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R STREET POLICY STUDY NO. 146
June 2018

THE ROLE OF MARKETS IN SPECTRUM POLICY

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INTRODUCTION

Today, almost everyone depends on, or at least uses, a wireless device every day. We use our smartphones to stream videos and text friends, we fly on airplanes that navigate with radar and we look at weather maps constructed by satellites. The future of wireless devices is even more exciting and will include the expansion of the Internet of things, improved telemedicine and increasingly connected cars. But in order to reach the best possible wireless future, we must grapple with the technically difficult, legally complicated and politically contested medium of the electromagnetic spectrum.

Electromagnetic radiation has long been harnessed to engage in communications. Over time, we have increased the efficiency with which we use the spectrum of electromagnetic frequencies and the parts of the spectrum that are usable. The techniques and innovations that make wireless devices work both shape and depend on spectrum policy.

That policy has endured a checkered history—one characterized by invasive government control that is justified by mistaken economic reasoning. As a result, the role for markets has been minimized and this has held spectrum back from its maximum productivity. While the roots of these mistakes have been effectively refuted, their effects still persist in statutes and regulations.

By implementing further market-based reforms, the federal government can greatly increase the productive use of spectrum to the benefit of American consumers and entrepreneurs. To this end, improving the terms of spectrum licenses to incentivize innovation and efficiency, thinking critically about the role for both licensed and unlicensed spectrum and removing government regulation of speech over broadcast spectrum should be priorities for policymakers in every branch of government.

Accordingly, this paper discusses how wireless communication using spectrum works. It then recounts the history of spectrum regulation in the United States and the policy shortcomings that it created. Finally, it suggests a market-based lens through which to view future spectrum reforms and then applies that lens to several current policy issues.

USING SPECTRUM TO COMMUNICATE

The term "spectrum" applies to a range of frequencies of electromagnetic radiation. We interact with the spectrum all the time in the form of visible light, as the different colors our eyes perceive are the result of electromagnetic waves that vibrate at different frequencies and have different wavelengths. We can communicate through visible light, for example, by transmitting different frequencies of light to indicate meaning, as a colored flag would do, or modulating the amplitude or brightness of the light, as when the lights dim in a theater.

Wireless communications apply a similar principle, using waves too long for our eyes to perceive. These "radio waves" are generated and transmitted by sending an electric current through an antenna. These waves can then be received by an antenna at the other end of the transmission. Information is

encoded into the wave usually in a pattern that slightly varies its frequency or amplitude.

These wireless signals are sent and received as particular wavelengths, and each wavelength has unique characteristics for how signals travel and propagate. Longer wavelengths, for example, tend to travel farther and are better able to penetrate physical obstacles like walls or trees. Shorter wavelengths reach less far and are often limited by their physical surroundings, but they also have the ability to carry larger quantities of information more quickly than lower bands.

To account for these tradeoffs and other factors, constructing wireless networks requires clever engineering. For example, low band spectrum is necessary for over-the-air television signals that need to get through the walls of your home. But for a Wi-Fi network within your home, higher frequencies that do not propagate as far are necessary in order to limit interference with neighbors' signals. A combination of both low and high band spectrum can provide the coverage and capacity needed to construct a nationwide 5G network.[1]

While the number of electromagnetic frequencies is vast, the amount available for communication cannot, in practice, be divided infinitely because signals that are carried by waves too close together will interfere with one another. This results in messages not getting to their intended destinations. Harmful interference can be mitigated by various methods including technical protocols for how and when different users transmit signals and legal rules governing who can operate radio equipment in a particular way. Technological innovations can allow for more efficient use of spectrum and essentially can create "more" of it by allowing more information to be squeezed into narrower bands.

HISTORY OF SPECTRUM LICENSING

Not long after Marconi and Tesla started experimenting with "wireless telegraphy" in the late 1800s, the United States government took an interest in regulating spectrum use. A review of the history of the government's involvement in spectrum policy reveals a general shift in views, from treating spectrum as a scarce resource that merited substantial intervention in earlier years to a more economically oriented willingness to let markets play a greater role in allocating it.

Major regulatory efforts in the United States began in 1910 when the Department of the Navy alleged that spectrum use was characterized by rampant interference with almost no management over spectrum users or frequencies. At that time, the Navy issued a dire warning to the Senate Commerce Committee with respect to spectrum use: "There exists in many places a state of chaos [...] It is not putting the case too strongly to state that the situation is intolerable, and is continually growing worse."[2]

Congress attempted to remedy this "state of chaos" via the Radio Act of 1912.[3] Though the original impetus of the law was linked to the sinking of the *HMS Titanic*, it is most notable for its requirement that everyone using a radio apparatus do so under the terms of a license acquired from the Department of Commerce.[4] This began the policy of spectrum licensing in the United States that continues to this day.

