

Invisible Infrastructure: Adapting the Commercial Spectrum Enhancement Act to Meet Current Needs

Andrew Ware*

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* J.D., May 2025, The George Washington University Law School; MPhil, Technology Policy, 2020, University of Cambridge; B.A., Philosophy, and B.S., Economics, 2018, University of New Hampshire. I am sincerely grateful for the guidance and advice Professor Ethan Lucarelli generously offered throughout the process of writing this Note—he was an extraordinary mentor who inspired my passion for telecommunications law and policy, and he is deeply missed. I would also like to thank the Volume 77 FCLJ Editorial Board for their valuable suggestions. I am thankful, too, for the endless support of my parents, who have encouraged curiosity throughout my life and academic journey.

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I. INTRODUCTION

On a busy sidewalk in Washington, D.C., smartphones buzz in peoples' pockets. They are sharing photos, following turn-by-turn directions, streaming music, and talking on video calls. The cars passing by are connected and communicating, too—providing real-time traffic updates and improving safety, since many cars are driving themselves. The city's buildings and infrastructure are connected: Internet-linked sensors and cameras collect data that drive decision-making to enhance public safety, improve energy efficiency, and better manage the busy streets. These benefits aren't limited to cities, either. High-speed wireless broadband spans the country, connecting rural areas to the Internet and enabling impressive innovations.

This future is not yet a reality, and it might never be achieved if the radiofrequency (RF) spectrum is not carefully managed. The RF spectrum consists of the frequencies over which information can be transmitted, enabling wireless connectivity and communication.¹ Spectrum is a finite resource because the amount available is limited, but investments and advancements in technology can increase the amount of usable spectrum.² Spectrum is a form of invisible infrastructure that is increasingly strained by a wide range of uses—from everyday website and app visits to military communications that preserve national security. To maintain technology leadership and a healthy innovation ecosystem without compromising national security and public safety, the United States must balance varied interests and conflicting considerations.³ In the context of RF spectrum utilization, this means ensuring frequency bands are appropriately allocated toward uses in the federal government, including for missile defense systems and government communications, as well as toward non-federal and commercial uses, including public safety communications, connected cars, and more reliable connectivity for our many personal electronic devices.⁴

Through its active engagement in spectrum policymaking and standards-setting for wireless equipment, China is recognizing the economic, leadership, and security gains that can be achieved by involvement and influence.⁵ Failure to actively engage in standards-setting and failure to allocate spectrum appropriately in the United States has wide-

1. See STUART MINOR BENJAMIN & JAMES B. SPETA, *INTERNET AND TELECOMMUNICATION REGULATION* 48-49 (Carolina Academic Press 2019).

2. See *id.* at 57-58.

3. Austin Bonner, *Resolving Interference Conflicts Among "Highest and Best" Uses of the Radio Spectrum*, 21 *COLO. TECH. L.J.* 177, 185 (2023).

4. See Principles for Promoting Efficient Use of Spectrum and Opportunities for New Servs., *Policy Statement*, 38 *FCC Rcd* 3682, paras. 1-3 (2023), <https://docs.fcc.gov/public/attachments/DOC-392197A1.pdf> [<https://perma.cc/73XC-GBH4>].

5. See James Andrew Lewis & Clete Johnson, *Modernizing Spectrum Allocation to Ensure U.S. Security in the Twenty-First Century*, *CTR. FOR STRATEGIC & INT'L STUD.* (Sept. 26, 2023), <https://www.csis.org/analysis/modernizing-spectrum-allocation-ensure-us-security-twenty-first-century> [<https://perma.cc/R37U-ABGQ>].

ranging effects, from adverse national security implications to stagnating innovation and engineering progress.⁶

Historically, the United States has been a global leader in allocating spectrum for wireless communications services, facilitating innovation—including having moved “expeditiously to repurpose high- and low-band spectrum to support new advancements in technology, such as 5G.”⁷ In addition, “[n]early every modern weapons system—such as those used by airplanes, satellites, tanks, ships, and radios—depends on the spectrum to function.”⁸ Not only is spectrum an essential resource to enabling our increasingly connected lives, but it is critical to military applications including communications and situational awareness.⁹ Advancements in technology bring new uses to existing spectrum, and demand for spectrum continues to grow; therefore, it is vital that priorities for spectrum use be carefully considered by the Federal Communications Commission (FCC) and National Telecommunications and Information Administration (NTIA), the government agencies primarily responsible for spectrum policy and management in the United States.¹⁰

An updated legal framework and systematic way of evaluating priorities—and making determinations regarding how spectrum will be allocated between federal and non-federal uses—is needed. Applications are wide-ranging, from telecommunications technologies such as Wi-Fi to environmental monitoring systems, and important uses can be in conflict.¹¹ Different uses of the same finite spectrum can lead to interference and other reliability issues. In balancing varied interests and evaluating competing priorities, the FCC, NTIA, and broader federal government must leverage existing law and pave new paths forward that enable more efficient spectrum allocation.¹²

This Note focuses on one aspect of spectrum management—the reallocation of federal spectrum for non-federal uses. The current legal framework for repurposing federal spectrum for non-federal and commercial uses, defined in part by the Commercial Spectrum Enhancement Act of 2004 (the CSEA), does not meet its purpose of promoting more efficient use of spectrum because it does not adequately

6. See generally KELLEY SAYLER, CONG. RSCH. SERV., IF11251, NATIONAL SECURITY IMPLICATIONS OF FIFTH GENERATION (5G) MOBILE TECHNOLOGIES (2023).

7. U.S. DEP’T OF COM., NAT’L TELECOMMS. & INFO. ADMIN., ANNUAL REPORT ON THE STATUS OF SPECTRUM REPURPOSING AND OTHER INITIATIVES 1 (2023).

8. JOHN HOEHN, JILL GALLAGHER & KELLY SAYLER, CONG. RSCH. SERV., R46564, OVERVIEW OF DEPARTMENT OF DEFENSE USE OF THE ELECTROMAGNETIC SPECTRUM 4 (2021).

9. See *id.*

10. See U.S. GOV’T ACCOUNTABILITY OFF., GAO-22-106170, SPECTRUM MANAGEMENT: IMPROVED PLANNING AND INTERAGENCY COLLABORATION COULD STRENGTHEN SPECTRUM REALLOCATION EFFORTS 1 (2022); see also *Who Regulates the Spectrum*, NAT’L TELECOMMS. & INFO. ADMIN., <https://www.ntia.gov/book-page/who-regulates-spectrum> [https://perma.cc/KU3S-PPJL] (last visited Sept. 30, 2024).

11. See THE WHITE HOUSE, NATIONAL SPECTRUM STRATEGY 1 (2023).

12. See generally LINDA K. MOORE, CONG. RSCH. SERV., R40674, SPECTRUM POLICY IN THE AGE OF BROADBAND: ISSUES FOR CONGRESS (2013).

incentivize federal incumbents to relinquish or share spectrum, nor does it adequately foster innovation in spectrum use.

Part II of this Note provides basic background information on spectrum and spectrum policy. Part II, Sections A and B include a brief discussion of some of the current uses of spectrum and explain aspects of spectrum policymaking in the United States. Part II, Section C provides information about the CSEA; Section D describes international efforts to harmonize spectrum policy and explains standards-setting in this context. This background is followed by analysis in Part III, which includes discussion of how the CSEA fails to meet its purpose in Section A, the need for a sound approach to spectrum repurposing in Section B, and the important role of standards-setting in maintaining United States leadership in spectrum policy in Section C. Part IV, Section A offers recommendations in the form of potential adjustments to the CSEA. This is followed by a suggestion for an entirely novel approach to spectrum allocation in Section B and discussion of additional considerations that could enable efficient and more innovative uses of finite spectrum in Section C. Part V concludes this Note.

II. BACKGROUND

This section introduces the concept of spectrum and explains how spectrum is used in the United States. This section also describes aspects of spectrum policy in the United States, explaining the roles of the FCC and NTIA in spectrum management and introducing the 2023 National Spectrum Strategy released by the Biden Administration. Then, this section describes the CSEA, including its purpose to benefit the public. The section further explains the legal framework the CSEA provides for spectrum reallocation and amendments since its adoption. Finally, this section discusses international harmonization of standards.

A. Introduction to Spectrum and Spectrum Usage in the United States

The RF spectrum is a range of electromagnetic frequencies used for wireless communication and broadcasting; it is commonly referred to as “spectrum” and this Note will refer to RF spectrum used for communications as such.¹³ Different frequencies have different characteristics and therefore different applications.¹⁴

For purposes of deciding how to allocate spectrum for different uses, subsets of the broader spectrum are divided into “bands,” or specific ranges

13. *Radio Spectrum Allocation*, FCC, <https://www.fcc.gov/engineering-technology/policy-and-rules-division/general/radio-spectrum-allocation> [<https://perma.cc/Y6ES-3V6V>] (last visited Sept. 30, 2024).

