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Unlocking Spectrum Value through Improved Allocation, Assignment, and Adjudication of Spectrum Rights

Wireless devices—providing services from mobile communications to TV to air traffic control—use electromagnetic signals in the radio frequency range. This range is also known as the radio (or wireless) spectrum. Limits on the ability of multiple radio systems to operate near each other in time, place, and frequency constrain the number of services that can use the same spectrum band at the same time and place. This presents policy challenges for how to efficiently allocate spectrum access.

Until recently, expanding demand for wireless service could be accommodated by providing access to frequency ranges (also known as spectrum bands) previously held by governmental or private users who could relocate to other bands. With few remaining opportunities for relocation, today's great policy challenge is to maximize the value of wireless technology by facilitating more-intensive spectrum use through market transactions.

The National Telecommunications and Information Administration (NTIA), which oversees spectrum used by the federal government, and the Federal Communications Commission (FCC), which oversees the rest of the wireless spectrum, have yet to identify more-efficient strategies for overseeing spectrum. In particular, regulators have been unsuccessful in efficiently managing “interference”—wireless transmissions degrading the quality of other wireless services—and in adjudicating spectrum disputes. With demand growth for wireless services showing no signs of slowing down, reevaluating the legacy spectrum policy framework is both advisable and inevitable.

An important spectrum policy frontier remains largely unexplored: how to design a system of spectrum operating rights and dispute adjudication that permits more-efficient spectrum use and more-rapid innovation. Unfortunately, today's regulatory regime makes it difficult for spectrum players to reach mutually agreeable, efficiency-enhancing arrangements through direct negotiation. Moreover, the existing regime also fails to provide a means for disputes to be adjudicated quickly and without extensive lobbying of regulators and lawmakers.

In a new Hamilton Project discussion paper, J. Pierre de Vries of the Silicon Flatirons Center and Philip J. Weiser of the University of Colorado Law School argue that the FCC and NTIA should take bold steps to unlock greater spectrum value by implementing a set of reforms designed to better delineate, decentralize, and enforce rights in wireless spectrum. This policy framework would help demand for wireless services to be met more efficiently, and would facilitate innovation in this dynamic and important sector of our economy.

The Challenge

The current system of wireless spectrum regulation is failing along four distinct lines.

First, government regulators have not defined the rights and responsibilities of spectrum access clearly enough to facilitate bargaining between neighboring users in increasingly crowded spectrum neighborhoods. As with neighboring property owners, one user's right to be unharmed has to be balanced by its responsibility to protect itself from harm.

As explained by Nobel laureate Ronald Coase, all harm is reciprocal: reducing disturbance imposes costs on the disturber. For example, the greater an operator's allowed transmit power, the better its service can be. But the transmitted power can create interference for a neighbor seeking to operate in the presence of that signal. In economic terms, radio interference is a negative externality (i.e., a cost that affects a party that did not choose to incur that cost). To mitigate unwanted interference, the two ready options are for transmitters to reduce their power, or for receivers to use more-selective filters that block out signals in the neighboring band.

As in the case of other types of property, the initial rights to use spectrum must be defined, even if those rights are subsequently altered by contract. The authors note that, at present, the FCC defines the relevant entitlement for nonfederal users through detailed limitations on transmit power, out-of-band and out-of-area emissions, antenna requirements, and more. In most cases, it also places limits on the services an operator can offer (e.g., broadcast TV) and the technology it can use (e.g., the Advanced Television Systems Committee [ATSC] broadcast standard). This cumbersome and detailed regulatory system more closely resembles a command-and-control regime than it does a market-based system. Furthermore, the legacy regulatory regime requires that any modification to defined property rights receive regulatory approval, which is a process that involves excessive costs and painful delays.

Second, today's spectrum policy generally focuses on transmitters and fails to address the important role of receivers. Historically, regulators have preferred to space services out in frequency to avoid interference. Such a regulatory approach makes economic sense only when the value of access to swaths of spectrum is low relative to the cost of investing in higher-quality receiver technology. Although the more economically efficient approach for today's world is to improve outdated and inferior receiver technology, many operators who have long used particular spectrum bands have little to no incentive to upgrade their equipment, because their neighbors would capture the benefit and there is no means for those neighbors to pay them for that benefit.

There are numerous examples of poor receiver performance precluding or delaying the introduction of valuable new services. Consider the case of the FCC's low-power FM initiative, which involved an effort to grant new licenses to low-power stations to broadcast locally in underused parts of the spectrum within the FM radio band. Incumbent broadcasters suggested that the relevant standard for judging interference was whether a single listener, owning the lowest-quality receiver on the market, faced

any interference. The broadcasters' position ultimately prevailed, benefiting low-quality equipment at the expense of the more-dynamic and more-intensive use of the spectrum.

Third, band fragmentation is a problem. For a variety of reasons, many wireless spectrum bands are fragmented; in other words, many different kinds of wireless service are allowed in a band, and/or a large number of operators share control of the band. This fragmentation makes effective bargaining difficult, within the band and especially with neighbors, particularly if no structure for coordinating among them exists.