Several years later, the Radio Act of 1927 moved the licensing authority from the Commerce Department to a newly created Federal Radio Commission (FRC) and provided more detailed rules.[5] The Commission's purpose was:

> to provide for the use of such channels, but not the ownership thereof, by individuals, firms, or corporations, for limited periods of time, under licenses granted by Federal authority, and no such license shall be construed to create any right, beyond the terms, conditions, and periods of the license.[6]

The FRC was also charged with applying a "public interest" standard to spectrum use:

> If upon examination of any application for a station license [...] the licensing authority shall determine that public interest, convenience, or necessity would be served by the granting thereof, it shall authorize the issuance, renewal, or modification thereof.[7]

Rather than allowing markets to determine its most productive use, this broad government discretion over spectrum was the bedrock of future regulation and legislation until much more recently.

In 1934, President Franklin Roosevelt signed the Communications Act, which replaced the FRC with the Federal Communications Commission (FCC).[8] The Communications

1. Peter Rysavy, "Low Versus High Radio Spectrum," *High Tech Forum*, March 5, 2012. http://hightechforum.org/low-versus-high-radio-spectrum.

2. George von Lengerke Meyer, "House of Representative Report No. 924: Letter to Committee on the Merchant Marine and Fisheries," *Radio Communication*, March 30, 1910, p. 4. https://books.google.com/books?id=RmA3AQAAIAAJ&pg=RA1-PA168&lpg=RA1-PA168&dq#v=onepage&q&f=false.

3. S. 6412, An Act To regulate radio communication, 63rd Congress, 1912. http://legisworks.org/sal/37/stats/STATUTE-37-Pg302b.pdf.

4. Ibid. p. 303.

5. H.R. 9971, An Act For the regulation of radio communications, and for other purposes, 69th Congress, 1927. http://www.legisworks.org/congress/69/publaw-632.pdf.

6. Ibid. p. 1162.

7. Ibid., p. 1167.

8. 47 U.S.C. § 151. https://www.law.cornell.edu/uscode/text/47/151.

Act has been amended several times since then, but it still forms the basic foundation of U.S. communications policy. The FCC continued to perform licensing functions for the use of spectrum in comparative hearings, which became known as the "beauty contests."[9] Would-be licensees submitted applications for the use of certain frequencies, and the Commission would decide who got to use what frequencies and how the awardees could employ their allocations, based on the Commission's determination of whether the applicant would serve the "public interest, convenience, and necessity."[10] The FCC's role, therefore, went far beyond its original intention[11] merely to manage interference, instead literally determining if radio stations could play rock or classical music.[12]

Throughout this period, the rationale for such invasive government involvement was the same as it was in 1910: spectrum is a scarce resource, therefore, the government must control it and ensure that it is used in the "public interest."[13] And, the government leaned on its own discretion rather than on markets to decide how spectrum ought to be used.[14] Accordingly, the winners of "beauty contests" got the right to broadcast without paying for it. The absence of a price system to compare the relative opportunity costs of alternative uses necessarily resulted in spectrum being underutilized and less productive than it otherwise could have been.[15]

Enter Ronald Coase

A landmark shift in the old way of thinking began in 1959 when economist Ronald Coase, who would later win the Nobel Prize in economics, published a paper entitled simply "The Federal Communications Commission."[16] Coase challenged the very foundation of U.S. spectrum policy throughout its history. Spectrum is indeed scarce, he said, but that quality in itself is wholly irrelevant to whether government needs to control it.[17] After all, Coase explained, the whole point of market exchange is to rationally allocate scarce resources.[18] Therefore, as with other economic goods like land and paper, the most efficient way of allocating spectrum was, in Coase's view, to create a market for it rather than to give it away for free at the whims of the FCC.

At the time, Coase's proposal was far outside of mainstream communications policy and the scarcity rationale for government control of spectrum continued to dominate policy for decades. When the FCC had a chance to comment on the possibility of a market for spectrum in 1978, commissioners said that the odds of competitive bidding being implemented or improving upon beauty contests were tantamount to "those on the Easter Bunny in the Preakness."[19] Even if the FCC had been willing to consider a market for spectrum at the time, enabling legislation would be needed, yet Congress gave the idea of auctions an equally icy response. Indeed, some members fought to legislate against any possibility of spectrum markets throughout the 1980s.[20] The reluctance to adopt Coase's argument was doubtlessly fueled by the fact that policymakers (and incumbent licensees) preferred a regime that gave them more discretion over the outcomes. The command-and-control regime was never merely a necessary evil in response to spectrum's scarcity; it was a tool of social policy used to control the content of the airwaves.[21]

Eventually, however, the logic of Coase's argument carried the day. In 1993, Congress passed a law allowing the FCC to distribute licenses through competitive bidding.[22] The agency began conducting spectrum auctions in 1994 and has

9. Jonathan E. Nuechterlein and Philip J. Weiser, *Digital Crossroads: Telecommunications Law and Policy in the Internet Age* (MIT Press, 2013), p. 93. https://books.google.com/books?id=2aN5AAAAQBAJ&.

