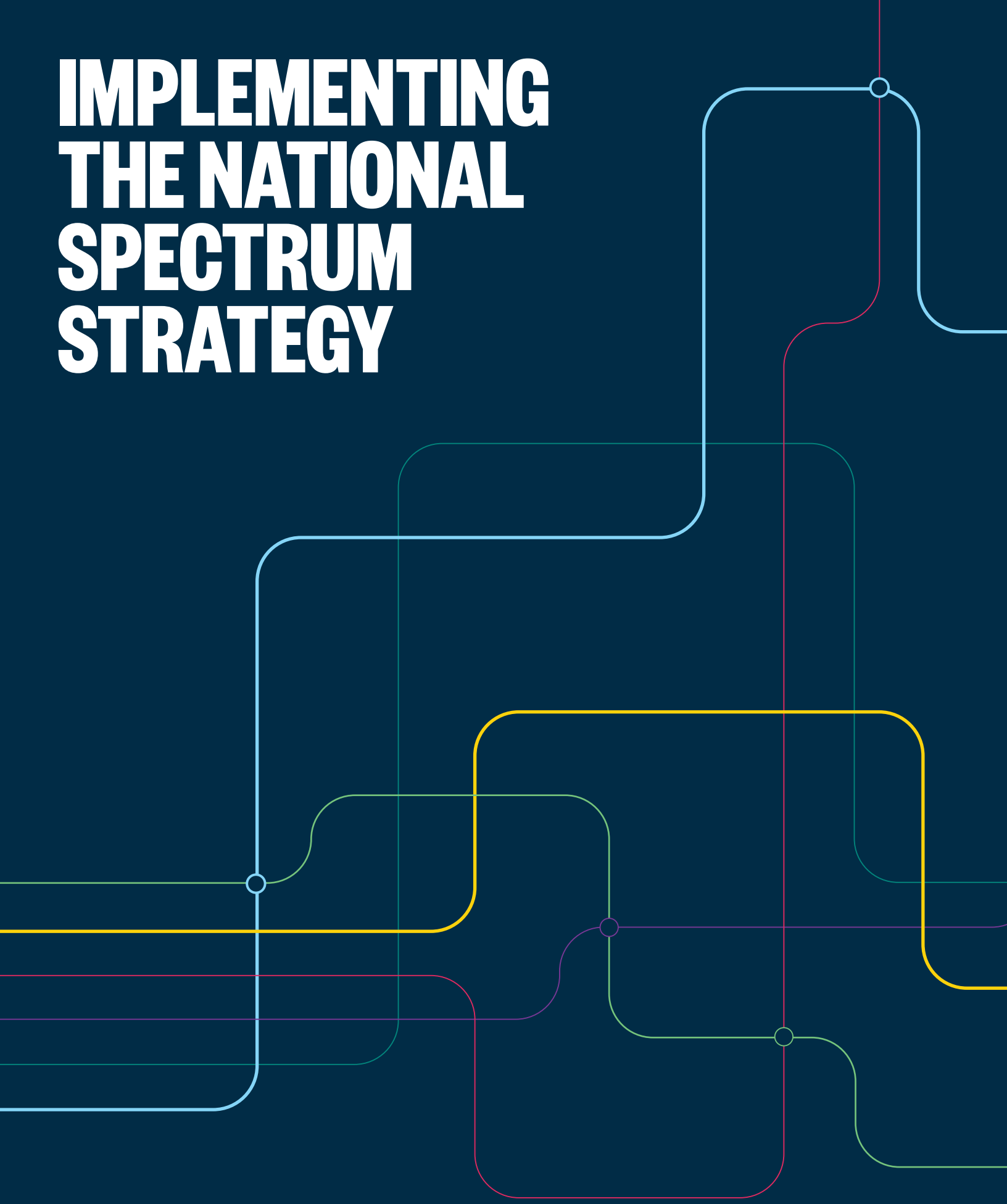
IMPLEMENTING THE NATIONAL SPECTRUM STRATEGY



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FOREWORD

Wireless technologies connect our nation, power our economy, reshape critical public services, and will do so even more in the years to come. These essential technologies are leveraged across industries and functions—in manufacturing, supply chain, media, automotive, communications, agriculture, education, and so much more. Radio waves, otherwise known as "spectrum," make wireless technology possible. The global and U.S. spectrum environment has become increasingly contested and constrained as demand for innovative wireless services has accelerated. At the same time, spectrum stakeholder policy disputes have amplified.

Retaining U.S. leadership in next-generation technology and services will require the U.S. Government to reinforce principled, forward-looking national spectrum priorities. Over the past several decades, the U.S. has been the international leader by developing, in a bipartisan fashion, new spectrum policies to meet increasing commercial demand. Despite tremendous progress in the last three decades, however, the U.S. once again finds itself with a need to develop ways to enable the wireless revolution to meet the demands of new innovative technologies and services.

In 2022, the Aspen Institute convened a roundtable on spectrum policy with Government and public and private sector stakeholders to address that need, which led to a report issued a few months later, a report that was intended to help frame the discussion for the U.S. Department of Commerce's National Spectrum Strategy issued the following year. On July 11–12, 2024, the Aspen Institute again convened a roundtable on spectrum policy to build on the intellectual foundation and achievements in Aspen's 2022 spectrum policy report and to forge new opportunities to move forward into the next era of U.S. policy leadership. The efforts sought to balance the needs of both the commercial wireless sector and federal missions while highlighting consensus-based themes across all interested vectors.

This report captures the discussions at that 2024 roundtable, setting forth broad recommendations for a principled and science-based U.S. spectrum policy for the years ahead.
First, the report delves into the evolving spectrum landscape, discussing the terrestrial wireless marketplace, space economy, and how spectrum supports U.S. Government missions.

Second, the report provides an overview of the 2022 Aspen Institute Report, the National Spectrum Strategy, and U.S. spectrum policy now and in the future.

