Before the
NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION
Washington, D.C. 20230

In the Matter of Developing a Sustainable Spectrum Strategy for America's Future	Docket No. 181130999-8999-01 RIN 0660-XC044

COMMENTS OF GOOGLE LLC

Megan Anne Stull
Counsel

Andrew W. Clegg, PhD
Spectrum Engineering Lead

Google LLC
25 Massachusetts Avenue NW
9th Floor
Washington, DC 20001

January 22, 2019

Table of Contents

Before the
NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION
Washington, D.C. 20230

In the Matter of Developing a Sustainable Spectrum Strategy for America's Future	Docket No. 181130999-8999-01 RIN 0660-XC044

COMMENTS OF GOOGLE LLC

Google has long supported spectrum policies that help bring affordable, ubiquitous, high-speed broadband to all Americans while fostering competition, innovation, and investment in the telecom and tech sectors. Consistent with these goals, Google and other companies are developing new technologies that can better protect existing Federal and non-Federal uses of spectrum while simultaneously allowing the introduction of new licensed and unlicensed commercial services. A sound National Spectrum Strategy should recognize that database systems and other tools for near real-time spectrum management are available today to administer spectrum sharing quickly, efficiently, and reliably. Agencies should be encouraged to embrace these other solutions to maximize spectrum usage, including acceptance of smaller geographic authorizations and time-limited permissions where appropriate. A National Spectrum Strategy should prioritize opening mid-band spectrum for commercial uses to ensure the nation's global 5G leadership. A balanced strategy also should include significant expansion of opportunities for unlicensed or lightly licensed access and avoid inflexible service rules that, in a misguided effort to anticipate or shape the future direction of wireless technologies and the marketplace, actually suppress innovation. The goal of a long-term spectrum strategy for the

United States should be positioning the country to lead in developing the best possible new technologies and services, rather than directing spectrum to currently favored uses or users.

I. Dynamic Sharing Can Increase Spectrum Availability.

The government should capitalize on new technologies to maximize the availability of usable spectrum. In particular, modern spectrum sharing can augment utilization while still protecting against harmful interference. Dynamic spectrum databases and automated admission technologies hold the promise of revolutionizing wireless communications and transforming network deployments by incumbent operators, neutral hosts, and end users, catapulting the United States into its 5G future.

Reports indicate that Americans used "15.7 trillion megabytes of mobile data in 2017—nearly quadrupling since 2014 and representing 40 times the volume of traffic in 2010."[1] As wireless usage builds, demand for better connectivity and higher throughputs is also increasing. For instance, data released in 2017 indicate that the average smartphone user in the United States used 31.4 GB of data per month (including Wi-Fi and cellular consumption), a 25% increase from the previous year.[2] As Ericsson explained in November 2018, "[t]wo key factors in enabling new immersive formats to go mainstream will be reductions in latency and support for more symmetrical uplink/downlink throughput – both of which are attributes of 5G."[3]

---

[1] CTIA, *The State of Wireless 2018*, July 10, 2018, https://www.ctia.org/news/the-state-of-wireless-2018.
[2] The NPD Group, *Unlimited Data Plan Users Consume 67 Percent More Cellular Data Than Users on Limited Plans Consume*, Dec. 27, 2017, https://www.npd.com/wps/portal/npd/us/news/press-releases/2017/unlimited-data-plan-users-consume-67-percent-more-cellular-data-than-users-on-limited-plans-consume.
[3] Ericsson, *Ericsson Mobility Report: November 2018*, 25 (2018), https://www.ericsson.com/assets/local/mobility-report/documents/2018/ericsson-mobility-report-november-2018.pdf.

In this environment of greater and greater demand, underutilization of spectrum resources is increasingly unacceptable.

Fortunately, new dynamic spectrum database technologies enable innovative uses and prevent frequencies from lying fallow. When relying on smart databases, devices using a given frequency register their transmissions, allowing others to see when the spectrum is in use (while maintaining privacy where warranted). Government policies that incorporate opportunistic spectrum use can enable more efficient use, lowering barriers to entry for new products, applications, and use cases, which are essential for economic development and achieving 5G. At the same time, effective use of databases is fully compatible with traditional licensing in the same spectrum bands, enabling wireless carriers and other providers to meet quality of service needs.

Following the United States' lead, spectrum sharing is becoming a global phenomenon; maintaining U.S. leadership in wireless innovation therefore depends on continuing to expand shared use. Looking to spectrum sharing technologies in the United States, especially in the Citizens Broadband Radio Service (CBRS) at 3.5 GHz, regulators abroad are codifying policies to promote and maximize the use of dynamic spectrum database technologies. For instance, Recital 119 of the European Electronic Communications Code notes that "growing radio spectrum demand and new varying applications and technologies . . . necessitate more flexible access and use of radio spectrum."[4] Member States are urged to promote sharing, which allows for usage "under various types of legal regimes in order to make additional radio spectrum

[4] Directive 2018/1972, of the European Parliament and of the Council of 21 November 2018 establishing the European Electronic Communications Code (Recast), 2019 O.J. (L 321) 57, *available at* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972.

resources available, raise usage efficiency and facilitate radio spectrum access for new users."[5]

Recital 119 explains that spectrum sharing policies can include:

> [G]eneral authorisations or licence-exempt use allowing, under specific sharing conditions, several users to access and use the same radio spectrum in different geographic areas or at different moments in time. [Sharing] can also be based on individual rights of use under arrangements such as licensed shared access where all users (with an existing user and new users) agree on the terms and conditions for shared access, under the supervision of the competent authorities, in such a way as to ensure a minimum guaranteed radio transmission quality.[6]

As Recital 119 makes clear, spectrum sharing need not rely on an "one size fits all" regulatory approach.