14. See BENJAMIN & SPETA, *supra* note 1, at 47-50, 75-78.

of frequencies.¹⁵ Lower frequency bands have longer wavelengths, allowing these waves to travel longer distances and work more effectively through obstacles, like buildings and walls.¹⁶ Higher frequency bands, which have shorter wavelengths and generally are allocated in greater bandwidths, can allow for wider channels and therefore carry more data—but are more suitable for communications over relatively shorter distances.¹⁷ Advancements in wireless technologies have demanded larger licensed bands.¹⁸ These higher-frequency bands, often with larger bandwidths, can also be used for radio communications, as well as other applications as far-ranging as Wi-Fi and Bluetooth in personal electronic devices to television broadcasting.¹⁹ It is necessary to allocate spectrum because different uses within the same band can lead to interference that is detrimental to each use, and allocation ensures that spectrum—a finite resource—is used efficiently.²⁰

Spectrum is an “invisible” infrastructure that supports critical and ubiquitous technologies.²¹ One of the most prominent applications of spectrum is mobile communication, where spectrum enables cellular and Wi-Fi networks that offer constant connectivity.²² Additionally, spectrum allows radio and television broadcasting across the country.²³ Spectrum is integral to public safety communication, too, supporting first responders and emergency services.²⁴ There are also applications of spectrum in medical imaging, meteorology, and scientific research.²⁵

As technology continues to advance and digital devices continue to proliferate, spectrum is increasingly important. Spectrum is critical to enabling the Internet of Things (IoT), autonomous vehicles, and connected cities—but these innovations must coexist with current and future uses related to communication systems, national security, navigation systems, and other applications.²⁶ Spectrum is critical to the United States’

15. See *Radio Spectrum Allocation*, *supra* note 13; see also Catherine G. Manning, *What are the spectrum band designators and bandwidths?*, NAT’L AERONAUTICS & SPACE ADMIN. (Sept. 2, 2018), <https://www.nasa.gov/general/what-are-the-spectrum-band-designators-and-bandwidths/> [<https://perma.cc/D7PN-5UVQ>].

16. See BENJAMIN & SPETA, *supra* note 1, at 48-50.

17. *Id.*

18. LINDA K. MOORE, CONG. RSCH. SERV., R40674, SPECTRUM POLICY IN THE AGE OF BROADBAND: ISSUES FOR CONGRESS 1 (2013).

19. See BENJAMIN & SPETA, *supra* note 1, at 50, 54-56; John Herrman, *Giz Explains: Why Everything Wireless Is 2.4 GHz*, GIZMODO (Sept. 7, 2010), <https://gizmodo.com/giz-explains-why-everything-wireless-is-2-4ghz-5629814> [<https://perma.cc/AV2D-MR6G>].

20. See BENJAMIN & SPETA, *supra* note 1, at 63-68.

21. THE WHITE HOUSE, *supra* note 11.

22. BENJAMIN & SPETA, *supra* note 1, at 54-56; see also John Herrman, *Giz Explains: Why Everything Wireless Is 2.4 GHz*, GIZMODO (Sept. 7, 2010), <https://gizmodo.com/giz-explains-why-everything-wireless-is-2-4ghz-5629814> [<https://perma.cc/AV2D-MR6G>].

23. BENJAMIN & SPETA, *supra* note 1, at 49, 52-56.

24. See THE WHITE HOUSE, *supra* note 11.

25. *Id.*

26. See *id.* at 21.

telecommunications infrastructure, serving as the medium for wireless communication services and many other applications.²⁷

B. United States Spectrum Policy

Spectrum policy is essentially how governments manage the use of spectrum—the allocation and use of spectrum are regulated by national and international organizations, which designate bands for specific applications.²⁸ In the United States, the FCC manages spectrum and oversees non-federal uses, while NTIA oversees use of spectrum by federal agencies.²⁹ The International Telecommunication Union (ITU) develops standards for global spectrum allocation.³⁰ Increasing demand for wireless communication, along with new and innovative uses of spectrum driven by advancements in technology, have led to an increasingly congested spectrum environment and therefore an increased need for government agencies and the ITU to carefully consider various uses of spectrum.³¹ To this end, NTIA coordinates “with the FCC and other stakeholders to understand the value of repurposing choices to the nation when making these critical decisions, while still preserving federal capabilities.”³²

1. The Roles of the FCC and NTIA in Spectrum Management

The FCC plays a key role in overseeing and managing spectrum by issuing licenses to entities for the non-federal use of specific frequencies and designating certain bands for use by unlicensed operations.³³ Different services, including radio and television broadcasting, mobile communication, satellite services, and public safety communication, operate within allocated frequency ranges to prevent interference with other services.³⁴ Changes in technology over time require the FCC to reevaluate and adjust spectrum allocations periodically.³⁵

The FCC works to encourage the “highest and best use” of spectrum—that is, to align spectrum allocations with the mandate of the Communications Act, which gives the FCC its authority to regulate

27. *Id.*

28. *See Who Regulates the Spectrum*, NAT’L TELECOMMS. & INFO. ADMIN., <https://www.ntia.gov/book-page/who-regulates-spectrum> [<https://perma.cc/KU3S-PPJL>] (last visited Sept. 30, 2024); *see also Radio Spectrum Allocation*, *supra* note 13.

29. *See Who Regulates the Spectrum*, *supra* note 28.

30. *See About International Telecommunication Union (ITU)*, INT’L TELECOMM. UNION, <https://www.itu.int/en/about/Pages/default.aspx> [<https://perma.cc/H78S-4Z9C>] (last visited Sept. 30, 2024).

31. THE WHITE HOUSE, *supra* note 11, at 11-12.

32. U.S. DEP’T OF COM., NAT’L TELECOMMS. & INFO. ADMIN., *supra* note 7, at 42.

33. *See Radio Spectrum Allocation*, *supra* note 13.

34. *See BENJAMIN & SPETA*, *supra* note 1, at 63-68.

35. *See Radio Spectrum Allocation*, *supra* note 13.

communications to promote the public interest.³⁶ The FCC must consider how decisions regarding spectrum allocation will serve the broader public interest, including promoting competition, innovation, and access to wireless services.³⁷ As part of this effort, the FCC has conducted spectrum auctions to assign licenses for specific frequency bands to non-federal entities.³⁸

Further, the FCC monitors spectrum and enforces rules and regulations to prevent interference between different wireless services and users.³⁹ Related to its roles, the FCC has opened an inquiry related to improving its understanding of spectrum usage by employing more advanced technologies and methods.⁴⁰ The FCC's oversight ensures that different and diverse services can coexist.⁴¹ The FCC also develops policy, establishing rules and regulations related to spectrum usage and management with consideration of technological advancements and the evolving needs of wireless services.⁴² This includes efforts to engage with other nations and foster international harmonization of standards for spectrum policy.⁴³

NTIA oversees the allocation of spectrum for federal government use.⁴⁴ It works to ensure that government agencies have the spectrum they need for their missions, coordinating among federal agencies to determine the most efficient uses of spectrum, weighing priorities, and preventing potential conflicts.⁴⁵ NTIA also engages in research and planning activities to identify spectrum bands for government use and to explore opportunities for spectrum sharing.⁴⁶ Further, as part of the Department of Commerce,

36. See *What We Do*, FCC, <https://www.fcc.gov/about-fcc/what-we-do> [<https://perma.cc/T3TE-E65Q>] (last visited Sept. 30, 2024); see also 47 U.S.C. § 151.

37. *What We Do*, FCC, <https://www.fcc.gov/about-fcc/what-we-do> [<https://perma.cc/T3TE-E65Q>] (last visited Sept. 30, 2024).

38. See Implementation of the Com. Spectrum Enhancement Act and Modernization of the Comm'n's Competitive Bidding Rules and Procs., *Further Notice of Proposed Rulemaking*, 20 FCC Rcd 11268, paras. 1-3, 6 (2006), <https://docs.fcc.gov/public/attachments/FCC-06-8A1.pdf> [<https://perma.cc/J7Q7-YQXF>].

39. See, e.g., Advancing Understanding of Non-Federal Spectrum Usage, *Notice of Inquiry*, FCC 23-232, paras. 1, 4 (2023), <https://docs.fcc.gov/public/attachments/FCC-23-63A1.pdf> [<https://perma.cc/QR5B-HG92>].

40. *Id.* at paras. 1-3, 22, 25-27, 34, 39.

41. See *id.*

42. See *Radio Spectrum Allocation*, *supra* note 13.

43. See *International Affairs*, FCC, <https://www.fcc.gov/international-affairs> [<https://perma.cc/8G2D-HYNB>].

44. See *Spectrum Management*, NAT'L TELECOMMS. & INFO. ADMIN., <https://www.ntia.gov/category/spectrum-management> [<https://perma.cc/2MLX-G3YE>] (last visited Sept. 30, 2024).

