Hegarty eds. Artech House, 2d ed. 2006).

[10] *See* Comments of GPS Innovation Alliance, Docket No. 181130999–8999–01, at 4 (filed Jan. 22, 2019) ("GPSIA NTIA Spectrum Management Plan Comments"); *see also, e.g.,* Tim Bartlett, *Threats to GPS from Land-Based Signal Boosters,* POWER AND MOTORYACHT (Sept. 19, 2017), *https://www.powerandmotoryacht.com/electronics/understanding-impact-threats-gps-land-based-signal-boosters* ("GPS signals come from solar-powered 50-Watt transmitters 12,000 miles out in space."); Sebastian Anthony, *Think GPS is Cool? IPS Will Blow Your Mind,* EXTREMETECH (Apr. 24, 2012, 12:52 PM), *http://www.extremetech.com/extreme/126843-think-*

GPS receivers are inherently vulnerable to high-powered transmissions in closely adjacent spectrum.

That is why, while GPS receivers are designed to withstand adjacent-band transmissions that are substantially stronger than GPS signals, they can be "overloaded" by high-powered mobile broadband transmissions in adjacent frequencies.[11] Even lower power mobile telephone networks operating in adjacent spectrum will be a billion times stronger than a GPS signal when a GPS receiver is in close proximity (*e.g.,* 100 meters). Given the ubiquity of GPS devices in the United States, high-powered operations in adjacent spectrum are likely to seriously degrade and/or disrupt the operation of GPS devices on an ongoing basis. For these reasons, continued adherence to the 1 dB standard is critical.

The consequences of disruption to GPS receivers and the devices and systems in which they are embedded are also fundamentally different from the consequences of interference to communications devices. Mobile phone users can observe the results of interference in dropped calls or poor call quality. In contrast, the disruption or degradation to the accuracy and integrity of a GPS receiver is not readily detectable by the end user, producing an inaccurate readout of position or time, which can have untold consequences. The device or system will continue to operate with a degraded position or timing output, but will perform worse as a result.[12] In extreme cases of interference, when a GPS receiver "loses lock" on available GPS satellites altogether, the user is left with no means of determining location until the interference is abated—another potentially catastrophic outcome when GPS is relied upon for critical life-saving services.

Wireless operators have technology and expertise to monitor operations and design their networks to minimize interference to wireless operators in adjacent spectrum. Wireless systems can also take advantage of adaptive power control, forward error correction, retry capability, and other systems that allow mobile devices and the network to dynamically adjust to reduce the impact of interference. It is therefore appropriate to adopt more permissive standards of what constitutes harmful interference protection for communications systems, as the FCC did when it adopted a 3 dB standard for the H Block.

Because interference to positioning, navigation, and timing ("PNT") services, as opposed to communication services, creates different kinds of risks, the Commission's rules, like those of the International Telecommunications Union, defines interference to each differently. In particular, the Commission's rules define harmful interference as that "*which endangers the functioning of a radionavigation service or of other safety services or* [which] seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with Radio Regulations."[13] The *Ligado Order* mistakenly applies the Commission's own "seriously degrades, obstructs, or repeatedly interrupts" standard for *radiocommunications* to GPS—a radionavigation service. A 1 dB standard serves as the appropriate level to protect GPS receivers against severe impact to performance and guard against harmful interference. The international standard metric for protecting the functioning of a radionavigation service and guarding against it from being endangered is the 1 dB standard,[14] and it should have been employed in the *Ligado Order.*

The difference in standards is critical. The Commission's rules and ITU Radio Regulations are specifically written to ensure that a pilot, farmer, boat owner, or first responder is not required to demonstrate after the fact, once the harm has already occurred, that the operation of his or her GPS-dependent device has been "seriously degraded" or "repeatedly interrupted." The FCC should have determined whether Ligado's operations "endanger[] the functioning" of GPS devices, and the Commission's failure to do this was a fundamental error that requires correction.

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gps-is-cool-ips-willblow-your-mind ("Detecting a GPS signal on Earth is comparable to detecting the light from a 25-watt bulb from 10,000 miles.").

[11] *See* Letter from Russell H. Fox, Counsel for Trimble Navigation Limited, to Marlene H. Dortch, Secretary, FCC, IB Docket Nos. 11–109 and 12–340, Attachment at 3 (filed June 19, 2015).

[12] *See* GPSIA NTIA Spectrum Management Plan Comments at 7–8; Letter from M. Anne Swanson, Counsel to Garmin, to Ms. Marlene H. Dortch, Secretary, FCC, IB Docket Nos. 11–109 and 12–340, at Attachment 2 at 4–5 (filed Oct. 27, 2015).

[13] *See* 47 C.F.R. § 2.1(c); *see also* ITU Radio Regulations § 1.169; Reply to Opposition to Petition for Reconsideration of Trimble, IB Docket Nos. 11–109 and 12–340, at 5 (filed June 8, 2020) (explaining that the definition of harmful interference is also different for communications and navigation systems).

[14] *See Background Paper on Use of a 1-dB Decrease in C/N_0 as GPS Interference Protection Criterion,* UNITED STATES AIR FORCE, at 2–4 (2017), *https://www.gps.gov/spectrum/ABC/1dB-background-paper.pdf.*

Ligado's Spectrum Does Nothing to Advance U.S. Leadership in the Race to 5G

When asked if Ligado's spectrum is necessary to win the race to 5G, Chairman Pai responded by listing other bands to which the FCC faced resistance in the process of converting them to full mobile wireless use.[15] He claimed that if the Commission had listened to all those objections, there would be no 5G spectrum. Chairman Pai seems to be suggesting that all objections to converting spectrum to 5G are equally invalid. His statements do not account for different spectrum band characteristics and, because of how they are used, their vulnerabilities to interference. The distinction between communications and navigation systems discussed above should have required a different evaluative approach alongside the laudable goal of pursuing 5G deployment.

Notably, Chairman Pai did not say that L-Band spectrum is necessary to win the race to 5G. Indeed, nothing about L-Band spectrum makes it even relevant—let alone critical—to winning the race to 5G. As Senator Duckworth correctly pointed out, until the *Ligado Order,* the FCC did not consider this spectrum to be 5G-suitable.[16] And the 5G FAST Plan introduced by Chairman Pai includes no mention of the L-Band as being necessary or relevant to winning the 5G race or maintaining U.S. leadership on 5G.[17]

That is not surprising. First, Ligado's spectrum is merely a sliver of spectrum. As compared to the large contiguous swaths of spectrum the FCC has made available to support 5G services,[18] Ligado's network would operate only on spectrum blocks of 10 non-contiguous megahertz—well below what is needed for 5G. Second, Ligado's spectrum is not internationally harmonized. Neither Europe, China, or Japan, nor any other major country has identified the L-Band for 5G. As GSMA has emphasized, international harmonization is important to "make the best possible mobile services available for everyone and everything."[19] Third, Ligado's proposed network would only be able to offer limited Internet of Things ("IoT") services. Specifically, Ligado proposes to provide an Industrial IoT service, primarily delivered over custom private networks to specific geographic areas for limited vehicular and utility operations. Not only is this *not* a 5G service offering, but similar services are already being provided by wireless service providers on an ancillary basis, often using the guard band of spectrum otherwise used for wireless broadband.[20] Ligado's service is simply not a 5G service.

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The GPSIA thanks the Committee for its interest in this matter. Should you or other Committee members have any questions regarding the foregoing, please do not hesitate to contact me.

Sincerely,

J. DAVID GROSSMAN,
Executive Director,
GPS Innovation Alliance.

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[15] FCC Oversight Hearing (statement of Chairman Pai).

[16] FCC Oversight Hearing (questions of Sen. Tammy Duckworth).

[17] *See 5G FAST Plan,* FCC, *https://www.fcc.gov/5G* (aiming to free up another 2.75 gigahertz of spectrum in the 26 GHz and 42 GHz bands and over 800 megahertz of mid-band spectrum for 5G services, but making no mention of L-band spectrum).

[18] *See, e.g., C-Band Order* ¶¶3–4 (making 280 megahertz of spectrum in the 3.7–4.2 GHz band available); *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band,* Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd 3959, ¶1 (2015) (opening 150 megahertz in the 3550–3700 MHz band for commercial use); *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services,* Fifth Report and Order, 34 FCC Rcd 2556, ¶1 (2019) (making "available millimeter wave (mmW) spectrum, at or above 24 GHz, for fifth-generation (5G) wireless, Internet of Things, and other advanced spectrum-based services").