A core lesson from Coase is that law and policy should define property rights to enable efficient bargaining. Applied to spectrum policy, Coase's teaching would call for enabling negotiations between thousands of licensees—and multiple uses—within each band. Consider the conflict between cellular operators like Nextel and land mobile radio (LMR) systems in the 800 megahertz (MHz) band. Not only were LMR assignments given to various commercial and governmental radio users, but the licensees were also small municipal police and fire service providers, as well as local commercial operators. Consequently, when interference issues between Nextel's cellular service and individual public safety LMR services arose, the FCC was forced to get involved and develop a nationwide process to resolve the matter. The fragmentation resulted in a challenging, time-consuming, and costly process.

Fourth, today's adjudication process for resolving spectrum interference conflicts is weak and inefficient. As described by the authors, regulators are unable to resolve conflicts effectively when they occur. The NTIA does not devote many resources to conflict resolution and the FCC currently has little to no ability to resolve conflicts, as its adjudication process is unpredictable and ad hoc. In most cases, the FCC resorts to the delay and politics of notice-and-comment rule making when adjudication would have been more appropriate and efficient.

The costs of insufficient adjudication are highest at spectrum boundaries with greater numbers of operators or more-diverse technologies, or where an incumbent operator is sharing access to spectrum with another provider. In these cases, the likelihood of disputes emerging—and not being resolved easily—is great. By contrast, disputes are rarer in situations where relevant parties are few, well known to one another, and share associated technologies—such as in the cellular industry. The cellular case is the exception that proves the rule: the often-large license areas and repeated interactions in many settings by nationwide operators create considerable incentives for cooperative behavior.

A New Approach

A framework is needed that enables more sophisticated—and more efficient—means of sharing spectrum use between different parties. To advance this goal, the authors describe three pillars of a new policy and regulatory framework that would better define the rights of spectrum licensees, create a mechanism for resolving the problems that stem from fragmentation, and establish an adjudication venue that provides a setting for peer-to-peer dispute resolution.

Pillar 1. Define Harm Claim Thresholds

Removing all ambiguity from rights to use spectrum is neither possible nor desirable. Without creating unnecessary regulatory complexity, however, the government could provide greater clarity through the establishment of a "harm claim threshold" system. The authors propose that radio systems should be expected to tolerate an explicitly stated degree of interference. This would create the incentive for operators to either adjust their systems to better tolerate interference, for example by upgrading receivers, or to bargain with their neighbors to manage the consequence of not upgrading. This model allows a spectrum operator to compensate a consenting spectrum neighbor for interference above the threshold—in this case, the affected neighbor could negotiate compensation for having its service degraded by strong signal transmission—or for an affected neighbor that does not wish to use interference tolerant receivers to pay for a reduction in signals that are already below the threshold.

This framework applies equally well to government or private operators. If the federal government defined harm claim thresholds for its assignments—and if federal agencies and departments were allowed to negotiate commercial arrangements—government users could receive funds for agreeing to modified interference thresholds that allow more-intensive coexistence in bands shared between federal and nonfederal users.

A harm claim threshold spells out precisely how much interference a spectrum operator must be able to tolerate before it can bring a harmful interference claim against a neighbor. Until the party causing the interference exceeds the threshold for more than a specified number of times and places in a specified area, then dealing with the interfering signal and its consequences is the responsibility of the party experiencing rather than causing the interference.

A key strength of this approach is that it decentralizes technical decisions on how to manage interference. Private entities would be allowed to determine for themselves whether and how to build receivers that can tolerate such interference, or even to determine that they will choose to ignore these limits and accept reduced performance. Conversely, an operator could use payments from a neighbor to upgrade to high-performance receivers that tolerate high levels of adjacent band noise. In the wake of any adjustments, the FCC would function as a recorder of how parties are operating, putting other parties on notice of the relevant changes, rather than dictating how parties are permitted to operate. In cases where agreements cannot be reached, the injured party would have the right to bring action against the purported interfering party. Thus, harm claim thresholds facilitate bargaining to reach the most economically efficient arrangement.

The model De Vries and Weiser describe is not one size fits all. Different bands will have different harm claim thresholds. For example, if the existing receivers in an allocation are very susceptible to degradation from interfering signals, the harm claim threshold can be set very low to protect them. Conversely, if there is already strong signal operation in the adjacent band, the harm claim threshold could be set higher to ensure that the incumbent can continue operating.

Pillar 2. Introduce Band Agents for Fragmented Bands

To address the high level of fragmentation in many spectrum bands, the authors propose that the FCC and NTIA facilitate the establishment of “band agents” that can represent, and even bind, large collections of fragmented licensees. These situations require one or more trusted intermediaries that can act on behalf of a range of users. The authors propose that bands where such agents can enable more-effective coordination should have at least one, or at most a few, band agent(s) to facilitate negotiations across block boundaries.

Band agents can be thought of as band managers or frequency coordinators with additional powers. In spectrum regulation, the concept of band managers is well established: band managers are responsible entities that manage interference between operators in a band. Frequency coordinators, by contrast, facilitate the establishment of operating assignments that minimize in-band interference, and play the role of a facilitator without having any formal authority. Building on these two models, band agents would possess the ability to negotiate adjustments to operating rules in a given band—including the ability to make or accept payments as well as oblige the operators they represent to conform to these adjustments.

