Perspectives from FSF Scholars
June 1, 2018
Vol. 13, No. 21

Spectrum Above 95 GHz: An Opportunity to Implement a Property Rights-Oriented Approach

by

Theodore R. Bolema *

I. Introduction and Summary

The Federal Communications Commission at its February 22, 2018, meeting voted to issue a Notice of Proposed Rulemaking (NPMR) describing the Commission's proposal for opening up new spectrum for private use in the range above 95 GHz and the specific rules it proposes for bands of spectrum in the 95 to 275 GHz range. Public comments have been filed in the proceeding, which remains before the Commission.

Very little of the spectrum above 95 GHz is currently being used, so this is an opportunity to set spectrum policy with less concern about how it affects current use and users of the spectrum. Consequently, there is a unique opportunity for the Commission to apply a more property rights-oriented approach than it traditionally has employed. For once incumbent firms are in place using particular spectrum, it is difficult to modify a spectrum policy. Whatever the Commission decides for these new higher bands of spectrum will have important implications for future technologies and how the spectrum ultimately will be used. And it may also have important implications for how the Commission and the public think about spectrum policy.

As the Commission considers rules regarding this virgin spectrum above 95GHz, to the maximum extent possible, it should place a premium on flexibility and not command and control

policies. In this regard, it should also recognize that addressing interference concerns as purely a technological issue alone is not sufficient. Rather, the trade-off between promoting efficient use of spectrum in order to achieve maximum consumer welfare gains and minimizing interference is primarily an economic issue – that is, how to best allocate scarce resources subject to technological constraints. The NPRM commendably proposes considerable flexibility in some important ways, but in others it appears to continue past policies that rely too much on a regulatory approach that will inevitably lead to less efficient use of spectrum than would otherwise be the case. A better policy would be to rely more on an approach embodying a property rights-orientation that creates incentives for market forces to work by allowing holders of those rights to find the highest-value use for the spectrum.

The spectrum that is the subject of the NPRM would be classified as either "licensed" or "unlicensed." The Commission is proposing to make up to 102.2 GHz of spectrum available for licensed point-to-point use and another 15.2 GHz available for unlicensed use. Licensed spectrum is in defined ranges that can be assigned to a license holder in a defined geographic area for a set time period. Spectrum uses in the licensed bands traditionally tend to require large capital investments, including cell tower networks, broadcast towers for TV and radio stations, and the equipment associated with these technologies. These investments are unlikely to occur without the protection of long-term licenses to spectrum with a strong renewal expectancy.

Other bands of spectrum proposed in the NPRM are considered "unlicensed" because they can be used to transmit signals or to operate wireless devices without specific licensed authorizations. Unlicensed spectrum generally supports lower-power localized uses, which means that the spectrum can be reused far more often. This shared used of the spectrum may lead to interference from other users, although the Commission proposes restrictions on transmission power in these bands to limit interference. Some of the most common uses of unlicensed spectrum are for Wi-Fi, Bluetooth, radio frequency identification (RFID), cordless telephones, automobile and garage door openers, and security alarms.

Having some unlicensed spectrum available has proven beneficial, and I am not suggesting there should be no more of it. But its benefits are largely limited to applications that can function at low power levels to minimize interference. The lack of both market pricing signals and enforceable property rights may mean that insufficient market incentives are available for reaching the most economically efficient balance between spectrum usage and avoiding interference. Moreover, many of the low-powered applications currently using unlicensed spectrum might well be available on licensed spectrum, by virtue of the development market-based organizational mechanisms, if they did not have access to unlicensed spectrum or if too much interference developed on unlicensed spectrum. Thus, the FCC should proceed with caution regarding the opening of new unlicensed spectrum, at least with regard to the amount.

Most of the NPRM addresses rules the Commission is proposing for licensed spectrum above 95 GHz. Licensed spectrum solves many of the problems associated with overuse of unlicensed spectrum by giving license-holders the right to exclude other users. The license-holder then has the incentive to use the spectrum as efficiently as possible, either by using the spectrum itself or charging others who also want to use it but won't pay for overused spectrum with an unacceptable level of interference.

The NPRM proposes to extend previous rules from the 70/80/90 GHz bands, which provide that the licenses would be non-exclusive nationwide licenses, with interference protection provided for the first registered fixed point-to-point link, and with renewals available. It should be noted that the NPRM itself does not authorize auctions of spectrum, which presumably will come later. Thus, the details about how spectrum will be licensed will be clarified when the FCC proposes spectrum auctions. For licensed spectrum, the NPRM claims the Commission intends to provide incentives and opportunities for investment in the development of innovative new technologies and services. It asserts that creating flexible rules in these bands serves the public interest because that will lead to novel communications opportunities while reducing pressures in lower parts of the spectrum. The NPRM also acknowledges that potential services and devices that might be developed in this spectrum are not yet known. Adopting less restrictive rules will encourage greater use of these bands and more innovation because equipment likely will be less expensive, and licensees will have more flexibility in the uses they can make of this spectrum. Thus, the Commission concludes that "it is appropriate to provide for greater flexibility in our rules unless there is good reason to be more restrictive."

The NPRM also concludes that emerging 5G technology, driven by the ever-increasing data appetite of smartphones and other consumer devices, has created demand for more spectrum. Other uses also demand more spectrum, including large constellation non-geostationary satellite orbit networks, weather and air-traffic control radars, automotive safety, and scientific research.

FCC Chairman Pai recently reiterated this focus on the importance of making spectrum available for 5G wireless applications in his speech before the Mobile World Congress:

> Our overall philosophy is founded on a simple but profound premise: The market, not government, is best positioned to drive innovation and investment in the wireless sector. Government's role is not to command and control, but to enable and encourage: to promote competition by maximizing carriers' willingness and ability to invest in their networks, to free up spectrum for wireless services and make it available for flexible use, and to make it easy to deploy the physical infrastructure necessary for networks to work.

In many ways, the NPRM is a step in the right direction. Current and emerging technologies, including 5G wireless, promise tremendous economic benefits, which can be promoted by making more spectrum available. More flexible rules will encourage greater use of these bands and promote spectrum being used in the ways that provide the greatest economic benefits. Opening up spectrum auctions and removing many of the restrictions on how specific bands of spectrum can be used has gone a long way toward allowing a market process to determine the highest-value use of spectrum. These reforms have allowed wireless firms to enter, grow, and use spectrum to build the mobile services market we have today. The net present value of consumer benefits of the 650 MHz of existing flexible-use spectrum, according to a conservative estimate, exceeds $3.5 trillion. Spectrum auctions have also generated billions of dollars in revenues for the U.S. government.

Nobel laureate economist Ronald Coase first proposed that the FCC auction spectrum licenses in 1959. The proposal was not well received at the time, and many policymakers and economists were skeptical of Coase's analytical approach. Coase responded with the article that is still probably the most cited economics article in history, "The Problem of Social Cost."

In "The Problem of Social Cost," Coase challenged the prevailing view of economists that externalities like interference were special cases in economic analysis that required a government response to prevent harm to other parties. Coase turned the prevailing approach on its head when he pointed out that externalities are far from special cases. Externalities are very common and are created by most people every day as they make decisions that have effects, large and small, on other people. But very few externalities are actually addressed by government regulation. In most cases, if the government tries to regulate economic outcomes, the government is not capable of choosing a more beneficial outcome than the parties would reach on their own, and the regulator often would choose a worse outcome.