10. 47 U.S.C. § 309. https://www.law.cornell.edu/uscode/text/47/309.

11. At the outset of the FCC, individual commissioners may not have been intent on adjudicating the content of broadcasts but the lack of a price mechanism made that outcome inevitable as the Commission searched for a non-price rule to evaluate the "public interest." See, e.g., Louis G. Caldwell, "Freedom of Speech and Radio Broadcasting," *The Annals of the American Academy of Political and Social Science* 177 (Jan. 1935), pp. 197-202. https://www.jstor.org/stable/1019983?seq=1#page_scan_tab_contents.

12. *Citizens Comm. to Keep Progressive Rock v. FCC*, 478 F.2d 926, 930 (D.C. Cir. 1973). https://scholar.google.com/scholar_case?case=12200776955557677O6&hl=en&as_sdt=6&as_vis=1&oi=scholar.

13. 47 U.S.C. § 303. https://www.law.cornell.edu/uscode/text/47/303.

14. The courts explained that the FCC's authority under the Communications Act is rooted in the scarcity rationale in *NBC v. United States*, 319 U.S. 190 (1943), pp. 216-17. https://scholar.google.com/scholar_case?case=11254761392460211230.

15. For example, the FCC recently proposed to liberalize spectrum that it set aside for educational television in 1963 but that went largely unused: "Two decades later, nearly half of all states had zero ITFS licensees, even though we were essentially giving away licenses for free." *See, Statement of Commissioner Brendan Carr*, In the Matter of Transforming the 2.5 GHz Band, WT Docket No. 18-120, May 10, 2017. https://transition.fcc.gov/Daily_Releases/Daily_Business/2018/db0510/FCC-18-59A4.pdf. Frequencies in the Ultra High Frequency (UHF) band have also been known to be underutilized for some time. See, e.g., Philip J. Weiser and Dale N. Hatfield, "Policing the Spectrum Commons," *Fordham Law Review* 74:2 (2005), p. 669. https://ir.lawnet.fordham.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=4111&context=flr.

16. Ronald H. Coase, "The Federal Communications Commission," *Journal of Law and Economics* 2 (October 1959). https://www-journals-uchicago-edu.mutex.gmu.edu/doi/pdfplus/10.1086/674871.

17. Idid. p. 891.

18. Ibid. p. 894.

19. Glen O. Robinson, "The Federal Communications Commission: An Essay on Regulatory Watchdogs," *Virginia Law Review* 64:2 (March 1978) p. 243. https://www-jstor-org.mutex.gmu.edu/stable/1072617?origin=crossref&seq=1#page_scan_tab_contents.

20. Thomas W. Hazlett et al., "Radio Spectrum and the Disruptive Clarity of Ronald Coase," *Markets, Firms, and Property Rights: A Celebration of the Research of Ronald Coase Conference* (Dec. 2009), pp. 10-11. https://www.chapman.edu/ESI/wp/Porter-Smith-Hazlett-RadioSpectrum.pdf.

21. Brent Skorup and Joseph Kane, "The FCC and Quasi-Common Carriage," *Minnesota Journal of Law, Science & Technology* 18:2 (June 2017), p. 637. https://scholarship.law.umn.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1429&context=mjlst.

22. H.R. 2264, "Omnibus Budget Reconciliation Act of 1993" 103rd Congress. 47 U.S.C 309(j). https://www.law.cornell.edu/uscode/text/47/309.

completed around 100 since then.[23] Policy debates continue about the structure of FCC auctions, but spectrum's scarcity is now generally understood to make it ideal for market allocation rather than making such allocation impossible.[24]

THE USE OF MARKETS IN SPECTRUM POLICY

For decades, legislation and regulation had been based on the scarcity rationale, and that rationale has now been shown to be mistaken. It is true that there were interference problems in the early days of radio communication, but that state of affairs was the result not of private spectrum markets but of their absence. It is easy to see that, without property rights, competing uses for other resources, like land, would result in "interference" that reduces overall productivity. For example, if one person wants to use a piece of land for farming but another wants to use it for an office building, the two aims are obviously incompatible. Yet, they can be kept from "interfering" by defining tradable rights to the land in question.