[19] Luciana Camargos, *WRC–19 Strikes a Good Balance, Sets Stage for mmWave 5G,* GSMA (Nov. 25, 2019), *https://www.gsma.com/spectrum/wrc-19-strikes-good-balance-sets-stage-for-mmwave-5g/#:~:text=Striking%20a%20balance%20between%20enabling,and%2040%20GHz%20for%20IMT*.

[20] *See, e.g., The first Nationwide Narrowband Network Designed for IoT Devices,* T-Mobile, *https://www.t-mobile.com/business/coverage* (last visited July 8, 2020) ("Our NB-IoT network operates on a dedicated guard band of existing networks, so it can efficiently carry data without competing against other network traffic."); Kendra Chamberlain, *Verizon Lights Up Nationwide NB-IoT Network,* FIERCEWIRELESS (May 14, 2019), *https://www.fiercewireless.com/iot/verizon-lights-up-nb-iot-network-across-country;* Sue Marek, *AT&T Will Launch Nationwide NB-IoT Network in 2019,* SDX CENTRAL (June 20, 2018), *https://www.sdxcentral.com/articles/news/att-will-launch-nationwide-nb-iot-network-in-2019/2018/06/*.

July 22, 2020

Hon. JOHN THUNE,
Chairman,
Subcommittee on Communications, Technology, Innovation and the Internet,
Committee on Commerce, Science, and Transportation,
United States Senate,
Washington, DC.

Hon. BRIAN SCHATZ,
Ranking Member,
Subcommittee on Communications, Technology, Innovation and the Internet,
Committee on Commerce, Science, and Transportation,
United States Senate,
Washington, DC.

Dear Chairman Thune and Ranking Member Schatz:

As a coalition of transportation industry stakeholders comprised of state, city, and county departments of transportation, public transportation, automakers, vehicle suppliers, trucking, transportation safety groups, law enforcement, first responders, auto insurers, bus associations, infrastructure equipment suppliers, bicyclists, and pedestrians, among others that care deeply about transportation safety, we write to express significant concern with efforts underway at the Federal Communications Commission (FCC) to reallocate spectrum in the 5.9 GHz band away from transportation safety. Reducing the amount of spectrum available to Reducing the amount of spectrum available to Vehicle-to-Everything (V2X) technology undermines our shared interest in reducing the number of traffic fatalities and injuries that occur each year on U.S. roadways, improving motor vehicle safety, and improving the operational performance of roadways by reducing congestion across the transportation system. Such a decision would also harm U.S. global competitiveness with respect to next-generation automotive safety technologies. We ask you to use the Committee's authority over the FCC to direct the Commission to reconsider the approach in the Notice of Proposed Rulemaking (NPRM) that reallocates spectrum within the 5.9 GHz band for unlicensed uses.

As you know, the 5.9 GHz spectrum band is currently reserved for intelligent transportation systems. Commonly referred to as V2X technologies, these systems allow vehicles to communicate with other vehicles, infrastructure, law enforcement, and bicycle and pedestrian road users to avoid crashes, enhance safety, improve transportation efficiency, and reduce air pollution. The National Highway Traffic Safety Administration (NHTSA) predicts that the safety applications enabled by V2X technologies could eliminate or mitigate the severity of up to 80 percent of non-impaired crashes, significantly reducing the nearly 37,000 lives lost and three million injuries that occur on U.S. roadways each year.[1] In addition, 70 percent of crashes involving commercial trucks could be mitigated by V2X technologies according the NHTSA. V2X technologies will provide real economic savings as well by significantly reducing the more than $800 billion in annual costs associated with crashes on American roads.[2]

Furthermore, these technologies are uniquely capable of reducing traffic congestion through prioritized traffic signal timing, truck platooning, and crash reduction, reducing travel time and delays for commuters and commerce alike, delays that cost the Nation more than $166 billion annually according to the U.S. Department of Transportation (USDOT).[3] V2X pedestrian detection systems will better protect vulnerable road users, which encompasses a broad set of road users—people walking, children being pushed in strollers, people using wheelchairs or other mobility devices, passengers embarking and disembarking buses and trains, and people riding bicycles and scooters. Preserving the spectrum for V2X would provide greater benefit for the American people than reallocating the spectrum for unlicensed devices.

USDOT and public and private sector transportation stakeholders have worked together to bring this technology to the U.S. market. Billions of dollars—including at least $2 billion in public funding from federal, state, and local governments—have been invested in the development and deployment of V2X technology.[4] The re-

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[1] National Highway Traffic Safety Administration Press Release: Proposed rule would mandate vehicle-to-vehicle (V2V) communication on light vehicles. Dec. 13, 2016. Available at: *https://one.nhtsa.gov/About-NHTSA/PressReleases/ci.nhtsa_v2v_proposed_rule_12132016.print.*

[2] Comments of U.S. Department of Transportation, ET Docket No. 19–138, at 8 (filed Mar. 13, 2020).

[3] Comments of U.S. Department of Transportation, ET Docket No. 19–138, at 8 (filed Mar. 13, 2020).

[4] How Connected Vehicles Work, U.S. Department of Transportation. (Feb. 27, 2020). Available at *https://www.transportation.gov/research-and-technology/how-connected-vehicles-work.*

sult of U.S. innovation and investment in V2X is now shown through existing and planned deployments around the country. At least 30 states—from Michigan to Pennsylvania to Ohio to Florida—have invested in building out intelligent infrastructure using V2X technology. Two of the country's largest automakers, General Motors and Ford Motor Company, have deployed or announced plans to deploy these technologies in vehicles in the U.S. market, and, recently, the Alliance for Automotive Innovation announced a commitment to deploy at least five million V2X devices in vehicles and roadway infrastructure over the next five years.[5]

Even as automakers and infrastructure owners and operators move forward with deploying these technologies, V2X innovation continues. In recent years, we have seen the development of new applications and novel use cases that will further advance transportation safety, particularly related to advanced driver assistance systems (ADAS) and automated vehicles (AVs). V2X technologies enable applications that cannot be performed by un-connected AVs, such as communicating with vehicles that are out of line-of-sight, providing road hazard warnings from roadside infrastructure, and allowing AVs to coordinate actions rather than making decisions individually. V2X complements AV sensors by providing information that is more precise, over longer ranges, and in non-line-of-sight conditions.

Unfortunately, since 2013, the FCC has been threatening to repurpose spectrum away from these cutting-edge transportation safety technologies and has now released a NPRM to reduce the spectrum that is available to V2X technologies.[6] The FCC's proposed rule would reallocate the majority of the 5.9 GHz band away from transportation safety. Numerous technical assessments related to the FCC's proposal, including preliminary assessments released by USDOT, show that out-of-channel interference from unlicensed devices operating in adjacent bands would be likely to make the spectrum reserved for transportation safety communications unusable for such purposes.[7] This interference would delay or block safety-critical messages where split-second action is required to avert a crash.

The United States has led the world in creating V2X technologies and in developing the standards that enable and support V2X technologies. The FCC's proposal would cede American leadership as countries around the world are building out their V2X networks. There is no doubt that, if implemented, the NPRM would undercut the public and private investments that have been made in the United States, stifle further innovation, and challenge American global competitiveness. This approach is in direct conflict with efforts underway in other parts of the world. At precisely the same time that other countries are reiterating their commitment to V2X technologies and, in many cases, looking to increase the amount of spectrum that is available to support V2X technologies, the FCC is poised to take action that would all but ensure that these technologies would not realize their full potential in the United States.

The comments and reply comments submitted to the FCC in response to the NPRM overwhelmingly opposed repurposing spectrum away from transportation safety. In fact, more than 85 percent of the commenters opposed the FCC's proposal, including state and city departments of transportation, automakers, vehicle suppliers, technology companies, law enforcement, first responders, safety advocates, engineers, telecommunications companies, the drone industry, and many others. These groups asked the FCC to heed the warnings of USDOT that this plan would not allow sufficient spectrum for V2X to function, threatening the significant safety benefits this technology provides.

We are representative of a broad and diverse group of stakeholders that strongly support preserving the 5.9 GHz safety spectrum band for transportation safety. We ask you to use the Committee's authority over the FCC to direct the Commission to reconsider the approach in the NPRM that reallocates spectrum within the 5.9 GHz band for unlicensed uses. Use of your authority at this critical juncture could save thousands of American lives and hundreds of billions of dollars each year. We look forward to working with you to ensure that the safety, economic, congestion

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[5] Letter from John Bozella, President and CEO of the Alliance for Automotive Innovation, to the Honorable Elaine Chao, Secretary of Transportation, and the Honorable Ajit Pai, Chairman of the FCC (April 23, 2020). Available at: *https://www.autosinnovate.org/wp-content/uploads/2020/04/Ext.-Comm.-Letter-2020-5.9-GHz-Build-OutCommitment-Letter-April-23-2020-ID-1567.pdf.*

[6] In the Matter of Use of the 5.850–5.925 GHz Band, ET Docket No. 19–138, Notice of Proposed Rulemaking, FCC 19–129 (2019).