Of course, there are some situations where the parties run into impediments that prevent them from reaching an agreement. Such impediments may be called "transactions costs," or costs of reaching a bargain. At the same time, even when transaction costs prevent parties from reaching the most efficient outcomes, the economic inefficiency created by uncompensated externalities may be outweighed by the costs of having the government take on a new regulatory role. But even with transaction costs and costs of government intervention, the Coase approach still applies, even though in some rare cases the economic importance of the commerce involved may be sufficient to justify government intervention to overcome transaction costs impediments to reach the most efficient outcomes.

Coase argued that spectrum policy does not require strict government oversight. Instead, when determining the policy that leads to the greatest total benefits from using spectrum, the FCC should find that it is most efficient to rely on market forces. Coase argued that auctioning spectrum both promotes an economically efficient outcome and generates the greatest revenue for the federal government, although both outcomes may be diminished if the FCC imposes overly restrictive or poorly designed rules for the spectrum use.

In his highly readable and wonderfully instructive 2017 book, *The Political Spectrum*, published by Yale University Press, former FCC Chief Economist Thomas Hazlett highlights this from Coase: "It is sometimes implied that the aim of regulation in the radio industry should be to minimize interference. But that would be wrong. The aim should be to maximize output."

When the approach described in the NPRM is examined in detail, it appears to be overly regulatory and falls short of its own description of what the FCC intends to do in two important ways. First, the proposed approach is inconsistent with the claimed emphasis on flexibility in the NPRM, because it stresses regulatory measures to prevent interference that limit the very flexibility the NPRM claims to be seeking to provide, while also undermining property-like rights of license holders. Second, the proposed approach is somewhat at odds with the very purpose the NPRM claims to be pursuing – making more spectrum available for the deployment of fixed and mobile wireless technologies. Instead, the proposal creates a regulatory structure that may unnecessarily limit how efficiently the spectrum can be used, effectively making less of it available for future technologies.

As Coase showed with his example of the cattle herder and the farmer, a regulator simply cannot anticipate in advance how to allow the two adjoining landowners to balance the benefits from using their adjoining properties for the greatest economic gain. In the same way, the Commission cannot use regulation of interference to promote the most efficient use of spectrum.

As Coase explained in 1959, there is nothing particularly unique about spectrum licenses, as opposed to any other property rights, that would fail to lead to efficient market outcomes. The license-holder with strong property rights protections has every incentive to use the spectrum as efficiently as possible. Such property rights in spectrum should have exclusivity rights to the maximum extent possible, should be for long terms, and with a very substantial expectation of renewal. The licensee can then use the spectrum itself or, if someone else can use it more efficiently, it can make a greater profit by charging someone else to use it. As Thomas Hazlett puts it in *The Political Spectrum*, "flexible spectrum rights, exclusively assigned, can and do support a vast array of use models."

The NPRM, with its heavy focus on technological considerations for managing interference, misses the mark. Hazlett declares striving for perfect rules regarding spectrum allocation is a fool's errand:

> [W]hile quarrels over interference are cited as the basis for preferring extensive rulemakings to define spectrum rights upfront, the key to harmony lies not in exactitude but in incentives to cooperate. Regulators have weak motivation to resolve problems efficiently. In their efforts to prevent border disputes, they often separate users into spacious, barren silos. [Pages 312-13.]

Thus, the preferred approach for the NPRM would be to ask how to best design a property rights-like approach for the spectrum, following Coase and Hazlett, that will let the market operate to achieve maximum efficiency and overall consumer welfare.

II. The FCC's Above 95 GHz Notice of Proposed Rulemaking

The Commission is proposing to permit licensed fixed point-to-point operations in 102.2 GHz of spectrum and to authorize an additional 15.2 GHz for unlicensed use. It will also create a new category of experimental licenses for spectrum in the 95 GHz to 3 THz.[1] The NPRM notes that: "Because we presently have no licensed service rules in these bands, and these bands are currently "restricted" under Part 15 rules for unlicensed devices, there is limited Commission-authorized use above 95 GHz, other than for experimental and amateur radio operations."[2]

The NPRM itself does not propose making licensed spectrum above 95 GHz available for commercial use through spectrum auctions at this time. As Chairman Pai noted last month, the FCC is about to initiate NPRMs for other spectrum in high bands, so it seems unlikely that the Commission will turn to auctions for spectrum above 95 GHz until these other auctions go forward.[3] The NPRM describes its approach in terms that appear to emphasize flexibility:

---

[1] Federal Communications Commission, "In the Matter of Spectrum Horizons, Battelle Memorial Institute Petition for Rulemaking to Adopt Fixed Service Rules in the 102-109.5 GHz Band, Request for Waiver of ZenFi Networks, Inc. and Geneva Communications LLC, James Edwin Whedbee Petition for Rulemaking to Allow Unlicensed Operation in the 95-1,000 GHz Band Draft Notice of Proposed Rulemaking" (NPRM), ET Docket No. 18-21, available at https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-24A1.pdf. (visited February 13, 2018).

[2] NPRM, at ¶2, p. 2.

[3] Ajit Pai, "Remarks of FCC Chairman Ajit Pai at the Mobile World Congress," (Speech, Barcelona, Spain, February 26, 2018), available at: https://www.fcc.gov/document/chairman-pai-remarks-mobile-world-congress ("I'm excited to announce today that it is my intention for the United States to hold an auction beginning this November of spectrum in the 28 GHz band, followed immediately thereafter by an auction of spectrum in the 24

> Our proposed approach is intended to provide incentives and opportunities for investment in the development of innovative new technologies and services while remaining cognizant of the flexible international, federal and non-federal allocations, and the already extensive and planned passive uses of these bands. Developing rules in these bands serves the public interest; not only can it lead to new and novel communications opportunities in an uncrowded frequency range, it could also pay dividends by reducing pressures in lower parts of the spectrum. We also recognize that all the potential services and devices that might be developed in this spectrum are not yet known. Thus, while we are proposing a wide range of expanded licensed, unlicensed and experimental use opportunities now, we also leave room to enable future federal and non-federal access opportunities and technologies.[4]

The NPRM later adds:

> Adopting less restrictive rules will encourage greater use of these bands because equipment will likely be less expensive, and licensees will have more flexibility in the uses they can make of this spectrum. We believe it is appropriate to provide for greater flexibility in our rules unless there is good reason to be more restrictive.[5]

The NPRM also describes the Commission's motivation for making additional spectrum available:

> Given the growth in interest in millimeter wave spectrum, we believe it is now appropriate to make spectrum above 95 GHz more readily available for the deployment of fixed and mobile wireless technologies. The active research and development in this area, the interest expressed when we have invited comment on the potential use of bands above 95 GHz, and the submission of petitions and pleadings relating to these frequencies all support our view that the pace of development of technology for spectrum use above 95 GHz shall continue to increase. We want to ensure that we have appropriate authorization mechanisms available so that when new devices that use these frequencies become available, users will be able to begin operations without delay and without foreclosing longer term development in conjunction with the necessary coordination with NTIA, as part of the co-primary allocation of Federal and non-Federal use (citations omitted).
>
> The Commission tentatively concludes that finding new ways to promote the development of bands above 95 GHz will also serve the public interest. The development of 5G technology, which has been driven by the ever-increasing data appetite of smartphones and other consumer devices, has created demand for more spectrum. In addition, numerous large constellation non-geostationary satellite orbit (NGSO) networks have been proposed that will require large swaths of spectrum. The demand for spectrum

---

GHz band. To set the foundation for these auctions, the FCC will ask for public input this spring on the right procedures for these auctions.")