For these reasons, the government should continue the process of reversing its mistaken rejection of tradable rights in spectrum and view new legal rules governing its use as analogous to those governing the use of land. Whether spectrum is, in fact, analogous to land is a matter of some debate[25] but as a matter of economic incentives, there is much to be said in favor of the comparison. For example, the owner of a piece of land can (among other things), divide it up, transfer it, use it in diverse ways and exclude others from using it. When property rights are assigned to land, the resulting opportunities for profit incentivize the owner to use the land productively. Likewise with spectrum: flexible, durable rights to operate in the spectrum promote productive use.[26]

While there may be divergent value judgements over the best social outcome from spectrum policy, many of them could be better realized through a free market. Insofar as free markets are desirable generally, the overall goal of spectrum policy should be to maximize its productive use. Importantly, this implies that, while mitigating interference is important, the goal is *not* to minimize interference at all costs.[27] Maximizing productivity may mean tolerating some interference or creating rules that are flexible enough to allow creative engineering to resolve problems. The FCC has made significant strides toward a more market-based approach to spectrum, but substantial policy issues remain before the above framework can be fully realized.

POLICY ISSUES

With wireless technologies becoming ubiquitous in more parts of people's everyday lives, spectrum policy has a growing impact on the public and the nation. Accordingly, several key questions that have come to the forefront of recent spectrum policy are outlined below. Each of these requires careful thought and consideration.

Flexible Use

As with any scarce resource with alternative uses, with spectrum, a flexible ability to change how it is used is essential to making it as productive as possible. Given the rapidly changing nature of technology and the economy, the FCC should not be expected to anticipate the best use of a given spectrum band for all time.

The FCC has been moving in the direction of flexible-use licensing, with clear benefits along the way. For example, commercial mobile radio services (CMRS), which include things like cell phones, utilize flexible-use spectrum. While quantifying the benefits of such spectrum is difficult, economist Tom Hazlett has estimated that the consumer surplus[28] from CMRS spectrum was over $81 billion in 2003.[29] Since that estimate predates most of the wireless devices in use today and future demands from ever-expanding connectivity will continue to grow, flexible-use spectrum certainly generates far greater amounts of consumer surplus today. This fact invites the important note that, while FCC spectrum auctions often raise large sums for the U.S. Treasury,[30] the main benefits of getting spectrum into the marketplace come from the uses to which it is put. These gains swamp the sums collected in initial auctions.

23. "Auctions Summary," Federal Communications Commission. http://wireless.fcc.gov/auctions/default.htm?job=auctions_all.

24. See, e.g., Gregory L. Rosston and Jeffrey S. Steinberg, "Using Market-Based Spectrum Policy to Promote the Public Interest," *Federal Communications Law Journal* 50:1 (1997), p. 92-99. https://www.repository.law.indiana.edu/cgi/viewcontent.cgi?referer=https://scholar.google.com.au/&httpsredir=1&article=1147&context=fclj.

25. See generally Coase, pp. 891, 908-10. https://www-journals-uchicago-edu.mutex.gmu.edu/doi/pdfplus/10.1086/674871; Philip J. Weiser and Dale N. Hadfield, "Spectrum Policy Reform and the Next Frontier of Property Rights," *Colorado Law Legal Studies Research Paper Series* 8:8 (March 19, 2008). https://dlc.dlib.indiana.edu/dlc/bitstream/handle/10535/6262/spectrum.pdf?sequence=1; Thomas W. Hazlett, "A law and economics approach to spectrum property rights: a response to Weiser and Hatfield [sic]," *George Mason Law Review* 15:4 (2008). https://goo.gl/MNwF1H; Thomas W. Merrill and Henry E. Smith, "Making Coasean Property More Coasean," *Journal of Law and Economics* 54:4 (November 2011). https://goo.gl/hqDFGc; J. Pierre de Vries and Jeffrey Westling, "Not a Scarce Natural Resource: Alternative to Spectrum-Think," Telecommunications Policy Research Conference, Oct. 2, 2017. https://goo.gl/mAqzkj.

26. Coase, pp. 897-98. https://www-journals-uchicago-edu.mutex.gmu.edu/doi/pdfplus/10.1086/674871; Thomas W. Hazlett and Evan T. Leo, "The Case for Liberal Spectrum Licenses: A Technical and Economic Perspective," *George Mason University Law and Economics Research Paper Series* (March 23, 2010), pp. 11-12. https://www.law.gmu.edu/assets/files/publications/working_papers/1019CaseforLiberalSpectrumLicenses20100412.pdf.