The report then offers five broad recommendations as the U.S. Government examines its national spectrum policies: (1) prioritize principled and forward-looking national spectrum policies; (2) balance values and perspectives, including national security; domestic economic considerations and global competition; consumer, enterprise, and public safety needs; and innovation and scientific discovery; (3) continue to seek new Federal and non-Federal spectrum access opportunities by evaluating additional bands for reallocation and repurposing, building upon U.S. spectrum auction success, and exploring spectrum sharing development and opportunities; (4) promote coordination and harmonization here and abroad; and (5) expand on existing recommendations by enhancing transparency around Federal and non-Federal spectrum use and needs, reforming the Commercial Spectrum Enhancement Act, facilitating radio spectrum workforce development, and conducting targeted community outreach on the societal benefits of spectrum and spectrum policy. We are hopeful that this report will prove valuable to policymakers and lawmakers on bipartisan steps that can be taken to support commercial and Government spectrum needs now and into the future.

VIVIAN SCHILLER
Vice-President and Executive Director
Aspen Digital

I.
AN EVOLVING SPECTRUM LANDSCAPE

A. SPECTRUM ACCESS AND POLICY DRIVE ECONOMIC GROWTH AND FURTHER NATIONAL SECURITY

Many essential technologies rely on access to spectrum, including cellular phones, TV, weather tracking systems, Wi-Fi hotspots, national security radars, drones, and satellites. Wireless technologies that provide advanced connectivity boost economic growth and enhance the global competitiveness of U.S. industries. And, as noted in the National Spectrum Strategy ("NSS"), "[e]ssential government missions rely on wireless systems on the ground, in the air, at sea, and in space to protect our national security and to provide services that deliver important public benefits."[1]

Spectrum Stakeholders and Users. Spectrum stakeholders, as referred to throughout this document, are those with an interest in how spectrum policy is developed and managed, and include commercial and federal incumbents (i.e., private industry and Government users already holding licensed or other authorizations to use a particular band) and unlicensed users (i.e., those who are using bands without a license pursuant to allowances for this kind of "free" use by the Government). Spectrum users are found across sectors, including federal and state agencies and employees, cellular and satellite Internet companies and their customers, first responder agencies and first responders themselves, TV and radio broadcasters, non-profits, critical infrastructure service providers, space launch service providers and space researchers, and others. Spectrum access by each of these sectors drives U.S. economic growth, increasing access to education and job training, creating jobs, and encouraging foreign and domestic economic investment. It enables companies to be more innovative and serve the needs of consumers nationwide. And it empowers Government and public safety users to keep our communities safe and enhance our national security.

U.S. Spectrum Policy and Management. Spectrum is a public resource that, when managed effectively and equitably, can be used to increase economic growth and innovation. However, spectrum is also a finite resource, and access to and use of different frequency bands is managed by the Government. In the U.S., Congress can pass legislation on spectrum policy and spectrum bands are designated for oversight by two expert federal agencies: the Federal Communications Commission ("FCC"), an independent federal agency, and the National Telecommunications and Information Administration ("NTIA"), a specialized Executive Branch agency housed within the U.S. Department of Commerce. NTIA manages the Federal Government's spectrum access and use, while the FCC manages non-federal spectrum access and use, including private, commercial, and public safety radio signals. Spectrum also provides a source of revenue for the U.S. Government, where the rights to transmit signals over specific bands for certain wireless services are auctioned off to telecommunications companies, bringing in billions of dollars to the U.S. Department of the Treasury and supporting congressionally directed national priorities.

Spectrum Authorization Models. As spectrum is a finite resource, various spectrum authorization models have been developed to satisfy ever-increasing spectrum demand by different categories of uses. For example, "exclusively licensed," auctioned spectrum rights have enabled mobile network providers to continually invest in successive generations of cellular networks. Unlicensed spectrum access is another model, which allows "free access" to a portion of spectrum. Various important technologies we use every day are made possible through unlicensed use, such as Bluetooth and Wi-Fi.

Spectrum Sharing. Because there is very little freely available spectrum left "for the taking," sharing of spectrum bands between different, compatible uses is an essential part of principled, forward-looking national spectrum priorities. Spectrum sharing leverages advances in radio technology to enhance a band's productivity, particularly when a band cannot be cleared of its older incumbent uses.

There are two main types of spectrum sharing: (1) sharing and coordination between a federal or non-federal legacy incumbents and new entrants, like commercial wireless, which could be licensed (e.g., in the AWS-3 band or the Citizens Broadband

Radio Service ("CBRS")) or unlicensed (e.g., the 6 GHz band, which is shared with incumbent licensees) and (2) secondary sharing, between new entrants on a "level playing field" (e.g., unlicensed sharing in bands by default (e.g., Wi-Fi or Bluetooth). Spectrum sharing has been successfully executed in the allocation of various spectrum bands using innovative technological approaches, including dynamic spectrum sharing ("DSS") and more static sharing frameworks.

B. THE TERRESTRIAL WIRELESS MARKETPLACE

Wireless data traffic has exploded over the last two decades, and wireless connectivity providers have had to continually invest to keep pace with data growth.[2] Moreover, there has been a shift in competitive dynamics in both the terrestrial fixed and mobile wireless markets. Below are just some examples of the state of the terrestrial wireless marketplace.

Mobile Wireless Market. The mobile wireless market has seen substantial growth in deployments and device development, with large growth due to the increase in data-only devices and Internet of Things connectivity as well as the increased popularity of smartphones and the move away from landlines. In the U.S., "overall mobile wireless traffic grew at a compound annual rate of approximately 55 percent between 2010 and 2022 and overall U.S. mobile subscribers grew at a compound annual rate of approximately five percent between 2010 and 2022."[3] Additionally, "U.S. mobile wireless providers invested more $364 billion in nominal dollars ($434 billion in December 2022 dollars) between 2010 and 2022 to improve networks."[4] Cable companies also have become players in the mobile wireless market, appearing to serve as a "true fourth" competitor, and have gained market share against nationwide mobile network operators.[5]

Fixed Wireless Access ("FWA") Market. FWA "provides home internet access using wireless mobile network technology rather than fixed lines."[6] And "North America is expected to hold the most significant global fixed wireless access market share during the forecast period."[7] This technology is rapidly growing, offering wireless high-speed home broadband connectivity to consumers

across the country. FWA accounts for about half of mobile network traffic,[8] and by 2029, over 330 million FWA connections are expected worldwide.[9]

Unlicensed Technologies. The terrestrial wireless market is also home to technologies such as Wi-Fi and Bluetooth, which make use of the "permissionless" innovation enabled by unlicensed spectrum access, or the portion of spectrum not licensed by the FCC. A 2022 report found that unlicensed spectrum "generates $95.8 billion per year in incremental sales value."[10] Other technologies that function by using unlicensed spectrum include "smart" home appliances, unlicensed IoT devices, electric vehicle toll tags, and more. As of July 2024, there were approximately 400 thousand base stations for CBRS (i.e., the 3.5 GHz band), which, in part provides for "license by rule" and open, flexible access to the band.[11]

Additional access to spectrum can benefit each of these markets, and spectrum access should not be limited to those use cases that exist today but should also look forward to use cases that might exist in the future. This is particularly the case when building out network capacity to support mobile and fixed wireless competition.