[4] NPRM, at ¶2, pp. 2-3.

[5] NPRM, at ¶32, p. 18.

> also continues for other uses such as weather and air-traffic control radars, automotive safety, scientific research, and defense-related purposes.[6]

Everything so far from the NPRM is laudable. Current and emerging technologies, including 5G wireless, promise tremendous economic benefits, which can be promoted by making more spectrum available.[7] More flexible rules will encourage greater use of these bands and promote spectrum being used in the ways that provide the greatest economic benefits. In many ways, the NPRM is a step in the right direction.

Recent Commission policy opening up spectrum auctions and removing many of the restrictions on how specific bands of spectrum can be used has gone a long way toward allowing a market process to determine the highest-value use of spectrum. These reforms have allowed wireless firms to enter, grow, and use the spectrum to build the mobile services market we have today. "Economists estimate that spectrum reallocated from a restricted use to flexible use generates annual consumer benefits in the same order of magnitude as auction value. The net present value of consumer benefits of that 650 MHz of existing flexible-use spectrum, according to a conservative estimate, exceeds $3.5 trillion."[8] Spectrum auctions have also generated billions of dollars in revenues for the U.S. government.[9]

As Chairman Pai recently stated:

> Our overall philosophy is founded on a simple but profound premise: The market, not government, is best positioned to drive innovation and investment in the wireless sector. Government's role is not to command and control, but to enable and encourage: to promote competition by maximizing carriers' willingness and ability to invest in their networks, to free up spectrum for wireless services and make it available for flexible use, and to make it easy to deploy the physical infrastructure necessary for networks to work.[10]

However, as will be discussed below, when the approach described in the NPRM is examined in detail, it becomes clear that it falls short of its own description of what the FCC intends to do in two important ways. First, the proposed approach is inconsistent with the claimed emphasis in the NPRM on providing flexibility, because it stresses regulatory measures to prevent interference that limit the very flexibility the NPRM claims to be seeking to provide, while also undermining property rights of license holders. Second, the proposed approach is somewhat at odds with the very purpose the NPRM claims to be pursuing – making more spectrum available for the deployment of fixed and mobile wireless technologies. Instead, the proposal creates a

---

[6] NPRM, at ¶¶18-19, pp. 11-12.

[7] *See, e.g.,* Michael J. Horney, "5G Deployment Projected to Create 3 Million Jobs and $500 Billion in GDP," *FSF Blog*, (January 17, 2017) available at: http://freestatefoundation.blogspot.com/2017/01/5g-deployment-projected-to-create-3.html.

[8] Brent Skorup, "The Importance of Spectrum Access to the Future of Innovation," *Mercatus on Policy* (December, 2016), p. 2, available at: https://www.mercatus.org/system/files/skorup-spectrum-access-future-innovation-mop-v2.pdf.

[9] Thomas W. Hazlett, David Porter and Vernon L. Smith, "Radio Spectrum and the Disruptive Clarity of Ronald Coase," *The Journal of Law and Economics*, Vol. 54, No. S4, pp. 140–149 (November 2011), p. S125.

[10] Ajit Pai, "Remarks of FCC Chairman Ajit Pai at the Mobile World Congress," (Speech, Barcelona, Spain, February 26, 2018), available at: https://www.fcc.gov/document/chairman-pai-remarks-mobile-world-congress.

regulatory structure that is certain to unnecessarily limit how efficiently the spectrum can be used, effectively making less of it available for future technologies.

The NPRM proposes to extend previous rules from the 70/80/90 GHz bands, which provide that the licenses would be non-exclusive nationwide licenses, with interference protection provided for the first registered fixed point-to-point link, and with renewals available. Thus, the details about how spectrum will be clarified when the Commission proposes spectrum auctions. Nonetheless, the NPRM declares that licenses in these bands will not be exclusive, and the Commission appears to be relying heavily on FCC regulation to manage interference concerns.[11] As discussed below, this arrangement is similar to the way non-exclusive licenses allow private users access to spectrum in lower bands on a shared basis with government agencies.

A better approach would be to rely more on allowing property rights to function and let market forces work to allow the owners of those rights to find the highest-value use for spectrum. Rather than trying to improve flexibility by adopting a softer version of past regulatory approaches to spectrum policy, the Commission should move away from the approach that seeks to regulate market outcomes, and instead focus on promoting a property rights orientation that creates incentives to use spectrum efficiently.[12] Such an approach is not a new idea – it dates back almost six decades to the seminal work of economist Ronald Coase and his call for auctioning spectrum rights and eliminating unnecessary restrictions.

III. Ronald Coase and the Issue of Spectrum Interference

With the Radio Act of 1927, the United State government claimed ownership to all radio spectrum and the power to license the use of spectrum.[13] The Communications Act of 1934 created the Federal Communications Commission as a regulatory agency and gave it the power to administer spectrum designated for use by private parties and state and local governments.[14] For most of its history, the FCC allocated licenses to use spectrum through administrative "command and control" processes. Usually this meant that the FCC would consider applications from parties seeking to use spectrum, and then the agency would allocate certain bands for particular uses and would assign spectrum licenses to parties within those bands that the FCC decided were the most likely to provide the greatest public benefit. Not until 1994 did the FCC begin to allocate spectrum using an auction process.

Nobel laureate economist Ronald Coase first proposed that the FCC auction spectrum licenses in a 1959 article.[15] The proposal was not well received at the time, and many policymakers and economists were skeptical of Coase's analytical approach.[16] Coase responded with the article

[11] NPRM, at ¶28, p. 15 and ¶31, p. 17.
[12] *See, e.g.*, Seth L. Cooper, "Licensed Spectrum Sharing Lessens Prospects for Wireless Broadband," *Perspectives from Free State Foundations Scholars*, Vol. 8, No. 7, (March 4, 2013), available at: http://www.freestatefoundation.org/images/Licensed_Spectrum_Sharing_Lessens_Prospects_for_Wireless_Broadband_030113.pdf.
[13] Radio Act of 1927, Public Law 632, February 23, 1927 (repealed).
[14] The Communications Act of 1934, Public Law 73-426, June 19, 1934.
[15] Ronald H. Coase, "The Federal Communications Commission," *The Journal of Law and Economics*, Vol. 2, p. 1 (1959).
[16] Daniel L. Lyons, "Toll-Free Assignment Modernization and the Triumph of Coase," *Perspectives from Free State Foundations Scholars*, Vol. 12, No. 31, (September 18, 2017), available at:

that is still probably the most cited economics article in history, "The Problem of Social Cost."[17] In "The Problem of Social Cost," Coase challenged the prevailing view of economists, following the work of the British economist A.C. Pigou, that externalities were special cases in economic analysis that required a government response to prevent inefficient outcomes.[18] Spectrum interference is an example of a negative externality because the party transmitting and the party receiving the transmission using spectrum, in the Pigovian analysis, do not take into account the negative effects of their decisions on third parties who are external to their relationship. Coase turned the Pigovian approach on its head when he pointed out that externalities are far from special cases. Externalities are very common and are created by most people every day as they make decisions that have effects, large and small, on other people. But very few externalities are actually addressed by government regulation or taxation.