The United Kingdom's Office of Communications (OFCOM) has taken a notable leadership role in spectrum sharing. More than five years ago, OFCOM explored the potential for spectrum sharing to meet the "significant growth in demand for mobile broadband and wireless data capacity."[7] At that time, OFCOM identified three areas—indoor use (e.g., Wi-Fi connectivity), outdoor use (e.g., small cells), and internet of things (IoT)—where sharing would facilitate delivery of benefits to users.[8] In 2015, OFCOM took the additional step of issuing a framework to assess sharing opportunities in new bands.[9] For instance, in 2016, OFCOM expressed interest in "further exploring enhanced sharing [in the 3.8 to 4.2 GHz band] based on geographically defined authorisations while continuing to allow current and future deployments

---

[5] *Id.*
[6] *Id.*
[7] *See* OFCOM, *The Future Role of Spectrum Sharing for Mobile and Wireless Data Services - Licensed Sharing, Wi-Fi, and Dynamic Spectrum Access*, Aug. 9, 2013, https://www.ofcom.org.uk/consultations-and-statements/category-1/spectrum-sharing.
[8] *Id*.
[9] *See* OFCOM, *A Framework for Spectrum Sharing*, July 31, 2015, https://www.ofcom.org.uk/consultations-and-statements/category-2/spectrum-sharing-framework

of incumbent Fixed and Fixed Satellite Services [(FSS)],"[10] which led to issuance of a consultation in December 2018 to achieve that objective.[11]

To maintain American leadership, therefore, a National Spectrum Strategy should affirm the nation's commitment to increasing spectrum sharing. Doing so would be grounded in a growing roster of successful deployments of database technologies to enable dynamic spectrum access. For instance, although the utility of television white spaces spectrum has been limited due to lack of available bandwidth and shifting regulations, databases have proved up to the challenge of verifying available spectrum and successfully preventing harmful interference to broadcast television and licensed wireless microphones.[12]

The strengths of spectrum sharing technologies also are being demonstrated in CBRS. With CBRS, all segments of the wireless industry have collaborated to implement sharing in a particularly challenging environment that includes incumbent military users that are both mobile and at undisclosed locations. CBRS is governed by a three-tiered licensing framework in which incumbent users, including authorized Federal and grandfathered fixed wireless broadband users, retain the highest priority.[13] Priority Access Licenses (PALs), assigned within the 3550–3650 MHz portion of the band through competitive bidding, enjoy the second highest level

---

[10] *See* OFCOM, *3.8 GHz to 4.2 GHz Band: Opportunities for Innovation,* Apr. 14, 2016, https://www.ofcom.org.uk/consultations-and-statements/category-2/opportunities-for-spectrum-sharing-innovation.

[11] *See* OFCOM, *Enabling Opportunities for Innovation: Shared Access to Spectrum Supporting Mobile Technology*, 2-3 (Dec. 18, 2018), https://www.ofcom.org.uk/__data/assets/pdf_file/0022/130747/Enabling-opportunities-for-innovation.pdf.

[12] Microsoft Corporation, *A Rural Broadband Strategy: Connecting Rural America to New Opportunities*, 12, 14 (July 10, 2017), https://blogs.microsoft.com/uploads/2017/07/Rural-Broadband-Strategy-Microsoft-Whitepaper-FINAL-7-10-17.pdf.

[13] *See In the Matter of Promoting Investment in the 3550-3700 MHz Band*, Report and Order, GN Docket No. 17-258, ¶ 3, n.6 (rel. Oct. 24, 2018) (*2018 CBRS Report and Order*).

of interference protection.[14] Finally, licensed-by-rule General Authorized Access (GAA) users must accept interference from and may not cause harmful interference to PALs and top-tier incumbents.[15] Spectrum Access System (SAS) administrators, augmented by the Environmental Sensing Capability (ESC) network, manage automated frequency coordination and mediate and control access rights between the tiers of users.[16] Within this model, non-traditional and smaller wireless users, such as IoT and private LTE network operators, rural broadband providers, and the largest national mobile carriers can share CBRS spectrum to extend connectivity and increase capacity, all while protecting critical use of the band by the United States Navy.[17] Use of CBRS frequencies will improve users' mobile broadband experience,[18] enhance performance of novel applications including IoT, private LTE networks, and smart homes,[19] and allow for advancements in manufacturing, energy, and healthcare by industrial and enterprise users.