27. Coase, pp. 903-04. https://www-journals-uchicago-edu.mutex.gmu.edu/doi/pdfplus/10.1086/674871.

28. I.e. the difference between what consumers would be willing to pay and what they actually pay.

29. Thomas W. Hazlett, "Spectrum Tragedies," *Yale Journal on Regulation* 22:2 (2005), p. 251. https://www.manhattan-institute.org/pdf/cde5-17-04_hazlett.pdf.

30. For example, the 2014 AWS-3 Auction yielded over $44 billion in gross bids. "Auction 97: Advanced Wireless Services," Federal Communications Commission. http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=97.

Flexible-use licenses also allow market transactions to assemble contiguous blocks of spectrum for the same use. Such aggregation confers technical advantages, as contiguous channels allow for greater throughput than spreading transmissions over multiple channels. Having to work around bands that are restrictively licensed for different uses or attempting to reshuffle predefined uses through a bureaucratic process is more costly and time consuming than necessary.[31]

One potential shortcoming of this approach is the possibility of holdouts: precisely because contiguous frequencies are known to be complements, one or a few users situated in the middle of a band of frequencies could demand extraordinarily high rates to allow that band to be unified. This could result in a fragmentation that decreases the overall productivity in what is known as the "tragedy of the anticommons."[32] While this is a serious concern for private spectrum markets, two points should be borne in mind. First, one must consider the relevant alternative: The costs from holdouts may still be lower than the deadweight loss caused by the FCC defining the use of contiguous blocks of spectrum by regulation. That is, it is not obvious that the cost of buying out a holdout is higher than that which results from bureaucratic reallocation processes at the FCC.[33] A holdout that can be persuaded to move with enough cash is preferable to one that is unable to move because of regulatory rigidity. Second, the fact that the price of any spectrum license is high does not necessarily indicate a failure of the market. A so-called holdout's willingness to forgo buyout offers is itself an indication of that holdout's high valuation of the spectrum. It is unclear that the government ought to override the licensee's subjective valuation.

License flexibility is now an essential consideration whenever the FCC reevaluates the rules for spectrum bands. Many bands, however, still suffer from underutilization because of restrictions on the services that may be offered within them. Current proceedings on the 2.5,[34] 4.9[35] and 5.9 GHz[36] bands illustrate this fact. The FCC set aside these bands for particular uses that have not come to fruition, leaving the spectrum fallow. For this reason, the FCC has the opportunity to dramatically increase the productivity of those bands by designating them for flexible use. Flexible use is more important than ever in today's rapidly evolving technological landscape. The most productive use of particular frequencies may change rapidly and restrictive regulatory frameworks should not stand in the way of this dynamism.

License Size and Duration

Besides flexible use, other attributes of spectrum licenses can enhance the productive use of radio frequencies. The geographic area covered by a license has significant effects on how spectrum is utilized. Historically, the FCC has carved up the United States in a variety of different ways, including areas as large as the entire country and as small as census blocks. As with assembling contiguous frequencies, the ability of market transactions to efficiently aggregate or disaggregate licenses for particular areas is essential.

While interested parties will insist on their preferred geographic size, these preferences are not always economic necessities. Smaller companies, for example, sometimes fear they will be unable to gain access to larger licenses either in full (from the initial auction) or in part (on the secondary market). But spectrum policy should not bias outcomes in response to the preferences of companies, regardless of size. The goal is productivity and efficiency; and, when a secondary market is in place, the original size of license becomes, in itself, less relevant to that objective.

The real question becomes one of transaction costs. The relative transaction costs of the FCC facilitating more auctions for smaller license areas—compared to those for private companies conducting secondary-market transactions with larger licenses—is not evident *a priori* and will depend upon the economic factors present in the specific case.[37] For example, if a certain frequency is licensed using one size of geographic area, there may be efficiencies to preserve those same geographic areas for adjacent bands. Factors such as

31. See, e.g., the repack following the recent Incentive Auction, in which television spectrum was reallocated to alternative uses in Colin Gibbs, "FCC's repacking effort may far exceed 39 months: Guggenheim," *FierceWireless*, Aug. 25, 2017. https://www.fiercewireless.com/wireless/fcc-s-repacking-plan-may-far-exceed-39-months-guggenheim; and John Eggerton, "FCC Frees Up $742 Million More for Post-Incentive Auction Repack," *Broadcasting & Cable*, April 16, 2018. https://www.broadcastingcable.com/news/fcc-frees-up-742-million-more-for-post-incentive-auction-repack.

32. Michael A. Heller, "The Tragedy of the Anticommons: Property in the Transition from Marx to Markets," *University of Michigan Law School Scholarship Repository* (1998). https://repository.law.umich.edu/cgi/viewcontent.cgi?article=1608&context=articles.

