Before the
NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION
Washington, DC 20230

In the Matter of	)	
	)	
Developing a Sustainable Spectrum Strategy for America's Future	)	Docket No. 1811309999-8999-01
	)	

COMMENTS OF THE TELECOMMUNICATIONS INDUSTRY ASSOCIATION

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The Telecommunications Industry Association ("TIA")[1] respectfully submits these comments in response to NTIA's Request for Comments ("RFC")[2] in the above-captioned proceeding.

I. INTRODUCTION

TIA strongly supports the goals of the 2018 Presidential Memorandum,[3] including the development of a national spectrum strategy that will establish a path forward for both federal and non-federal users alike, as well as the manufacturers of the communications technologies and platforms that support them both. The development of new advanced technologies, the global race to 5G, and the emergence of the Internet of Things as a practical reality over the past

[1] TIA is the leading trade association for the information and communications technology ("ICT") industry, representing companies that manufacture or supply the products and services used in global communications across all technology platforms. TIA represents its members on the full range of policy issues affecting the ICT industry and forges consensus on industry standards.

[2] National Telecommunications and Information Administration, *Developing a Sustainable Spectrum Strategy for America's Future*, Notice and Request for Comments, 83 Fed. Reg. 65,640 (Dec. 21, 2018).

[3] President Donald J. Trump, Memorandum on Developing a Sustainable Spectrum Strategy for America's Future, 2018 DAILY COMP. PRES. DOC. 00730 (Oct. 25, 2018) ("2018 Presidential Memorandum").

decade all mean that policies established by the previous Administration at the dawn of the smartphone era now warrant a serious review.[4] A new, comprehensive strategy would offer a path to provide all spectrum stakeholders with more input into, and guidance about, how U.S. spectrum management will evolve in the coming years.

In these comments, we begin with a general set of principles TIA has long espoused and that could form the foundation of a national spectrum strategy. We then provide responses to the specific questions in the RFC, some of which are very far-reaching. Indeed, given the short timeline and unusual circumstances under which these comments are being filed,[5] we encourage NTIA – and as applicable, other federal agencies – to provide additional opportunities for stakeholder engagement, whether through further written comments, roundtables, or other means.

II. PRINCIPLES FOR A NATIONAL SPECTRUM STRATEGY

As the Administration begins its work on a national spectrum strategy, TIA believes that such a strategy should be based on the following principles:[6]

- *Predictability.* To drive investment by commercial and government users alike, as well as the technology developers, spectrum allocations and regulations need to be

[4] *See* President Barack H. Obama, Memorandum on Unleashing the Wireless Broadband Revolution, 2010 DAILY COMP. PRES. DOC. 00556 (June 28, 2010) (calling for making 500 MHz of spectrum available over 10 years).

[5] The RFC was issued on December 20, 2018, just prior to the holidays and a major event (CES 2019) at which many stakeholders were participating. Moreover, these comments are being filed during a partial government shutdown, during which NTIA was unable to consider acting on potential requests for an extension.

[6] *See generally* Comments of the Telecommunications Industry Association, *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 GHz and 24 GHz*, filed Oct. 2, 2017 in FCC GN Docket No. 17-183, at 1 & 5-6 ("TIA Mid-Band NOI Comments"); Comments of the Telecommunications Industry Association to OSTP, FR Doc. No. 2014-03413, *Spectrum Policy*, Mar. 20, 2014 ("TIA OSTP Comments"), *also available at* https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/rfi_responses_-_fr_doc._2014-03413_filed_2-14-14_all.pdf (at 156 *et seq*.)

predictable. Identifying demand and changes in demand, understanding the pace of radio technology development by platform, and long-term planning are all essential parts of a spectrum policy that can provide predictability for both commercial and government users.

- *Flexibility.* For commercial allocations, flexible use policies consistent with baseline technical rules that are technology-neutral have proven to be the best approach.

- *Efficiency.* Policies should encourage more efficient use of spectrum where technically and economically feasible.

- *Priority.* In cases where band sharing is technically and economically possible, policies must advance good engineering practice to best support an environment that protects those with superior spectrum rights from harmful interference.

Avoiding one-size-fits-all approaches. Good spectrum policy decisions need to be made on a band-by-band basis, depending on the particular propagation characteristics of a band, existing service allocations, and existing incumbent services within a band. For example, while spectrum sharing approaches and technologies are increasingly becoming available, the existence of either should not, by itself, justify regulatory action to implement a sharing system. Rather, that should be one of multiple factors for each specific service and band. In creating a successful sharing environment, the following combination of factors should be considered:

- An economic model, especially to encourage investment by both existing and future users;

- Availability of spectrum for nationwide use;

- The needs of existing services in a particular band, especially with regard to security and avoiding harmful interference;

- Limitations in significant markets, and the time, bandwidth, and geographic license boundary limitations under which the limitations exist;

- Sufficient importance of the considered spectrum to warrant investment in further innovation;

- Adjacency of spectrum to, or complementary with, existing bands/services;

- Potential for innovation and growth by the incumbent service.