C. THE SPACE ECONOMY

The space economy, powered by spectrum and utilized by both federal and non-federal satellite users, provides critical information and services to the U.S. and world economy. Among other uses, the space economy includes remote sensing satellites (both commercial and Government, enabling Earth observation and weather satellites); radio astronomy; Positioning, Navigation, and Timing ("PNT") needs; radars; and satellite communications (both military and commercial). Space exploration was pioneered by the Federal Government, including by the National Aeronautics and Space Administration ("NASA") and other federal agencies. The National Weather Service ("NWS") uses spectrum to acquire and transmit meteorological observations back to earth stations[12] and NASA lunar systems. Space is critical to securing our nation, and U.S. defense agencies have requested increased budgets for space-based services relying on spectrum, recognizing this criticality. Globally, the space economy is forecasted to reach $1.8 trillion in value.[13]

PNT Needs. PNT is the combination of three different interrelated capabilities: Positioning, Navigation, and Timing.[14] As the U.S. Department of Homeland Security has discussed, "PNT services have become an invisible but essential utility for critical infrastructure operations across many sectors, including the electric power grid, communications infrastructure, transportation, agriculture, financial services, and emergency services."[15] The Global Positioning System ("GPS") is an example of PNT service available for use to the public, as well as some capabilities reserved for military and national security operations. GPS satellites depend on spectrum access to airwaves function properly. GPS demonstrates the interrelationship between different spectrum users as many terrestrial cellular networks depend on GPS for network synchronization and timing. In the United States, GPS has been estimated to generate $1.4 trillion in economic benefits (in 2017 dollars) since it was launched.[16]

Commercial Space Communications. Satellite Internet, television, radio, and phones are all commonly used commercial communications in our society, and all are powered by spectrum. Commercial communications transmitted via satellite to, from, and within the U.S. must be licensed by the FCC and requires a space station and an earth station communicating with each other using spectrum. Satellite Internet can deliver high-speed broadband to households in rural areas, especially those with geographic features that make it more difficult for a spectrum signal to transmit (e.g., mountains or thick forest cover). The global socio-economic benefits of satellite broadband for households are estimated to be approximately $52 billion by 2030.[17]

Commercial Space Launch Services. Commercial space launch entities are increasingly involved in all aspects of U.S. space-based activities, including the "transportation of cargo and people into space, orbital launches to place satellites into space, and suborbital launches."[18] Wireless communications, and therefore spectrum access, are essential to the command and control of all phases of space travel. The global commercial space launch services market size is expected to grow from $4.91 billion in 2024 to $10.98 billion by 2032.[19]

Military Uses. The U.S. Government, including the Department of Defense ("DoD") and intelligence community, increasingly relies on commercial satellites and space services for secure communications, remote sensing services, and other capabilities

necessary for national security. Satellites also may provide advanced weather forecasts and monitoring of important sites. The military communications industry is expected to be valued at $35.4 billion by 2028.[20]

D. SUPPORTING GOVERNMENT MISSIONS

Spectrum is deployed to support Government missions, both military and non-military. Uses include, but are not limited to, communications, radar, weather monitoring, navigation, intelligence gathering, and research. U.S. Government missions dependent on spectrum access are conducted by the Executive Branch and a wide range of federal agencies, including DoD, NASA, the National Oceanic and Atmospheric Administration ("NOAA"), the Central Intelligence Agency, the National Security Agency, and others. Military spectrum monitoring systems enable troubleshooting to resolve interference when "friendly" transmissions are interfered with and disrupted. Below are discussions of just two examples of the many spectrum-based Government missions.

National Defense. Electronic Warfare ("EW") is the use of electromagnetic energy by the military to effectively engage in combat. Modernizing EW and improving U.S. capabilities to counter EW is essential to our national defense and requires funding and additional spectrum access. Among other things, agents in the field need EW capabilities to be nimble in their response to an ever-changing threat environment. Government systems and equipment also require sharing by design and must be able to be iterated constantly. In addition to EW capabilities, the adoption of open radio access network ("O-RAN") capabilities presents new interesting use case opportunities to DoD and the defense industry as they implement 5G and advanced communications. (O-RAN is an approach to designing and deploying spectrum access network infrastructure that "provides operators with enhanced flexibility and scalability, reduced costs, increased efficiency, and improved service quality" by, among other things, allowing multiple vendors on a wireless network.)[21] U.S. military services are working with defense contractors on conducting O-RAN use experiments, to, among other things, improve military base operations.[22]

Scientific Missions. The Government employs space-based spectrum use for a variety of scientific missions that enhance public safety, to ensure national security, and to push the boundaries of knowledge. For example, the NWS is more accurately able to forecast major, life-threatening weather events due to satellite technology deployed by NOAA.[23] And NASA uses dozens of spectrum bands for earth science, space science, aeronautics and space transportation, and space exploration.[24]

II. THE NATIONAL SPECTRUM STRATEGY

A. ASPEN INSTITUTE STAKEHOLDER RECOMMENDATIONS FOR STRATEGIC SUCCESS

In September 2022, the Aspen Institute published a report (the "Aspen 2022 Report")[25] following a spectrum policy roundtable conducted with Government and private sector stakeholders. That meeting's purpose was twofold: first, to establish a common understanding of the relevant goals and principles of an all-of-Government national spectrum strategy; and second, to produce a framework for a spectrum action plan indicating potential steps, key actors, and timeframe for implementation. The Aspen 2022 Report provided an overview of spectrum's role in U.S. society and within its economy and analyzed the changing spectrum environment and the policy challenges that would need to be addressed as the environment evolves. The Aspen 2022 Report set forth several broad recommendations for U.S. spectrum policy going forward, and potential implementing actions for those recommendations:

- As part of the then-forthcoming NSS, the U.S. Government should issue a 10-year plan with clear national goals to release more spectrum into the commercial marketplace;
- In making new spectrum available for commercial use, Congress, the FCC, and the Administration should ensure a balance of licensed, unlicensed, and shared authorization models as appropriate for the bands under consideration;
- The FCC and NTIA should enhance and expand policies that enable market- and technology-driven determinations and evaluations of spectrum uses;
- A NSS should provide assurance that all Americans have access to all generally used wireless services, regardless of geography, income level, race, sexual orientation, or education;

- The FCC and NTIA should ensure that the NSS and associated plans are conducive to U.S. leadership in strategic, spectrum-dependent platform technologies;
- The FCC and NTIA should modernize the core institutions and processes of spectrum governance to ensure that the U.S. continues to lead the world in developing and implementing spectrum policy;
- The FCC, in coordination with the Department of Justice and the Federal Trade Commission, should undertake a comprehensive review of wireless competition policy; and
- Congress, the FCC, and NTIA should implement multiple reforms to build capacity for ongoing improvement in spectrum policymaking and management.

While this report does not endeavor to replicate each of these recommendations, we highlight several recommendations in Section III.E. below from the Aspen 2022 Report that remain important for a fulsome national policy framework for spectrum success.

B. THE NATIONAL SPECTRUM STRATEGY

Released on November 13, 2023, the White House issued a Presidential Memorandum that sought to modernize United States spectrum policy and that effectively established the NSS, which was released as a companion to the Presidential Memorandum.[26] Together, the documents included new actions to improve spectrum management and spectrum access, including a call for studying more than 2,700 megahertz of spectrum for potential repurposing to commercial use.

The Presidential Memorandum, composed of 11 sections, directed specific departments within the Biden Administration to "promot[e] efficient and effective spectrum use by both agencies and non-[f]ederal users."[27] It also established the Interagency Spectrum Advisory Council "to serve as the principal interagency forum for heads of agencies to advise NTIA on spectrum policy matters and to ensure that all decisions made by NTIA take into consideration the diverse missions of the Federal Government."[28] The Presidential Memorandum further required the Secretary of

Commerce, acting through NTIA, to develop and deliver the NSS to the President, which would include "plans to optimize United States spectrum management and use by considering different types of spectrum governance models, including exclusive licensing, unlicensed use, shared use, and combinations of these approaches."[29] In addition, the Presidential Memorandum required the Secretary of Commerce, acting through NTIA, to publish an NSS Implementation Plan detailing the timelines for the spectrum band studies;[30] identified responsibilities of the Department of Commerce and NTIA for completing the band studies[31] and responsibilities of other agencies[32] detailed procedures for resolving disputes both before and after FCC action in making additional spectrum available;[33] and called for a report identifying spectrum management principles and methods to guide Government spectrum studies and science.[34]

The NSS divided the effort into four pillars with associated strategic objectives:

- **Pillar 1:** A Spectrum Pipeline to Ensure U.S. Leadership in Advanced and Emerging Technologies.
- **Pillar 2:** Collaborative Long-Term Planning to Support the Nation's Evolving Spectrum Needs.
- **Pillar 3:** Unprecedented Spectrum Access and Management Through Technology Development.
- **Pillar 4:** Expanded Spectrum Expertise and Elevated National Awareness.[35]

1. ADVANCING NEAR-TERM SPECTRUM ACCESS (NSS PILLAR 1)

The NSS identified 2,786 megahertz of spectrum for evaluation for potential repurposing for more efficient or expanded uses across five different spectrum bands: (1) the Lower 3 GHz band (3.1-3.45 GHz); (2) the 5030-5091 MHz band; (3) the 7/8 GHz band (7.125-8.4 GHz); (4) the 18.1-18.6 GHz band; and (5) the Lower 37 GHz band (37.0-37.6 GHz). The Implementation Plan[36] released in March 2024 provided a schedule and study approach for each of the four pillars and associated strategic objectives identified in the NSS, with spectrum band evaluations starting in March 2024 and running through at least October 2026.

Lower 3 GHz Band. DoD currently has operations within the Lower 3 GHz band, but as part of an evaluation required by the 2021 Infrastructure Investment and Jobs Act, "DoD determined that sharing is feasible if certain advanced interference mitigation features and a coordination framework to facilitate spectrum sharing are put in place."[37] The NSS directs a follow-on investigation of commercial opportunities in the band, which will include evaluation of this spectrum for sharing, repacking, relocation, and/or compression. NTIA and DoD will co-lead the studies in this band, which are expected to be completed by October 2026.[38] NTIA has initiated a bi-monthly series of multi-stakeholder meetings, the first meeting of which took place on August 23, 2024, to facilitate non-federal stakeholder engagement. Furthermore, the NSS requires an advanced DSS demonstration to be conducted in this band to "show how to simultaneously create spectrum access for commercial users while enabling DOD to continue to accomplish its mission in a complex spectrum environment."[39] This evaluation is being conducted with DoD through the National Spectrum Consortium.[40]

5030-5091 MHz Band. Terrestrial control links for Unmanned Aircraft System ("UAS") operators are permitted in the 5030-5091 MHz band. The FCC recently took steps to enable UAS operators to access dedicated spectrum in this band for control-related communications.[41] The Federal Aviation Administration, FCC, and NTIA were tasked with performing computability studies to further optimize UAS operations in this spectrum, with the evaluation expected to be completed by March 2026.

7/8 GHz Band. The 7/8 GHz band is being studied for wireless broadband use and currently contains "a variety of mission-critical Federal operations in this band (including Fixed, Fixed Satellite, Mobile, Mobile Satellite, Space Research, Earth Exploration Satellite, and Meteorological Satellite services)."[42] Per the NSS, this band study will be led by NTIA alongside affected federal agencies and will focus on evaluations for potential commercial sharing, repacking, relocation, and/or compression. NTIA has initiated a bi-monthly series of multi-stakeholder meetings, the first meeting of which took place on August 23, 2024, to obtain non-federal stakeholder engagement on the band evaluation, which is projected to be completed by October 2026.