[7] USDOT Preliminary Technical Assessment (Dec. 6, 2019). Available at: *https://www.transportation.gov/sites/dot.gov/files/docs/research-and-technology/360181/oobe-energy-59-safety band-final-120619.pdf.* Comments of Ford Motor Company, ET Docket No. 19–138, at 9 (Mar. 9, 2020).

mitigation, environmental, and efficiency benefits that V2X technologies can provide are realized in the United States.

Sincerely,

Intelligent Transportation Society of America
Alliance for Automotive Innovation
Amateur Radio Emergency Data Network
America Walks
American Association of Motor Vehicle Administrators
American Association of State Highway and Transportation Officials
American Automobile Association
American Bus Association
American Council of Engineering Companies
American Council of Engineering Companies of Arizona
American Highway Users Alliance
American Paramedic Association
American Public Transportation Association
American Motorcyclist Association
American Society of Civil Engineers
American Traffic Safety Services Association
American Trucking Associations
Arizona Society of Professional Engineers
Center for Auto Safety
Commercial Vehicle Safety Alliance
Consumer Reports
Ergon Asphalt & Emulsions, Inc.
Governors Highway Safety Association
Greyhound Lines, Inc.
Institute of Transportation Engineers
International Association of Fire Chiefs
International Municipal Signal Association (IMSA)
League of American Bicyclists
Maryland Asphalt Association
Mid-West Truckers Association
Mothers Against Drunk Driving
Motor and Equipment Manufacturers Association (MEMA)
NAFA Fleet Management Association
National Association of City Transportation Officials
National Association of State EMS Officials
National Electrical Manufacturers Association
National Federation of the Blind
National Rural Letter Carriers' Association
National Safety Council
National School Transportation Association
National Sheriffs' Association
National Stone, Sand & Gravel Association
Potters Industries
RV Industry Association
SAE International
State Farm
The Paramedic Foundation
Tire Industry Association
Truck and Engine Manufacturers Association (EMA)
United Motorcoach Association
Volvo Group North America

cc:
The Honorable Roger Wicker, Chairman, Committee on Commerce, Science, and Transportation (R–MS)
The Honorable Marsha Blackburn (R–TN)
The Honorable Roy Blunt (R–MO)
The Honorable Shelley Moore Capito (R–WV)
The Honorable Deb Fischer (R–NE)
The Honorable Cory Gardner (R–CO)
The Honorable Ron Johnson (R–WI)
The Honorable Mike Lee (R–UT)
The Honorable Jerry Moran (R–KS)
The Honorable Rick Scott (R–FL)
The Honorable Dan Sullivan (R–AK)

The Honorable Todd Young (R–IN)
The Honorable Maria Cantwell, Ranking Member, Committee on Commerce, Science, and Transportation (D–WA)
The Honorable Tammy Baldwin (D–WI)
The Honorable Richard Blumenthal (D–CT)
The Honorable Tammy Duckworth (D–IL)
The Honorable Amy Klobuchar (D–MN)
The Honorable Ed Markey (D–MA)
The Honorable Gary Peters (D–MI)
The Honorable Jacky Rosen (D–NV)
The Honorable Kyrsten Sinema (D–AZ)
The Honorable Jon Tester (D–MT)
The Honorable Tom Udall (D–NM)

AEROSPACE INDUSTRIES ASSOCIATION
July 23, 2020

Hon. JOHN THUNE,
Chairman,
Committee on Commerce, Science and Technology,
Subcommittee on Communications, Innovation and the Internet,
United States Senate,
Washington, DC.

Hon. BRIAN SCHATZ,
Ranking Member,
Committee on Commerce, Science and Technology,
Subcommittee on Communications, Innovation and the Internet,
United States Senate,
Washington, DC.

Dear Chairman Thune and Ranking Member Schatz,

On behalf of over 300 leading aerospace and defense (A&D) manufacturers and suppliers, the Aerospace Industries Association (AIA) is pleased to file this statement for the record in response to the Senate Committee on Commerce, Science and Transportation's Subcommittee on Communications, Technology, Innovation and the Internet's hearing, "The State of U.S. Spectrum Policy." We thank the Committee for holding this important hearing and for its leadership on issues affecting the aerospace and defense (A&D) industry, including spectrum policy.

For more than 100 years, our members have been on the cutting edge of innovation and are leading the development of emerging technologies that will revolutionize the way in which goods and people are moved, services are performed, and people connect.

Spectrum is the life blood of our industry and enables virtually everything that our members design, manufacture, operate, and launch. For that reason, our industry represents some of the largest users of the FCC's experimental licensing regimes which is one of the critical enablers to U.S. technology development and leadership. As these products move from development to reality, access to spectrum becomes critical.

That access comes through ensuring continuity of existing allocations for harmonized equipment designs as well as meeting the need for additional spectrum for new capabilities, such as urban air mobility, through efficient and timely rulemaking processes. This process is critical to the success of the A&D industry and our Nation's economy. However, it is not optimized for the current and future economy and advancing U.S. global leadership across all sectors of our economy.

In 1934, Congress established the Federal Communications Commission (FCC) as an independent federal agency to manage our nation's non-federal spectrum allocations.[1] This was followed by the establishment of the National Telecommunications and Information Administration (NTIA) in 1978 which serves as the president's principal adviser on spectrum policies and is viewed as the voice of Federal spectrum stakeholders.[2] For many years, these two agencies have worked together to help enable spectrum access for all stakeholders through a formal memorandum of understanding (MOU), last updated in 2007, and other processes. One such process is the Interdepartment Radio Advisory Committee (IRAC) which allows for the Federal government agencies, including the FCC, to directly weigh in with the NTIA on their spectrum priorities.

This structure has, in part, led to the U.S. being the leader in wireless communications technologies like 4G LTE, as well as enabling other sectors of the economy,

[1] See, Communications Act of 1934
[2] See, *https://www.ntia.doc.gov/book-page/national-telecommunications-and-information-administration#:~:text=The%20NTIA%20of%20the%20U.S.,102538%2C%20106%20Stat.*

like the A&D industry, to thrive. However, the bifurcated structure has also enabled a system that is not optimized for today's spectrum sharing economy and where spectrum dependence is regularly an administration priority. Spectrum is a scarce resource that is only becoming more congested, which requires the FCC and Government to look at creating new allocations, repurposing existing bands, or, more importantly, developing new sharing arrangements to continue the U.S. technology leadership, beyond 5G and next generation A&D capabilities.

Today's spectrum realities also highlight the difficulties with our Nation's spectrum governance structure. As we look to enable greater spectrum sharing, we must develop creative sharing solutions that enable growth and innovation by both existing and new users of spectrum.

This evolution toward sharing presents an opportunity to look at how to optimize spectrum management to better enable sharing amongst all stakeholders—commercial industries and federal/state/local users. Fortunately, there is a recognition of the need to ask questions about U.S. spectrum policy, as evidence by this hearing. Discussion is also underway in the Commerce Spectrum Management Advisory Committee (CSMAC), which serves as a formal advisory body to the Assistant Secretary for Communications and Information at NTIA on spectrum issues,[3] which will soon publish a report titled, "Report on the Presidential Memorandum on Developing a Sustainable Spectrum Strategy for America's Future: Governance."[4] This report sought to answer a similar question as the hearing today-is U.S. spectrum management optimized for the implementation of a 21st century national spectrum strategy?[5]

The group's preliminary finding was that "our country's current approach for managing the use of spectrum is no longer effectively serving the needs of the managing the use of spectrum is no longer effectively serving the needs of the entire stakeholder community and would benefit from reform."[6]

The need to optimize the spectrum governance model is further evident in the increasing and visible fractures in our decades-old bifurcated model—where statutory priorities differ between our two regulators, and unilateral decision-making authority exists in one. It will be important to ensure that a future spectrum governance model is designed to address all U.S. priorities, particularly as we seek to increase spectrum efficiency for all users through true spectrum sharing. Issues with the current process were evident in recent FCC decisions such as 24 GHz, C Band, 5.9 GHz, and Ligado.