45. See *id.*

46. See *NTIA At-A-Glance*, NAT'L TELECOMMS. & INFO. ADMIN. (Mar. 2021), https://www.ntia.gov/files/ntia/publications/ntia_at_a_glance_march_2022.pdf [<https://perma.cc/795V-P3PD>] (updated Mar. 2021).

NTIA contributes to efforts by the United States to engage in global spectrum harmonization alongside the FCC.⁴⁷

NTIA focuses on coordinating and managing spectrum use for federal government agencies, but works closely with the FCC to ensure efficient and effective spectrum utilization in the United States.⁴⁸ The agencies have a formal agreement regarding coordination “to promote the efficient use of the radio spectrum in the public interest.”⁴⁹

2. The 2023 National Spectrum Strategy

In November 2023, the Biden Administration released a National Spectrum Strategy (the Strategy) that aims to improve spectrum management in an increasingly congested spectrum environment.⁵⁰ It involves conducting an in-depth study of five spectrum bands for potential repurposing, describes a “national testbed” for spectrum research, and emphasizes spectrum sharing.⁵¹ This strategy was the result of the NTIA’s engagement with a wide range of stakeholders.⁵²

The goals of the Strategy are “[t]o promote innovation and U.S. leadership in wireless technologies” and to “make the most efficient use possible of [spectrum] to enhance the quality of life for all Americans.”⁵³ The Strategy states that spectrum is an infrastructure that supports countless aspects our daily lives and articulates the importance of developing a “comprehensive strategy to modernize spectrum policy.”⁵⁴ A presidential memorandum accompanying the Strategy document establishes the Interagency Spectrum Advisory Council, which will encourage coordination on spectrum policy matters across agencies.⁵⁵ An implementation plan for the Strategy was released in March 2024, and a related research and development plan was released in October 2024.⁵⁶

47. See *International*, NAT’L TELECOMMS. & INFO. ADMIN., <https://www.ntia.gov/category/international> [<https://perma.cc/R4XK-ZKDH>] (last visited Sept. 30, 2024).

48. Memorandum of Understanding Between the Federal Communications Commission and the National Telecommunications and Information Administration, at 1-2 (Aug. 1, 2022) (on file with the NTIA), https://www.ntia.gov/files/ntia/publications/ntia-fcc-spectrum_mou-8.2022.pdf [<https://perma.cc/KE7N-4SXC>].

49. *Id.*

50. Memorandum on Modernizing United States Spectrum Policy and Establishing a National Spectrum Strategy, 88 Fed. Reg. 80079, 80079 (Nov. 17, 2023).

51. THE WHITE HOUSE, *supra* note 11, at 1-3, 16.

52. *National Spectrum Strategy*, NAT’L TELECOMMS. & INFO. ADMIN., <https://www.ntia.gov/issues/national-spectrum-strategy> [<https://perma.cc/M3VY-3HM2>] (last visited Oct. 16, 2024).

53. THE WHITE HOUSE, *supra* note 11.

54. *Id.*

55. Memorandum on Modernizing United States Spectrum Policy and Establishing a National Spectrum Strategy, 88 Fed. Reg. 80079, 80080 (Nov. 17, 2023).

56. U.S. DEP’T OF COM., NAT’L TELECOMMS. & INFO. ADMIN., NATIONAL SPECTRUM STRATEGY IMPLEMENTATION PLAN (2024); NAT’L SCI. & TECH. COUNCIL, NATIONAL SPECTRUM RESEARCH AND DEVELOPMENT PLAN (2024).

C. *The Commercial Spectrum Enhancement Act*

This subsection outlines the legal framework for spectrum reallocation in the United States within the context of current spectrum usage and policy. The CSEA is a key part of this framework; it aims to promote more efficient use of spectrum by encouraging—and compensating—the transition of federal spectrum to non-federal uses.⁵⁷ This subsection discusses the purpose of the CSEA and subsequently explains how it functions as a mechanism for spectrum reallocation in more detail. The subsection concludes by describing amendments to the CSEA since its enactment.

1. The Purpose of the CSEA

The CSEA was a bipartisan legislative effort with the aim of “get[ting] new valuable spectrum into the hands of the commercial wireless carriers so they can bring new advanced wireless services to the consumer.”⁵⁸ The sponsor of the bill noted that a framework for reallocating spectrum from federal to non-federal users “would be good for the wireless carriers, good for the equipment manufacturers, good for the consumer, and terrific for the economy.”⁵⁹

The CSEA was designed to provide increased certainty to the private sector regarding the availability of spectrum for innovative uses, creating an environment more conducive to investment compared to one in which the future availability of spectrum was unknown.⁶⁰ In addition to the goal of stimulating investment by providing certainty to corporate interests, the legislative history indicates that the CSEA aimed to provide benefits to consumers using wireless services.⁶¹ Legislators noted that consumers would “praise the benefits” offered by innovative wireless services enabled by making more spectrum available for commercial uses.⁶² In addition, drafters ensured the CSEA would benefit government agencies who were the incumbent users of spectrum bands by providing a compensation scheme to cover the costs of relocation to other bands.⁶³

At the time, the focus was on freeing up spectrum to be used for 3G services—a major advancement in wireless communications that dramatically increased the viability and usefulness of the smartphones that would reshape society.⁶⁴ Prior to the CSEA, there was not a streamlined

57. The Commercial Spectrum Enhancement Act of 2004, 47 U.S.C. §§ 901, 923, 928.

58. *The Commercial Spectrum Enhancement Act: Hearing Before the Subcomm. on Telecomms. and the Internet of the Comm. on Energy and Com.*, 108th Cong. 1 (2003) (statement of Rep. Upton).

59. *Id.*

60. *Id.* at 2.

61. *Id.*

62. *Id.*

63. *Id.*

64. *The Commercial Spectrum Enhancement Act: Hearing on H.R. 1320 Before the Subcomm. on Telecomms. and the Internet of the Comm. on Energy and Com.*, 108th Cong. 5 (2003) (statement of Rep. Dingell).

process for reallocating spectrum: the FCC would conduct an auction to sell spectrum licenses to the highest bidders, and winners would be responsible for paying twice, “once at auction and then again to . . . facilitate the movement of Government spectrum users to new spectrum bands.”⁶⁵

Recognizing that “legislation must provide for full reimbursement of all reasonable expenses the incumbents incur in relocating to new spectrum,” the CSEA was implemented to make this process more straightforward and efficient.⁶⁶ The legislation established a fund to collect auction proceeds and a mechanism to “ensure that the entities bidding for spectrum are not subject to additional relocation costs for the incumbents beyond the amount they pay for the spectrum at auction.”⁶⁷

During the development of the legislation, lawmakers were aware of the critical defense implications associated with reallocating spectrum from federal users to non-federal users.⁶⁸ In particular, Department of Defense (DOD) leadership explained to legislators that spectrum was essential for the communications and preparedness of the military, and noted its “commit[ment] to ensuring the right balance is maintained in accommodating the economic needs of our Nation while preserving critical military capabilities.”⁶⁹ In agreeing to cooperate with proposed efforts to repurpose federal spectrum, the DOD required that the legislation account for the DOD’s spectrum needs.⁷⁰ The DOD also requested reimbursement for relocation costs and the ability for it to set timelines to transition and vacate reallocated spectrum.⁷¹

In addition to addressing the needs of commercial entities, American consumers, and government interests, legislators recognized the need to “support making more spectrum available for unlicensed use” as a way to enable experimentation and “enhance economic growth and entrepreneurial activity.”⁷²

Ultimately, the CSEA aimed to enable new applications and services that use spectrum—primarily for the benefit of consumers, by way of providing increased certainty to commercial interests and reliable compensation to federal incumbents.⁷³ The CSEA created a mechanism that

65. *Id.*

66. *Id.* at 11 (statement of Nancy Victory, Assistant Secretary, National Telecommunications and Information Administration).

67. *Id.*

68. *Id.* at 17 (statement of Steven Price, Deputy Assistant Secretary for Spectrum, Space, Sensors, and C3 Policy, Department of Defense).

69. *Id.*

70. *The Commercial Spectrum Enhancement Act: Hearing on H.R. 1320 Before the Subcomm. on Telecomms. and the Internet of the Comm. on Energy and Com.*, 108th Cong. 17 (2003) (statement of Steven Price, Deputy Assistant Secretary for Spectrum, Space, Sensors, and C3 Policy, Department of Defense).

71. *Id.*

72. *Id.* at 3 (statement of Rep. Markey).