18 GHz Band. The 18 GHz band contains fixed satellite downlink operations, and the 18.1-18.3 GHz portion of the band contains non-Federal fixed service. Action on this band is expected in the mid-term, as the NSS Implementation Plan requires a final report on findings in this band by November 2024. On August 16, 2024, the FCC released a Public Notice seeking public comment to facilitate the evaluation of the 18 GHz band.[43]

Lower 37 GHz Band. The "NSS identified the Lower 37 GHz band for in-depth study to determine how a co-equal, shared-use framework which allows federal and non-federal operations should be implemented."[44] Action on this band is expected in the mid-term, as the NSS Implementation Plan requires a final report on findings in this band by November 2024. On August 16, 2024, the FCC released a Public Notice seeking public comment to facilitate the evaluation of the Lower 37 GHz band.[45]

2. ENHANCING LONG-TERM COORDINATION AND DATA-DRIVEN PROCESSES (NSS PILLAR 2)

The NSS focused on improving the collaboration in spectrum policy development not only across federal agencies, but also with non-federal stakeholders.[46] The NSS underscored the notion that it is crucial for the Government to develop and document a spectrum decision-making methodology that "incorporate[s] best practices, developed through the new collaborative framework, for conducting technical and economic analyses that are data-driven, science-based, and peer-reviewed."[47]

3. MAXIMIZING SPECTRUM EFFICIENCY (NSS PILLAR 3)

The NSS calls for "U.S. spectrum regulating agencies, Federal agencies, U.S. commercial industry, academia, and technology developers to work collaboratively to encourage dynamic spectrum sharing that employs spectrum management technologies and techniques that increase spectrum-use efficiency and enhance U.S. competitiveness, while taking issues such as cybersecurity into account."[48] The NSS also recognizes that innovative technologies enable dynamic spectrum sharing models, such as DSS, and that "[i]mproving the efficient and effective use of spectrum requires enhancing the frameworks, processes, and tools for spectrum access and management."[49] The NSS Implementation Plan also calls for evaluation of factors for driving Federal and non-Federal investment in spectrum innovation and development and publication of a National Spectrum Research

and Development Plan ("R&D Plan") through the National Science Foundation, and the R&D Plan is intended to "identify key innovation areas for spectrum research and development."[50]

4. EDUCATING DECISION-MAKERS AND BOLSTERING THE SPECTRUM WORKFORCE (PILLAR 4)

The NSS states that a "whole-of-government approach is necessary" to support a well-trained spectrum workforce, and directs the U.S. Government to "develop and periodically update a National Spectrum Workforce Plan to prioritize development of, and enhancements to, the spectrum ecosystem workforce (including the full range of operational, technical, and policy positions involved in spectrum-related activities)."[51] The NSS Implementation Plan also calls for educating the public, policy-makers, and lawmakers on spectrum policies and its role in everyday life.

C. U.S. SPECTRUM POLICY NOW AND IN THE FUTURE

1. LOOKING TOWARD THE FUTURE

Publication of this Aspen report comes in a U.S. general election year. As of this writing, there is considerable uncertainty as to the outcome, including the future leadership of the executive and the legislative branches. But spectrum policy has traditionally involved a bipartisan consensus and it was the goal of all the Aspen spectrum policy roundtable participants and this report that our efforts will be useful to policy makers regardless of the election's results.

Spectrum policy efforts are ongoing in this country and across the world. For example, in the U.S., the FCC has focused this year on multiple spectrum rulemakings besides its information requests related to the NSS band studies, such as those dealing with the 2200-2290 MHz band (space launch operations), 3.5 GHz band (Citizens Broadband Radio Service ("CBRS")), 4.9 GHz band (public safety operations), 5.9 GHz band (intelligent transportation services), 12.2 GHz band (terrestrial fixed use), and 12.7 GHz band (terrestrial wireless use). Across the world, spectrum standards setting efforts are ramping up as countries respond to the ever-increasing demand for advanced communications and look ahead

to the next generation of wireless, which is already in development and expected to launch at the start of the next decade. And preparations are already underway in the U.S. and abroad for the 2027 International Telecommunication Union's World Radiocommunication Conference ("WRC"), which sees delegations from countries around the world partake every few years to develop harmonized spectrum policies for an increasingly globalized spectrum marketplace.

2. THE ASPEN POLICY ROUNDTABLE

On July 11-12, 2024, the Aspen Institute convened a spectrum policy roundtable with Government and public and private sector stakeholders. The aim of this roundtable was to develop a set of recommendations that would not only build on past achievements in the Aspen 2022 Report but that would also examine and create new opportunities to move forward into the next era of U.S. spectrum policy leadership, balancing the needs of both the commercial wireless sector and federal missions while highlighting consensus-based themes across all interested parties.

The report here captures the themes and ideas discussed at that roundtable and recommends a broad framework for principled and science-based U.S. spectrum policies built upon the common threads of previously successful spectrum policies while incorporating lessons learned over time. This report should prove informative for the next U.S. Presidential Administration and Congress in developing future U.S. spectrum policies in furtherance of spectrum-based innovation and the economic and security benefits that innovation can bring.

III. SPECTRUM POLICY RECOMMENDATIONS

The discussions from the July 2024 Aspen policy roundtable led to five broad recommendations, discussed below, along with multiple sub-recommendations: (1) prioritize reinforcing principled and forward-looking national spectrum policies; (2) balance values and perspectives, including national security; domestic economic considerations and global competition; consumer, enterprise, and public safety needs; and innovation and scientific discovery; (3) continue to seek new Federal and non-Federal spectrum access opportunities by evaluating additional bands for reallocation and repurposing, building upon the U.S. spectrum auction success, and exploring spectrum sharing development and opportunities; (4) promote coordination and harmonization here and abroad; and (5) expand on existing recommendations presented in the 2022 Aspen Report.

A. PRIORITIZE PRINCIPLED AND FORWARD-LOOKING POLICIES

The U.S. Government should work to ensure that any future spectrum policy plan that may be developed is one that transcends partisan or parochial stakeholder interests, is grounded in science, fosters collaboration, enables stakeholders to engage in long-term planning, and encourages transparency. These objectives are consistent with themes that have been identified over time across federal and commercial stakeholders and across the political aisle as core components to successful spectrum policy. Most importantly, any spectrum policy plans should build on what has been done while recognizing that much work remains to position the U.S. for future leadership in spectrum-based markets, technologies, and national security capabilities.