U.S. global leadership depends upon the system being optimized and incorporating the full suite of economic and security interests into the decisions on spectrum governance. We no longer have the long-enjoyed luxury of exclusive spectrum lanes, let alone users. For example, future Advanced Air Mobility technologies like Unmanned Aircraft Systems and Urban Air Mobility platforms will, in some cases, need additional spectrum to safely operate with the required reliability and safety that aviation demands, particularly when we consider either passengers or large cargo delivery capabilities. While unlicensed spectrum or mobile wireless are options for platforms at low altitudes in urban/suburban areas, it will not serve the myriad of use cases that will enable the billions of dollars and tens of thousands of jobs that these technologies will provide.[7]

This hearing today presents the first legislative opportunity to take a fresh look at the future of our Nation's spectrum governance model. AIA believes that this opportunity is long overdue and encourages the Subcommittee to take the next step of engaging with the broader industry stakeholder community that depends on access to spectrum. We would encourage a survey among the broader industry stakeholder community for their views on the importance of and ideas for future spectrum governance. It is critical that we take a step back and go beyond the traditional entities whose businesses are directly regulated by the FCC.

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[3] See, *https://www.ntia.doc.gov/category/csmac*

[4] See, *https://www.ntia.doc.gov/files/ntia/publications/csmac_sc1_presentation_april_22_2020.pdf—this was a presentation of a draft report.*

[5] Ibid.

[6] iBid.

[7] See, AIA Petition For Rulemaking in the 5030–5091 MHz Spectrum Band, Filed February 2018; *https://ecfsapi.fcc.gov/file/10209988018431/AIA%20Petition%20for%20Rulemaking%20on%20UAS%202018-02-08%20FILED.pdf*

We look forward to working with this Committee and all relevant spectrum stakeholders as this conversation continues and leads to a system that enables the U.S. to remain the global leader in all sectors of the spectrum economy.

Sincerely,

TIM MCCLEES,
Vice President, Legislative Affairs,
Aerospace Industries Association.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. JERRY MORAN TO TOM POWER

Question. You mentioned in your testimony the need to increase collaboration between industry and the Federal government to identify sections of spectrum currently in use by the government that could be reallocated. You also mentioned a process by which this transfer of information could happen securely, to protect sensitive government information. Please describe the process by which industry and the government could securely work together to identify spectrum for reallocation, especially the steps taken to prevent sensitive government information from being exposed.

Answer. Collaboration and information-sharing between government agencies and the private sector can be extremely beneficial to both sides, particularly as the government seeks to share its spectrum with commercial networks, or relocate government systems from one band to another. To assist in these efforts, the private sector subject matter experts (SMEs) require information about Federal systems and operations, much of which is classified. Yet there is no program designed to grant security clearances to qualified private sector SMEs for the purpose of sharing classified information about government spectrum operations. One model that the Department of Defense and other agencies might consider is the Department of Homeland Security's Private Sector Clearance Program for Critical Infrastructure. Under this program, DHS oversees a rigorous vetting process to grant security clearances to qualified representatives from the private sector, for the purpose of enhancing public-private collaboration when it comes to identifying and mitigating risks to critical infrastructure. A similar program dedicated to granting clearances to private sector spectrum SMEs—if well managed—could accelerate the deployment of commercial wireless networks while ensuring the robustness and security of government systems and operations.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARSHA BLACKBURN TO TOM POWER

Question 1. The physics associated with the 12 GHz band present some interesting opportunities for expanding mid-band mobile broadband services in our 5G infrastructure. Compared to CBRS or C-band, this frequency appears to have some additional rain fade; however, the data rates should be comparably excellent. Furthermore, there are fewer hurdles to bring this band into the mobile broadband market. Can you comment on the overall benefits the 12 GHz band can bring to the wireless market?

Answer. CTIA shares your focus on the need for the U.S. to allocate more spectrum for licensed wireless terrestrial use. Although the U.S. will be auctioning 350 MHz of mid-band spectrum this year alone, other nations remain ahead in the deployment of critical spectrum resources. The 12 GHz band could thus be an extremely valuable component in the buildout of 5G networks and beyond. The 12 GHz band offers an attractive mix of high capacity, capable of transmitting large amounts of data at high speeds similar to high-band spectrum, while also having some better geographic range than spectrum above 20 GHz. Operators have been hard at work deploying 5G in high band spectrum at 28 GHz, 37–30 GHz, and other frequencies taking into account rain fade considerations. Allocating a portion of the 12 GHz band to mobile broadband would require accommodation of the incumbent licensed users of the band. Those incumbents include providers of satellite television services who count numerous rural residents among their subscribers. CTIA is working with members in an effort to develop a consensus approach to a potential 12 GHz auction, putting that band to its highest and best use while also generating billions of dollars in auction revenues.

Question 2. The next several years will be transformative for the U.S. for 5G infrastructure, with the CBRS auction currently ongoing and the C-band auction scheduled for December. An intriguing approach to how this network could be de-

fined is by using the Open Radio Access Network (ORAN) specification, which is garnering attention in foreign markets but has been slow to be adopted in the US. Can each of you comment on the implications of whiteboxing our global 5G infrastructure? What are the economic implications if the U.S. *doesn't* adopt the ORAN specification in its mobile broadband infrastructure?

Answer. CTIA supports efforts to increase U.S. competitiveness in the wireless networking space, and Open RAN can play an important role in that regard. The addition of open interfaces to network components will provide carriers with added flexibility in the design of their network architecture, while promoting greater competition among infrastructure vendors, and potentially reducing total cost of ownership. The introduction and scaling of Open RAN solutions will take time, given the complexity of wireless networks; however, the U.S. is well positioned to take advantage of the emergence of Open RAN, with its potential to contribute significantly to U.S. job creation and economic productivity.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARSHA BLACKBURN TO MARK GIBSON

Question 1. The physics associated with the 12 GHz band present some interesting opportunities for expanding mid-band mobile broadband services in our 5G infrastructure. Compared to CBRS or C-band, this frequency appears to have some additional rain fade; however, the data rates should be comparably excellent. Furthermore, there are fewer hurdles to bring this band into the mobile broadband market. Can you comment on the overall benefits the 12 GHz band can bring to the wireless market?

Answer. The 12 GHz band presents interesting wireless opportunities. Currently allocated for the Multichannel Video Distribution and Data Service (MVDDS) and Direct Broadcast Service (DBS), the band presents 500 MHz of spectrum that could be used for 5G. The physics of the band mean that due to propagation loss, signals will travel about a quarter less as far as the CBRS or C-band. However, signals will travel about twice as far as the lowest of the millimeter wave bands. That puts the band in a good place to be used for general mobile broadband services. Data rates would be related to the size of the channels, but with 500 MHz of spectrum available, channels could be sufficiently wide to support high-speed data.

The band is used by several licensees in the MVDDS and DBS, so sharing must be considered. Since the band is the subject of a rulemaking request at the FCC (RM–11768), it would make sense for the FCC to conduct a rulemaking to study the whether the band can be used for mobile broadband (either 5G or a subsequent technology) and any related comments on sharing. CommScope would make the observation that typically bandwidth requirements increase for each successive generation of mobile broadband service. Policymakers and regulators should consider increasing bandwidth requirements versus the amount of spectrum available in the allocation to accommodate the number of expected licensees.

Question 2. The next several years will be transformative for the U.S. for 5G infrastructure, with the CBRS auction currently ongoing and the C-band auction scheduled for December. An intriguing approach to how this network could be defined is by using the Open Radio Access Network (ORAN) specification, which is garnering attention in foreign markets but has been slow to be adopted in the U.S. Can each of you comment on the implications of whiteboxing our global 5G infrastructure? What are the economic implications if the U.S. *doesn't* adopt the ORAN specification in its mobile broadband infrastructure?

Answer. This is a very important question in regard to U.S. leadership and competitiveness in next generation wireless technologies and networks.

CommScope is closely following two initiatives—(1) mobile network function virtualization (*i.e.,* VRAN, "whiteboxing", etc..) and (2) Open Radio Access Network standardization (*e.g.,* Open RAN, O–RAN, etc..).

Mobile network function virtualization will leverage advancements in software abstraction of formerly hardware functions, computing power, and cloud systems to transform proprietary hardware in the mobile network core and RAN into software components running on commodity computing platforms (typically based on x86 processor technology). This follows the broader technology trend of the virtualization and 'cloudification' of many functions that were formerly handled by vendor proprietary hardware, as evidenced in the storage, web serving, and enterprise networking sectors.

Open RAN is an initiative to standardize the communications interfaces between the various components in the Radio Access Network over existing commoditized technologies such as fiber, ethernet, and TCP/IP. Historically, mobile networks have

been deployed using compatible radio network equipment from a single vendor as a "closed" proprietary solution, making it virtually impossible to 'mix and match' components from various vendors. Because Open RAN implements standardized interfaces that are truly open and interoperable, and components can be tested and certified to comply with those interfaces, it breaks this vendor lock in, enabling innovation, creating a more competitive market, and accelerating deployments. Similarly to mobile network function virtualization, O–RAN follows the broader industry trend to standardize communications services (*e.g.,* IBM's Systems Network Architecture [SNA], voice, video, etc. . .) over globally common interfaces.