Paraphrasing how Coase applied his analysis at the beginning of his article to another negative externality, the three Pigovian solutions to an interference externality would be to have the government (1) make the spectrum users causing the interference liable for the harm they caused to others, (2) impose a tax on the spectrum users with the revenues used to compensate those being harmed, or (3) exclude certain uses of the spectrum to try to minimize the harm. Coase responded, "It is my contention that the suggested courses of action are inappropriate, in that they lead to results which are not necessarily, or even usually, desirable."[19]

Coase gives the example of two offices that shared a wall. In one office, the proprietor uses noisy machinery that disturbs the doctor on the other side of the wall to the point that she cannot effectively serve her patients. Coase pointed out how it is not clear whether the machine operator should be allowed to disrupt the doctor with the noise or whether the doctor should be allowed to disrupt the neighboring business by preventing the noise. But that is not really the issue, as Coase explains. So long as a clear property right is established, the parties on their own can reach the best solution. If the doctor has the right to avoid the noise and the machine operator's business is producing greater economic benefits than the doctor's, the machine operator could use some of his profits to pay the doctor to tolerate the noise or move elsewhere. If the machine operator has the right to make the noise and the doctor's office is more profitable, she could use some of her profits to pay the machine operator to be quiet or move elsewhere. Either way, the parties on their own can reach a bargain that leads to the greatest benefits from the use of the two adjoining properties, regardless of how the initial property rights are assigned.[20]

In another famous example, Coase describes a cattle herder whose land is next to a crop farm. The two properties are not separated by a fence, so the cattle sometimes cross the property line and destroy some of the crops. Coase shows that from these facts alone, it is not possible for a government regulator to determine what the optimal economic outcome is. It may be cost-effective to let the cattle continue to wander, because the damage they do is less than the cost of erecting a fence. Or it may be cost-effective to build the fence. A third possibility is that if the cattle herd is only marginally profitable, the most cost-effective solution may be to sell the cows.

---

http://www.freestatefoundation.org/images/Toll-Free_Assignment_Modernization_and_the_Triumph_of_Coase_091817.pdf.

[17] Ronald H. Coase, "The Problem of Social Cost," *The Journal of Law and Economics*, Vol. 3, p. 1 (1960).

[18] Arthur Cecil Pigou, *The Economics of Welfare,* 4th ed., Macmillan *(*1932).

[19] Coase, "The Problem of Social Cost," pp. 1-2. Coase was describing the negative externality from a factory emitting pollution, but the Pigovian solutions he described apply equally well to spectrum interference.

[20] Coase, "The Problem of Social Cost," pp. 3-6.

In this case, Coase shows that so long as a clear property rights rule is in place (which could be either the cattle herder is liable for damage or else the farmer has no right to compensation for wandering cattle), the two landowners should be able to determine the best solution for themselves, depending on the relative profitability of the two businesses and the cost of the fence. In other words, having the government decide by regulation whether the cattle herder should be allowed to let the cattle wander or whether the crop farmer should be protected from the cattle is not going to improve the economic outcome. If the government tried to regulate this outcome, the government would never choose a more beneficial outcome than the parties would reach on their own, and often would choose a worse outcome.

Of course, there are some situations where the parties run into impediments that prevent them from reaching an agreement. Such impediments may be called "transactions costs," or costs of reaching a bargain. At the same time, there are government costs of imposing regulation. For many externalities, if not most externalities, even if transaction costs prevent parties from reaching the most efficient outcomes, the economic inefficiency created by uncompensated externalities is outweighed by the costs of having the government take on a new regulatory role. But even with transaction costs and costs of government intervention, the Coase approach still applies, and in some cases the Coasian approach may be consistent with government intervention to overcome transaction costs impediments to reaching the most efficient outcomes. As Coase concludes:

> But in choosing between social arrangements within the context of which individual decisions are made, we have to bear in mind that a change in the existing system which will lead to an improvement in some decisions may lead to a worsening of others. Furthermore we have to take into account the costs involved in the operation of the various social arrangements (wither it be the working of a market or of a government department), as well as the costs involved in moving to a new system. In devising and choosing between social arrangements we should have regard for the total effect. That, above all, is the change in approach which I am advocating.[21]

The same approach should apply for spectrum policy. The FCC should adopt the policy that leads to the greatest total benefits from using spectrum, which is likely to be leaving arrangement of rights to the market. As Coase explained in 1959:

> There is no reason why users of radio frequencies should not be in the same position as other businessmen. There would not appear, for example, to be any need to regulate the relations between users of the same frequency. Once the rights of potential users have been determined initially, the rearrangement of rights could be left to the market. The simplest way of doing this would undoubtedly be to dispose of the use of a frequency to the highest bidder, thus leaving the subdivision of the use of the frequency to subsequent market transactions. Nor is it clear that the relations between users of adjacent frequencies will necessarily call for special regulation. . . . It is easy to embrace the idea that the interconnections between the ways in which frequencies are used raise special problems not found elsewhere or, at least, not to the same degree. But this view is not likely to survive the study of a book on the law of torts or on the law of property in which

[21] Coase, "The Problem of Social Cost," p. 44.

> will be found set out the many (and often extraordinary) ways in which one person's actions can affect the use which others can make of their property. [22]

It should be noted that the issue of how to assign property rights is not a trivial matter. Whether the machine operator has the right to make noise operating his machines or whether the doctor next door has the right to be protected from such noise when seeing her patients may not affect the economic outcome of how to best use the adjoining properties to create the greatest value. And whether the cattle herder has to compensate the farmer for the cattle wandering across the property line or whether the farmer can only stop the wandering cattle by compensating the cattle herder does not affect the ultimate outcome for how those adjoining properties are used. But how those property rights are allocated matters a great deal to the machine operator, doctor, cattle herder and farmer, because determining which party has to pay the other party affects their wealth. Moreover, if transactions costs are very high, how the property rights are assigned may well determine the final economic outcome, because the transactions costs may prevent the parties from reaching an agreement that yields an outcome different from the original property rights assignment.

In the case of regulation of spectrum that is being opened up for new use, however, the assignment of property rights has already been determined. The federal government has claimed the property right to the spectrum, and other parties can only gain access by paying to license the spectrum. A large part of the justification for spectrum auctions is that the highest bidder is presumably the party that can use the spectrum to the greatest economic advantage. Thus, auctioning spectrum both promotes an economically efficient outcome and generates the greatest revenue for the federal government, although both outcomes may be diminished if the FCC imposes overly restrictive or poorly designed rules for the spectrum use. If spectrum has already been licensed, however, that leads to many complications if the FCC tries to change the rules and relative property rights after licenses have been issued. Therefore, it is especially important for the Commission to get the policy right before incumbent licensees are established in a band of spectrum.

IV. Licensed vs. Unlicensed Spectrum

The NPRM proposes to open up some bands of spectrum in the 95 to 275 GHz range for licensed spectrum use and other bands for unlicensed spectrum use. The specific requests in the NPRM for which the Commission seek comment are for adopting rules for making up to 102.2 GHz of spectrum in this range available for licensed point-to-point use, and another 15.2 GHz available for unlicensed use.