73. H.R. REP. NO. 108-137, at 5-6 (2003).

the FCC and NTIA could use to reallocate spectrum frequencies predictably and efficiently from federal to non-federal users.⁷⁴

2. The CSEA as a Mechanism for Facilitating Spectrum Reallocation

The CSEA allows federal agencies operating services using spectrum to be reimbursed for the cost of reallocation of frequencies from federal to non-federal use.⁷⁵ Frequencies eligible for reallocation include those that are specifically identified by Congress and any other spectrum frequency assigned by the FCC to be repurposed through the competitive bidding process.⁷⁶ Costs of reallocation consist of “relocation costs,” which refer to “the costs incurred by a Federal entity in connection with the auction . . . or the sharing of spectrum frequencies . . . in order to achieve comparable capability of systems as before the relocation or sharing arrangement.”⁷⁷

Under the CSEA, the FCC and NTIA conduct an assessment of the spectrum currently held by federal agencies, identify spectrum bands that can be repurposed for non-federal use, and determine transition costs—that is, the costs that the agency would incur if it were to relinquish or share spectrum to allow for commercial or other non-federal use.⁷⁸ In accordance with the CSEA, NTIA is responsible for publishing “an annual report on the status of existing efforts and planned near- to mid-term spectrum repurposing initiatives” through coordination with the FCC and the Office of Management and Budget (OMB).⁷⁹

The FCC has historically conducted auctions for the frequencies determined eligible for reallocation, providing licenses to the highest bidders for use of the spectrum bands being relinquished by federal users.⁸⁰ The FCC is required to receive proceeds that are “at least 110 percent of the total estimated relocation costs.”⁸¹ The proceeds of auctions go to the Spectrum Relocation Fund (SRF), which compensates federal agencies for costs incurred in making requisite adjustments to their operations.⁸² A timeline is set for federal agencies to vacate or otherwise make available auctioned spectrum available to non-federal users.⁸³

74. 149 CONG. REC. H5182 (daily ed. June 11, 2003) (statement of Rep. Markey).

75. 47 U.S.C. § 923(g)(1).

76. See KAREN GORDON ET AL., INST. FOR DEF. ANALYSES, A REVIEW OF APPROACHES TO SHARING OR RELINQUISHING AGENCY-ASSIGNED SPECTRUM 5 (2014), <https://www.ida.org/-/media/feature/publications/a/ar/a-review-of-approaches-to-sharing-or-relinquishing-agency-assigned-spectrum/p5102final.ashx> [<https://perma.cc/GZL3-XG2M>].

77. 47 U.S.C. § 923(g)(3)(a).

78. See generally 47 U.S.C. § 923.

79. U.S. DEP’T OF COM., NAT’L TELECOMMS. & INFO. ADMIN., *supra* note 7, at 11.

80. LINDA K. MOORE, CONG. RSCH. SERV., R40674, SPECTRUM POLICY IN THE AGE OF BROADBAND: ISSUES FOR CONGRESS 3-7, 10-11 (2013).

81. 47 C.F.R. § 1.2104 (2023).

82. See generally 47 U.S.C. § 928.

83. See 47 U.S.C. § 928(d)(2)(B).

Assessing costs associated with making spectrum available involves evaluating the spectrum's market value, technical characteristics (to determine potential utility and limits), and economic value (including, for example, innovative potential and associated contributions to GDP).⁸⁴ Repurposing spectrum is associated with opportunity costs, coordination costs, and investments in infrastructure and equipment.⁸⁵

The CSEA requires NTIA to develop a relocation plan with incumbent federal agencies and to monitor progress against estimated costs and timelines of transitions.⁸⁶ To this end, NTIA issues a progress report on the CSEA annually based on data submitted by federal agencies.⁸⁷ The report also describes “the costs estimated, funds transferred, and costs paid from the SRF.”⁸⁸

Revenue from licensing spectrum to commercial users, primarily through auctions run by the FCC, funds the SRF, which can in turn support modernization and transition efforts of government users.⁸⁹ Essentially, the SRF created a mechanism for “federal agencies to recover relocation costs directly from auction proceeds when they are required to vacate spectrum slated for auction.”⁹⁰ The SRF allows federal entities to recover costs associated with relocation “without additional congressional appropriations.”⁹¹

By design, the CSEA favors exclusive use of spectrum—licenses are needed to raise funds for the SRF, and unlicensed spectrum by definition does not involve entities bidding and paying for licenses issued by the FCC.⁹² Unlicensed spectrum bands, such as those used for Wi-Fi, are “instead accessible to anyone using wireless equipment certified by the FCC for those frequencies.”⁹³ However, new technologies now can allow for more dynamic spectrum sharing—that is, non-exclusive use of spectrum that is either licensed or unlicensed. For example, algorithms can dynamically select frequencies within a spectrum band, such that

84. See U.S. DEP'T OF COM., NAT'L TELECOMMS. & INFO. ADMIN., *supra* note 7, at 11-17.

85. See *id.* at 15.

86. 47 U.S.C. § 923(h).

87. See, e.g., U.S. DEP'T OF COM., NAT'L TELECOMMS. & INFO. ADMIN., COMMERCIAL SPECTRUM ENHANCEMENT ACT: ANNUAL PROGRESS REPORT FOR 2022 (2023).

88. *Id.* at iii.

89. See *Updating the Spectrum Relocation Fund to Enable Innovation, Flexibility in Spectrum Use*, NAT'L TELECOMMS. & INFO. ADMIN. (Dec. 17, 2015), <https://www.ntia.gov/blog/updates/spectrum-relocation-fund-enable-innovation-flexibility-spectrum-use> [<https://perma.cc/3AFC-XHQH>].

90. LINDA K. MOORE, CONG. RSCH. SERV., R44433, FRAMING SPECTRUM POLICY: LEGISLATIVE INITIATIVES 8 (2016).

91. KAREN GORDON ET AL., INST. FOR DEF. ANALYSES, A REVIEW OF APPROACHES TO SHARING OR RELINQUISHING AGENCY-ASSIGNED SPECTRUM 5 (2014), <https://www.ida.org/-/media/feature/publications/a/ar/a-review-of-approaches-to-sharing-or-relinquishing-agency-assigned-spectrum/p5102final.ashx> [<https://perma.cc/GZL3-XG2M>].

92. *Id.* at 7.

93. LINDA K. MOORE, CONG. RSCH. SERV., R44433, FRAMING SPECTRUM POLICY: LEGISLATIVE INITIATIVES 12 (2016).

interference is largely avoided.⁹⁴ It is important to note, though, that these approaches to spectrum management are not without challenges: “available airtime for each network [using the same band] is reduced because some of the airtime is occupied by the other networks” and the remaining potential for interference “can result in a severe performance degradation.”⁹⁵

3. Amendments to the CSEA Since Its Enactment

Subsequent legislation has amended the CSEA in minor ways, adapting the mechanism to changes in technology and otherwise improving the framework. The 2012 Spectrum Act introduced “provisions to increase the amount of spectrum licenses available for auction and to improve management of the [SRF].”⁹⁶ It also “establishe[d] a process for television broadcasters to release spectrum licensed to them to be auctioned as commercial licenses for mobile broadband.”⁹⁷ In addition, it “include[d] provisions to apply spectrum-license auction revenues toward deficit reduction; to establish a planning and governance structure to deploy public safety broadband networks, using some auction proceeds for that purpose; and to assign additional spectrum resources for public safety communications.”⁹⁸ The 2012 Spectrum Act permits the use of funds in the SRF to be used not only to reimburse costs of federal users, but also to support investment for the advancement of public safety infrastructure in the United States.⁹⁹

The Middle Class Tax Relief and Job Creation Act of 2012 further amended the CSEA, implementing additional changes to the SRF that permitted funds to be used “to reimburse Federal entities for costs associated with the shared use of spectrum frequencies.”¹⁰⁰ However, the amendment “requires NTIA to give priority to options involving reallocation of the band for exclusive non-Federal use,” preferring exclusive use over sharing.¹⁰¹ The only circumstances in which NTIA may permit spectrum sharing are when relocating the federal incumbent “is not feasible because of technical or cost constraints.”¹⁰²

The Middle Class Tax Relief and Job Creation Act of 2012 also added the explicit authorization for SRF funds to be used to acquire and implement

94. ANDREAS KÖNSGEN, DESIGN AND SIMULATION OF SPECTRUM MANAGEMENT METHODS FOR WIRELESS LOCAL AREA NETWORKS 103-104 (Vieweg+Teubner Verlag 2010).

95. *Id.*

96. LINDA K. MOORE, CONG. RSCH. SERV., R44433, FRAMING SPECTRUM POLICY: LEGISLATIVE INITIATIVES Summary (2016).

97. *Id.*

98. *Id.*

99. *Id.* at 3.

100. KAREN GORDON ET AL., INST. FOR DEF. ANALYSES, A REVIEW OF APPROACHES TO SHARING OR RELINQUISHING AGENCY-ASSIGNED SPECTRUM 5-6 (2014), <https://www.ida.org/-/media/feature/publications/a/ar/a-review-of-approaches-to-sharing-or-relinquishing-agency-assigned-spectrum/p5102final.ashx> [<https://perma.cc/GZL3-XG2M>].