CommScope is a leader in the Open RAN ecosystem through our internal research and development activities and our external participation in standardization efforts via groups like the *O–RAN Alliance* and advocacy organizations like the *Open RAN Policy Coalition.*

The United States has long been the global leader in network function virtualization and 'democratizing' proprietary interfaces by implementing open standards over common interfaces. In fact, the U.S. led all of the historical examples of virtualization and open interfaces listed above. Given this, it would be logical and natural for the U.S. to lead as these macro industry trends are applied to the mobile industry in the areas of VRAN and O–RAN. CommScope supports the various government initiatives and legislative proposals to allocate Federal funds for Open RAN research and development and that would encourage Federal agencies to foster the deployment of open and interoperable 5G networks in their various pilot programs and procurement guidelines. This type of government support would accelerate domestic development, helping to secure future U.S. leadership in these key technology fields.

While none of the leading incumbent mobile equipment vendors are U.S. companies, O–RAN enables the possibility of building the overall mobile network from a combination of companies, many being U.S. firms. Rather than having a monolithic solution from a foreign vendor as was done in the past, standardization plus virtualization enables a litany of U.S. companies to work in both competition and collaboration to provide a more dynamic, faster, and best-in-breed network to support all of America's Mobile Telecommunications needs.

In terms of the economic impacts, both VRAN and O–RAN seek to lower the costs for mobile network operators by transforming proprietary components and communications services and allowing them to run on common computing platforms and network technologies. O–RAN also allows for network operators to 'mix and match' RAN components from various vendors, creating a more competitive market for each aspect of the RAN. American operators would be at a competitive disadvantage if they were not able to access and leverage VRAN and O–RAN developments. Fortunately, U.S. mobile operators are helping lead much of the industry activity and we believe they fully intend to realize the economic benefits of VRAN and O–RAN.

For more details on CommScope's leadership and position on Open RAN, please see our *filing* in response to NTIA's *Request for Public Comment on The National Strategy to Secure 5G Implementation Plan.*

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARSHA BLACKBURN TO ROSLYN LAYTON, PH.D.

Please note that these answers reflect my personal views and should not necessarily be construed as the opinion of any organization with which I am affiliated.

Question 1. The physics associated with the 12 GHz band present some interesting opportunities for expanding mid-band mobile broadband services in our 5G infrastructure. Compared to CBRS or C-band, this frequency appears to have some additional rain fade; however, the data rates should be comparably excellent. Furthermore, there are fewer hurdles to bring this band into the mobile broadband market. Can you comment on the overall benefits the 12 GHz band can bring to the wireless market?

Answer. The effort to find more spectrum for 5G is commendable. The hearing and my written testimony detailed the problems of administrative allocation of spectrum. There was a consensus among panelists that many Federal agencies are reluctant to make efficient use of frequencies for which they do not pay, to share them with other parties with more valuable uses, or even to disclose how they use the spectrum. All these problems can be attributed to the lack of pricing for Federal spectrum.

To avoid the problems of administrative allocation noted in the hearing, the Federal Communications Commission (FCC) should make any new spectrum available in the 12 GHz on a licensed basis with competitive bidding. It should avoid unli-

censed use of the band. Unlicensed spectrum regimes offer little means to allocate the spectrum rationally among users, introduce security risk and vulnerabilities into networks, and provide no means to recover the spectrum. Two articles are attached to this response which describe these issues.

Aside from the limitations of the 12 GHz band for terrestrial 5G service (notably rain fade and limited ability to deliver long distance coverage), the band could ostensibly support more coverage in cities. In general, having more spectrum for 5G would support greater deployment of services, market entry by firms, increased specialization by firms, and increased value for consumers. While the 12 GHz opportunity is promising, it should not detract form the more important goal of enabling greater spectrum in lower parts of the mid-band with frequencies which offers a better mix of physical properties for 5G. Nor should the 12 GHz effort delay Congress from its critical task to improve accountability from Federal spectrum holders.

Question 2. The next several years will be transformative for the U.S. for 5G infrastructure, with the CBRS auction currently ongoing and the C-band auction scheduled for December. An intriguing approach to how this network could be defined is by using the Open Radio Access Network (ORAN) specification, which is garnering attention in foreign markets but has been slow to be adopted in the U.S. Can each of you comment on the implications of whiteboxing our global 5G infrastructure? What are the economic implications if the U.S. *doesn't* adopt the ORAN specification in its mobile broadband infrastructure?

Answer. Thank you for the exciting question. As a starting point, it is important for such inquiries to be technology neutral. Ideally the telecommunications industry should choose the technology that best serves their needs and objectives. I don't fear that the U.S. won't be part of the ORAN development. Indeed, it is American companies that are driving much of ORAN's development.[1] My assessment of ORAN is based on 5G commercial development, and the fact that U.S. operators have been among the first to launch 5G. Given the hype around ORAN, it is wise to take a step back and take a critical view.

Understanding ORAN must account for the product lifecycle: idea, concept, development, and implementation. It's a long process from conceiving the idea of ORAN to turning it into a marketable product/service which is then implemented on tens of thousands of mobile sites serving millions of customers. Moreover, U.S. carriers must maintain a high standard of coverage and operability to satisfy their customers. Similarly, mobile operators place great demands on their equipment suppliers. Just as NASA has a set of software quality requirements to send people into space, mobile operators have requirements and standards for software. Mobile subscribers expect their mobile phones to function in the same way every time, just life turning on the faucet or flicking the light switch.

Some refer to ORAN as a substitute for native 3GPP solutions. However ORAN is not a substitute for 3GPP. ORAN is dependent on 3GPP and the patents that are the foundation of 5G.[2] ORAN will likely coexist with native 3GPP RAN which today serves more than 8 billion mobile subscribers globally. To date, there have been 92 5G networks launched in the world.[3] All of these are built on native 3GPP RAN; none are built on ORAN. The first operator to deploy ORAN will likely be Japan's Rakuten,[4] a virtual greenfield operator which is not comparable to NTT Dokomo, the country's leading mobile provider. As such, native RAN solutions still have significant value and should not be dismissed. Indeed, the prevailing market for 3GPP is staggering.[5]

All the first mover nations in 5G, including the US, are in the same position regarding 3GPP. The U.S. and South Korea lead in 5G in part because they use proven 3GPP solutions deployed for hundreds of millions, if not billions, of mobile subscribers. It is best to question U.S. mobile operators as to when ORAN is expected to be viable.

Network security is important. Thankfully the U.S. restricts Huawei and related malicious Chinese in-formation technology equipment. As such, the U.S. has flexibility to experiment with ORAN solutions while maintaining security. However, deploying ORAN in Europe could be disastrous because many Huawei elements re-

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[1] Consider the representation at the upcoming event "Forum on 5G Open Radio Access Networks" to be held by the Federal Communications Commission on September 14, 2020. *https://www.fcc.gov/news-events/events/forum-5g-virtual-radio-access-networks*

[2] About 3GPP. Accessed August 23, 2020. *https://www.3gpp.org/about-3gpp/about-3gpp*

[3] Global Mobile Suppliers Association. Accessed August 23, 2020. *https://gsacom.com/*

[4] Press release. "Rakuten Mobile and NEC Begin Production of Open RAN 5G Radio Equipment". March 24, 2020. *https://www.nec.com/en/press/202003/global_20200324_02.html*

[5] See report by Statista "A Mobile Connected World."*https://www.statista.com/study/74670/a-mobile-connected-world/*

main in mobile networks.[6] As such the benefits of ORAN will be undermined by Huawei products and services which will be able to infiltrate the network through ORAN's open inter-faces.

The first order of business is to rid the world's networks of malicious Chinese equipment. Only then should operators start experimenting with ORAN. Otherwise, combining ORAN with Huawei, ZTE, or other Chinese network products could increase risk and vulnerabilities.

ORAN is not by inherently more secure that native 3GPP, nor is open source technology more secure than proprietary technology. Indeed, ORAN will require additional security measures that are not addressed fully by 3GPP SA3 security standards, since ORAN introduces additional open interfaces and functions (such as LLS, SMO, near Real Time RIC, etc.) that are not part of the 3GPP standard. Moreover, the ORAN Alliance only recently formed a security task force, within O–RAN WG1 (Architecture) to address the new associated security risks with ORAN.[7] This means that security issues will take some time to address. Combining open source RAN with Chinese equipment poses a serious security risk.