- Resiliency of new or incumbent services against cyberattacks.

Global harmonization. Global harmonization enables efficiencies of scale in product development and manufacturing. Such harmonization is also important for promoting coverage, and some systems, including satellite systems, rely heavily upon it to efficiently utilize the capabilities of launched satellites. TIA therefore urges policymakers to prioritize attention on globally-harmonized spectrum bands, and a national spectrum strategy should reflect the importance of this principle. Harmonization alone, however, should not determine the government's actions; it is one factor among several that should be considered.[7]

III. RESPONSES TO QUESTIONS

A. In what ways could the predictability of spectrum access for all users be improved?

At the outset, we appreciate that NTIA recognizes the importance of predictability as a cornerstone of an effective national spectrum policy. We address below several factors that could promote predictability for all users.

Longer license terms. Longer license terms provide incentives for operators to invest in a particular band, while shorter lengths can undermine investment and in turn harm the ecosystem of device development. Moreover, the FCC has recognized that longer term lengths are particularly appropriate in bands where "new technology is still nascent and will require time to fully develop."[8] For example, and for this reason, TIA has supported 10-year term lengths for

[7] *See also* CSMAC Key Characteristics Subcommittee report, July 2018, https://www.ntia.doc.gov/files/ntia/publications/csmac_2018_key_characteristics_final_document_july_24_2018_meeting.pdf (describing key characteristics that commercial industry considers when evaluating the desirability of a particular frequency band).

[8] Report and Order and Further Notice of Proposed Rulemaking, *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, GN Docket No. 14-177, *et al.*, 31 FCC Rcd 8,014, 8,077-78 ¶ 176 (2016) ("Spectrum Frontiers Report & Order").

the Upper Microwave Flexible Use Service ("UMFUS") in the Spectrum Frontiers bands as well as for 3.5 GHz Priority Access Licenses ("PALs"), and we were pleased that the FCC ultimately extended its PAL term lengths to 10 years after initially adopting 3-year term lengths.

Avoiding spectrum fees. Spectrum use fees – the imposition of which have occasionally been proposed in the past – are not a helpful tool to drive efficiency. To begin with, the implementation of any such fees would almost certainly not be universal, and would therefore create myriad opportunities for "market distortions" including administrative and/or legislative intervention over time. To use an analogy, the existing problems of the tax code should not be imported into spectrum policy. Moreover, such differentiated fees would result in a marketplace that may not be technology-neutral, *i.e.*, in which the government is picking technological winners and losers. Finally, experience shows that fees are unnecessary, since the commercial spectrum market already reflects intense market-based competition and strong pressure to use spectrum as efficiently as possible, all without spectrum fees.

Care regarding leases. TIA has noted a recent NTIA proposal regarding the use of spectrum leasing and we view it with caution.[9] Much would depend on exactly how such leases would be implemented. Any mechanism that could result in extensive infrastructure investments being stranded would significantly undermine predictability and chill future investment.

Clarity regarding government needs. A national spectrum strategy should promote predictability and certainty by seeking clarity regarding government uses to the greatest extent possible. The 2018 Presidential Memorandum does this in part by requiring agencies to assess their current and future use,[10] and such mechanisms should be made permanent and reinforced

[9] U.S. Department of Commerce, NTIA FY19 Budget Request, Feb. 2018, at 77 (legislative proposal to lease shared secondary access rights to federal spectrum).

[10] 2018 Memorandum § 2(a).

through a national spectrum strategy. In contrast, uncertainty about future federal use of a band can harm investment. For example, TIA expressed concerns about the FCC's decision to make the 37-37.6 GHz band available for sharing on an ostensibly "co-equal" basis between federal and non-federal users, even as the proposal raised many questions about the nature of the federal use.[11] Indeed, the FCC apparently went further than even NTIA's request by not merely requiring coordination with 14 requested sites, but ensuring the "ability for Federal agencies to add future sites."[12] The resulting uncertainty could potentially harm investment in the lower 37 GHz band.

Transparency regarding future transitions. Stakeholders benefit from government transparency regarding bands that may be under consideration for future transitions and/or the enabling of non-federal use. For example, we appreciate that NTIA has been transparent about its current exploration of the 3.4 GHz and 1300-1350 MHz bands, even as other bands will hopefully be added to that list in the future. Such transparency allows the ICT device ecosystem to anticipate the potential availability of such spectrum in the future and direct R&D resources accordingly. Other suggested approaches to transparency, such as the creation of a calendar for future spectrum auctions, may also be worth exploring.[13]

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[11] Petition for Reconsideration of the Telecommunications Industry Association, *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services*, filed Dec. 14, 2016 in FCC GN Docket No. 14-177, *et al.*, at 2-5.

[12] *Id.* at 4 (citation omitted).