---

[14] *Id.* ¶ 3, n.8.
[15] *Id.* ¶ 3.
[16] *Id.*
[17] *See, e.g.,* National Institute of Standards and Technology, *NIST Facilitates First-ever Spectrum Sharing Between Military and Public Wireless Users*, PHYS.ORG, Mar. 22, 2018, https://phys.org/news/2018-03-nist-first-ever-spectrum-military-wireless.html.
[18] *See, e.g., Private LTE & 5G-ready Network Rollouts Accelerate, Driven by Critical Communications and Industrial IoT*, VANILLAPLUS, June 29, 2018, https://www.vanillaplus.com/2018/06/29/39805-private-lte-5g-ready-network-rollouts-accelerate-driven-critical-communications-industrial-iot/ (summarizing a report from SNS Telecom & IT that anticipates "significant activity in the 3.5 GHz CBRS and 5 GHz unlicensed bands, to support private LTE and 5G-ready network deployments across a range of environments, particularly enterprise buildings, public venues, factories and warehouses").
[19] *See, e.g.,* Michael Wedd, *The 3 Most Impactful Recent Advances in IoT*, IOT FOR ALL, Dec. 17, 2018, https://www.iotforall.com/3-key-advances-iot-industry/ (noting that the "open CBRS band could fill a missing spectrum gap for IoT solutions providers working on use cases like indoor asset tracking"); Jason Marcheck, *In-building Wireless 2019: CBRS and Shared Spectrum*, IN-BUILDING TECH, Oct. 29, 2018, https://inbuildingtech.com/venues/in-building-wireless-2019-cbrs-and-shared-spectrum/ (explaining how "CBRS is envisioned to use standardized LTE technology propagated over unlicensed, or lightly licensed spectrum to build private wireless networks that can be managed either by an MNO, neutral host, or, even a tenant within a building").

The strong support CBRS has gained from major mobile operators, fixed service (FS) providers, and IoT operators is particularly noteworthy because it demonstrates how technology can create new opportunities for using spectrum. Within the last six years, mobile carriers viewed the 3.5 GHz band as unusable for their services. AT&T claimed that the 3.5 GHz band was "ill-suited for exclusive-use licensing" due to its "limited signal propagation and the presence of incumbent users,"[20] and CTIA stated that because the "spectrum is not below 3 GHz" it was "not suitable at this time for mobile broadband."[21] By 2017, the mobile industry had done a 180-degree turn, and sought optimization of CBRS PAL licenses to support wide-area deployments of their services.[22] Cable operators also are engaging in field trials to explore using CBRS spectrum for new fixed and mobile deployments, making clear how spectrum sharing technology generates conditions for expanded competition.[23] Incorporation of wireless Internet services into the CBRS framework also demonstrates how dynamic sharing can help address rural broadband shortages. For instance, a December 2017 survey of the Wireless Internet Service Providers Association's operator members revealed that more than 60% of respondents

[20] *See* Comments of AT&T in GN Docket No. 12-354 at 9 (filed July 14, 2014).
[21] *See* Comments of CTIA – The Wireless Association in GN Docket No. 12-354 at 1 (filed Feb. 20, 2013).
[22] *See, e.g.,* Petition for Rulemaking of CTIA for Rulemaking in GN Docket No. 12-354 at 2 (filed June 16, 2017); Petition for Rulemaking of T-Mobile USA, Inc. in GN Docket No. 12-354 at 4 (filed June 19, 2017).
[23] *See, e.g.,* Diana Goovaerts, *Comcast Gears up for 3.5GHz Field Trials*, MOBILE WORLD LIVE, Feb. 15, 2018, https://www.mobileworldlive.com/featured-content/top-three/comcast-gears-up-for-3-5ghz-field-trials (discussing Comcast's plans to launch pre-commercial field trials in the 3.5 GHz band, covering both fixed and mobile applications); Charter Communications, *An Up-Close Look at Charter's Network Operations and 3.5 GHz Trials in Tampa*, May 4, 2018, https://policy.charter.com/blog/close-look-charters-network-operations-3-5-ghz-trials-tampa/ (discussing testing of small cells using the CBRS band in Florida).

had purchased equipment and begun serving customers using 3.5 GHz spectrum.[24] New users of spectrum have also spoken about the promise of CBRS for a host of diverse business models that would not have been possible by merely licensing the same spectrum for exclusive use. For instance, colleges, ports, hospitality, industrial parks, manufacturing plants, sports arenas, and other users have expressed interest in using CBRS spectrum to meet a variety of needs.[25]

While incumbent naval radars make sharing in the CBRS complex, not every spectrum band poses the same complications for commercial use. In the vast majority of cases, application of dynamic sharing presents no special difficulties, making it a natural fit as a critical component of the nation's 5G strategy. Indeed, the FCC rightly is investigating using database-powered technologies to support licensed and unlicensed terrestrial services in underutilized 3.7–4.2 GHz satellite (C-Band) spectrum and the 6 GHz band.[26] Additional bands where sharing should be encouraged include the 3.45–3.55 GHz band, which is used primarily by military radar systems and holds particular promise if paired with CBRS spectrum,[27] and the

---

[24] Comments of the Wireless Internet Service Providers Association in GN Docket No. 14-177 *et al.* at 8 (filed Sept. 11, 2018) (explaining that white internet service providers are using of the upper portion of the band [3650-3700 MHz] to serve customers).