33. See, e.g., analysis of alternative methods considered by the FCC for reallocating the television band in Thomas W. Hazlett, "Reallocation with Hold-ups and Without Nirvana," *George Mason University Law and Economics Research Paper Series* 14:16 (2014). https://goo.gl/TZDEmm.

34. "In the Matter of Transforming the 2.5 GHz Band Notice of Proposed Rulemaking," Federal Communications Commission, WT Docket No. 18-120, April 19, 2018. https://transition.fcc.gov/Daily_Releases/Daily_Business/2018/db0419/DOC-350331A1.pdf.

35. "In the Matter of Amendment to Part 90 of the Commission's Rules," Federal Communication Commission, WP Docket No. 07-100, March 1, 2018. https://apps.fcc.gov/edocs_public/attachmatch/DOC-349524A1.pdf.

36. Joe Kane, "For connected cars, let the best technology win," *R Street Blog*, Oct. 2, 2017. https://www.rstreet.org/2017/10/02/for-connected-cars-let-the-best-technology-win.

37. See, e.g., Tom Struble and Joe Kane, "Reply Comment of R Street Institute In the Matter of Promoting Investment in the 3550-3700 MHz Band," GN Docket No. 17-258, Jan. 29, 2018, pp. 11-13. https://ecfsapi.fcc.gov/file/10129084413708/3.5%20GHz%20Reply%20Comments.pdf.

population density in a given area will also contribute to whether aggregation or disaggregation are cheaper overall. It may make sense, for example, to ensure that an entire metropolitan area can be covered by a single license at the outset rather than incurring the transaction costs of assembling a contiguous license from small pieces. On the other hand, dense urban areas may provide sufficiently high revenue to overcome these transaction costs. Likewise in rural areas, smaller licenses may be preferable where use cases are more localized, but they also could be susceptible to anticommons tragedies that result from the difficulty in assembling a critical mass of customers in a sparsely populated area. The tradeoffs in each scenario must be evaluated on a case-by-case basis, however, as there is no universally superior license size.

Even more important than license area is license term length. In order for a robust market to efficiently allocate spectrum to productive uses, spectrum licenses must be characterized by terms long enough to justify long-term investments. In this respect, spectrum is, again, akin to land. The degree to which landowners will invest in improving land—and the types of improvements they build—will be skewed if the land were taken and auctioned by the government after only a few years. The reason people invest in long term projects that increase the value and productivity of land is that they expect to benefit from those investments for years to come.

There is good reason, therefore, to think that spectrum licenses ought to be perpetual. Auctions should be used once to get spectrum to market, but after it is in private hands, it is counterproductive for the government to repeat the process. As discussed above, the justification for limited-term licenses in the first place was based on the mistaken scarcity rationale. Licenses of limited duration now only artificially reduce the value of spectrum and distort its uses.

In this respect, the FCC has made less progress. Licenses are still granted for limited terms (albeit with renewal expectancy) and some recent proceedings have seen attempts to create terms as short as three years in order to make the licenses more affordable for smaller bidders.[38] However, this position seeks to substitute the continual FCC auctions—and the transaction costs they entail—for a robust secondary market in perpetual licenses, which could be leased for any period of time. Congress should harness the efficiencies of such markets by enacting legislation that directs the FCC to move toward perpetual licenses. Indeed, it is possible that the FCC will not be needed at all to manage spectrum. Economic history is replete with instances of resource allocation that might conventionally be thought to devolve into chaos but in which private rules and enforcement mechanisms emerge.[39] If applied properly, similar arrangements could prevail. Such creative, long-term solutions for spectrum policy are therefore worth serious consideration.

Government Spectrum

Another barrier to spectrum access is the extensive control of high-quality spectrum by government agencies. For example, more than half of so-called "beachfront"[40] spectrum is allocated to federal use.[41] This spectrum has simply been given to government users without a market mechanism.[42] While government users often perform important functions with their spectrum, the lack of market prices means there is little incentive for the government to economize on its use and no way to calculate whether it could be put to better use by the private sector.

Many government actions have recognized and sought to ameliorate the need for additional spectrum by addressing federal holdings. The Spectrum Pipeline Act of 2015,[43] for example, directed both the FCC and National Telecommunications and Information Administration to identify spectrum that could be cleared and auctioned for commercial use. Another option would be for the FCC to auction overlay licenses that facilitate the ability of private users to buyout government ones.[44]

Government agencies may have legitimate concerns that critical services could suffer if they are deprived of access to spectrum, and, in some cases, sharing with the private sector may be preferable to removing government users. Innovative sharing arrangements, like the pending Citizens' Broadband Radio Service in the 3.5 GHz band,[45] can allow for private use of underused federal bands. More work is needed, however, to implement such efforts and develop new solutions to

38. "In the Matter of Promoting Investment in the 3550-3700 MHz Band," Federal Communications Commission, Notice of Proposed Rulemaking, GN Docket No. 17-258, Oct. 24, 2017, p. 5. https://ecfsapi.fcc.gov/file/1024196454861/FCC-17-134A1.pdf.