[13] *See* Jessica Rosenworcel, *It's time to chart a course for 5G success*, TECHCRUNCH, Jan. 10, 2018, https://techcrunch.com/2018/01/10/its-time-to-chart-a-course-for-5g-success/ ("[W]e should plan for the future. We can do this with something simple: a calendar. It's time to state clearly to the entire wireless ecosystem – from existing providers to new spectrum interests to manufacturers and consumers – when and how the FCC will auction new airwaves to support 5G services.").

B. To what extent would the introduction of automation facilitate assessments of spectrum use and expedite the coordination of shared access, especially among Federal and non-Federal spectrum stakeholders?

As an initial matter, TIA continues to support the clearing of re-purposed spectrum bands to the maximum extent feasible. Where possible, cleared, exclusively licensed spectrum bands allow for the most efficient and dependable use of spectrum suitable for mobile broadband deployment, and maximize network investment, marketability, availability and consumer use.[14] However, when incumbent uses make clearing infeasible, TIA has supported greater spectrum efficiency through sharing.

Shared access. Automation can play a potentially significant role in many aspects of spectrum management. Beginning with shared access regimes, spectrum policy has gradually transformed from fixed allocations, to quasi-manual database-driven approaches, to more sophisticated spectrum access systems ("SAS") such as those being developed for the 3.5 GHz CBRS band. When coupled with continuing reductions in device size and power consumption, and the potential for moving more automation from the network to edge devices – *i.e.*, beyond simply "listen-before-talk" or querying a database – there is significant potential for automation to greatly increase the potential for using spectrum more efficiently. Indeed, with the anticipated explosion in devices as the Internet of Things becomes a reality, automation is likely to become not just optimal but *essential* over time as part of a national spectrum strategy.

That said, any strategy must also adopt a clear-eyed view of potential obstacles, at least in the short-to-medium term. The 3.5 GHz band remains at a nascent stage after many years of discussions, with the first auctions finally expected to happen in 2019. Moreover, issues regarding security and interference, particularly where federal or non-federal systems are

[14] TIA OSTP Comments at 7.

providing mission-critical services with higher needs for resiliency and priority access, could still pose challenges that need to be addressed. To that end, there are still many *non*-automatic (or simple automatic) means to increase spectrum use efficiency in various bands, such as better coordination of geographic exclusion zones or simple time- or calendar-based sharing depending on the incumbent use. While automation holds great promise and should be vigorously pursued, a national spectrum strategy should remain flexible to use other, potentially simpler means of improving spectrum utilization.

Assessments of spectrum use. Automation holds significant promise to improve assessments regarding spectrum use. For example, distributed sensor networks could play an important role in identifying existing spectrum uses and the intensity of such uses, and "model city" scenarios could be helpful in this context. However, "automation" should not be viewed simply as the implementation of listen-before-talk technology, spectrum access systems, or even distributed sensor networks for monitoring. At present, NTIA does not always have a complete, detailed understanding of how each federal agency is using its assigned spectrum, and the initial exploration of opening any band often requires significant collection of inter-agency information that ideally NTIA should already have access to. As described below, TIA strongly supports efforts to strengthen NTIA, including more staffing, to ensure that the agency has a better picture of existing federal use. The use of automation could potentially be applied to streamline both bottom-up means (sensor networks) as well as top-down means (agencies informing NTIA regarding uses) of collecting better data.

C. What is the practical extent of applying standards, incentives, and enforcement mechanisms to promote efficient and effective spectrum use?

Standards. Standards are critical to ensuring that spectrum is used both efficiently and effectively. Indeed, the basic philosophy underlying spectrum management, as far back as the

Radio Act of 1927, is that the airwaves cannot be used efficiently if spectrum use is not managed in some orderly way. TIA is an ANSI-accredited standards organization itself, and many of our members participate actively in global wireless standards-setting bodies such as 3GPP. Standardization, as a complement to regulation, is a very important factor in enabling spectrum to be utilized as efficiently as possible.

Indeed, a national spectrum strategy should recognize that there is a careful interplay between industry-driven standardization and government regulation. For example, the FCC's Part 15 rules, which establish basic parameters regarding power levels and other properties, are technologically-neutral and have allowed an unlicensed ecosystem to flourish far beyond any original expectations. Instead, standards bodies such as (for example) the IEEE are left to develop standards for Wi-Fi channelization and operation, or for numerous other protocols such as Bluetooth, Zigbee, Z-Wave, etc. Similarly, the 3GPP established the LTE standards and has been working more recently to standardize protocols such as 5G NR.[15] This cooperative model, in which regulators establish basic parameters and industry fills in the details through ever-evolving standards – has been critical to enabling innovation in both licensed and unlicensed bands. This philosophy should remain the cornerstone of any national spectrum strategy.