[25] *See, e.g.,* Reply Comments of the Wireless Internet Service Providers Association in GN Docket No. 17-258 at 23-24 (filed Jan. 29, 2018); J. Sharpe Smith, *FCC's Creation of CBRS May Change Future of Spectrum Allocations*, AGL MEDIA GROUP, Oct. 23, 2018, https://www.aglmediagroup.com/fccs-creation-of-cbrs-may-change-future-of-spectrum-allocations/ (acknowledging private wireless opportunities using CBRS spectrum, including industrial, port, rail yard, power plant, logistics handling, hospitality, health care, and property management).

[26] *In the Matter of Expanding Flexible Use of the 3.7 to 4.2 GHz Band et al.*, Order and Notice of Proposed Rulemaking, 33 FCC Rcd. 6915 (2018) (*C-Band NPRM*); *In the Matter of Unlicensed Use of the 6 GHz Band et al.*, Notice of Proposed Rulemaking, ET Docket No. 18-295, GN Docket No. 17-183 (rel. Oct. 24, 2018) (*6 GHz NPRM*).

[27] David J. Redl, *NTIA Identifies 3450-3550 MHz for Study as Potential Band for Wireless Broadband Use*, National Telecommunications and Information Administration, Feb. 26, 2018, https://www.ntia.doc.gov/blog/2018/ntia-identifies-3450-3550-mhz-study-potential-band-wireless-broadband-use.

25.25–27.5 GHz band, in which dynamic sharing could facilitate both bidirectional sharing between Federal and non-Federal users and sharing among disparate non-Federal uses.

The potential for dynamic spectrum sharing extends even further when combined with other technologies. For instance, advanced propagation models make use of increasingly detailed geodata, allowing greater accuracy in coordinating uses so that more parties can benefit from sharing.[28] The National Spectrum Strategy accordingly should promote increased investment in research and development, particularly to enhance spectrum sharing. For example, the Strategy should include increased government/industry collaboration through efforts such as the National Spectrum Consortium;[29] increased funding of general spectrum-related research similar to the previous National Science Foundation Enhancing Access to the Radio Spectrum (EARS);[30] and expansion of research programs that examine increased opportunities for shared spectrum access such as the previous Shared Spectrum Access for Radar and Communications[31] program at DARPA.

As a complement to increased investment in research, the National Spectrum Strategy should facilitate access to experimental FCC radio licenses that can be used to develop

---

[28] *See, e.g.,* Yi Hsuan, Google, *Impacts of Propagation Models on CBRS GAA Coexistence and Deployment Density* (Nov. 15, 2018), https://winnf.memberclicks.net/assets/Proceedings/2018/Invited%20Hsuan.pdf (presentation at WinnComm 2018 evaluating the impact on GAA coexistence from use of different propagation models—e.g., standardized propagation models used by SAS for incumbent and PAL protection and clutter-aware/ray tracing propagation models—to estimate interference).

[29] *See* National Spectrum Consortium, https://www.nationalspectrumconsortium.org/ (last visited Jan. 22, 2019).

[30] *See* National Science Foundation, *Enhancing Access to the Radio Spectrum (EARS) – Addressing Future Challenges*, Program Solicitation, Document No. NSF 16-537 (posted Feb. 5, 2016), https://www.nsf.gov/pubs/2016/nsf16537/nsf16537.htm.

[31] Defense Advanced Research Projects Agency, *Shared Spectrum Access for Radar and Communications (SSPARC)*, https://www.darpa.mil/program/shared-spectrum-access-for-radar-and-communications (last visited Jan. 22, 2019).

innovative new services. While government and other incumbent users sometimes resist experimental licenses today, such licenses should instead be encouraged to facilitate innovation. Specifically, an incumbent user that opposes an experimental license on grounds of harmful interference should demonstrate with specificity how the proposed experimental transmissions will cause interference to their operations. Absent such a concrete showing, the incumbent's objections should not receive weight in the decision whether to grant the experimental authorization.

II. Smaller License Areas and Secondary Spectrum Transactions Can Help Maximize the Use of Spectrum.

License areas need not be one-size-fits-all, nor do their boundaries need to be etched in stone. Furthermore, a licensee that is not using the entirety of its spectrum assignment should have wide latitude to allow others to put the spectrum into use. Smaller license areas, optimization of secondary market mechanisms, and use of tools like partitioning, disaggregation, and light-leasing all should be included in a National Spectrum Strategy.

The FCC has long held the view that robust private sector markets for spectrum "serve the public interest by creating new opportunities for increasing the communications capacity and efficiency of spectrum use by licensees."[32] While not a substitute for freeing new spectrum resources or reallocating/reassigning underutilized spectrum, a "robust and effective" secondary market for spectrum could "alleviate spectrum shortages by making unused or underutilized spectrum held by existing licensees more readily available to other users and uses and help to promote the development of new, spectrum efficient technologies."[33] Secondary markets can be

[32] *See Principles for Promoting the Efficient Use of Spectrum by Encouraging the Development of Secondary Markets*, Policy Statement, 15 FCC Rcd. 24178, ¶ 2 (2000).
[33] *Id*.

most effective when regulators allow licensees to lease spectrum in whatever size blocks are attractive to other productive users, without minimum bandwidth or geographic area requirements. Bigger is not better for all users. Rather, tools like partitioning and disaggregation can enhance the ability of secondary markets to promote investment and encourage robust and efficient usage by an array of stakeholders. A National Spectrum Strategy should urge the exploration of these and other tools, such as "use it or share it" approaches and interim buildout requirements, to encourage secondary market transactions.