101. *Id.* at 7.

102. 47 U.S.C. § 923(j).

“state-of-the-art replacement systems intended to meet comparable operational scope.”¹⁰³ This introduced an incentive for federal agencies to upgrade equipment, enabling more efficient use of spectrum. Finally, the revisions clarified that expenditures associated with estimating costs and planning for potential relocation or sharing would be reimbursed by the SRF.¹⁰⁴

The Spectrum Pipeline Act of 2015 followed these earlier amendments and similarly aimed to make more spectrum available for auction, clarify the CSEA’s reimbursement mechanism, and emphasize spectrum sharing; it also included a focus on “federal research to improve spectrum and network efficiency.”¹⁰⁵ Ultimately, though, the changes presented by amendments to the CSEA have not been significant, but rather minor modifications, including some changes that have largely been concerned with “describing reimbursable costs and providing guidelines to the Office of Management and Budget,” the federal agency responsible for approving transfers from the SRF.¹⁰⁶

D. International Harmonization and Standards-Setting

International harmonization efforts are important to consider in the broader context of spectrum management and the goals of the CSEA. While the FCC and NTIA are responsible for spectrum policy in the United States, they also engage in international coordination and collaboration on standards, advising the Department of State in international spectrum policy discussions and supporting efforts that enable coordination.¹⁰⁷ Supply chains and markets for telecommunications equipment are global, and leadership in standards-setting is critical to maintaining interoperability, economic competitiveness, and national security.¹⁰⁸

Consistent global standards enable seamless international roaming for customers using mobile phones across different countries, economies of scale for hardware equipment manufacturers to sell to a global market, and competitive advantages for countries that play a role in setting the

103. KAREN GORDON ET AL., INST. FOR DEF. ANALYSES, A REVIEW OF APPROACHES TO SHARING OR RELINQUISHING AGENCY-ASSIGNED SPECTRUM 5-6 (2014), <https://www.ida.org/-/media/feature/publications/a/ar/a-review-of-approaches-to-sharing-or-relinquishing-agency-assigned-spectrum/p5102final.ashx> [https://perma.cc/GZL3-XG2M].

104. *Id.*

105. LINDA K. MOORE, CONG. RSCH. SERV., R44433, FRAMING SPECTRUM POLICY: LEGISLATIVE INITIATIVES (2016).

106. *Id.*

107. *See International Affairs*, FCC, <https://www.fcc.gov/international-affairs> [https://perma.cc/AG9D-AH7X] (last visited Sept. 30, 2024); *International*, NAT’L TELECOMMS. & INFO. ADMIN., <https://www.ntia.gov/category/international> [https://perma.cc/R4XK-ZKD H] (last visited Sept. 30, 2024).

108. *See International Affairs*, FCC, <https://www.fcc.gov/international-affairs> [https://perma.cc/AG9D-AH7X] (last visited Sept. 30, 2024); *International*, NAT’L TELECOMMS. & INFO. ADMIN., <https://www.ntia.gov/category/international> [https://perma.cc/R4XK-ZKD H] (last visited Sept. 30, 2024).

standards.¹⁰⁹ For example, 3GPP, an organization of standards bodies that set technical specifications for the mobile telecommunications industry, set standards for harmonized bands for LTE technology.¹¹⁰ Technical standards are “sets of mutually agreed-upon engineering specifications” that “help facilitate international trade and can solidify . . . competitive advantages.”¹¹¹ The harmonization of technical standards creates a global market for buyers and sellers—including government entities—that enables economies of scale, more affordable devices, and interoperability of devices and networks.¹¹²

In addition to the practical and economic implications of globally harmonized standards, leading the standards-setting process can allow the United States and its allies to favor their own manufacturers of equipment, involving these interests in the process of setting standards and technical specifications to build economies of scale for trusted equipment manufacturers.¹¹³ Leadership also enables the United States to continue to drive research, development, and experimentation related to dynamic spectrum sharing that would allow for more efficient use of spectrum.¹¹⁴ If instead China or other countries are responsible for driving global spectrum policymaking and standards-setting in opposition to the United States and its allies, equipment manufactures from these countries, such as China’s Huawei, will benefit from economies of scale and cause the rest of the world to be reliant on their equipment.¹¹⁵ Recently, China has been “moving aggressively to bolster Chinese companies’ domestic and international advantages in 5G/6G and in advanced technologies more broadly, with significant implications for China’s drive to dominate emerging tech, set norms and standards, and build influence in Global South countries currently investing in digital infrastructure.”¹¹⁶

Similarly to efforts of the United States and its allies, “China seeks to align global spectrum bands with its own domestic allocations” to achieve the benefits of economies of scale and technology leadership.¹¹⁷ This would “provide an opportunity for Chinese vendors to exploit first mover advantage in creating products for the globally harmonized 5G bands” and

109. See *Exploring China’s Global Agenda on Spectrum Policy and 5G/6G*, ATLANTIC COUNCIL (Nov. 15, 2023), <https://www.atlanticcouncil.org/event/exploring-chinas-global-agenda-on-spectrum-policy-and-5g-6g/> [<https://perma.cc/A9LF-8BXW>].

110. See Lorenzo Casaccia, *Understanding 3GPP – starting with the basics*, QUALCOMM (Aug. 1, 2017), <https://www.qualcomm.com/news/onq/2017/08/understanding-3gpp-starting-basics> [<https://perma.cc/GF3E-D48Z>].

111. OWEN DANIELS, GEO. CTR. FOR SEC. AND EMERGING TECH., CSET ANALYSES OF CHINA’S TECHNOLOGY POLICIES AND ECOSYSTEM: THE PRC’S EFFORTS ABROAD 7 (2023), https://cset.georgetown.edu/wp-content/uploads/20230036_The-PRCs-Efforts-Abroad_FINAL9.20.2023.pdf [<https://perma.cc/53QY-8P73>].

112. See *id.* at 6-8.

113. LEWIS & JOHNSON, *supra* note 5, at 1-3, 7, 9.

114. *Id.*

115. See *id.*

116. *Exploring China’s Global Agenda on Spectrum Policy and 5G/6G*, *supra* note 109.

117. LEWIS & JOHNSON, *supra* note 5, at 6.

cause harmful effects to the economic leadership and national security of the United States and its allies.¹¹⁸

These issues are distinct from, but closely connected with, efforts to reallocate spectrum domestically, where repurposing spectrum currently used by radar systems for 5G and 6G services could adversely affect military readiness.¹¹⁹ The DOD holds large amounts of spectrum that could be used for 5G and 6G development and deployment.¹²⁰ If other countries set standards for these wireless services that are not aligned with how the United States continues to use spectrum for military systems, the operation of these systems abroad could be compromised.¹²¹ Further, since Chinese companies such as Huawei receive subsidies from the Chinese government for facilities, research and development, and other important inputs to developing and manufacturing equipment, they are “well-positioned as global 5G suppliers.”¹²² Despite efforts by the United States to prevent equipment manufactured by Chinese companies from being used in the network infrastructure of the U.S. and its allies, in large part due to concerns that “vulnerabilities in Chinese equipment could be used to conduct cyberattacks or military/industrial espionage,” Chinese companies have continued to deploy equipment and services for 5G infrastructure in dozens of countries around the world, including Hungary, Iceland, Turkey, Saudi Arabia, and South Africa.¹²³ This presents serious potential national security issues.

III. ANALYSIS

The CSEA provides a framework for repurposing federal spectrum for non-federal uses based on the reimbursement of relocation costs, with an emphasis on having federal incumbents fully relinquish spectrum for exclusive licensed use.¹²⁴ While amendments have increased flexibility, the CSEA does not meet the needs of an increasingly congested spectrum environment with a growing number of new, innovative ways to use spectrum.¹²⁵ This section will explain how the current CSEA framework does not meet its purpose of promoting more efficient use of spectrum because it is limited in its abilities to promote efficient spectrum use.

118. *See id.*

119. *See* KELLEY SAYLER, CONG. RSCH. SERV., IF11251, NATIONAL SECURITY IMPLICATIONS OF FIFTH GENERATION (5G) MOBILE TECHNOLOGIES 1-2 (2023).

120. *See id.* at 1.

121. *See id.* at 1-2.

122. *Id.* at 1.

123. *See Secure and Trusted Communications Networks Reimbursement Program*, FCC, <https://www.fcc.gov/supplychain/reimbursement> [<https://perma.cc/U5GU-B5CP>] (last visited Sept. 30, 2024); *see also* KELLEY SAYLER, CONG. RSCH. SERV., IF11251, NATIONAL SECURITY IMPLICATIONS OF FIFTH GENERATION (5G) MOBILE TECHNOLOGIES 1-2 (2023); *see also* David Sacks, *China's Huawei Is Winning the 5G Race. Here's What the United States Should Do To Respond*, COUNCIL ON FOREIGN RELS. (Mar. 29, 2021), <https://www.cfr.org/blog/china-huawei-5g> [<https://perma.cc/C3FK-6QWL>].