B. BALANCING VALUES AND PERSPECTIVES

Effective implementation of U.S. spectrum policy must balance a variety of important values, including national security; domestic economic considerations and global competition; consumer, enterprise, and public safety needs; and innovation and scientific discovery. The Aspen policy roundtable included sessions on these issues in which relevant stakeholders provided diverse perspectives, but through which a general consensus emerged, as discussed in this report. The U.S. Government should examine and consider these various interrelated values and perspectives in implementing our nation's spectrum policies, including:

1. NATIONAL SECURITY CONSIDERATIONS

Spectrum policy has a direct connection to our national security and that of our allied partners. National security spectrum holders have historically taken a conservative approach to shared spectrum use and protection of federal operations. On the other hand, we have seen in the CBRS band a willingness to iterate over time to balance incumbent protections and commercial access. And there is an increased need for spectrum to advance our nation's EW offensive and mitigation techniques. While there was a general agreement at the roundtable that security uses justify a high priority, there was also agreement that the Government should implement a regulatory structure that enables risk-taking—i.e., rewarding spectrum relinquishment—and it must continue to build trust across agencies and with Government and industry so that both our commercial and national security needs can be achieved. Consideration may also be needed to develop Government systems in a "dirty" spectrum environment where many competing uses of a band might be present—i.e., the domestic test and training spectrum environment should mirror what the EW battle space is like in real world settings.

2. ECONOMIC AND COMPETITIVE CONSIDERATIONS

Spectrum policy can dramatically impact our nation's economic standing, with wireless connectivity providing a key input to a myriad of sectors contributing millions of jobs and billions of dollars to our country each year.[52] This domestic decision-making also impacts the commercial sector's ability to compete in the global marketplace; for instance, domestic spectrum policies can impact the ability of U.S. vendors to benefit from economies of

scale in an international equipment market. In the early days of spectrum-based communications services, most of the economic impact relied on one business model: exclusive licensing. Then technology enabled the use of unlicensed spectrum for connectivity. More recently, enterprises have used shared spectrum to deliver services. These business models are in healthy competition with one another. More spectrum allows each model to deliver improved capacity at lower cost. The Government must mediate those competing demands so that each has an opportunity to compete in serving different segments of the market demand.

In addition, there are spectrum users who, in times past, used spectrum in ways that provided significant economic and social goods. But as the marketplace changes, the value of the spectrum can sometimes become more valuable than the business that uses the spectrum, suggesting a potential misallocation of a public good. It was this insight that led to the successful broadcast incentive auction, which simultaneously provided broadcasters a $10 billion capital infusion, wireless providers more low-band spectrum, and the Government over $7 billion for deficit reduction. But that insight may not be limited to that single auction or a single sector using spectrum allocated long ago.

Government should consider these impacts on all the stakeholders in weighing spectrum policies and outcomes, including by promoting international leadership and harmonization where possible to generate economies of scale in the global spectrum-based market.

3. CONSUMER, ENTERPRISE, AND PUBLIC SAFETY NEEDS

Consumer and enterprise demands drive much discussion on commercial spectrum policy, including how to promote our nation's global competitiveness, expand rural broadband, close the digital divide, promote verticals such as agriculture and advanced and intelligent manufacturing, and more. Network reliability is key to many of these sectors, especially for public safety users. Government must weigh these benefits in its spectrum policy considerations.

4. INNOVATION AND SCIENTIFIC DISCOVERY

An effective spectrum policy must be grounded in the laws of physics but must also be open to the promises of new technologies. The NSS band studies and any further spectrum evaluations should be conducted in a science- and data-driven manner. The process should acknowledge that innovation in spectrum policy often enables broader technological innovations. Furthermore, non-national security-related Government functions focused on scientific activity, such as space research and weather, should be recognized in any spectrum policy for the important functions and information they provide to society.

C. CONTINUE TO SEEK NEW SPECTRUM ACCESS OPPORTUNITIES

1. EVALUATE ADDITIONAL BANDS FOR REALLOCATION AND REPURPOSING.

The NSS provides a framework for evaluating five spectrum bands that hold promise to support new commercial opportunities. The Government should continue to explore how it can advance these and additional bands for exploration for potential commercial use. The NSS Implementation Plan contains detailed timelines for assessing different reallocation options and these complex, multi-stakeholder study processes have already begun. We encourage the next Administration to leverage the foundational work undertaken through the NSS and its implementation.

2. BUILD UPON THE UNITED STATES' SUCCESSFUL 30-YEAR TRACK RECORD IN AUCTIONING SPECTRUM.

i. Restore FCC auction authority.

Congress should strive to restore the FCC's auction authority so that any spectrum identified for auction, including as part of the NSS band studies, can, if appropriate, be auctioned on a timeline that achieves the goal of facilitating commercial access to spectrum in the near term. If Congress does not wish to restore general auction authority, it should provide the FCC auction authority for specific bands with studies underway or constrained to a certain time period as even such a more tightly defined auction authority could be beneficial in facilitating the repurposing of spectrum for commercial use. However, all things being equal,

the restoration of general auction authority—which has supported several generations of wireless investment, growth, and innovation—would be most conducive to ushering in the next generation of investment, growth, and innovation.

ii. Conduct another incentive auction.

The 600 MHz broadcast incentive auction employed a novel auction design that enabled the Government to reevaluate and incentivize the reallocation of commercial spectrum to more efficient use. The incentive auction model, which has seen bipartisan support, should be considered a valuable tool in the spectrum-allocation toolkit for further future use for repurposing spectrum for licensed use.[53] This recommendation would necessarily rely on the FCC's auction authority being reinstituted.

iii. Push the frontiers of economic theory to ensure the highest and best spectrum use.

The FCC should evaluate the potential reallocation of spectrum where the value of the current use has diminished relative to the potential value of the spectrum. Aspen spectrum policy roundtable participants discussed a variety of new mechanisms that could facilitate the continual transition of spectrum to its highest use. As just two examples, these included (where appropriate) defining time-limited license terms in future spectrum auctions and the depreciating auction concept proposed by Nobel laureate Paul Milgrom, which proposes to "replac[e] the existing license structure with a new system of 'depreciating licenses' that can allow markets to perform better along all these dimensions."[54] The FCC should continue its proud tradition of putting novel economic theory into practice for the betterment of spectrum policy.