The right ingredients are present for the CBRS band to serve as an exemplar of a robust secondary market for commercial access. The PAL tier has been opened by the FCC to partitioning and disaggregation to encourage offerings "responsive to market demands for particular types of services, increas[e] competition by allowing new entrants to enter markets, and expedit[e] provision of services that might not otherwise be provided in the near term."[34] Light-touch leasing also is available to allow PAL holders to provide access on the secondary market with "minimal administrative requirements or transaction costs."[35] If build-out requirements are strictly enforced and SAS administrators are fully empowered to support automated secondary licensing and surrounding negotiations, then secondary market transactions for PALs could enable a market-based way to determine license sizes "on a market-specific and needs-based basis."[36]

In addition to PAL opportunities, 3.5 GHz band GAA spectrum is available on an

[34] *See In the Matter of Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, et al.*, Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd. 8014, ¶ 233 (2016) (*Spectrum Frontiers Order)*.
[35] *In the Matter of Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Order on Reconsideration and Second Report and Order, 31 FCC Rcd. 5011, ¶ 8 (2016).
[36] *Id.*, ¶ 97.

opportunistic basis, and could offer a low-cost CBRS entry point for short-term investments.[37] While lightly-licensed, unprotected GAA operations are not a substitute for interference-protected PAL operations,[38] GAA spectrum could provide a level of spectrum access for a range of services.[39] The mix of licensed and lightly licensed use, as well as the potential for a secondary market, make the CBRS band worth monitoring when developing the National Spectrum Strategy.

III. A Spectrum Strategy Should Maximize Access to Mid-Band Spectrum and Ensure Unlicensed or Lightly Licensed Access Sufficient to Meet Fast-Growing Demand.

Maintaining the United States' global leadership in wireless requires unlocking ample spectrum for both fixed and mobile 5G. In particular, the United States should maximize access to mid-band spectrum, including in CBRS and underutilized C-Band spectrum, which offers both significant coverage potential and sufficient bandwidth to accommodate high-capacity services. Mid-3 GHz spectrum suits dense 5G small cell networks well, for instance in crowded urban environments where additional capacity is vital. While higher-frequency mmWave spectrum is not ideal for mobility and has never been widely commercially deployed, mid-3 GHz spectrum's combination of wireless signal distance, building penetration, and bandwidth can support widespread fixed and mobile 5G deployments at sustainable levels of investment.[40]

---

[37] *Id.*, ¶¶ 53, 64.
[38] *See, e.g.,* Reply Comments of the General Electric Company in GN Docket No. 17-258, n.41 (filed Jan. 29, 2018) (explaining that unlicensed or GAA spectrum may not "provide sufficient security for the enormous amounts of mission-critical data transmitted on these networks").
[39] *In the Matter of Promoting Investment in the 3500-3700 MHz Band et al.*, Notice of Proposed Rulemaking and Order Terminating Petitions, 32 FCC Rcd. 8071, ¶ 60 (2017).
[40] Jeremy Horwitz, *FCC Expands 3.5GHz Band to 5G and Opens 6GHz Band to Future Wi-Fi*, VentureBeat, Oct. 23, 2018, https://venturebeat.com/2018/10/23/fcc-expands-3-5ghz-band-to-5g-and-opens-6ghz-band-to-future-wi-fi/.

Indeed, because mid-band spectrum is "where most of the rest of the world will deploy 5G,"[41] keeping pace with the European Union, China, Japan, and South Korea as they allocate mid-band spectrum is essential.[42] Failure to focus on international harmonization would put the United States on a path to isolation to the detriment of American service providers, manufacturers, and consumers. Availability of equipment and semiconductors would be more limited, prices would be higher, and network coverage would suffer.[43] Rather than over-emphasizing much higher-frequency spectrum with challenging propagation characteristics that will play a more limited role in 5G, therefore, the National Spectrum Strategy should prioritize unleashing the power of mid-band spectrum for both fixed and mobile 5G services.

To ensure that spectrum is available to meet increasing demand, the National Spectrum Strategy also should incorporate a balance between licensed and unlicensed designations, in addition to both exclusive and shared access. Unlicensed technologies like Wi-Fi and Bluetooth have generated tremendous economic wealth, directly or indirectly contributing billions of dollars to the nation's gross domestic product (GDP). Research conducted for WifiForward found that unlicensed applications contributed $29.06 billion to the nation's GDP in 2017, a figure

---

[41] Roslyn Layton, *The U.S. Must Move Quickly On Mid-Band Spectrum If It Wants To Lead In 5G,* Forbes, May 23, 2018, https://www.forbes.com/sites/roslynlayton/2018/05/23/the-us-must-move-quickly-on-mid-band-spectrum-if-it-wants-to-lead-in-5g/#1da0a35b7462 (*Layton Editorial*).