Spectrum is used for many applications, including radio, broadcast television, mobile phones, GPS devises, aviation communications, and radar. On a more local level, spectrum is used for Wi-Fi, Bluetooth, microwave ovens, garage door openers, baby monitors, and many other applications. Spectrum also has important public safety and military applications. The FCC's Table of Frequency Allocations contains the list of spectrum allocations.[23] Some spectrum,

[22] Coase, "The Federal Communications Commission," p. 30.
[23] FCC, Table of Frequency Allocations 47 CFR §§ 2.104, 2.105, 2.106; FCC, Office of Engineering and Technology, Policy and Rules Division, FCC Allocation History File, available at: https://www.fcc.gov/oet/spectrum/table/FAHF.pdf.

including certain bands in the 95 to 275 GHz range, is reserved for government use, including military and public safety applications, although some of those spectrum bands may allow some private use as the spectrum is shared between government and private users. The spectrum that is made available for private companies' use is classified as either "licensed" or "unlicensed."

Licensed spectrum is in defined ranges that can be assigned exclusively or nonexclusively to a license holder in a defined geographic area for a set time period. The Commission typically includes other restrictions in the license, such as the maximum power level for transmissions, and may restrict the types of uses (*e.g.*, broadcast television, cellular voice, radio) to which the spectrum in that range may be put.

Other bands of spectrum are considered "unlicensed" because they can be used to transmit signals or to operate wireless devises without specific licensed authorizations, subject to certain FCC restrictions. This shared use of the spectrum may lead to interference from other users, although the Commission has imposed restrictions on transmission power in these bands to limit interference. Some of the most common uses of unlicensed spectrum are for cordless telephones, automobile and garage door openers, security alarms, and cordless telephones. Many of these applications using unlicensed technology require standards to encourage compatibility, with standards set by government agencies or by private standard-setting organizations. For example, a growing use of unlicensed spectrum is for radio frequency identification (RFID). RFID requires a small chip that is attached to animals, vehicles, or products.[24] RFID chips allow lost items to be located, products to be tracked in store or hospital inventories, and remote payment of highway tolls.

Unlicensed spectrum is also used extensively for communicating between electronic devises. Wireless Local Area Networks (WLANs), including Wi-Fi (for wireless fidelity), connect unlicensed computers, tablets, mobile phones, MP3 players, and other devises within a limited coverage area. Similarly, Wireless Personal Area Networks (WPANs), including Bluetooth, allow connections of keyboards, headsets, printers, gaming controls, and other computer peripherals, as well as credit card readers and barcode scanners in stores, wireless monitors in hospitals, and electric utility meters.

Spectrum uses in the licensed bands tend to require large capital investments, including cell tower networks, broadcast towers for TV and radio stations, and the equipment associated with these technologies. These investments are unlikely to occur without the protection of long-term licenses to spectrum. Unlicensed spectrum generally supports lower-power localized uses, which means that the spectrum can be reused far more often, making sharing of spectrum less likely to lead to conflicts even without exclusive ownership rights.

As the FCC describes how it views unlicensed spectrum:

> Low-power, non-licensed transmitters are used virtually everywhere. Cordless phones, baby monitors, garage door openers, wireless home security systems, keyless automobile entry systems and hundreds of other types of common electronic equipment rely on such

[24] Thomas W. Hazlett and Michael Honig, "Valuing Spectrum Allocations," *Michigan Telecommunications and Technology Law Review*, Vol. 23, pp. 45-111 (2016), available at: https://repository.law.umich.edu/cgi/viewcontent.cgi?article=1222&context=mttlr.

transmitters to function. At any time of day, most people are within a few meters of consumer products that use low-power, non-licensed transmitters.

Non-licensed transmitters operate on a variety of frequencies. They must share these frequencies with licensed transmitters and are prohibited from causing interference to licensed transmitters.

The Federal Communications Commission (FCC) has rules to limit the potential for harmful interference to licensed transmitters by low-power, non-licensed transmitters. In its regulations, the FCC takes into account that different types of products that incorporate low-power transmitters have different potentials for causing harmful interference. As a result, the FCC's regulations are most restrictive on products that are most likely to cause harmful interference, and less restrictive on those that are least likely to cause interference.[25]

V. The Economic Problems with Unlicensed Spectrum

Unlicensed spectrum is an example of a common resource. Most goods are private goods based on two characteristics. Private goods are excludable, in that the owner can exclude others from using them, and they are also rivalrous in consumption, because if one person is consuming them, others either cannot consume them or the amount others can consume is diminished. Public goods, like public parks, differ in that no one is excluded from using them and one person's use normally does not prevent another person's use. Public goods are often provided by the government, because it is difficult for private markets to get users to pay because of the lack of exclusivity.

Common goods fall in between private goods and public goods. They are non-excludable, like public goods, because it is difficult or costly to prevent users from using them, and they are also rivalrous in consumption because too many users interfere with the use of the good by others. Thus, the economic problem with common goods is that overuse can reduce or destroy the benefits from using the good, but it can be difficult to prevent overuse if exclusion is not possible. This problem in the context of overgrazing by cattle on common land was famously called the "tragedy of the commons."[26] In the case of radio spectrum, the overuse problem is interference from signals sharing the spectrum.

For licensed spectrum, the problem of overuse can be solved by licenses giving the license-holder the right to exclude other users. The license-holder then has the incentive to use the spectrum as efficiently as possible, either by using the spectrum itself or charging others who also want to use it but won't pay for overused spectrum with interference above a certain level. In this way, the tragedy of the commons is solved with licensed spectrum and clear property rights, and at the same time the federal government can raise revenues from the sale of licenses. Given these advantages, it seems reasonable to expect that policymakers should generally favor

[25] Federal Communications Commission, Office of Engineering and Technology, "Understanding the FCC Regulations for Low-Power Non-Licensed Transmitters," OET Bulletin 63 (October, 1993, Edited and reprinted February 1996), available at: http://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet63/oet63rev.pdf.

[26] Garrett Hardin," The Tragedy of the Commons," *Science*, Vol. 162, pp. 1243-1248 (1968).

licensed spectrum and make new spectrum available on an unlicensed basis only if it has a compelling reason for doing so.

Moreover, it is fair to ask whether many of the current applications using unlicensed spectrum actually require unlicensed spectrum, and whether the economic benefits from these uses would be the same or even greater if they were using licensed spectrum. The lack of market signals from unlicensed users who don't have to pay for spectrum access makes it difficult to assess the economic value of these uses, and also whether these uses are consuming too much spectrum.