124. *See supra* Section II.C.2.

125. *See supra* Section II.C.3.

Following discussion of how the CSEA fails to meet its purpose, this section describes the need for a more reliable and robust framework for repurposing spectrum. The section concludes by highlighting the importance of U.S. involvement in international standards-setting and harmonization efforts.

A. *The Failure of the CSEA to Meet Its Purpose*

The CSEA currently does not adequately meet its purpose because the framework and mechanisms it provides to repurpose spectrum are limited, especially in today's context of innovative applications and increased needs for spectrum. The CSEA must be adapted to better meet its purpose—that is, to ensure spectrum is being used effectively and efficiently by enabling the repurposing of federal spectrum for non-federal uses.¹²⁶ The CSEA should be revised to create stronger and varied incentives for federal users to relinquish and share spectrum. The purpose that the CSEA originally set out to achieve was to “bring new advanced wireless services to the consumer” by providing increased certainty to commercial entities considering investment—while recognizing and maintaining national security and other federal needs by providing compensation for modifications to operations.¹²⁷ Currently, the CSEA does not meet its purpose because it does not provide adequate incentives for federal users of spectrum to innovate, nor does it provide a framework that would encourage federal users to more readily relinquish or share spectrum. Commercial and other non-federal entities must have access to additional spectrum to have opportunities to put it to new uses that could greatly benefit the public interest. The CSEA must be updated to reflect changes in technology and the increasingly congested spectrum environment.

The requirement that the FCC raise proceeds that are “at least 110 percent of the total estimated relocation costs”—determined by the federal incumbents—means that certain potentially innovative and valuable projects go unexplored and underinvested due to commercial uncertainty and risk that the CSEA initially aimed to address.¹²⁸ The high costs and risks associated with research and development of new technologies essentially forces commercial entities to maximize profit in the short term, rather than innovating for long-term economic value and societal benefit. Therefore, the high costs dissuade companies from potential investment and ultimately from innovative efforts that could bring immense benefit to the economy and American society. Further, these high costs create a barrier to entry for innovative upstarts that lack the resources to invest heavily for the opportunity to use spectrum.

When the CSEA was written in 2003, with the immediate goal of freeing up spectrum to be used for 3G services, it would have been practically impossible to predict the iPhone's release in 2007 and that more

126. *The Commercial Spectrum Enhancement Act: Hearing on H.R. 1320 Before the Subcomm. on Telecomms. and the Internet of the Comm. on Energy and Com., supra* note 58.

127. *Id.*

128. 47 C.F.R. § 1.2104 (2023).

than ninety-five percent of American adults under 50 years old would own a smartphone 20 years later.¹²⁹ In many instances, the potential public interest benefit of enabling such progress likely outweighs the costs of transition estimated by incumbent government users, but the uncertainty surrounding such potential benefit prevents it from being pursued. The current framework undervalues innovative commercial and consumer uses and overvalues federal uses.

Rather than requiring commercial users who are granted licenses to spectrum to more than fully compensate federal users that are relinquishing spectrum, potential economic and societal benefits should be considered alongside government interests. These broader benefits to the economy and society should essentially serve to “discount” the value of incumbent federal uses in spectrum reallocation analyses. If there is an immense potential benefit to providing commercial users access to a frequency band but some uncertainty regarding whether these benefits can be achieved, this should be taken into account. A best estimate of these potential benefits, considered in the context of the likelihood that the benefits will be achieved, should be weighed against similar estimates of the costs associated with transitioning government uses to other bands. The calculation of costs associated with government interests should include economic costs as well as the costs of sharing, like potential for interference. It is important to incentivize research and development that may not, but could, lead to commercially viable or otherwise productive uses to further the public interest.

In addition to the requirements of its reimbursement mechanism, the framework of the CSEA prefers relinquishment and reallocation over sharing.¹³⁰ This does not reflect the current state of technology and the ability for spectrum to be shared and used more dynamically by both federal and commercial users.¹³¹ By design and by mandate, the FCC must raise proceeds from auctions of licenses to fully fund relocation and NTIA must prefer exclusive use when assessing how spectrum might be repurposed.¹³² Shared spectrum is not as valuable at auction because it offers less certainty

129. See *The Commercial Spectrum Enhancement Act: Hearing on H.R. 1320 Before the Subcomm. on Telecomms. and the Internet of the Comm. on Energy and Com., supra* note 64; see also John Markoff, *Apple Introduces Innovative Cellphone*, N.Y. TIMES (Jan. 10, 2007), <https://www.nytimes.com/2007/01/10/technology/10apple.html> [<https://perma.cc/XY8L-Y4GL>]; see also *Share of Americans Owning a Smartphone in the U.S. as of June 2024, by Age*, STATISTA (Sept. 2024), <https://www.statista.com/statistics/231612/number-of-cell-phone-users-usa/> [<https://perma.cc/ULK7-MBW3>].

130. See KAREN GORDON ET AL., INST. FOR DEF. ANALYSES, A REVIEW OF APPROACHES TO SHARING OR RELINQUISHING AGENCY-ASSIGNED SPECTRUM 7 (2014), <https://www.ida.org/-/media/feature/publications/a/ar/a-review-of-approaches-to-sharing-or-relinquishing-agency-assigned-spectrum/p5102final.ashx> [<https://perma.cc/GZL3-XG2M>].

131. See JONATHAN AGRE & KAREN GORDON, INST. FOR DEF. ANALYSES, A SUMMARY OF RECENT FEDERAL GOVERNMENT ACTIVITIES TO PROMOTE SPECTRUM SHARING 12-15, 47-49 (2015), <https://www.ida.org/~/-/media/Corporate/Files/Publications/STPIPubs/2015/p5186final.pdf> [<https://perma.cc/VN9H-BLEY>].

132. See 47 U.S.C. §§ 923(j), 928; see also 47 C.F.R. § 1.2104 (2003).

to licensees in terms of resources that will be reliably available for use by the licensee. In addition, sharing spectrum involves coordination with other users to avoid interference.

Government users can be reluctant to share spectrum, especially where the frequencies are used for critical national security applications. For example, the DOD “holds large portions of the usable spectrum” for military operations, including bands that could “facilitate the build-out of 5G networks and the development of 5G technologies.”¹³³ While the Defense Innovation Board has encouraged the DOD to share spectrum to support these innovative efforts, the DOD contends “that sharing presents operational, interference, and security issues for DOD users.”¹³⁴ While the DOD has been increasingly considering more opportunities for spectrum sharing, it has expressed these challenges alongside concerns related to high cost and long timelines for transitions associated with sharing or relinquishing spectrum for non-federal uses.¹³⁵ The public interest may favor—and technology can enable—a shared spectrum approach for some bands. However, the CSEA does not allow for more flexible spectrum management policies, as it relies on the SRF to cover all of the costs associated with repurposing spectrum.

Overall, the CSEA’s structure that provides compensation for relocation does not appropriately reflect the opportunity costs and benefits associated with decisions to repurpose spectrum from federal uses to services that would be in the public’s interest. Therefore, the CSEA does not achieve the goals it was established to meet. Spectrum usage is critical to innovation and the public interest, and therefore a revised approach is needed.

B. The Need for a More Reliable, Robust Spectrum Repurposing Framework

A more robust system for reallocating federal spectrum to non-federal uses would present opportunities for innovation across government, academia, and the private sector. Historically, the CSEA has enabled government users to update “legacy analog systems to new digital systems and IP-based technologies, improving communications efficiencies and capabilities” and delivered substantial benefits to the American people by making spectrum available for commercial wireless services.¹³⁶ Strengthening incentives for enhancing spectrum use can allow for the

133. KELLEY SAYLER, CONG. RSCH. SERV., IF11251, NATIONAL SECURITY IMPLICATIONS OF FIFTH GENERATION (5G) MOBILE TECHNOLOGIES 1 (2023).

134. *Id.*

135. *See id.* at 1-2.

136. CTIA, REPURPOSING GOVERNMENT SPECTRUM FOR LICENSED COMMERCIAL USE: A WIN-WIN FOR WIRELESS PROVIDERS AND FEDERAL AGENCIES 4 (2020), https://api.ctia.org/wp-content/uploads/2020/08/Win-win_8-06.pdf [<https://perma.cc/XAW2-T9QK>]; *see* Memorandum on Modernizing United States Spectrum Policy and Establishing a National Spectrum Strategy, 88 Fed. Reg. 80079, 80080 (Nov. 17, 2023).

CSEA to continue to contribute to economic and societal benefits in the broader context of spectrum policy in the United States.