[42] *See, e.g.,* Letter from Senator John Thune, Chairman, U.S. Senate Committee on Commerce, Science, and Transportation, to Ajit V. Pai, Chairman, FCC in OL Docket No. 17-18 at 1 (June 21, 2017), https://ecfsapi.fcc.gov/file/1072854128942/17-518.pdf (noting that Europe, China, Japan and South Korea are allocating "hundreds of megahertz of mid-band spectrum, for licensed and unlicensed uses, in anticipation of both new [IoT] applications as well as rising demand for mobile broadband that can be met with small cell deployments").

[43] *See Layton Editorial* (explaining how global harmonization "could benefit consumers by lowering equipment costs and speeding 5G deployments" and "bring tremendous economic benefits to the American companies which can export 5G enabled products and services.").

anticipated to reach at least $42.40 billion by 2020.[44] Furthermore, the ability to offload data from cellular networks to Wi-Fi has saved mobile network operators tens of billions of dollars in network deployment costs and expanded connectivity for consumers. In 2017 alone, Wi-Fi cellular offloading contributed an estimated $25.22 billion to the nation's economy.[45] Extensive buildout of Wi-Fi for Internet access by non-traditional telecom companies has further strengthened the economic benefits of connectivity in the United States. For instance, the economic value of so-called "free Wi-Fi" offered by retailers or public sites was estimated at $7.359 billion in 2018.[46]

As the FCC recently noted, when the 2.4 GHz and 5 GHz bands were made available for unlicensed use under the Commission's Part 15 rules in 1985, few predicted the ensuing explosion of innovation.[47] More than half of global mobile data traffic is offloaded to Wi-Fi or small cell networks, and the percentage is growing.[48] As wireless broadband connections grow in popularity, however, unlicensed spectrum resources are becoming overtaxed. To address this issue, the FCC has rightly initiated several rulemakings to explore making more spectrum

---

[44] Telecom Advisory Services LLC, *A 2017 Assessment of the Current & Future Economic Value of Unlicensed Spectrum in the United States*, 2, 58 (Apr. 2018), http://dynamicspectrumalliance.org/wp-content/uploads/2018/05/WiFi-Foward_Economic-Value_Shared-Spectrum_Report_05172018.pdf.

[45] WifiForward, *New Report: Economic Value of Unlicensed Spectrum in the U.S. Tops $525 Billion*, May 27, 2018, http://wififorward.org/2018/05/17/new-report-economic-value-of-unlicensed-spectrum-in-the-u-s-tops-525-billion/.

[46] Telecom Advisory Services LLC, *The Economic Value of Wi-Fi: A Global View (2018 and 2023)*, 38 (Oct. 2018), https://morningconsult.com/wp-content/uploads/2018/10/Economic_Value_of_Wi-Fi_2018.pdf.

[47] *6 GHz NPRM*, ¶ 3.

[48] Cisco Systems Inc., *Cisco Visual Networking Index: Global Mobile Data Traffic Forecast, 2016–2021 Q&A*, https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/vni-forecast-qa.html (last visited Jan. 22, 2019).

available for both licensed and unlicensed applications.[49] Likewise, a National Spectrum Strategy should seek to ensure the ongoing practical availability of spectrum that can be accessed with low entry barriers, for applications that do not require the quality-of-service benefits of licensed spectrum.

In identifying opportunities for unlicensed and lightly-licensed access, NTIA should consider the propagation characteristics of candidate bands. For instance, the propagation and atmospheric absorption characteristics of frequencies in the 70/80 GHz range make them generally poorly suited to wide-area operations.[50] 70/80 GHz operations typically require high power and directional gain to achieve significant range, better positioning them for high-speed point-to-point (P2P) or short range applications.[51] Because any 70/80 GHz application with significant range is likely to be highly directional (i.e., using high gain antennas), the resulting narrow beamwidths can operate close to one another with little risk of interference. Likewise, wider beamwidth (lower gain) applications necessarily have much shorter range, again facilitating sharing through coordination and minimal separation distances. Thus, various users can efficiently reuse this spectrum through required coordination and the observation of minimal separation distances. In circumstances such as these, the FCC's light-licensing framework provides an efficient approach to ensuring opportunity while preventing harmful interference. A

[49] *See, e.g., 6 GHz NPRM*; *C-Band NPRM*; *In the Matter of Use of Spectrum Bands Above 24 GHz for Mobile Radio Services et al.*, Third Report and Order et al., 33 FCC Rcd. 5576 (2018); *In the Matter of Spectrum Horizons et al.,* Notice of Proposed Rulemaking and Order, 33 FCC Rcd. 2438 (2018); *In the Matter of Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, Notice of Proposed Rulemaking, 28 FCC Rcd. 1769 (2013).
[50] *See* Comments of Google Inc. and Google Fiber Inc. in GN Docket No. 14-177 et al. at 2-3 (filed Oct. 31, 2016).
[51] *See id.*

National Spectrum Strategy should consider other bands with limited propagation for similar treatment.