Economist Thomas Hazlett and engineering professor Michael Honig point out these concerns in their examination of RFID uses. They note that RFID applications must be profitable, because of their rapid recent growth, but point out that it is indeterminate whether they would still be profitable if they had to compensate rival users for spectrum. If not, that would indicate that spectrum is being used wastefully because RFID applications don't have to pay for the spectrum, which is spectrum that could be used more beneficially for other purposes. Moreover, they note that if RFID applications had to pay for spectrum access, the technology might evolve in ways that use less spectrum, which would indicate that any measure of the total current economic benefits of RFID would have to include an offset for inefficient use of spectrum.[27]

Nonetheless, some economists argue for a shift in favor of more unlicensed spectrum, at the expense of licensed spectrum. For example, Paul Milgrom, Jonathan Levin, and Assaf Eilat, in a paper advocating greater reliance on unlicensed spectrum as an alternative to licensed uses, argue:

> An alternative to assigning exclusive rights to particular small bands is to establish rules or regulations governing the utilization of bands as a common pool resource. In the case of radio spectrum, restrictions on transmission power are an example of a regulatory approach. For example, Wi-Fi operates at very low power relative to cellular networks. This has a downside because Wi-Fi signals do not travel as far, but also reduces and in many cases eliminates problems of interference, thereby addressing the potential for congestion. . . .
>
> As the Wi-Fi example suggests, the regulation of unlicensed spectrum can be viewed as a successful example of a managed commons approach. Traditionally, governments have regulated the use of unlicensed spectrum by establishing clear standards as well as pre-approving unlicensed devices. From an economic perspective, this regulatory approach has a number of benefits that allow unlicensed spectrum to be part of a platform for innovation and a source of services that are complementary to those created by licensed spectrum.[28]

The "tragedy of the commons" with common goods is a problem that sometimes can be overcome. Economists, including Nobel laureate Elinor Ostrom, have studied the economics of common goods and have found that alternative mechanisms are often available that do not

[27] Hazlett and Honig (2016), pp. 72-73.
[28] Paul Milgrom, Jonathan Levin and Assaf Eilat, "The Case for Unlicensed Spectrum," (October 12, 2011), pp 13-14, available at: https://web.stanford.edu/~jdlevin/Papers/UnlicensedSpectrum.pdf.

require creating exclusive property rights.[29] Even so, it is a large leap to argue, as Milgrom, Levin, and Eilat do, that the FCC should "expand the quality and quantity of unlicensed spectrum alongside that of licensed spectrum" based on the relatively specific examples that can be found where a managed commons approach appears to be working reasonably well.[30]

Another important point that is often missed is that the choice of the property rights regime and the economic outcomes are intertwined in ways that are difficult to separate. Adding to the complexity, the property rights regimes themselves are often somewhat mixed or distorted by regulatory policies, making conclusions from a particular application under a particular regime difficult to generalize. As Hazlett and Honig explain:

> We do not see radio spectrum allocation as a binary choice between "licensed" and "unlicensed" categories, but rather as a policy competition between different possible rule regimes. For instance, unlicensed spectrum, under rules favoring Wi-Fi, conflicts with unlicensed spectrum under rules favoring vehicle telematics, as seen in an existing U.S. regulatory proceeding concerning 5.9 GHz frequencies. Both competing policies are "unlicensed," but regulators have made, and will make, choices that strongly influence market outcomes. Conversely, liberal licenses are neither "pure" (not all spectrum usage rights are usefully assigned exclusive owners) nor do they uniquely identify efficient business models. Exclusive spectrum rights can be deployed to support mobile communications networks, as currently configured, but also can (and do) support various alternatives. These include service models parallel to those used in unlicensed bands, where spectrum is set-aside for low-power devices coordinated by a radio "type acceptance" regime. In the case of unlicensed, compatible devices and power limits are authorized by regulatory rules; with licensed spectrum, by competing spectrum rights holders (citations omitted). [31]

The Commission appears to be committed to making more unlicensed spectrum available. As Chairman Pai stated in his most recent speech:

> Unlicensed spectrum can pay great dividends in terms of wireless innovation and consumer benefits. That's why many of you are using Wi-Fi as I speak. And that's why the FCC is committed to making more spectrum available for the next generation of unlicensed use.
>
> Last year, we began to explore unlicensed use in the 6 GHz band. We are actively reviewing the public's input. And I'm confident that we will be able to move forward by year's end. We also want to make unlicensed spectrum more usable for all technologies.[32]

Having some bands set aside for unlicensed spectrum has proven beneficial and making more unlicensed spectrum available may well be desirable. For example, NCTA-The Internet & Television Association argues that more unlicensed spectrum will be critical to the Internet of

[29] *See, e.g.*, Elinor Ostrom, *Governing the Commons: The Evolution of Institutions for Collective Action*, Cambridge University Press, 1990.
[30] Milgrom, Levin and Eilat (2011), p. 15.
[31] Hazlett and Honig (2016), p. 49.
[32] Ajit Pai, "Remarks of FCC Chairman Ajit Pai at the Mobile World Congress," (Speech, Barcelona, Spain, February 26, 2018), available at: https://www.fcc.gov/document/chairman-pai-remarks-mobile-world-congress.

Things.[33] But the benefits of unlicensed spectrum are largely limited to applications that can function at low power levels and other regulatory restrictions to minimize interference. The lack of both market pricing signals and enforceable property rights may not allow for sufficient market incentives to reach the most economically efficient balance between spectrum usage and avoiding interference. Moreover, some low-powered applications currently using unlicensed spectrum would likely be available on licensed spectrum if they did not have access to unlicensed spectrum or if too much interference developed on unlicensed spectrum.

Mercatus Center Senior Fellow Brent Skorup made the same point about the lack of economic incentives to use unlicensed spectrum efficiently. He calls on the Commission to "bring some economic rigor" to its determinations of how much unlicensed spectrum to allocate. Skorup adds:

> Congress and the FCC need to proceed much more carefully before allocating more unlicensed spectrum. The FCC's 2008 decision, for instance, to allow unlicensed devices in the "TV white spaces" has been disappointing. As some economists recently noted, "[s]imply stated, the FCC's TV white space policy to date has been a flop." Unlicensed spectrum policy is also generating costly fights (see WiFi v. LTE-U, Bluetooth v. TLPS, Lightsquared v. GPS) as device makers and carriers lobby about who gains regulatory protection and how to divide this valuable resource that the FCC parcels out for free (citations omitted).[34]

It may well be appropriate to allocate much more to licensed spectrum (102.2 GHz) and less to unlicensed (15.2 GHz) uses. Nothing herein is intended to say that the FCC should not allocate more spectrum to unlicensed use. But given the potential for a tragedy of the commons problem with unlicensed spectrum and the lack of market signals available to assess how efficiently such spectrum is being used, the economic case for increasing the amount of unlicensed spectrum is difficult to assess, and it would seem to be an issue that merits more study by the Commission.

VI. The NPRM's Approach for Licensed Spectrum is Overly Regulatory

The FCC for two decades has been moving in the direction of increasing flexibility in the use of both licensed and unlicensed spectrum. As Hazlett and Honig describe the movement:

> In recent decades, however, regulators have specified less, relying on market forces more. This is achieved, in the one instance, by issuing licenses that define spectrum spaces, but then delegating to licensees the freedom to determine how such spaces are used. These liberal authorizations, often analogized to de facto property rights in spectrum, are widely used to host mobile voice and data networks via wireless wide area networks (WWANs). In another instance, deregulation of certain unlicensed bands has granted greater flexibility to device vendors and radio users, leaving service models unspecified and allowing considerable scope for innovation. Coordination is achieved via power limits

[33] Comments of the NCTA – The Internet & Television Association," "The Benefits, Challenges, and Potential Roles for the Government in Fostering the Advancement of the Internet of Things," U.S. Department of Commerce Docket No. 170105023-7023-01 (March 12, 2017), available at: https://www.ntia.doc.gov/files/ntia/publications/031317_ncta_iot_green_paper_comments.pdf.

[34] Brent Skorup, "Thoughts on 'Demand' for Unlicensed Spectrum," The Technology Liberation (January 23, 2017), available at: https://techliberation.com/2017/01/23/thoughts-on-demand-for-unlicensed-spectrum/.