Government agencies need a more reliable system for spectrum repurposing. In addition to challenges with the structure of financial incentives created by the CSEA—which can easily weigh in favor of incumbency and impede innovation that could emerge from a more balanced consideration of societal and economic costs and benefits—it relies primarily on the FCC’s auction authority to repurpose spectrum from federal to non-federal uses. As such, the FCC does not have the reliable ability to meet its mandate to manage spectrum for the public interest because its auction authority is time-limited and subject to the political process.¹³⁷ For example, Congress failed to grant an extension to the FCC upon the lapse of the FCC’s auction authority in March 2023.¹³⁸ A more stable basis of authority would promote better spectrum management. The FCC’s ability as an expert agency to make important decisions regarding how to allocate spectrum to support national security, promote innovation and competition, and advance the public interest, among other priorities, should not be hindered by Congress’s failure to act. Further, the FCC has raised significant revenue from spectrum auctions (outside of the context of repurposing federal spectrum) that could support federal agencies’ transitions to other spectrum bands and fund other important efforts.¹³⁹

In addition, “SRF funds can . . . be used only to reimburse expenses related to a spectrum band that is auctioned by the FCC, or is previously identified by statute”—limiting the spectrum frequencies for which reimbursement is available.¹⁴⁰ Expanding the scope of the SRF by making it more broadly available to cover transition costs “would encourage proactive agency efforts to identify sharing opportunities in reallocated bands that are not assigned through the FCC’s competitive bidding process.”¹⁴¹ The FCC’s decision-making processes are also influenced by the CSEA—even with auction authority, the FCC must make decisions regarding whether to auction spectrum for reallocation purposes within the constraint of having to raise 110% of relocation costs estimated by federal incumbents.

137. See Press Release, FCC, Chairwoman Rosenworcel’s Statement on the Expiration of FCC Spectrum Auction Authority, (Mar. 10, 2023), <https://docs.fcc.gov/public/attachments/DOC-391576A1.pdf> [<https://perma.cc/28LG-QJH5>].

138. *Id.*

139. CTIA, *supra* note 136, at 5, 7.

140. KAREN GORDON ET AL., INST. FOR DEF. ANALYSES., A REVIEW OF APPROACHES TO SHARING OR RELINQUISHING AGENCY-ASSIGNED SPECTRUM 7 (2014), <https://www.ida.org/-/media/feature/publications/a/ar/a-review-of-approaches-to-sharing-or-relinquishing-agency-assigned-spectrum/p5102final.ashx> [<https://perma.cc/GZL3-XG2M>].

141. *Id.*

C. International Harmonization and U.S. Involvement in Standards-Setting

In considering how to repurpose spectrum, it is critical to consider the challenges and realities of international spectrum policy to ensure that a balance is struck between stimulating the U.S. innovation ecosystem and maintaining national security for the United States and its allies. International harmonization and active involvement in standards-setting is key in this respect. In the absence of an updated CSEA that enables more flexible spectrum management, the United States risks losing its global leadership.

An updated CSEA could align U.S. spectrum management policy more closely with international norms, enabling U.S. companies to continue to leverage economies of scale and allowing the United States to rely on trusted manufacturers of telecommunications equipment rather than on foreign hardware that could undermine U.S. infrastructure. For example, if 3GPP set technical specifications for an emerging technology without input from the United States and its interests, the U.S. market could suffer severely from being left out of the global market for the new technology. A version of the technology would need to be made exclusively for the U.S. market, but without the economies of scale and interoperability that a global market enables—making such equipment more expensive and potentially less useful.

In addition, Chinese equipment manufacturers continue to deploy equipment and services for 5G infrastructure around the world that may be vulnerable and used to conduct cyberattacks.¹⁴² Therefore, it is essential that the CSEA serves to promote U.S. technology leadership and meet growing demand from commercial entities and consumers while carefully balancing these interests with defense and national security needs.

IV. RECOMMENDATIONS

This section extends the previous analysis to provide recommendations to adapt the CSEA to current needs. The section begins by discussing potential adjustments and alternatives to the CSEA, including allowing for more flexible access rights and emphasizing spectrum sharing. Then, the use of prize competitions is introduced as a novel approach to spectrum allocation and mixed use. This section concludes by describing additional considerations that could foster innovation in spectrum use, including a brief description of unlicensed spectrum's role.

A. Potential Adjustments to the CSEA

The CSEA should be revised to better reflect the high value of public interests and to more reliably allow government entities to repurpose

142. See KELLEY SAYLER, CONG. RSCH. SERV., IF11251, NATIONAL SECURITY IMPLICATIONS OF FIFTH GENERATION (5G) MOBILE TECHNOLOGIES 1-2 (2023).

spectrum for more efficient uses, all while preserving national security and other important federal government operations. Researchers have identified several approaches to spectrum repurposing that might provide incentives for federal agencies to relinquish or share spectrum beyond the CSEA framework, including offering “spectrum property rights” to license holders and creating licensing systems that offer “flexible access rights.”¹⁴³ These mechanisms can be implemented into the current CSEA framework or form the basis of a new system for spectrum reallocation.

“Spectrum property rights” allow federal agencies full property ownership rights to the spectrum they hold, “giving them . . . the ability to aggregate, subdivide, sell, lease, or share their spectrum holdings.”¹⁴⁴ Such property rights could also permit federal agencies to determine whether spectrum could be shared among different services (federal or non-federal) to achieve more efficient utilization, as long as uses adhere to FCC rules and other applicable law.¹⁴⁵ This would provide substantially more power to incumbent federal users and NTIA. It would enable new arrangements between government agencies and other entities, fostering a secondary market for spectrum and opening new opportunities for funding innovation. However, the FCC and NTIA would need to carefully manage this change in spectrum management policy to maintain international harmonization and avoid interference domestically. Providing federal agencies the opportunity to trade or transfer spectrum (and allowing them to keep proceeds from such agreements) could enable new uses and sharing arrangements, but there are also significant implementation challenges associated with this approach, and it would likely lead to spectrum fragmentation.¹⁴⁶ “Flexible access rights” are an alternative form of spectrum sharing in which non-exclusive licenses would be issued.¹⁴⁷ These market-based mechanisms can be made more prominent to increase incentives for federal users to vacate, or share, spectrum with non-federal users.

Removing the preference for reallocation over sharing would be a productive first step. The combination of a more robust legal framework with a preference for spectrum sharing, advanced technologies to support dynamic spectrum allocation, and innovative funding mechanisms could greatly improve the efficiency of spectrum use—serving to fulfill the purpose of the CSEA. Spectrum sharing, while not a new concept, is increasingly seen as an important aspect of effective spectrum

143. KAREN GORDON ET AL., INST. FOR DEF. ANALYSES, A REVIEW OF APPROACHES TO SHARING OR RELINQUISHING AGENCY-ASSIGNED SPECTRUM 25, 29-32, 36-40 (2014), <https://www.ida.org/-/media/feature/publications/a/ar/a-review-of-approaches-to-sharing-or-relinquishing-agency-assigned-spectrum/p5102final.ashx> [https://perma.cc/GZL3-XG2M].

144. *Id.* at 11.

145. *See id.* at 11, 25-28.

146. *Id.* at 29-32.

147. *Id.* at 36-40.

management.¹⁴⁸ For example, the FCC issued a Notice of Proposed Rulemaking (NPRM) in 2023 to seek comment on how “[i]nnovative, non-exclusive spectrum access models” could be deployed “to provide increased access to high-band spectrum,” improving efficiency “to bring next generation services to consumers, support expanding access for 5G, and prepare for 6G and beyond.”¹⁴⁹ In particular, the FCC noted in the NPRM that “[m]illimeter wave transmissions have a shorter propagation range than lower-frequency spectrum and are blocked by walls and other obstacles, making it easier to reuse the same band or channel within a smaller geographic area.”¹⁵⁰ The FCC also expressed that advancements in technology have made spectrum sharing more viable, indicating that non-exclusive licenses could become increasingly valuable as technology continues to develop and new approaches to spectrum management are considered and implemented.¹⁵¹

The FCC has previously explored alternatives to exclusive spectrum use and has considered rules to facilitate spectrum transfers among current users.¹⁵² Relying on property rights concepts discussed previously, the FCC’s rules for “leasing” spectrum would be “designed to facilitate spectrum access and encourage secondary market transactions that will lead to efficient use of spectrum.”¹⁵³ Prioritizing spectrum sharing and leveraging technology to enable more dynamic allocation arrangements could enable more efficient uses of spectrum without disrupting some government uses.¹⁵⁴ However, there are challenges associated with these mechanisms, including “tracking spectrum allocations, establishing interference rules, enforcement, and incorporation into auctioning schemes.”¹⁵⁵

Given this context, and as an alternative to spectrum sharing and the existing framework that prefers repurposing after federal users vacate spectrum, federal agencies could lease spectrum to commercial entities when practicable. This could provide a revenue stream to support modernization efforts over time and enable continued operations. In

148. See JONATHAN AGRE & KAREN GORDON, INST. FOR DEF. ANALYSES, A SUMMARY OF RECENT FEDERAL GOVERNMENT ACTIVITIES TO PROMOTE SPECTRUM SHARING, at x (2015), <https://www.ida.org/~media/Corporate/Files/Publications/STPIPubs/2015/p5186final.pdf> [<https://perma.cc/VN9H-BLEY>].