39. See, e.g., Edward Peter Stringham, *Private Governance: Creating Order in Economic and Social Life* (Oxford University Press, 2016); Terry L. Anderson and Peter J. Hill, *The Not So Wild, Wild West: Property Rights on the Frontier* (Stanford Economics & Finance, 2004).

40. This is generally considered to be roughly between 200 MHz and 3,7000 MHz.

41. Brent Skorup, "The Importance of Spectrum Access to the Future of Innovation," *Mercatus Center*, December 2016, p. 2. https://www.mercatus.org/system/files/skorup-spectrum-access-future-innovation-mop-v2.pdf.

42. Agencies pay only a small fee that falls far short of the market value of their spectrum. See, e.g., "Spectrum Management: Incentives Opportunities, and Testing Needed to Enhance Spectrum Sharing," Government Accountability Office, November 2012, p. 11. https://www.gao.gov/assets/660/650019.pdf.

43. H.R. 1314 "Bipartisan Budget Act of 2015, Title IX," 114th Congress. https://www.congress.gov/bill/114th-congress/house-bill/1314.

44. See, e.g., Brent Skorup, "Sweeten the Deal: Transfer of Federal Spectrum through Overlay Licenses," *Mercatus Center*, August 2015. https://www.mercatus.org/system/files/Skorup-Spectrum-Overlay-Licenses.pdf.

45. "In the Matter of Promoting Investment in the 3550-3700 MHz Band," Federal Communications Commission, Notice of Proposed Rulemaking, GN Docket No. 17-258, Oct. 24, 2017. https://ecfsapi.fcc.gov/file/1024196454861/FCC-17-134A1.pdf.

ensure that government spectrum is used just as efficiently as spectrum in private hands.

At any rate, getting spectrum into the marketplace is more pressing now than ever. Developments such as the Internet of things and 5G wireless standards will greatly increase the possible applications of wireless technologies, but spectrum availability could be a bottleneck for innovation. So while government uses of spectrum are often important, that importance should be communicated through market prices that reflect its actual scarcity. Policymakers should ensure that outdated rules and free-riding by government are not the source of an artificial shortage.

Licensed vs. Unlicensed

Although it has been heavily influenced by its ambiguous economic and legal history, licensing is the method of management for much of the spectrum. But licensing is not the only way to manage spectrum use. Unlicensed spectrum has been and continues to be used to great effect. The most familiar unlicensed bands are those at 2.4 and 5 GHz, which are used for applications like Wi-Fi and Bluetooth. Operations in these bands have solved the tragedy of the anticommons by using relatively-low power levels and relatively-high frequencies, such that signals are limited in their range. Interference, therefore, is mitigated by the characteristics of the spectrum and the standards in use rather than by granting licenses. But even with these measures, unlicensed spectrum has sometimes become congested in areas where the number and density of users overwhelms even sophisticated traffic management tools.[46]

Additionally, unlicensed users have sometimes tried to have it both ways: seeking the benefits of licensed spectrum without having to pay for them.[47] Such actions are problematic for two reasons. First, the essence of the unlicensed spectrum bargain is that anyone is allowed to access it but they must also accept interference. Unlicensed spectrum should, therefore, be treated as what it is, and those seeking access to more valuable, exclusive rights should expect to pay for them. Second, asking for licensed-like privileges in unlicensed spectrum compromises efficient allocation. When assigning exclusive rights and absent a market mechanism in which competing uses bid against each other, there is no way of knowing whether a given band is more valuable when used for Wi-Fi than for, say, mobile data. However, some unlicensed spectrum can still be compatible within an overall policy of otherwise exclusive rights, just as public parks complement our largely private-property regime for land.

While the lack of a market mechanism in unlicensed spectrum is a significant concern, many believe that new sharing policies combined with innovative technology—such as dynamic frequency sharing through automated databases[48]—can allow unlicensed spectrum to play an increasingly significant role in our wireless future. Moreover, the existence of unlicensed spectrum could incentivize development of more innovative methods of dealing with interference on shared frequencies that could increase the productivity of unlicensed spectrum and also be applied elsewhere. Making unlicensed spectrum an avenue of consistent productivity rather than a giveaway to interest groups is an ongoing challenge. Policymakers should seek to balance the positive incentives created by exclusive licensing with the benefits of unlicensed spectrum, which can complement it.