> and (comparatively limited) technical specifications imposed by regulators, as well as industry standards nested within the FCC rules.[35]

Despite the statements described above from the NPRM claiming the proposed approach will stress flexibility in order to promote the benefits of greater spectrum usage, the NPRM sets forth a regulatory proposal for licenses spectrum that still relies too much on a regulatory approach. The NPRM contains a section at paragraphs 21-26 on the technical interference considerations for the spectrum above 95 GHz.[36] That discussion of technical concerns is followed by a section from paragraphs 27-30 laying out the proposal for licensed spectrum.[37] Notably absent in these sections is any discussion of the economic tradeoff between spectrum usage and interference. The NPRM asserts: "The Commission also believes that the 70/80/90 GHz rules in place since 2003, which have proven effective in efficiently providing access to spectrum in that frequency range, provide a useful model for the rules contemplated here."[38] Thus, the claims in the NPRM that the Commission is emphasizing flexibility are based on a comparison to a policy regime that existed before 2003, and the proposed approach is not significantly different from what has been in place for at least 15 years.

The NPRM follows this discussion of interference as a technological issue with an overview of how it proposes to regulate the bands of licensed spectrum for interference. While the specific details that follow are not the focus of this paper's analysis, the key point from this summary from the NPRM is that this is very much a regulatory approach to dealing with interference:

> We seek comment on draft rules for the proposed fixed bands, which would be mostly identical to the rules for 70/80/90 GHz band contained in Part 101. Briefly summarizing, both sets of rules provide that:
>
> • The Commission will issue non-exclusive nationwide licenses for ten-year terms.
>
> • Each fixed point-to-point link must be registered through a link registration system maintained by a database manager. An interference analysis for the link must be submitted to the database manager when registering the link.
>
> • The licensee must apply to the Commission for coordination of a link if: 1) the link receives a "yellow light" from NTIA's automated mechanism as part of the registration process; 2) it requires an environmental assessment; 3) it requires international coordination; or 4) it operates in a quiet zone. . .
>
> • An applicant may request a license for any portion of any band.
>
> • Interference protection is granted to the first-in-time registered non-federal link. Existing digital links are protected to a threshold-to-interference ratio (T/I) level of 1.0 dB of degradation to the static threshold. Existing analog links shall not experience more than a 1.0 dB degradation of the baseband signal-to-noise ratio required to produce an acceptable signal in the receiver.

[35] Hazlett and Honig (2016), p. 47.
[36] NPRM, at ¶¶21-26, pp. 12-15.
[37] NPRM, at ¶¶27-30, pp. 15-17.
[38] NPRM, at ¶¶27-30, pp. 15-17.

• Construction of links must be completed within 12 months of link registration.

• Transmitters may operate at a maximum Equivalent Isotropically Radiated Power (EIRP) of 25 decibel watts per megahertz (dBW/MHz).

• Transmitters must have a minimum antenna gain of 43 decibels (isotropic) (dBi) with a halfpower beamwidth of 1.2 degrees, but the maximum EIRP is reduced by 2 decibels for each decibel the antenna gain is less than 50 dBi.

• Out-of-band emissions are limited as specified in Section 101.111 of our rules for signals above 24 GHz with the value of B (bandwidth) set for 500 megahertz.

• Systems using digital modulation must have a minimum bit rate of 0.125 bits/second/Hz.[39]

The NPRM proposes to extend previous rules from the 70/80/90 GHz bands, which provide that the licenses would be non-exclusive nationwide licenses, with interference protection provided for the first registered fixed point-to-point link, and with renewals available. Thus, the proposed protections are not exclusive licenses, and appear to rely on FCC regulation rather than the market incentives of property rights holders, to manage interference concerns.[40]

The NPRM then asks a long series of questions mostly about technical regulatory details. The following three paragraphs contain a large share of these technical questions, although other such questions can be found elsewhere in the NPRM. Again, the details that follow are unimportant and are not the focus of the analysis in this paper. Instead, the takeaway point from this long string of questions should be that even though the NPRM occasionally mentions the tradeoff between interference and flexible use of spectrum, the Commission is proposing to regulate interference outcomes rather than rely on property rights and market incentives:

> We seek comment generally on extending the 70/80/90 GHz service and technical rules to the proposed fixed bands. Should any of the proposed rules be modified for bands above 95 GHz based on licensees' experiences with the 70/80/90 GHz rules or for other reasons? Are modifications to the rules needed to encourage more efficient use of spectrum or to avoid harmful interference? Should a higher EIRP be permitted to compensate for the atmospheric attenuation at these higher frequencies? We note that Battelle has suggested an EIRP of 70 dBW in their rulemaking petition, which would be 31.25 dBW/MHz if spread evenly across the 102-109.5 GHz band, claiming that the 70/80/90 GHz bands suffers from limited range and operating availability during severe weather and that there will be additional atmospheric attenuation in the 102-109.5 GHz band. Should we segment any of the proposed bands as the Commission did for the 90 GHz band? What segmentation would be appropriate? Would a specific channel plan be appropriate in any of the bands? Do the rules provide a workable framework for protecting radio astronomy facilities and federal operations in the band? Are there any modifications to the proposed rules that would be necessary to address any of the characteristics of the proposed fixed bands?

[39] NPRM, at ¶31, pp. 17-18.
[40] NPRM, at ¶28, p. 15 and at ¶31, p. 17.

> Do the antenna gain requirements for the 70/80/90 GHz bands strike an appropriate balance between facilitating sharing of the spectrum and providing flexibility? We note that the Fixed Wireless Communications Coalition has requested that the Commission relax the antenna gain standards for the 70/80 GHz band to enable the use of small planar antennas. We further note that phased array antennas have been used in microwave frequency devices to provide directionality while keeping the size of the antennas small. Do the proposed rules need to be modified to allow for the use of small planar or phased array antennas?
>
> Should we make provisions in the rules for fixed point-to-multipoint systems in addition to point-to-point links? For example, could we allow licensees to register operations in an area around a fixed location instead of requiring registration of individual links as required by the 70/80/90 GHz rules? This would enable a licensee to establish an access point/base station that serves a number of fixed customer locations in the surrounding area. The access point/base station would be permitted to operate with multiple beams where each beam must abide by the power limits we are adopting, but the sum of the power of all the beams could be higher. What are the advantages or disadvantages of such a proposal? We envision that the area served by an access/point base station would be small. What size area could an access point/base station serve given the propagation properties of these bands? Would allowing such point-to-multipoint systems require a higher degree of coordination with other licensees or Federal operations to prevent harmful interference from occurring? Should the area that is reserved around a particular access point/base station depend on the technical parameters of the access point such as its transmit power and antenna height and characteristics of the surrounding environment such as terrain and structures? Because the access point/base station may use dynamically steerable antenna arrays to point at particular customer locations as needed, would it make sense to allow licensees to specify their coverage areas as a probability density function that describes the relative likelihood of pointing in a particular direction? By specifying coverage areas in terms of probably density functions, the coverage areas of different licensees could overlap to allow a means of sharing the spectrum on a statistical basis. Do commenters agree with this assessment (citations omitted)?[41]

These questions from the NPRM are nearly all about how much interference should be tolerated as an outcome from spectrum usage. In his highly readable and wonderfully instructive 2017 book, *The Political Spectrum*, former FCC Chief Economist Thomas Hazlett highlights this from Coase: "It is sometimes implied that the aim of regulation in the radio industry should be to minimize interference. But that would be wrong. The aim should be to maximize output."[42]

As the NPRM shows, the FCC still evaluates interference primarily as a technological problem created by users of the licensed spectrum that needs FCC regulation. As such, the NPRM does not go far enough in removing regulatory barriers and allowing markets and property rights to operate. Hazlett explains why such an approach inevitably will lead to underutilization of spectrum in favor of excessive measures to prevent interference:

[41] NPRM, at ¶¶35-37, pp. 21-22.
[42] Thomas Hazlett, *The Political Spectrum*, Yale University Press (2017), p. 313.