Articles for the Record

THE U.S. RESTRICTS HUAWEI IN 5G, BUT WI-FI IS UP FOR GRABS

By Roslyn Layton, Senior Contributor, Forbes, April 23, 2020
https://www.forbes.com/sites/roslynlayton/2020/04/23/the-us-restricts-huawei-in-5g-but-wi-fi-is-up-for-grabs/#26915d83551e

The U.S. and other countries restrict Huawei in 5G (even providing funding to "*rip and replace"* the equipment), but this does not stop the company from deploying in Wi-Fi networks. Once a device is deployed in Wi-Fi, it can't be forcibly recalled for security reasons. Huawei touts its role in *Wi-Fi 6, considered the future-proofing strategy for the Wi-Fi industry.* The Austin-based Wi-Fi Alliance recently *honored* top tier *member* Huawei for its leadership in the Wi-Fi CERTIFIED™ program, allowing its products to be embossed with the Wi-Fi CERTIFIED™ seal. The advocacy group recently *congratulated* Federal Communications Commission Chairman Ajit Pai for the April 23 *vote* to designate 1200 MHz of the 6 GHz band for *unlicensed use,* quintupling the spectrum for technologies such as Wi-Fi. The Wi-Fi Alliance did not respond to a request for comment.

Unlicensed spectrum is celebrated for being free and open to anyone, and the Wi-Fi industry plans to deploy hundreds of millions of connected devices in the 6 GHz band. However, providers of critical infrastructure services in public safety, communications, rail, electric, gas, water, and wastewater are not enthused; they operate some 100,000 fixed service links in the band, over which the forthcoming Wi-Fi devices would be deployed. Failing to forestall the FCC's proposal which they say threatens the safety of their networks, they *urged* the FCC to adopt greater controls to mitigate interference, as regulating power levels for transmission is insufficient to protect existing networks. For example, many homes have backyards that border a railroad, and the signal for their Wi-Fi router, even at low power, can be observed outside. This means that a device need not have a security vulnerability to threaten critical infrastructure, to say nothing of deliberate security vulnerabilities.

The FCC may have *denied* China Mobile license to operate in the U.S. for national security concerns, but its daughter company *China Mobile Group Device Co.* can access U.S. networks through America's standards organizations and its Wi-Fi networks. Indeed China's influence of international standards organizations to circumvent national security policy is well established area of *policy research.*

Among the 800 members of the Wi-Fi Alliance are many firms owned and affiliated with the Chinese government and listed in the U.S. *National Vulnerabilities Database,* restricting their use in the Federal government. These member firms include Wi-Fi Alliance honoree *Lenovo,* world's leading maker of laptops, *ZTE Corporation* (network equipment), *Hangzhou Hikvision Digital Technology Co., Ltd.* (surveillance cameras), *Lexmark* (printers), and *TCL Corporation* (smart TVs). My report *Stealing from the States: China's Power Play in IT Contracts* documents how

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[6] Strand Consult. July 2020. "Understanding the Market for 4G RAN in Europe: Share of Chinese and Non-Chinese Vendors in 102 Mobile Networks." *http://strandreports.com/sw8772.asp*

[7] See Matt Kapko. "Integration Woes Throw Monkey Wrench Into Open RAN." SDX Central. July 13, 2020. *https://www.sdxcentral.com/articles/news/integration-woes-throw-monkey-wrench-into-open-ran/2020/06/* and Arielle Waldman. "Supply chain attack hits 26 open source projects on GitHub." Search Security. May 28, 2020. *https://searchsecurity.techtarget.com/news/252483808/Supply-chain-attack-hits-26-open-source-projects-on-GitHub* Note valuable free report linked to the article.

such companies have evaded rules against their deployment in U.S. Federal networks to embed themselves at the state level, home to treasure troves of sensitive data for elections, financial reports, and personal information but which have fewer security controls.

The bipartisan sanction of Huawei by Congress, the Department of Commerce, the FCC and other agencies may have stopped Huawei from Federal networks and 5G, but it doesn't necessarily stop Huawei in state government, private companies, and Wi-Fi networks. Indeed, many vulnerable technologies proliferate where there are not explicit restrictions. Moreover, Federal bans do not stop Chinese government-owned companies from playing important roles in U.S. standard setting and IT advocacy organizations. Following placement on the *Entity List,* Huawei was *ejected* but then quickly *rein-stated* as a member at the Wi-Fi Alliance, *IEEE, SD Association,* and *JEDEC.* Some claim there is no choice but to accept Chinese government owned vendors in standards groups, but China's endgame is clear: It has long been architecting an *alternative version of the Internet* which does not include American technology nor any pretense of coexistence.

While the value of Wi-Fi is undisputed, the FCC's proposal would give restricted Chinese firms free rein to a wide swath of spectrum *overlaying critical infrastructure for utilities, transportation and public safety.* Moreover, the U.S. is behind on licensing mid-band spectrum where malicious vendors and de-vices can be excluded. China has some 500 MHz of mid-band spectrum in play for 5G, the U.S. hasn't even concluded its mid-band 5G auctions, itself a national security issue *raised* by two dozen security and defense experts. If we don't want Huawei in 5G, it shouldn't be in Wi-Fi either.

FCC Should Use Its New Tools to Make Wi-Fi Safer

The FCC should step up security by restricting risky vendors on unlicensed Wi-Fi spectrum and make more licensed spectrum available for 5G wireless communications.

By Roslyn Layton and David Witkowski. Above Ground Level. August 2020
https://magazine.aglmediagroup.com/fcc-should-use-its-new-tools-make-wifi-safer

The coronavirus (COVID–19) pandemic has shown that broadband networks are essential. People have used wireless networks to work, learn and obtain health care services. However, they face greater security risks when accessing enterprise applications and sensitive data with unsecured networks and devices, as may be the case when they are working at home.

The most common cyberattacks—data breaches, phishing and hacking—are driven primarily by organized crime and state-sponsored actors for financial and espionage reasons. Cyber attackers are looking for valuable personal and financial information, intellectual property and proprietary product information, corporate account information about key employees and customers, and corporate network access. Individuals having endured extensive isolation during the pandemic are further vulnerable to phishing and social engineering attacks together with hacking when they increasingly multitask on a mobile device connected to Wi-Fi, a usable but architecturally unsecured network.

In the past year, the *FCC adopted* significant national security policy, including a prohibition of using Universal Service Funds to purchase equipment or services from companies posing threats to communications networks or supply chains. This move was designed in part to restrict *Huawei* and ZTE from 5G networks, which already have better security because of a superior architecture. The FCC has not stated a similar plan for Wi-Fi, even though Wi-Fi is teeming with vulnerable vendors, and *Huawei itself touts* its leadership role in Wi-Fi 6. Now armed with a *supercharged presidential executive order* to deny and revoke licenses and applications from risky vendors, the FCC should use its authority to make Wi-Fi safer.

Why 5G Has Better Security Than Wi-Fi

Wi-Fi is ideal for *local*-area networks and enterprise deployments in office buildings. 4G LTE and 5G NR, on the other hand, are suited to *wide*-area networks and infrastructure deployments that require connection management to ensure reliability and predictably for millions of users at once. These differences reflect the economic choices inherent in licensed and unlicensed spectrum. 5G providers, having spent billions of dollars to purchase the right to transmit data across the airwaves, steward the resource wisely and safely to ensure a good experience for their customers. Unlicensed spectrum, free and open to anyone, has few incentives to be stewarded well. As such, those who value security, pay for it.

Where other users are known, security is less important, and devices can manage their own connections. Users accessing an open, no-password-required Wi-Fi access

point take enormous risks. As Wi-Fi access points grow, it is prudent to adopt rigid security protocols where the network manages the device connection. A connection-oriented or connection-managed protocol (WiMAX, 4G LTE, 5G NR) *requires* that an end-to-end data link between the sending node and receiver node be established both before and while data is transferred.

Connection-managed protocols have better reliability, predictability and security because the encryption key exchange is end-to-end and must be completed before data is transferred. In a connection-less protocol, like Wi-Fi, data is sent from the sending node to the network *without requiring* an end-to-end link. Users can employ security technologies to protect data from being lost, misrouted or intercepted, but many threats are managed more efficiently at higher levels in the network. Although forthcoming Wi-Fi 6 equipment offers better security, it will take time for every Wi-Fi router to be upgraded, leaving Wi-Fi users at risk in the meantime. With 5G, however, users have built-in advanced security, regardless of the device.

Connection-managed wireless networks such as 4G/5G allow mobility, moving quickly across a large space while keeping a secure, consistent connection. This mobility is provided by a hand-off system that shifts the connection to the best possible tower or site. On unlicensed, connectionless systems, the client will remain attached to the access point until the connection is so poor that it fails. Although some solutions try to make Wi-Fi better, they typically require upfront investment, which can add cost to the proffered free-and-open business model.