3. FURTHER EXPLORE SPECTRUM SHARING DEVELOPMENT AND OPPORTUNITIES.

Spectrum sharing technologies have proven effective in addressing certain coexistence challenges and warrant additional consideration. Aspen spectrum policy roundtable participants noted that "sharing" is not a category of spectrum authorization per se, but rather a set of techniques that can be applied to different authorization models (licensed, unlicensed, coordinated) to increase productivity of spectrum use. Regulatory predictability is important to the success of shared spectrum. Given the ever-increasing demand for spectrum by commercial stakeholders,

policymakers and industry should consider ways in which spectrum sharing can be advanced, following four key principles: (1) technology enhancements; (2) implementation; (3) governance; and (4) transparency.

i. Technology Enhancements.

Government and industry should review existing sharing approaches with an eye toward lessons learned from earlier sharing models. There may be opportunities for "cross pollination" among the models. For example:

- **Overall Considerations.** Whenever the Government considers a new spectrum assignment or allocation, it should consider the relative trade-offs of sharing as compared to other models. In that consideration, it should study whether it is possible to enable timelier and more efficient spectrum access where sharing is envisioned.
- **3.45 GHz Sharing Learnings.** The 3.45 GHz band was made available using a structure that made full-power licensed spectrum available nationwide while leveraging new Cooperative Planning Areas and Periodic Use Areas in certain geographic locations to facilitate coordinated sharing with DoD users. Among other things, Aspen spectrum policy roundtable participants discussed making the coordination process timelier and more efficient; innovations that would enable sensing within the radio access network to enhance spectrum use; and leveraging improvements in propagation modeling from the CBRS band that could increase accuracy in the adjacent 3.45 GHz band.
- **CBRS Learnings.** The CBRS band is a unique spectrum sharing framework that utilizes three tiers of access: primary Federal Government incumbents; commercial licensees; and General Authorized Access ("GAA") users. This model has been fine-tuned over the last ten years, in terms of the technical rules, modeling characteristics, and functioning of the Spectrum Access Systems and Environmental Sensing Capabilities that are used to facilitate coordination in the band. Among other potential learnings, participants discussed the fact that shared spectrum will rely on regulatory certainty and sharing rules should be flexible enough to accommodate innovation within new propagation models. Participants also discussed that Government and

industry should further consider how the CBRS framework can be adjusted to enable efficiencies for both sides to improve accuracy while protecting federal systems; enhance information sharing; improve interference calculations and modeling to prevent against over-protection, which can lead to less efficient spectrum use; speed up dynamic interference time scales; and develop a framework for coordinating GAA coexistence.

- **6 GHz AFC Learnings.** The FCC allocated the 6 GHz band to shared access between unlicensed and incumbent licensees using a centralized automated frequency coordination ("AFC") architecture. Aspen spectrum policy roundtable participants discussed why that AFC certification took a long time, slowing adoption and ecosystem development. Some ideas discussed by participants to avoid similar issues in the future included improved AFC system design, using certified professional installers to address indoor interference, and increasing the availability of information on specific channel use.

ii. Implementation.

Government and industry should explore spectrum sharing possibilities through prototyping new developments (including DSS developments) using a multi-stakeholder, multi-tool initiative. Any DSS model to be developed should enable sharing that is commercially viable. This effort should be science-driven and transparent, and targeted band ranges should be considered.

iii. Governance.

Aspen spectrum policy roundtable participants agreed that in making spectrum decisions, policymakers should evaluate how much to let the market drive the development and enhancement of spectrum sharing databases, and how much the government should seed and frame the effort. In doing so, the Government should balance the needs for industry flexibility with clear objectives and rules. Government should also develop a workable, formal enforcement mechanism to manage spectrum interference when using spectrum coordination systems.

iv. Transparency.

There should be an open dialogue across all stakeholder levels, including Government, on how to improve and incentivize investment in spectrum sharing innovations and on how to gather and make publicly available relevant federal and non-federal spectrum use information, an effort for which NTIA should take responsibility. The FCC should also help educate potential shared users on the limitations and expectations of the use of a shared band.

D. PROMOTE COORDINATION DOMESTICALLY AND ABROAD

1. ENHANCE TRUST AND COOPERATION BETWEEN FEDERAL AND NON-FEDERAL STAKEHOLDERS.

The process for coordinating spectrum policies and allocations across Government and industries has improved in recent years, but more work is needed to promote transparency, trust, and accountability in the coordination process. The Government should continue to advance interagency collaboration—including, for example, through coordination meetings and memoranda of understanding among agenda. The Government should also enhance the transparency of progress toward achieving spectrum policy objectives, including programs on the NSS spectrum study deliverables. In that regard, NTIA should publish a readily accessible public dashboard—ideally on the NTIA website—that outlines progress on implementing the NSS and other spectrum policy objectives. This will be beneficial to stakeholders and Congress, as it will help to hold the Government accountable to timelines and deliverables while creating transparency in the interagency and spectrum evaluation processes.

2. ENSURE CONTINUED AND ENHANCED INTERNATIONAL SPECTRUM LEADERSHIP AND HARMONIZATION.

Harmonization with international standards and globally allocated spectrum bands is important to promoting innovation within the global marketplace as well as ensuring that our national security missions can be achieved here and abroad. There are bands in the National Spectrum Strategy that are part of the agenda for the 2027 World Radio Congress that, under the NATO treaty, are subject to coordination with our allies. The Government should

advance these innovation and national security goals and ensure that our domestic decisions are promoted in a unified way at the WRC and other international fora.