IV. Service Rules Should Not Inadvertently Suppress Innovation.

The one constant in wireless has been that the most significant innovations were unexpected.[52] No formula exists to predict which wavelengths of currently dubious utility will become central to the next wave of wireless technology. It therefore is important for regulations to leave sufficient room for these transformations to occur. Accordingly, any National Spectrum Strategy should not prejudge the outcome of future innovation or presuppose a particular business model for wireless service, but should be flexible enough to support a wide range of services, from commercial mobile, to fixed broadband, to point-to-multipoint (P2MP) networks, to airborne platforms, to other services not yet conceived.

A. Overly Prescriptive Rules Suppress Innovation.

Mid-band spectrum offers a prime example of why heavily prescriptive government service rules should be avoided. As noted above, mobile carriers advised earlier this decade that mid-band frequencies would lack utility for mobile broadband services. For instance, T-Mobile stated that "the spectral location" of the 3550-3650 MHz band made it "less suitable for mobile broadband applications."[53] And, AT&T asserted that the CBRS spectrum had "limited utility for mobile broadband."[54] Now, mid-3 GHz frequencies are at the heart of the mobile industry's plans for 5G. Indeed, CTIA recently urged policymakers to "act quickly to free up large blocks of mid-band spectrum and set auction dates so that the wireless industry can build

[52] Comments of Google Inc. and Google Fiber Inc. in GN Dkt. 14-177, et al. at 1 (filed Sept. 30, 2016).
[53] Comments of T-Mobile USA, Inc. in ET Docket No. 10-123 at 7 (filed Apr. 22, 2011).
[54] Comments of AT&T Inc. in ET Docket No. 10-123 at 7 (filed Apr. 22, 2011).

world-class 5G networks and help the U.S. retain [its] wireless leadership.[55] If the major mobile operators' calls to dedicate mid-band spectrum solely to fixed uses had been heeded, the FCC now would be rushing to undo that overly prescriptive decision in order to catch up with other countries' 5G allocations.

Just as predetermining what uses would thrive in mid-3 GHz band spectrum would have been an error, it could well be a mistake for the FCC to allow private transfers of C-Band spectrum rights directly to preferred buyers, as is currently being considered.[56] The auction system established by Congress has worked well to identify high-value uses and users, and the FCC should exercise extreme caution when considering proposals that would outsource selection of future C-Band users to foreign-owned satellite licensees that are motivated solely by their own business interests. In such a sale, there would be no guarantee that the satellite incumbents would free as much spectrum as possible, or that the new user or users would use the spectrum efficiently. A National Spectrum Strategy should discourage government policies that tip the scales in favor of particular technologies or service providers.

B. Regulations That Unnecessarily Restrict Flexible Spectrum Usage Should Be Modified or Eliminated.

The FCC has expressed a goal of promoting "investment in infrastructure and 5G networks by eliminating unnecessary administrative burdens."[57] This includes "continually reviewing" rules for potential revision or elimination to "promote innovation and job growth" and removing "unnecessary administrative burdens to promote investment in infrastructure and next

[55] Scott Bergmann, *The Growing Need for Mid-Band Spectrum*, CTIA, June 15, 2018, https://www.ctia.org/news/the-growing-need-for-mid-band-spectrum.
[56] *C-Band NPRM*, ¶ 71 (seeking comment on using a market-based approach in which FSS operators form a Transition Facilitator to repurpose C-Band spectrum).
[57] FCC, *Strategic Plan 2018-2022*, 8 (Feb. 12, 2018), https://docs.fcc.gov/public/attachments/DOC-349143A1.pdf.

generation networks."[58] A National Spectrum Strategy should encourage other Federal agencies to adopt spectrum policies consistent with these FCC goals.

And the FCC itself can do more. For instance, the FCC currently is weighing in its *C-Band NPRM* whether coordination of new C-Band spectrum uses should be based on protected FSS earth stations' actual spectrum usage, rather than excessively protective "full band, full arc" registrations or even protection of non-existent or long-dormant earth stations. Large portions of the C-Band lie fallow because new providers often must coordinate with incumbent earth station operators as if the earth station used the entire available bandwidth along the entire geostationary arc from its location. This "full band, full arc" policy is overprotective, as most earth stations' planned operations use a small fraction of the full 500 MHz of the band, and look at only a sliver of the sky. It is even more indefensible given C-Band operators' eagerness to sell off some of their licensed frequencies, proving that the spectrum is being underutilized.[59] Promotion of both fixed and mobile 5G technologies in the C-Band would be served by eliminating overbroad earth station registrations, thereby removing an artificial obstacle blocking use of vacant spectrum.

The *C-Band NPRM* also presents the FCC with a chance to adopt broadband-friendly changes to its Part 101 Rules, which were written decades ago to accommodate long-haul microwave links, the vast majority of which have long ago vacated the 3.7-4.2 GHz band. Relatively minor changes would enable the development of high-speed, P2MP broadband services in the C-Band, including in underserved rural areas. For example:

---

[58] *Id.* at 9.

[59] *See* Reply Comments of Google LLC in GN Docket No. 18-122 et al. at 3 (filed Dec. 11, 2018) (explaining that the C-Band Alliance has confirmed that "FSS licensees can relinquish hundreds of megahertz of C-Band spectrum for mobile and other terrestrial uses without harming satellite delivery of content").