4G/5G offers patented features to ensure a high-quality experience: centralized authentication (intelligence in the device ensures network authentication), network rules for security of data transmission; protocols to avoid congestion, spectrum/channel steering, and resource allocation management. 5G security is not perfect—attacks using cellular site equipment (either repurposed or deliberately built to allow state-sponsored surveillance) could harm subscribers, but hacking the firmware of a consumer-grade Wi-Fi access point is a lot easier—and far less expensive—than constructing a cellular site.

Restricting Risky Vendors Can Improve Wi-Fi

Although improving the architecture of Wi-Fi is difficult, Wi-Fi security can be immediately improved by restricting risky vendors and equipment from networks. The FCC has been dogged about restricting malicious Chinese government-owned technology on 5G. Consumers deserve the same security on Wi-Fi, and the FCC should hold Wi-Fi providers to the same standards as required on 5G.

Historically, any device could use unlicensed networks, provided it complied with the FCC's regulated power levels, a certification that comes with the FCC sticker on the back of the device. However, the new "Team Telecom" order allows the FCC to deny or revoke device applications for security reasons.

U.S. policy has clamped down on Huawei for good reason, but it is hardly the only Chinese government-owned technology firm to worry about. American Wi-Fi networks and standards organizations are teeming with such companies, including Lenovo, Panda Electronics, Skyworth, SVA, TCL, Xiaomi, BOE, Changhong, Haier, Hisense, Konka and DJI. The security threats of backdoors and viruses from devices from these companies are considerable. Moreover, they all operate under China's draconian Internet and espionage laws that assert China's sovereignty over the Internet and its authority to collect any data on any Chinese-made device anywhere in the world. These companies are restricted on Federal government networks, but their equipment presents the same vulnerabilities on commercial networks and on state government networks, where they are currently unrestricted.

Mid-band Spectrum Improves 5G Security

By opening the 6–GHz band, the FCC quintupled the spectrum for unlicensed technologies: some 1200 megahertz will be available for Wi-Fi. Not only does the FCC need to step up security by restricting risky vendors on unlicensed spectrum, it needs to make more licensed spectrum available for 5G, a more secure technology than Wi-Fi. China has some 500 megahertz of mid-band spectrum in use today and has deployed some *160,000 5G base-stations in 50 cities.* The United States must wait until December for an auction of 250 megahertz and yet another year thereafter to repack the spectrum, a slow pace which is itself a national security concern. As COVID–19 has shown, we needed networks yesterday. At the least, the FCC has more tools to use to improve security and should use them to make Wi-Fi safer.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JERRY MORAN TO MICHAEL CALABRESE

Question 1. The FCC took significant action in designating 1200 megahertz for unlicensed use in the 6 gigahertz band this spring. How do you expect this development to impact at-home connectivity opportunities in rural communities, especially as it relates to telehealth needs?

Answer. Senator Moran, thank you for your timely question. My organization and our entire Public Interest Spectrum Coalition (PISC) expect the FCC's world-leading decision in April to authorize unlicensed use across the entire 6 GHz band to yield perhaps its greatest benefits in rural communities, including for telehealth. Rural, small town, Tribal and historically marginalized communities are most likely to find themselves on the losing side of the digital divide. We expect the next generation of Wi-Fi—Wi-Fi 6—to be as big a leap forward in affordable connectivity as mobile 5G networks will be compared to 4G. Thanks to the wide, contiguous channels of unlicensed spectrum the FCC made available in the 6 GHz band, Wi-Fi 6 will accelerate the availability and affordability of 5G-quality applications and services in rural communities that will not have access to mobile carrier 5G for many, many years.

Unlicensed access to 1200 megahertz at 6 GHz will have a disproportionately positive impact on rural communities and telehealth for several reasons:

First, while 5G networks may not reach rural, small town or even many exurban communities for many years, smaller and local providers of high-capacity fixed wireless broadband that rely primarily on unlicensed and coordinated sharing of unused spectrum capacity can more rapidly extend high-capacity and more affordable fixed broadband access to these underserved areas. More mid-band unlicensed (at 5.9 and 6 GHz) and shared spectrum (the new Citizens Broadband Radio Service) will serve as the public infrastructure that enables high-capacity broadband in less densely-populated areas. The 850 megahertz in the 6 GHz band that will be accessible to WISPs and other providers at full (standard) Wi-Fi power limits allows for as many as five gigabit-fast, 160-megahertz channels of capacity for outdoor use. Capital costs to deploy fixed point-to-multipoint (P2MP) wireless connections using this unlicensed spectrum are a fraction—about one-seventh the cost—of fiber and are still able to provide high-throughput broadband service.[1] Fixed wireless service relying on unlicensed spectrum is also far more cost-effective per gigabyte for this purpose than mobile networks relying on more limited licensed spectrum. In addition, anywhere a high-capacity fixed service is available, Wi-Fi 6 can provide the same consumer benefits as licensed 5G and more affordably. This means more homes and small businesses will be connected for telehealth and other services at far higher speeds and more affordably.

Second, all 1200 megahertz of the 6 GHz band are available for use indoors at a lower power level and without the additional cost or complexity of being controlled by an Automated Frequency Control (AFC) system, as standard power outdoor Wi-Fi must be. (The AFCs required for outdoor use of 6 GHz are geolocation databases that operate very much like the TV White Space databases do today.) Indoors, all 1200 megahertz will be fully available, enabling multi-gigabit throughput on Wi-Fi routers that will have access to seven channels as wide as 160-megahertz. Wi-Fi is the workhorse of the Internet because low-cost, off-the-shelf routers and devices can easily and affordably offer access to unlicensed spectrum that provides high-capacity connectivity in homes, at work, at school, in libraries, retailers and healthcare facility. With access to 6 GHz, *all* of the bandwidth that a home can access on its fixed broadband service (whether wireline or wireless) can be distributed and useful to every device, including health care monitors and sensors that could be using a variety of unlicensed technologies.

Third, Wi-Fi plays an increasingly important role in connecting healthcare, education, manufacturing, technologies. Hospitals, clinics and doctors will increasingly be able to rely on telehealth as both they and their patients acquire affordable, high-capacity wireless connectivity. More broadly, IoT and other high-capacity, local-area networks—most of which will be indoors and connect everything—are likely to make unlicensed spectrum an even more critical part of a truly robust 5G ecosystem. Hospitals are a perfect example of congested, high traffic, constantly changing environments that would benefit from Wi-Fi 6. As more smart devices are adopted at hospitals and the use of data analysis in healthcare grows, the need for large, contiguous bands of unlicensed spectrum for indoor use is absolutely vital. Farms and ranches will also have far more capacity for smart agriculture and related pro-

[1] *See* The Carmel Group, *Ready for Takeoff: Broadband Wireless Access Providers Prepare to Soar with Fixed Wireless,* at 12, Fig. 6 (2017).

ductivity gains. Any farm, campus or enterprise will be able to customize a very high-capacity Wi-Fi 6 network to meet its needs without relying on a 5G mobile carrier service that might not even be available.

Overall, this new unlicensed capacity will make telehealth applications and services far faster, more reliable and more affordable.

Question 2. Your testimony described OTI's support for flexible use rights issued to Multichannel Video Distribution and Data Service (MVDDS) licensees in the 12 gigahertz band. Can you describe to this Subcommittee how this suggested policy change would benefit rural communities through increased broadband connectivity while protecting incumbent operations?

Answer. The 12 GHz Band provides an opportunity to adopt a sharing framework in this valuable but underutilized band that greatly expands the availability of spectrum for both fixed and mobile broadband deployments with mid-band propagation characteristics significantly better than the millimeter wave bands at 24 GHz and beyond. Specifically, my organization and many other parties support consideration of the proposal made in a petition for rulemaking filed by the MVDDS Coalition.[2] Given this Commission's commitment to opening additional mid-band spectrum for 5G services, including low-power unlicensed uses for Wi-Fi 6, a Notice of Proposed Rulemaking to consider the best way to achieve more intensive and efficient use of this 500 megahertz at 12.2–12.7 GHz is in the public interest.