E. EXPAND ON EXISTING RECOMMENDATIONS

Several additional recommendations discussed at this roundtable were similar to those discussed in the Aspen 2022 Report and expanded on these ideas, underscoring that such recommendations are important and lasting themes that should be incorporated into sound national spectrum policies. These include:

1. ENHANCE TRANSPARENCY REGARDING FEDERAL AND NON-FEDERAL SPECTRUM USE AND NEEDS.

There is a clear need for a better understanding of both federal and non-federal uses and needs, as both NTIA and the Aspen Institute have recognized. NTIA should:

i. Create a tailored inventory of spectrum use.[55]

On both the federal and commercial sides, there are challenges when it comes to the transparency and availability of information on spectrum use. Historically, these difficulties have occurred in part because of a lack of consensus on a definition of "use" for such purposes. Despite this, we continue to urge policymakers to take steps to gather and assess essential data and information on spectrum use, as the NSS and other initiatives have envisioned. To that end, a spectrum inventory should be created that accounts for allocations and uses without undermining national security or proprietary interests and while having sufficient detail so as not to render such an inventory useless. The inventory could include non-public information, but should be protected from public view, and limited to stakeholders for analysis.

There must also be an articulable goal regarding the creation of any federal or non-federal spectrum inventory so that the framework can better achieve the stated objective. In developing that goal, a clear definition of spectrum "use" must be agreed to and utilized, one that considers the variety of uses within various band segments and which accounts for the flexibility needed for growth, densification, and evolving use cases, as well as the preclusive effects and/or opportunity costs of those uses.

Although the task will be hard, the potential for insights into use of our in-demand and limited airwaves could prove invaluable to future conversations on spectrum authorization and repurposing.

ii. Assess future spectrum needs.[56]

NTIA and the FCC should have an ongoing conversation, with public input, about future spectrum needs, producing periodic reports projecting the spectrum needs for the next decade, along with supporting assumptions. These projections should incorporate up-to-date industry data as well as, on the government side, spectrum dependencies of new programs.

2. REFORM THE GAPS IN THE COMMERCIAL SPECTRUM ENHANCEMENT ACT ("CSEA").[57]

Authorized by the CSEA, the Spectrum Relocation Fund ("SRF") provides a funding mechanism federal agencies can use to recover the costs associated with spectrum relocation or sharing. The SRF has proven effective, but enhancements to its provisions are needed to keep pace with the evolving nature of spectrum R&D and allocation.

Specifically, while not consensus driven, some of the CSEA reform concepts discussed by Aspen spectrum policy roundtable participants included: (1) reforming the SRF to cover the full range of costs of relocation efforts and expanding SRF eligibility to encompass unlicensed or non-auctioned access; (2) finding ways to share bands where possible while noting that sharing may not be feasible in some bands; (3) creating a cost-recovery mechanism to facilitate legacy incumbent relocation akin to the UTAM authority used in the unlicensed PCS band; and in new unlicensed bands, (4) eliminating the sunset of SRF funds where they revert to the U.S. Department of the Treasury. Participants also emphasized the need to look back at instances where band relocation worked, such as in the case of AWS-3.

3. CONDUCT TARGETED COMMUNITY OUTREACH ON SPECTRUM TECHNOLOGIES AND POLICIES AND ENHANCE EFFORTS TO PROMOTE CAREER OPPORTUNITIES IN RADIOFREQUENCY ENGINEERING TO BOLSTER THE SPECTRUM WORKFORCE.[58]

A well-trained spectrum workforce begins with awareness of the role spectrum plays in our society. NTIA should conduct targeted outreach with a broad set of stakeholders to ensure impacted communities are reached and to understand use cases and impacts on public resources. This could include involvement, for instance, by public interest groups, trade associations that can represent the priorities of small and rural providers, and technology companies that are exploring the next frontier that can relay information about what is coming next.

NTIA, the FCC, and other Government agencies should also create additional pathways for technical students in high schools and undergraduate and graduate institutions to spectrum-related jobs. The agencies should also better market spectrum career opportunities within the Federal Government to bolster the spectrum workforce pipeline.

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Jeff Blum
Executive Vice President, External & Government Affairs, DISH

Austin Bonner
Deputy U.S. Chief Technology Officer for Policy, White House Office of Science and Technology

Phil Burnett
Equity Research Analyst, New Street Research

Michael Calabrese
Director, Wireless Future, Open Technology Institute, New America

Jonathan Campbell
Legal Advisor, Wireless, International, and Space, FCC

Jonathan Chaplin
Managing Partner, New Street Research

Andy Clegg
Spectrum Engineering Lead, Google

Charles Cooper
Associate Administrator, Office of Spectrum Management, NTIA

Alan Davidson
Assistant Secretary of Commerce for Communications and Information; NTIA Administrator

Monisha Ghosh
Professor, University of Notre Dame

Shiva Goel
Senior Advisor for Spectrum Policy, NTIA

David Goldman
Director of Satellite Policy, SpaceX

John Hane
CEO, BitPath

Jaime Hjort
Head of Wireless and Spectrum Policy, Amazon

Hank Hultquist
Vice President, Federal Regulatory, AT&T

Umair Javed
Senior Vice President, CTIA

Will Johnson
Senior Vice President, Federal Regulatory & Legal Affairs, Verizon

Duane L. Jones
Deputy Spectrum Branch Chief for the Joint Staff, Department of Defense

Brian Josef
Vice President, Regulatory Affairs, Comcast Corporation

Ira Keltz
Deputy Chief, Office of Engineering & Technology, FCC

Derek Khlopin
Deputy Associate Administrator for Spectrum Planning and Policy, NTIA

Colleen King
Vice President, Regulatory Affairs, Charter Communications

Joe Kochan
CEO, National Spectrum Consortium

John Kuzin
Vice President, Spectrum Policy and Regulatory Counsel, Qualcomm Incorporated

Jerry Leverich
Partner, Salt Point Strategies LLC

Blair Levin
Nonresident Senior Fellow, Brookings Institution

John Leibovitz
Principal, Jupiterra LLC

Jennifer McCarthy
Vice President, Legal Advocacy, Federated Wireless

Kyle McEneaney
Program Director, The Schmidt Family Foundation

Milo Medin
Principal, Medin Consulting

Ruth Milkman
Partner, Quadra Partners LLC

Susan Mort
Deputy Bureau Chief, Wireless Telecommunications Bureau, FCC

Scott Patrick
Executive Director, Office of Spectrum Management, NTIA

Matt Pearl
Director and Special Advisor for Emerging Technologies, White House National Security Council

David Redl
Founder and CEO, Salt Point Strategies LLC

Alisa Valentin
Broadband Policy Director, Public Knowledge

Jennifer Warren
Vice President, Global Regulatory Affairs & Public Policy, Lockheed Martin Corporation

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