Enforcement mechanisms. In addition to regulation and industry-developed standards, TIA believes that a set of principles by which radio spectrum can potentially be utilized more intensively could be an important tool for spectrum users and spectrum managers alike.[16]

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[15] *See, e.g.*, Lorenzo Casaccia, Qualcomm, *3GPP commits to 5G NR in unlicensed spectrum in its next release*, Dec. 13, 2018, https://www.qualcomm.com/news/onq/2018/12/13/3gpp-commits-5g-nr-unlicensed-spectrum-its-next-release.

[16] *See generally* Comments of the Telecommunications Industry Association, *Office of Engineering and Technology Seeks Comment on Technological Advisory Council Spectrum Policy Recommendations*, filed Jan. 31, 2018 in FCC ET Docket No. 17-340 ("TIA TAC Principles Comments").

Indeed, TIA believes that a principle-based approach to interference mitigation would be preferable to the adoption of mandatory receiver standards, requirements, or rules, for example. For commercial users, a set of spectrum-use principles could provide an important foundation for market-driven behavior that advances good spectrum stewardship. Specifically, such principles could ensure that every spectrum user has a choice. Ideally, they would choose to help themselves by following the good engineering practices implied by these principles. Or they could choose not to do so, with the consequence that their equipment may receive less protection in a case of subsequent harmful interference, for example.[17]

Meanwhile, some concrete steps can be taken. For example, TIA has urged the FCC to create a public database of past radio-related enforcement activities.[18] The Enforcement Bureau has been inconsistent in revealing such information in publicly-released documents, which impedes private sector analysis from which industry can learn. A citation to the FCC ID number should be included for both offending transmitter and victim receiver. TIA has also generally endorsed the idea that professional interference hunters could be part of the interference resolution process, but that any such learnings should be incorporated into a database in the public domain.[19]

Agency incentives. Spectrum plays an essential role in fulfilling government missions, and this will continue despite any transition or sharing of particular bands for commercial use. For this reason, although White House-driven leadership to ensure more efficient federal use is necessary, agency-level incentives are also necessary to ensure that federal spectrum uses (and

[17] *See id.* for TIA's analysis and assessment of the various principles proposed by the FCC TAC in 2017.

[18] *Id.* at 9-10.

[19] *Id.*

users) are responsive to constraints of efficiency, predictability, flexibility, etc. in a similar manner to those faced by commercial users. Forward-looking management of radio spectrum is essential to the goal of expanding telecommunications services and ensuring that the public derives maximum benefit from the use of spectrum – whether by its government or wireless operators. In addition to agency-wide efforts, the Administration should also explore ways to provide incentives for more efficient spectrum use that supports advancing the effective mission of the agency, perhaps at a deeper level within the agency budgeting process, *i.e.*, at a more granular level than simply an agency's top-line retention of a portion of auction proceeds.

CSMAC recommendations. The Commerce Spectrum Management Advisory Committee ("CSMAC") has made several recommendations regarding standardization, enforcement, and incentives. For example, in July 2018 the CSMAC 5G Subcommittee recommended that NTIA establish a formal and transparent process whereby NTIA receives input for its engagement with standards development organizations (SDOs).[20] The Enforcement Subcommittee observed that methodologies are needed to validate and accredit devices so that interference detection functions could directly monitor interference events, to confirm that resolution actions were undertaken successfully, and to resolve liabilities.[21] The Spectrum Efficiency Subcommittee suggested a variety of promising approaches, many of which are targeted at the issue of agency

[20] CSMAC 5G Subcommittee Recommendations, July 24, 2018, at 4, https://www.ntia.doc.gov/files/ntia/publications/csmac_5g_subcommittee_recommendations_july_24th_2018_final.pdf.

[21] Report of the Enforcement Subcommittee, CSMAC, July 24, 2018, at 3-4, https://www.ntia.doc.gov/files/ntia/publications/csmac_enforcement_sub-committee_report_072418.pdf.

incentives.[22] Exploring and/or fulfilling these various recommendations could form a meaningful part of any national spectrum strategy.

D. How might investment in RDT&E improve spectrum-utilization methods, and spectrum-sharing tools and techniques?

Investment in spectrum research and development is not optional – it is essential to ensure that networks will be able to keep pace with exploding demand for capacity. The benefits of spectrum R&D manifest themselves in several ways. For example, many transitions of federal spectrum to commercial use, and various sharing scenarios, have involved the government incumbents upgrading their equipment to more spectrally-efficient technology, even as non-federal spectrum users are also continuously "doing more with less." To ensure this trend continues, policymakers must continue to actively encourage spectrum sharing research and development.

Funding mechanisms. Spectrum R&D is the "seed corn" that has enabled more efficient uses of spectrum by federal and commercial users alike, resulting in macroeconomic benefits to the U.S. economy as well as direct benefits to the Treasury when more spectrum is made available for auction. To ensure that the pipeline of spectrum continues into the future, any national spectrum strategy must incorporate the principle that a portion of spectrum auction proceeds must be reinvested into spectrum research and development efforts.