- Fixed service licensees in the C-band currently may be assigned 20 MHz paired channels for common carrier or private links. FCC Rule 101.147(h) should accommodate time division duplex channels and channel aggregation to expand link capacity.
- For common carrier fixed microwave services, only point to point links are authorized, making link-by-link registration of broadband networks cumbersome and expensive. P2MP links should be listed as authorized services in FCC Rule 101.101.
- Streamlining outdated license assignment and frequency coordination processes in Rule 101.103(d) would foster faster entry by more C-band users. Automated systems employing industry-specified interference criteria and propagation models would provide realistic propagation predictions and speed coordination calculations in just milliseconds.
- Antenna performance and out-of-band emissions requirements should be modernized to better reflect the reduced interference potential of shorter-range P2P and P2MP systems compared to that of long-haul microwave systems installed on tall towers and mountaintops.
- The maximum EIRP formula in FCC Rule 101.143(b) favors long-haul connections and severely constrains low-power, short-haul links vital to wireless broadband. Regulatory power limits should make shorter-range services viable on a non-interfering basis.
- FCC Rule 101.131(a) requires that equipment at operating and transmitting positions must be installed and protected so as not to be accessible to or capable of being operated by people not authorized by the licensee. Wireless routers and other client devices using C-Band spectrum, however, safely could be mounted to provide a good connection back to the access point in a way that may not comply with the access restriction requirement the FCC adopted for high-power P2P systems.

Such easily adopted changes to Part 101 could facilitate broadband connectivity to as many as 120 million Americans. A National Spectrum Strategy should encourage these types of minor modifications to Federal agency rules to promote United States leadership in adoption and deployment of 5G wireless technologies.

The 60 GHz band offers another example. Although the FCC has started the process of modernizing its rules to make new short-range sensing technologies viable in this band,[60] the harmonized European Telecommunications Standards Institute (ETSI) standard governing operation of generic short range devices in the 60 GHz band in the European Union allows for

[60] *See Spectrum Frontiers Order*, ¶ 337; *see also In the Matter of Google LLC Request for Waiver of Section 15.255(c)(3) of the Commission's Rules Applicable to Radars used for Short-Range Interactive Motion Sensing in the 57-64 GHz Frequency Band*, Order, ET Docket No. 18-70 (2018).

use at significantly higher power levels.[61] This advantages European developers and suppliers, as compared to their U.S.-based competitors. A National Spectrum Strategy should encourage Federal agencies to undertake analyses of their rules to ensure that regulation is not unnecessarily constraining innovation in the United States.

Finally, NTIA and the FCC should re-examine the use of sensing networks in shared spectrum and encourage—or mandate—the use of portals that provide more security for the incumbent user at less cost to industry. In particular, NTIA and the FCC, in collaboration with the Department of Defense (DoD), should revisit the requirement for spectrum access administrators to use ESC networks to detect and avoid incumbent military radar operations in the 3.55–3.7 GHz CBRS band. ESC networks are very costly to develop, deploy, and operate. Furthermore, the sensor sites must be protected from interference in the band they are sensing, which requires exclusion zones around the sensor sites and reduces spectrum availability for commercial use. Instead of sensors, the DoD should submit its activity information to the portal that has been developed to inform SASs of military spectrum activity in some non-coastal areas. Such an arrangement provides incumbents a higher degree of security than sensing by ESCs because the DoD controls the information flow and can obfuscate its operations as desired, as compared to an ESC, which is designed to detect *actual* military operations. A small fraction of the resources being used to develop, deploy, and operate ESC networks would easily cover the minimal additional costs needed by the DoD to expand the use of the portal.

---

[61] *See* ETSI, *Short Range Devices (SRD); Radio equipment to be used in the 40 GHz to 246 GHz frequency range; Harmonized Standard for access to radio spectrum*, ETSI EN 305 550 V2.1.0, at 13-15 (Oct. 2017), http://www.etsi.org/deliver/etsi_en/305500_305599/305550/02.01.00_20/en_305550v020100a.pdf.

V. CONCLUSION

A National Spectrum Strategy should promote bringing affordable, ubiquitous, high-speed broadband to all Americans and help the United States maintain its leadership role in developing 5G wireless technologies. This can be accomplishing by leveraging existing database and automated admission technologies that protect incumbents while allowing for initiation of new licensed, lightly licensed, and unlicensed services. A National Spectrum Strategy should seek to maximize the amount of mid-band spectrum available for commercial uses, allowing for global harmonization while positioning the United States to maintain its leadership in 5G. The Strategy also should encourage simple steps that maximize spectrum use, including tweaks to existing rules, use of smaller license areas, promotion of secondary markets, and ensuring that new service rules are flexible and not overly prescriptive to avoid inadvertently blocking or delaying innovation.

Respectfully submitted,

Megan Anne Stull
Counsel

Andrew W. Clegg, PhD
Spectrum Engineering Lead

Google LLC
25 Massachusetts Avenue NW, 9th Floor
Washington, DC 20001

January 22, 2019