In addition to considering two-way and more flexible use rights for MVDDS licensees, the NPRM should request comment on the authorization of coordinated, shared use of the band for high-capacity fixed wireless services on an unlicensed or secondary basis. Opening access to unused 12 GHz spectrum can provide spectrum-as-infrastructure to fixed wireless ISPs and other broadband network providers in underserved rural, tribal and less densely populated communities. Coordinated sharing of unused portions of the 12 GHz band could be particularly beneficial for rural, tribal and other underserved communities. A recent study by BroadbandNow Research found that 42 million Americans lack access to wireline or fixed wireless broadband, nearly 13 percent of the population, with a disproportionate share in rural and small town communities.[3] Surveys by the Pew Research Center found that only 63 percent of rural Americans said they having broadband at home, compared to 79 percent of suburban Americans and 75 percent of Americans living in urban areas.[4]

These less-densely-populated areas tend to have lower rates of broadband adoption due to the high costs for both backhaul and last mile buildout. This makes fixed wireless access, both P2P and P2MP, particularly potent in narrowing the connectivity gap. Rural communities will especially benefit from the higher capacity throughput that wireless ISPs could potentially offer with local access to this spectrum. As the current COVID–19 crisis has made painfully clear, adequate and affordable broadband access has become critical for accessing education, healthcare, government services and the modern workplace.

A use-it-or-share-it opportunity at 12 GHz will help expand affordable broadband services in rural, tribal and other communities where there is a limited economic incentive for a national or regional carrier to offer service, but still a real economic need for the community. Rather than leave as much as 500 megahertz in the band fallow in underserved rural and other less-densely-populated areas, the Commission should consider a "use it or share it" approach that allows at least secondary, coordinated access for fixed broadband uses (both point-to-point and point-to-multipoint). Conceptually, this approach is similar to the Commission's very recent and successful authorization of coordinated access to unused spectrum in the lower 45 megahertz of the 5.9 GHz band in the face of the Covid crisis.[5] Wireless Internet service providers (WISPs) are making coordinated, secondary use of the spectrum to boost the capacity of their fixed wireless deployments that rely on the adjacent unlicensed

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[2] *See* MVDDS 5G Coalition Petition for Rulemaking to Permit MVDDS Use of the 12.2–12.7 GHz Band for Two-Way Mobile Broadband Service, RM–11768 (filed Apr. 26, 2016).

[3] John Busby *et al.,* "FCC Reports Broadband Unavailable to 21.3 Million Americans, BroadbandNow Study Indicates 42 Million Do Not Have Access," BroadbandNow Research (Feb. 3, 2020), *https://broadbandnow.com/research/fcc-underestimates-unserved-by-50-percent.*

[4] Andrew Perrin, "Digital gap between rural and nonrural America persists," Pew Research Center (May 31, 2019), *https://www.pewresearch.org/fact-tank/2019/05/31/digital-gap-between-rural-and-nonrural-america-persists/*.

[5] *See* FCC Press Release, "5.9 GHz Band Boosts Consumer Internet Access During Covid-19 Pandemic," May 4, 2020. Available at: *https://docs.fcc.gov/public/attachments/DOC–364138A1.pdf*

spectrum band (U–NII–3) to make affordable broadband service available in mostly rural, small town and historically underserved areas.[6]

A coordinated sharing process at 12 GHz could operate very much like the new Citizens Broadband Radio Service (CBRS), which authorizes secondary and temporary access to the licensed portion of the band (70 megahertz) in any local area where post-auction Priority Access licensees have not yet deployed or commenced service. By similarly relying on a coordination database, this proven approach can ensure that unused spectrum is put to use in rural and other hard-to-serve areas without any risk of interference or any negative impact whatsoever on the primary licensees.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARSHA BLACKBURN TO MICHAEL CALABRESE

Question 1. The physics associated with the 12 GHz band present some interesting opportunities for expanding mid-band mobile broadband services in our 5G infrastructure. Compared to CBRS or C-band, this frequency appears to have some additional rain fade; however, the data rates should be comparably excellent. Furthermore, there are fewer hurdles to bring this band into the mobile broadband market. Can you comment on the overall benefits the 12 GHz band can bring to the wireless market?

Answer. Senator Blackburn, thank you for your question and for recognizing the tremendous potential for expanded use of the 12 GHz band. As I noted in my response to Senator Moran's question concerning the potential benefits of the 12 GHz band to rural communities (above), my organization and many other parties support consideration of the proposal made in a petition for rulemaking filed by the MVDDS Coalition.[7] By adding the 12 GHz Band to the FCC's 5G FAST Plan, the Commission can make an additional 500 megahertz of contiguous spectrum available for two-way fixed and mobile 5G wireless broadband services, while protecting incumbent satellite uses (including satellite broadband) from harmful interference. This will promote competition, innovation and improve services to underserved communities.

When the Commission adopted the current MVDDS rules in 2000,[8] long before smartphones or online video services, we lived in a very different world. At that time, DBS was a fast-growing service and spectrum sharing based on interference mitigation technologies did not exist. Today, DBS is rapidly losing customers, while broadband satellite providers using a different technology from DBS are poised to enter the market. Fixed wireless using both licensed and unlicensed spectrum has become an important component in closing the rural digital divide. And competition in the mobile wireless sector has gone from highly competitive in 2000 to highly concentrated in 2020.

The 12 GHz Band provides an opportunity to adopt a sharing framework that greatly expands the availability of spectrum for both fixed and mobile broadband deployments with mid-band propagation characteristics significantly better than the millimeter wave bands at 24 GHz and beyond. As we told the FCC in a May letter joined by the Competitive Carriers Association and other diverse stakeholders, "if two-way, 5G wireless broadband services were allowed, initial use cases would include fixed broadband, mobile 5G services to handsets and street-level Internet of Things opportunities."[9]

More flexible spectrum use rights for existing licensees can also promote competition in mobile broadband. As a consequence of the T-Mobile acquisition of Sprint,

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[6] Claude Aiken, "FCC 5.9 GHz STA Helps WISPs Serve Through COVID–19 Pandemic," Claude's Blog, Wireless Internet Service Providers Association (WISPA), available at *http://wispa.org/news_manager.php?page=21979*.

[7] *See* MVDDS 5G Coalition Petition for Rulemaking to Permit MVDDS Use of the 12.2–12.7 GHz Band for Two-Way Mobile Broadband Service, RM–11768 (filed Apr. 26, 2016). *See also* Letter of Competitive Carrier Association, INCOMPAS, *et al.* to Chairman Ajit Pai, RM–11768 (filed May 26, 2020); Letter of the Dynamic Spectrum Coalition to Chairman Ajit Pai, RM–11768 (filed August 21, 2020).

[8] Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range, First Report and Order and Further Notice of Proposed Rule Making, 16 FCC Rcd 4096 (2000) ("MVDDS First R&O"); Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band with Frequency Range, Memorandum Opinion and Order and Second Report and Order, 17 FCC Rcd 9614 (2002)

[9] *See* Letter of Competitive Carrier Association, *et al.* to Chairman Ajit Pai, RM–11768 (filed May 26, 2020).

American consumers are now limited to a choice of three national carriers. As a consequence, it is imperative that the Commission ensure that DISH has access to sufficient spectrum to compete aggressively with the incumbent providers. More flexible use rules for MVDDS licensees will enhance DISH's chances of success. We believe maximizing the number of potential 5G providers through a 12 GHz rulemaking offer the best chance for rural Americans to benefit from more broadband access and competition.

Question 2. The next several years will be transformative for the U.S. for 5G infrastructure, with the CBRS auction currently ongoing and the C-band auction scheduled for December. An intriguing approach to how this network could be defined is by using the Open Radio Access Network (ORAN) specification, which is garnering attention in foreign markets but has been slow to be adopted in the US. Can each of you comment on the implications of whiteboxing our global 5G infrastructure? What are the economic implications if the U.S. *doesn't* adopt the ORAN specification in its mobile broadband infrastructure?

Answer. Senator Blackburn, thank you for your question about an Open RAN specification. I cannot answer in detail, since I haven't researched or focused on this important issue. My organization, the Open Technology Institute, generally supports open and interoperable technology platforms, which we believe promote innovation, competition and ultimately lower prices for consumers. ORAN has the potential 'break the RAN stack' and thereby stimulate new competition. Opening the stack to competing vendors, including American companies, can spur competition and downward pricing pressure for the various components of 5G network infrastructure. Virtualized RAN deployments can substantially reduce the capital and operating costs of 5G networks, yet the RAN ecosystem remains closed and dominated by non-American companies using proprietary interfaces.[10]

If the U.S. does not adopt an ORAN specification, these market entrants and U.S. companies will continue to be blocked by foreign-based companies that are able to force mobile network providers to purchase integrated 5G network infrastructure based on proprietary interfaces. Without an ORAN specification, a few large and foreign-based wireless infrastructure providers will have tremendous market power and dominate the market. This would likely result in higher prices and less innovation compared to a market premised on open and interoperable components. The absence of an ORAN specification could have security implications as well, particularly if the pressures of limited choice and competition pushes network providers into a reliance on infrastructure sold by companies that are not free from state influence and control.

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[10] *See, e.g.,* "Leveraging O–RAN to Stimulate U.S. Investment and Leadership in Wireless Technology," DISH, white paper (March 2020).