TIA strongly supported the inclusion of funding for public safety communications research in the 2012 Spectrum Act, much of which supported efforts by NTIA and/or NIST. The consolidation of NIST's wireless research efforts in 2014 into the Communications Technology

[22] CSMAC Spectrum Efficiency Subcommittee Report, July 2018, at 5-11, https://www.ntia.doc.gov/files/ntia/publications/csmac_spectrum_efficiency_subcommittee_report.pdf.

Laboratory has been a positive step, and these efforts should be recognized in a national spectrum strategy. However, significantly more far-reaching research initiatives, such as the creation of a Wireless Innovation Fund ("WIN"), were proposed but unfortunately not included in the 2012 spectrum law.[23] These and other proposals should be revived as part of any national spectrum strategy, and as part of any future legislative initiative to transfer or open federal spectrum for commercial use or to extend the FCC's spectrum auction authority.

Research areas. TIA released a Spectrum Sharing Research and Development whitepaper in 2013 that was developed with input from stakeholders across the ICT industry. The paper included recommendations for actions by policymakers in Congress, the Administration, and at specific funding agencies.[24] It identified several areas of potential research, including:

- Authorized shared access / licensed shared access mechanisms (ASA/LSA)
- Enhancing geolocation database effectiveness
- Cognitive radio and intelligent network selection
- Wideband and distributed sensing
- Cross-application and environment propagation modeling to facilitate spectrum aggregation and interference mitigation
- Various radar-related separation mechanisms, including radar beam avoidance by communications systems, adjusting transmit power based on measured path loss to radar receivers, signal processing methods, etc.

[23] *See* S. 911 (112th Cong.) § 224 (proposing creation and funding of a program for Advanced Information and Communications Technology Research).

[24] Telecommunications Industry Association, *Spectrum Sharing Research and Development* (2013), *available at* https://www.tiaonline.org/wp-content/uploads/2018/05/TIA_Spectrum_Sharing_Research_and_Development_White_Paper.pdf. TIA presented the white paper to the NITRD-led interagency Wireless Spectrum Research and Development Senior Steering Group (WSRD SSG) in 2014.

- Network resiliency and security, including the implications of spectrum sharing for wireless ad hoc networks

- Systemic research on how various network protocols and architectures respond in environments with link-layer interference caused by spectrum sharing.

To be sure, there has been significant technological progress in the past five years. Major advances include, for example, the development of new beamforming technologies and advances in basic manufacturing that are making today's millimeter-wave technologies a reality and a cornerstone of 5G applications. Nevertheless, many of the fundamental challenges identified in 2013 remain very present today, and any national spectrum strategy must highlight the importance of addressing them.

E. What are the risks, if any, to the global competitiveness of U.S. industries associated with spectrum management and policy actions?

The U.S. ICT industry is the most innovative in the world, but it now finds itself in the midst of an ongoing worldwide competition to develop, standardize, and deploy new wireless technologies. In perhaps the most prominent example, billions of dollars of direct spending – and perhaps even the future viability of the global ICT industry – are at stake in the global race to 5G. Some foreign governments, most notably China, have taken an increasingly strong policy and funding role in promoting their own wireless and satellite technology companies by facilitating testing and development.[25] While the U.S. and other ICT companies from allied nations may have led the way to 4G deployments, to quote Huawei's chairman, "we know deep down that the birth of 5G standards represents a new beginning."[26] Moreover, and as TIA has

[25] Josh Chin, Sarah Krouse, and Dan Strumpf, *The 5G Race: China and U.S. Battle to Control World's Fastest Wireless Internet*, WALL ST. J., Sept. 9, 2018.

[26] *Id.*

significantly documented, China provides significant subsidies to its ICT companies,[27] and has positioned the expansion of its domestic telecom equipment providers as a national priority.[28] Therefore, U.S. policymakers must take this threat seriously by creating the environment necessary to enable the U.S. ICT industry rapidly develop, standardize, and deploy new wireless technologies.

Development. The U.S. government must continue and expand its role in ensuring domestic leadership in developing next-generation wireless technologies. Steps to accomplish this goal may include:

- Reinvesting a meaningful portion of spectrum auction revenues into cutting-edge wireless research and development (*see* section III-D above);
- Continued investment in wireless testbeds, "model cities," or other paradigms that facilitate private-sector wireless research and public-private partnerships;
- Ensuring that experimental licenses are made available promptly to facilitate development of next-generation technologies;
- To the extent that federal sharing is involved, ensuring that mechanisms for public-private partnerships, potentially including appropriate security clearances, are available to non-federal stakeholders.

Standardization. TIA has long supported adjusting federal tax policies, such as a modification to the research and experimentation tax credit, to provide an incentive for companies to participate in standards-setting organizations and activities. The need for such policies has become abundantly clear in recent years with Chinese companies sending large

[27] Reply Comments of the Telecommunications Industry Association, filed July 3, 2018 in FCC WC Docket No. 18-89, at 62-65.