Free Speech and Content Regulation

One of the most troubling legacies of the federal government's mistaken twentieth-century spectrum policy is the legal ability of the FCC to regulate the content of communications over the electromagnetic spectrum. While this power seems obviously opposed to constitutional protections of free speech and a free press, courts gave it their blessing for reasons firmly rooted in the scarcity rationale.

In the 1943 case of *NBC v. United States*, for example, the Supreme Court recognized that Congress had given the FCC the right to regulate the content of the airwaves and said that such a delegation was permissible because "[t]he facilities of radio are not large enough to accommodate all who wish to use them."[49]

Similarly, in the 1969 case of *Red Lion Broadcasting v. FCC*, the Court found that: "Because of the scarcity of radio frequencies, the Government is permitted to put restraints on licensees in favor of others whose views should be expressed on this unique medium."[50] On this basis, the Court held that the FCC could regulate political speech of broadcasts, despite the fact that the scarcity rationale was shown to be vacuous in 1959.

46. Terry Ngo, "Why Wi-Fi Stinks—and How to Fix It," IEEE Spectrum, June 28, 2016. https://spectrum.ieee.org/telecom/wireless/why-wifi-stinksand-how-to-fix-it.

47. This happened, for example, when proponents of Wi-Fi fought the introduction of LTE-U, which sought to use unlicensed spectrum to facilitate mobile traffic. Wi-Fi advocates alleged (likely incorrectly) that LTE-U would create interference that would harm Wi-Fi even though unlicensed users are not entitled to interference protection. See Brent Skorup, "Spectrum NIMBYs and the Return of FCC Beauty Contests," *Technology Liberation Front*, July 23, 2015. https://techliberation.com/2015/07/23/spectrum-nimbys-and-the-return-of-fcc-beauty-contests.

48. As in the pending 3.5 GHz proceeding. See "In the Matter of Promoting Investment in the 3550-3700 MHz Band," Federal Communications Commission, Notice of Proposed Rulemaking, GN Docket No. 17-258, Oct. 24, 2017. https://ecfsapi.fcc.gov/file/1024196454861/FCC-17-134A1.pdf.

49. *NBC v. United States*, 319 U.S. 190 (1943), pp. 216-17. https://scholar.google.com/scholar_case?case=11254761392460211230.

50. *Red Lion Broadcasting v. FCC*, 395 U.S. 367 (1969). p. 390. https://scholar.google.com/scholar_case?case=7640733876913500692.

Since these cases were decided, Justices from across the ideological spectrum have questioned their legitimacy.[51] Nevertheless, both sides of the aisle have recently renewed calls for the FCC to exercise its power to censor content.[52] It is time for Congress or the Court to reverse mistaken, outdated precedents and make clear that the First Amendment applies equally to all media.

CONCLUSION

Despite living in an increasingly wireless world, it is easy to forget that the devices and connections we take for granted are limited by spectrum. Getting spectrum policy right is essential to provide the tools for technological innovation throughout the 21st century. Policy mistakes in the past have limited the productivity of spectrum, but it is not too late to reverse them and continue advancing on the path to rational, market-based allocation rather than expansive regulation. The federal government should now seek to foster the market for spectrum. Wireless technological advances in telemedicine, 5G and the Internet of things are on the horizon. Accordingly, we must ensure that spectrum policy is not the limiting factor to this future.

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51. In his concurrence to *FCC v. Fox Television Stations*, Justice Thomas, for example, has argued that even if the scarcity rationale were true, it would not make discriminatory treatment of different media constitutional. He then goes on to say that the scarcity rationale is, in fact, flawed. 129 S.Ct. 1800 (2009), pp. 1820-21. https://scholar.google.com/scholar_case?case=6114044271141802936. Justice Ginsburg expressed a similar opinion regarding the related case of *FCC v. Pacifica* in her concurrence to a second *FCC v. Fox Television Stations* decision. 132 S.Ct. 2307 (2012), p. 2321. https://scholar.google.com/scholar_case?case=9187101700166207966.

52. Joe Kane, "'News Distortion' Is Not Grounds for Violating the First Amendment," Morning Consult, April 19, 2018. https://morningconsult.com/opinions/news-distortion-is-not-grounds-for-violating-the-first-amendment; John Eggerton, "Sen. Manchin Bemoans Demise of Fairness Doctrine," *Broadcasting & Cable*, May 18, 2018. https://www.broadcastingcable.com/news/sen-manchin-bemoans-demise-of-fairness-doctrine.