149. Shared Use of the 42-42.5 Band, *Notice of Proposed Rulemaking*, 88 Fed. Reg. 49423, 49424-25 paras. 1-4 (2023), <https://docs.fcc.gov/public/attachments/FCC-23-51A1.pdf> [<https://perma.cc/P47V-L3ET>].

150. *Id.* at para. 7.

151. *Id.*

152. See, e.g., Partitioning, Disaggregation, and Leasing of Spectrum, *Notice of Proposed Rulemaking*, 34 FCC Rcd 1758, paras. 6-8, 14 (2019), <https://docs.fcc.gov/public/attachments/FCC-19-22A1.pdf> [<https://perma.cc/Z477-4HBX>].

153. *Id.* at para. 14.

154. See Stephan Wirsing & Peter Reichl, *Dynamic Spectrum Access and the Current Spectrum Management Paradigm: On the Challenges of Dynamic Licensing*, 2015 13TH INT’L CONF. ON TELECOMMS. (CONTEL) 1, 2-3 (2015).

155. KAREN GORDON ET AL., INST. FOR DEF. ANALYSES, A REVIEW OF APPROACHES TO SHARING OR RELINQUISHING AGENCY-ASSIGNED SPECTRUM 40 (2014), <https://www.ida.org/~media/feature/publications/a/ar/a-review-of-approaches-to-sharing-or-relinquishing-agency-assigned-spectrum/p5102final.ashx> [<https://perma.cc/GZL3-XG2M>].

addition, arrangements between federal and commercial users could enable new compensation structures and foster cooperation among federal and non-federal entities. For example, a commercial user could pay a federal user over time based on revenue generated by deployed services, providing funds to support federal modernization efforts. These arrangements would have the additional benefit of permitting continued repurposing or sharing as technologies develop.

Further, the CSEA is currently limited to the repurposing of federal uses, but it could also benefit from being more broadly inclusive, applicable to repurposing spectrum of any incumbent user. This could include non-federal users relinquishing spectrum for other non-federal users, as well as the opportunity for non-federal users to relinquish different bands to federal users, depending on specific circumstances and needs. Ultimately, this flexible approach to reallocating spectrum would be aligned with the overall purpose of the CSEA to use spectrum more effectively and efficiently, enhancing utilization to benefit the public interest.

B. A Novel Approach to Spectrum Allocation

Entirely novel approaches to spectrum allocation may be worth considering in the broader context of spectrum management and the specific area of repurposing federal spectrum for non-federal uses. For example, prize competitions and challenges could be run by the incumbent federal users. Prize competitions are increasingly used across a wide range of federal agencies to stimulate innovation and “as a means of finding creative solutions to challenging problems.”¹⁵⁶ Government-run challenges and prize competitions have also been shown not only to generate innovative ideas, but also as a way to foster productive partnerships between federal government agencies and other entities.¹⁵⁷ Instead of compensation or awarding a government contract for winning ideas, successful participants in a “spectrum repurposing” challenge could be given the reward of relinquished spectrum or the opportunity to share spectrum, coexisting with the federal incumbent. Proposals for spectrum use, presented by entities participating in the competition or challenge, would include a detailed plan for how economic proceeds or gains from the new spectrum use would compensate for changes in federal operations required to execute the proposal. While not feasible for all bands currently used by federal incumbents, this could offer a novel means of incentivizing the repurposing of spectrum where practicable, leveraging new compensation mechanisms that could essentially involve revenue sharing among commercial entities and government agencies.

156. THE WHITE HOUSE, THE OFF. OF SCI. AND TECH. POL’Y, IMPLEMENTATION OF FEDERAL PRIZE AND CITIZEN SCIENCE AUTHORITY: FISCAL YEARS 2019-2020 2 (2022).

157. *Id.* at 14-17; NAT’L SCI. & TECH. COUNCIL, NATIONAL SPECTRUM RESEARCH AND DEVELOPMENT PLAN 35-37 (2024).

C. Considering Other Factors and Unlicensed Spectrum to Foster Innovation

When determining whether and how spectrum should be reallocated, the FCC, NTIA, and other stakeholders should consider other factors in addition to those already discussed, including transition costs and the potential societal and economic benefits of reallocation. For example, the degree of disruption and other challenges with relinquishment and transition should be weighed against the opportunity cost of preventing innovation and research driven by commercial and other entities. In addition, the broader objective of fostering innovation and competition as a part of national security—by strengthening the U.S. equipment manufacturing industry and U.S. global competitiveness—should be emphasized. It is important to recognize that the suggestions presented in this Note would very likely require congressional legislation or authorization to implement, which presents a separate but significant set of related challenges.

Further, unlicensed spectrum has unleashed incredible innovation in an increasingly connected world (e.g., Wi-Fi and Bluetooth in the 2.4 GHz bands).¹⁵⁸ Opening up unlicensed bands can foster competition and lead to services that improve the daily lives of Americans. When spectrum can be used by any innovator, rather than a small and discrete number of licensees, new products and services can emerge. However, the economic challenges of spectrum repurposing are particularly acute in the context of making spectrum available for unlicensed use—by definition, users do not pay for licenses to use unlicensed spectrum, and therefore there is no clear revenue to cover the costs of relocating incumbent services.

The immense potential benefit of unlicensed bands must be weighed against the current uses of spectrum for critical national security operations and other federal uses. The potential value of enabling innovation by opening spectrum up to unlicensed use is difficult to predict and practically impossible to measure. Paired with the fact that unlicensed use does not provide revenue from licensees, there is not a clear compensation structure that would provide federal users proceeds needed to modify their existing operations. Instead, compensation can potentially come from government agencies such as the National Science Foundation (NSF) or National Institute for Standards and Technology (NIST), which invest in research and development to advance science, support national defense, champion U.S.

158. LINDA K. MOORE, CONG. RSCH. SERV., R44433, FRAMING SPECTRUM POLICY: LEGISLATIVE INITIATIVES 12 (2016).

industry, and generally promote the public interest.¹⁵⁹ Rather than investing in projects directly, these government agencies could compensate incumbent federal users for relinquishing or sharing spectrum, creating the space and opportunity for others to innovate in newly-available unlicensed bands.

V. CONCLUSION

In summary, adjustments or alternatives to the current framework for spectrum repurposing in the United States can enable a more efficient use of spectrum. The everyday uses of spectrum on which we rely, from communicating with apps on our smartphones to accessing websites containing the world's information, depend on reliable connectivity enabled by spectrum. Innovative, emerging uses of spectrum, such as connected cars and cities that can enhance public safety, improve energy efficiency, and drive better decision-making, will require additional spectrum allocations. To avoid compromising military communications and other uses that preserve national security, the United States must thoughtfully and carefully manage spectrum.

Spectrum is a vital, finite resource, and failing to allocate it appropriately has wide-ranging effects, from adverse national security implications to stagnating innovation and engineering progress. An updated framework is needed, in particular, for the reallocation of federal spectrum for non-federal uses, largely defined by the CSEA. The CSEA does not currently meet its purpose of promoting more efficient use of spectrum because it does not adequately incentivize stakeholders to determine ways to better use spectrum to advance the public interest. Investment and innovation are driven by economic viability—this was the driving force behind the CSEA framework and continues to be a critical consideration in spectrum policy.

Ultimately, a robust, reliable, and flexible framework for spectrum reallocation—allowing for new incentives, emphasizing spectrum sharing, and incorporating novel mechanisms for funding repurposing efforts—will help to address increasing demand for spectrum, foster innovation, preserve national security, and promote U.S. technology leadership.

159. See U.S. DEP'T OF COM., NAT'L TELECOMMS. & INFO. ADMIN., *supra* note 7, at 38; see also *Research & Development Programs*, NAT'L INST. OF STANDARDS & TECH., <https://www.nist.gov/chips/research-development-programs> [<https://perma.cc/WQZ4-3Q9R>] (last visited Sept. 30, 2024); see also *About NSF*, NAT'L SCI. FOUND., <https://new.nsf.gov/about> [<https://perma.cc/2GN7-6WG9>]. NSF has actively engaged with NTIA and the FCC on spectrum management policy challenges since 2020 through the Spectrum Innovation Initiative, which “presents a suite of opportunities to address the pressing challenges arising from the growing demand for usage of the electromagnetic spectrum.” *NSF's Spectrum Innovation Initiative*, NAT'L SCI. FOUND., https://www.nsf.gov/mps/osi/spectrum_innovation_initiative.jsp [<https://perma.cc/QWG2-PHT4>] (last visited Oct. 15, 2024).