[28] *Id.* at 66.

teams to global industry-sponsored wireless standards meetings.[29] These standards discussions could determine which companies will lead in the development of next-generation wireless technologies. A national spectrum strategy should therefore recognize the importance of standardization and provide both mechanisms and means to ensure that U.S. ICT companies have a seat at the table to ensure that companies from non-allied nations do not achieve dominance in these areas.

Deployment. Policies that encourage the rapid deployment of new wireless technologies are essential to maintaining a healthy and innovative U.S. ICT ecosystem, and should be included in any discussion of a national spectrum strategy. The FCC has recently adopted several orders to promote wireless infrastructure deployment, and Congress is considering legislation that would streamline small cell deployment, but other steps should also be taken to benefit all of the technologies that advance broadband across the United States and our leadership globally. For example, while the FCC has acted to make millimeter-wave spectrum available for commercial wireless uses, the agency must complete its equipment authorization proceeding to address RF exposure limits for millimeter-wave devices, lest the full potential of that spectrum not be realized. Finally, the U.S. space industry is increasingly playing a role in broadband deployment, with both established operators and new entrants proposing and/or deploying new technologies and networks. As with terrestrial deployments, policies should

[29] Newley Purnell and Stu Woo, *China's Huawei Is Determined to Lead the Way on 5G Despite U.S. Concerns*, WALL ST. J., March 30, 2018 ("Huawei … sent 40 representatives to the Chennai meeting, behind only the 41 from … Samsung …. There were 30 delegates from … Qualcomm, while Huawei's major wireless-equipment rivals, Sweden's Ericsson AB and Finland's Nokia Corp., sent 25 and 18 representatives, respectively. Representatives from Chinese companies now hold 10 of the 57 chairman and vice chairman positions on decision-making panels at 3GPP….").

encourage rapid deployment to ensure that the U.S. space industry retains its position of global leadership.

F. How could a spectrum management paradigm be structured such that it satisfies the needs of commercial interests while preserving the spectrum access necessary to satisfy the mission requirements and operations of Federal entities?

There are several steps that could be taken to improve federal spectrum management in a way that serves the interests of both federal and non-federal users alike.[30] Indeed, several CSMAC recommendations from the past several years have touched on this subject, even as we highlight some potential steps here.[31] Some of the actions discussed below may require the participation of other stakeholders such as Congress or independent agencies like the FCC, but some can potentially be taken through executive-branch administrative action.

Better Tracking is Needed. A better spectrum use tracking and management process will undoubtedly encourage more efficient uses of spectrum by all users. However, achieving this objective will require more frequent and sustained engagement between government and private-sector users at a technical level. In cases of spectrum sharing, federal policy should support forums for all stakeholders to periodically exchange information to better ensure that the sharing environment is and remains workable.

Stronger Central Coordination May Be Useful. NTIA – an agency in the Department of Commerce – is currently tasked with coordinating spectrum use for the federal government. However, as various spectrum-related efforts in recent years have demonstrated, a stronger level of coordination or management for federal spectrum usage may be required. Indeed, in some

[30] *See generally* TIA OSTP Comments.

[31] *See, e.g.*, CSMAC Spectrum Efficiency Subcommittee Report, July 2018, at 2-5 (discussing legal, structural, informational, and other barriers to implementing spectrum efficiency mechanisms).

cases NTIA has occasionally had difficulties even obtaining current information from other departments, making it difficult for the agency to effectively respond to Administration and Congressional requests for more detailed information regarding federal use. It may be valuable to have NTIA be staffed to engage more closely with other spectrum management offices to ensure that there is greater currency to government records of use, providing greater transparency for management purposes.

Flexible-Use Funding is Required. The use of commercial auction proceeds has become an important and effective tool to migrate and upgrade federal systems to allow for commercial uses, and to support cost impacts on existing programs/contracts when changes are made. As future spectrum transitions are contemplated, the Administration should ensure that any spectrum transition funds can be used in a manner flexible enough to cover a wide range of costs, including upfront tests, prototypes, and other significant investment costs by the agencies. Indeed, such flexibility may also help overcome any agency resistance to "unknowns" associated with any particular transition of spectrum.

Agencies Should Think Creatively About Needs. In 2014, the Department of Defense ("DoD") announced an Electromagnetic Spectrum Strategy.[32] This strategy clearly and publicly articulated to the DoD spectrum community the need for increased efficiency, creativity and flexibility in spectrum use. In doing so, DoD specifically called out various mechanisms that it believes may be useful in circumstances where spectrum sharing is possible. Critically, DoD also recognized that wise use of spectrum is a matter of national economic security as well as national security, and that appropriate balancing of these interests is required.

[32] Department of Defense, *Electromagnetic Spectrum Strategy*, Release No. NR-091-14 (rel. Feb. 20, 2014), *available at* http://www.defense.gov/news/dodspectrumstrategy.pdf.

G. What are the likely future needs of spectrum users, both terrestrially and for space-based applications, within the next 15 years? In particular, are present allocations of spectrum sufficient to provide next generation services like Fifth Generation (5G) cellular services and emerging space-based applications?