> Interference is an integral part of wireless communications – if you're doing things right – because it implies that at least some airwaves are being well utilized. A regulatory system that seeks to assure interference never occurs is doomed to underutilization, even if rent seeking did not so reliably turn "technical reasons" into anticompetitive barriers. Rather than implement new government rules to police interference in more ambitious ways, the pro-consumer policy reform is to release more bandwidth – through auctions, grandfathering, and liberalization enabling all uses and technologies – to more owners.[43]

The questions from the NPRM are not the right questions for the Commission to be asking. Instead, the NPRM should be asking how to best design and protect property rights in spectrum licenses, and then let the market operate. As Thomas Hazlett puts it in *The Political Spectrum*, "flexible spectrum rights, exclusively assigned, can and do support a vast array of use models."[44] As Hazlett further explains:

> But trade-offs between the cost of "harmful interference" in one application and the benefits of additional activities in another should be perceived as economic values, not engineering parameters. Regulators responding to political incentives reliably impose rigid use restrictions that prevent efficient utilization of bandwidth. A liberal property regime, conversely, enables economic solutions, squeezing far more value from the myriad wireless alternatives.[45]

Moreover, the NPRM proposes that spectrum in these bands be licensed non-exclusively, which is a weaker property right and one that requires the FCC to be more active in policing interference. As the FCC notes on its website, it is authorized to make spectrum available on an exclusive basis.[46] The same FCC webpage notes that: "The FCC has taken significant steps to remove regulatory barriers and facilitate the development of secondary markets for spectrum usage rights."[47] A well-established secondary market already allows access to licensed spectrum without being a license-holder. An exclusive license-holder would have the incentive to avoid excessive interference, because too much interference harms the license-holders' own use of the spectrum as well as the revenues the licensee can obtain from other users in the secondary market. If interference starts to become a problem, the license-holder has every incentive to find cost-effective solutions so that it can continue to profit from its own use of the spectrum or from charging others to use it. Thus, the Commission has the opportunity to better promote a property rights-oriented system by making licenses in the bands above 95GHz exclusive.

The inefficiency of making licenses non-exclusive in bands shared with government users can be seen from experience in other spectrum bands. As Free State Foundation Senior Fellow Seth Cooper explained in 2013:

---

[43] Thomas W. Hazlett, "Optimal Abolition of FCC Spectrum Allocation," *Journal of Economic Perspectives*, Vol 22, No. 1 (Winter, 2008), pp. 103-128, at 119.
[44] Thomas Hazlett, *The Political Spectrum*, Yale University Press (2017), pp. 315-316.
[45] Thomas W. Hazlett, "Optimal Abolition of FCC Spectrum Allocation, at 124-125.
[46] Federal Communications Commission, "Accessing Spectrum," (accessed March 2, 2018), available at: https://www.fcc.gov/general/accessing-spectrum ("Licensed spectrum allows for exclusive, and in some cases non-exclusive, use of particular frequencies or channels in particular locations. Some licensed frequency bands were made available on a site-by-site basis, meaning that licensees have exclusive use of the specified spectrum bands in a particular point location with a radius around that location.").
[47] *Id.*

> Recent experience demonstrates how requirements to share licensed spectrum can reduce its value and reduce the incentive to invest. The 700 MHz band D-Block auction bid winner would have been required to build a wireless network that included interoperable IP network functionality for public safety agencies. This requirement's negative impact on the value of the D-Block is revealed by the unwillingness of any bidder to make an offer when it was auctioned in 2008. Also instructive is the fact that the FCC's 700 MHz C-Block "open access" auction rules included restrictions on the use of the auctioned spectrum licenses. A 2010 paper by economists Gerald Faulhaber and David Farber concluded those encumbrances "decreased the value of the spectrum asset by 60%...reduc[ing] the affected telecommunication asset and thus reduc[ing] the incentive to invest in such assets."[48]

Hazlett declares striving for perfect rules regarding spectrum allocation is a fool's errand:

> [W]hile quarrels over interference are cited as the basis for preferring extensive rulemakings to define spectrum rights upfront, the key to harmony lies not in exactitude but in incentives to cooperate. Regulators have weak motivation to resolve problems efficiently. In their efforts to prevent border disputes, they often separate users into spacious, barren silos.[49]

A property rights-oriented system for spectrum use would be further enhanced if these licenses were exclusive, rather than shared with government users. As long as the secondary market remains reasonably competitive, those who want access will have a choice among the competitive options. By opening up more spectrum, the Commission can make this market even more competitive, which is all the more reason for the Commission to embrace a Coasian property rights approach over more traditional regulation.

Conclusion

The Commission has made important strides toward relying on the market rather than the government to drive innovation and investment, particularly in freeing up spectrum and making it more readily available for flexible use. While the approach the FCC proposes in the NPRM commendably provides considerable flexibility in how this largely virgin spectrum can be used, it nevertheless still puts too much emphasis on using regulation to prevent interference. Inevitably, regulatory attempts to minimize interference will unnecessarily minimize efficient use of spectrum. As Coase showed with the cattle herder and the farmer, a regulator simply cannot anticipate in advance how to allow the two adjoining landowners to balance the benefits from using their adjoining properties for the greatest economic gain. In the same way, the Commission cannot use regulation of interference to promote the most efficient use of spectrum.

---

[48] Seth L. Cooper, "Licensed Spectrum Sharing Lessens Prospects for Wireless Broadband," *Perspectives from Free State Foundations Scholars*, Vol. 8, No. 7, (March 4, 2013), available at: http://www.freestatefoundation.org/images/Licensed_Spectrum_Sharing_Lessens_Prospects_for_Wireless_Broadband_030113.pdf, citing Gerald R. Faulhaber and David J. Farber, "The Open Internet: A Customer-Centric Framework, *International Journal of Communication*, Vol. 4 (2010), pp. 302-342, available at: http://ijoc.org/index.php/ijoc/article/viewFile/727/411.

[49] Thomas Hazlett, *The Political Spectrum*, Yale University Press (2017), pp. 312-313.

As Coase explained in 1959, there is nothing particularly unique about spectrum licenses, as opposed to any other property rights, that would fail to lead to efficient market outcomes. The license-holder with strong property rights protections has every incentive to use the spectrum as efficiently as possible. The licensee can then use the spectrum itself or, if someone else can use it more efficiently, it can make a greater profit by charging someone else to use it.

The NPRM tilts too heavily towards asking too many questions about how to manage interference in spectrum bands above 95 GHz as it opens this new virgin spectrum for private use. It also misses out on an opportunity to make at least some of the spectrum in licensed spectrum available on an exclusive basis. Instead, the NPRM should be focusing more on how best to design an approach that embodies a property rights-orientation and then let the market operate to maximize efficient use for the spectrum in a way that maximizes consumer welfare.

* Theodore R. Bolema is a Senior Fellow of the Free State Foundation, an independent, nonpartisan free market-oriented think tank located in Rockville, Maryland.