1. Short-term needs

Present allocations of spectrum are not sufficient to meet demand for 5G networks and/or emerging space-based applications over the next 15 years. In particular, while policymakers have focused recently on making millimeter-wave spectrum available through the FCC's *Spectrum Frontiers* proceeding and making low-band spectrum available through the broadcast incentive auction, there is clearly a need for more mid-band spectrum. Mid-band spectrum is needed because it has propagation and building penetration characteristics that make it highly complementary to low-band and high-band allocations where policymakers have acted more recently.[33] It will play an important role in future mobile broadband wireless networks, including 5G networks and other platforms; access to that spectrum is also important for near and long-term space based applications.

Moreover, TIA believes in technology neutrality and that several different wireless solutions, including 5G, other terrestrial applications, and various space-based applications, can play a role in meeting future service needs. For example, satellite operators are now offering broadband service that satisfies the FCC's definition of broadband – 25 Mbps down / 3 Mbps

[33] *See generally* Comments of the Telecommunications Industry Association, *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 GHz and 24 GHz*, filed Oct. 2, 2017 in FCC GN Docket No. 17-183, at 1 & 5-6 ("TIA Mid-Band NOI Comments").

up[34] – and new service offerings will deliver 100 Mbps download speeds.[35] TIA has also recently noted that the FCC could consider creating reasonable spectrum opportunities for upper airspace-based technologies such as stratospheric platform stations ("STRAPS").[36] A comprehensive national spectrum strategy should recognize the important role that all of these different types of services will play.

2. Long-term needs

TIA offers below a few basic principles to help answer this challenging question. But to begin with the obvious, the future path of technology is very difficult to predict. For example, few could have imagined the explosive demand for wireless broadband that would result from the release of the first iPhone just 11 short years ago, the beginning of Netflix streaming that same year, or the creation of YouTube just two years prior. Today, the Internet of Things is beginning to take hold with everything from industrial devices and sensors to smart lightbulbs and even smart clothing. Meanwhile, different types of users ranging from consumers to enterprises and governments are deploying different types of commercial and private networks to connect these devices. Although wireless network design is inevitably a balance between factors such as spectrum availability, power levels, proximity to a hub (or the next node in a mesh network), and cost, it is too soon to establish with any precision how the millimeter-wave / small cell revolution will unfold.

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[34] *See, e.g.*, Press Release, *Hughes Announces HughesNet Gen5 High-Speed Satellite Internet Service*, March 7, 2017.

[35] *See, e.g.*, Jeff Baumgartner, *New Hughes/EchoStar Satellite to Deliver 100 Mbps-Plus*, MULTICHANNEL NEWS, Aug. 11, 2017,

[36] Comments of the Telecommunications Industry Association, *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, filed Sept. 10, 2018 in FCC GN Docket No. 14-177, at 6 ("TIA Spectrum Frontiers Third FNPRM Comments").

Different types of spectrum. Any measure of how much spectrum should be made available must recognize that different types of spectrum will still be needed, including low-band, mid-band, and high-band. A single, round numerical goal – such as "500 MHz of new spectrum" – may therefore not be sufficiently granular to be of practical use. Future mobile broadband technologies will rely on various technologies and spectrum bands, including low-band, mid-band, and high-band (millimeter-wave) spectrum. Future wireless networks are likely to rely upon some combination of new spectrum, leveraging existing spectrum, heterogeneous approaches, the use of small cells, and increased spectrum sharing. All will combine to affect the ultimate design and deployment of future networks.[37]

As mobile broadband networks progress, we will continue to see networks focus on traditional benchmarks such as increased speed and reduced latency, where millimeter-wave spectrum may play an important role. In addition, new measures such as network reliability, robustness, and security could play a larger role, particularly as wireless usage paradigms extend beyond phones and tablets to embrace appliances, vehicles, health care applications, widely distributed sensor networks, etc. Furthermore, future networks are likely to be characterized by elements such as advanced antenna solutions, ultra-lean design, spectrum flexibility, the possible convergence of access and backhaul networks, and larger bandwidths.[38]

Ultimately, future networks seem unlikely to be based upon a single wireless standard (*e.g.*, LTE or Wi-Fi) or particular type of spectrum (*i.e.*, VHF, UHF, SHF / centimeter-wave or

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[37] *See generally* Comments of the Telecommunications Industry Association, *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, filed Jan. 15, 2015 in FCC GN Docket No. 14-177, at 5-7 ("TIA Spectrum Frontiers NOI Comments").

[38] *See* Ericsson Review, *5G radio access*, June 18, 2014, *available at* http://www.ericsson.com/res/thecompany/docs/publications/ericsson_review/2014/er-5g-radio-access.pdf

EHF / millimeter-wave). Rather, future broadband networks may emerge as a suite of inter-related standards and protocols all working harmoniously, with the selection of particular technological tools being dependent on specific use cases.[39] Millimeter-wave spectrum will have a significant role to play, and will be an important new tool among several in the toolbox.

Many of the technologies for next-generation wireless networks discussed above will rely upon lower-band spectrum. Indeed, some of the new technologies may be inherently incompatible with millimeter-wave deployments due to the latter's unique propagation characteristics – for example, millimeter-wave spectrum seems inherently unsuited to macrocell applications due to range issues. Therefore, even as the current focus of the FCC is on spectrum auctions in the millimeter-wave bands, a national spectrum strategy must continue to seek ways to make additional lower-band spectrum available for non-federal uses as appropriate.

Different licensing models. A national spectrum strategy should recognize a need for different types of licensing models. For example, unlicensed spectrum should continue to play a very important role in the wireless ecosystem. Opening spectrum to unlicensed services has undoubtedly led to great innovations, including microwave ovens, cordless phones, garage door openers, sensors, and perhaps the most important innovation, Wi-Fi. This ecosystem of unlicensed operation has been an important ingredient in facilitating next-generation technologies and maintaining U.S. leadership in ICT innovation. It has also helped mobile operators cope with exploding demand, since Wi-Fi is virtually omnipresent in consumer devices such as smartphones and tablets.

[39] *See* Qualcomm, *5G and Wireless Broadband Evolution*, May 13, 2014, *available at* http://johannesbergsummit.com/wp-content/uploads/sites/6/2013/11/Smee-Qualcomm_5G_Johannesburg_2014.pdf

However, a one-size-fits-all approach to the role of unlicensed vs. licensed spectrum, or in using third-way models such as in the 3.5 GHz band, is not appropriate. To begin with, spectrum bands will not have the same propagation characteristics, and particular bands may lend themselves to support certain types of services. Also, the incumbent users of a band as well as adjacent bands can impact the types of new operations that can successfully occur. Indeed, spectrum policy is not being written on a blank slate – incumbent users exist in many bands used today and under consideration for future use by unlicensed devices.

A national spectrum strategy should therefore recognize that the choice of any particular band management plan is dependent upon several factors, including:

- *A band's physical propagation characteristics.* For example, higher frequencies may lend themselves to short range coverage (*e.g.*, Wi-Fi "hotspots") while lower frequencies are considered to be more efficient for large area coverage.

- *The nature of incumbent or nearby users.* Avoiding harmful interference is important, and unlicensed operations may pose (for example) different enforcement challenges vs. co-existence with users having controlled or managed access to spectrum.

- *The proposed unlicensed use or uses.* For some proposed uses, the need for assured quality of service may be a factor, or else statutory and regulatory mandates such as public safety / 911 requirements may apply.

Both Congress and the FCC have wisely considered many of these factors in their approaches to spectrum management. For example, the 2012 Spectrum Act required licensing of the 600 MHz band while encouraging the FCC to open more spectrum for unlicensed operations in the 5 GHz bands. Indeed, TIA has supported both aspects of the 2012 Spectrum Act as sound policy decisions that reflect the various factors above.[40] Moreover, the FCC established a tiered

[40] Other examples of unlicensed use potentially include 6.78 MHz and 900 MHz for industrial, scientific, and medical applications (ISM), Wi-Fi at 2.4 GHz, 5 GHz, or 60 GHz, and ultrawideband (UWB) operations above 6 GHz.

approached to spectrum access in the 3.5 GHz band by utilizing a SAS to manage access among the tiers of users/services and provide interference protection as required.

In the end, the choice of a band management plan or the use of particular approaches should be made to encourage more efficient uses of spectrum by all users. Forward-looking management of radio spectrum is essential to the goal of expanding telecommunications services and ensuring that the public derives maximum benefit from the use of spectrum, whether by its government, wireless operators, consumers or enterprises.

Setting a national goal. With the caveats above, TIA believes that a national spectrum strategy should consider setting a goal – or perhaps more precisely, multiple goals – for making more spectrum available. While the previous Administration's single goal of making 500 MHz available for mobile and fixed wireless broadband use was occasionally subject to criticism, it was an ambitious target that motivated all stakeholders, including government and industry, to try and achieve it. Establishing a similar set of goals for low-band, mid-band, and high-band spectrum could potentially help galvanize stakeholders once again to help achieve even further-reaching goals. Indeed, demand for spectrum is growing rapidly enough that reaching such goals may not just be optional, but essential, for ensuring that spectrum policy and availability keeps pace. Finally, a set of goals could potentially be designed to help ensure that different types of technologies (terrestrial, space, etc.) and services using different licensing models (licensed, unlicensed, shared access, etc.) will have room to grow over time.

IV. CONCLUSION

TIA greatly appreciates the work of NTIA toward coordinating and developing a national spectrum strategy that will benefit all stakeholders for years to come. We look forward to further opportunities for engagement with NTIA and other agencies as the process of implementing the 2018 Presidential Memorandum continues.

Respectfully submitted,

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