The band agent model could be implemented in several possible ways. One option is for licensees to appoint the band agent in the same way that shareholders appoint managers to act on their behalf. A second option is to build on existing institutions, such as frequency coordinators. At present, because frequency coordinators do not hold licenses, their rights would need to be augmented to enable them to negotiate effectively.

The NTIA could act as a band agent for federal government spectrum operation. Although the NTIA is the nominal band manager for government spectrum, in practice it operates more like a frequency coordinator because the agency cannot control federal departments and agencies, especially powerful ones like the Department of Defense and the Federal Aviation Administration. Given the extent to which spectrum is shared between federal and nonfederal users, it makes sense to assign band agent powers to the NTIA or, where appropriate, to give departments and agencies the additional powers necessary to negotiate commercial agreements as band agents in their own right.

Band agent rights could also be assigned by auction, which is what happens currently in the case of exclusively assigned flexible use rights, such as cellular system licenses. Such an approach could even work in unlicensed allocations, with a regulator using an auction to select a small number of band stewards, any of whom would be able to authorize the sale of unlicensed equipment. For the stewards to function efficiently as band agents, however, they would have to be empowered to compensate affected parties—for example, by exacting fees from unlicensed users in return for a right to operate at higher transmit power levels.

De Vries and Weiser recognize that there are challenges to the successful operation of a band agent regime. When a band agent arranges for transfer payments to compensate the losers in a

Roadmap

- The FCC and NTIA incorporate a statement in a wireless service’s rules that defines the signal levels the service needs to tolerate before it can make a harmful interference claim against an offending party. This harm claim threshold spells out precisely when the offending neighbor on the spectrum becomes liable.
- To address the level of fragmentation among spectrum rights holders, the FCC facilitates the establishment of band agents that can act on behalf of a range of rights holders. There can be more than one band agent in a frequency band. In the 800 MHz LMR bands, for example, there might be agents representing the petroleum, electrical utility, railroad, fire alarm, and forestry industries.
- The federal government develops an effective adjudication regime by appointing expert judges in the FCC Enforcement Bureau and referring interference disputes to them for resolution. Even with the FCC acting as an expert adjudicator, Congress also establishes a Court of Spectrum Claims to hear such cases, particularly disputes between federal and nonfederal parties.

negotiation, for instance, there will likely be some dissatisfaction. Having more than one band agent in a given band may offer principals the opportunity to shop for representation. A second difficulty occurs when the gain negotiated by the band agent is very large, encouraging licensees to engage in inefficient behaviors to gain a greater share of the rewards. Finally, there are the perennial challenges of principal–agent conflicts between the band licensee principals and the band agent.

Pillar 3. Reform Spectrum Adjudications

An efficient, decentralized spectrum management system needs to be supported by an effective adjudication regime. The authors explain that such a regime needs to move adjudication from the current ad hoc, politically charged, and notice-and-comment driven process, to a more fact-based process.

De Vries and Weiser’s proposal is two-fold. First, they propose that the FCC employ either administrative law judges or administrative judges to develop factual findings in spectrum disputes. The resolution of spectrum disputes is very likely to turn on specialized knowledge of how wireless services operate. For the FCC to develop a specialized adjudication function, it would first need to build a capacity it does not have.

Second, even with the FCC acting as an expert adjudicator, the authors propose that Congress should also establish a Court of Spectrum Claims that could hear cases in this field. This court could be housed within the existing Court of Claims and consist of specialized decision makers in the spectrum field. Establishing

Learn More about This Proposal

This policy brief is based on The Hamilton Project discussion paper, “Unlocking Spectrum Value through Improved Allocation, Assignment, and Adjudication of Spectrum Rights,” which was authored by:

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a new expert body, or even a rebooted adjudication apparatus in the FCC, will be an expensive and challenging proposition. But given the importance of increasing the efficiency of spectrum use, the authors believe these proposals will be well worth the investment.

Costs and Benefits

The principal benefit of this proposed framework to unlock spectrum value is its ability to enable more-dynamic and more-intensive radio use. This will benefit consumers and producers through lower costs and faster improvements in wireless services. The U.S. Treasury would benefit from increased tax revenue. Any new regulatory regime also has costs, however. There are both the opportunity costs of distraction and delay in implementing new ideas, and the direct costs of developing the new institutions, skills, and technology entailed by a new framework.

Harm claim thresholds will facilitate the more-intensive use of the spectrum by increasing certainty and reducing the cost of negotiation. The benefit of harm claim thresholds will depend on the number of bands where they are applied and the degree to which the new regime results in more-efficient radio coexistence (such as the efficiency gains that would be generated by improved receiver performance). The authors conservatively assume that the adoption of the threshold could result in an additional 600 MHz of spectrum being intensively used.

The band agent proposal would reduce the fragmentation of control and coordination that leads to economic inefficiencies. The authors estimate that about 40 percent of the 400–3700 MHz frequency range could be considered fragmented, and that at least 400 MHz would benefit from the introduction of band agents.

The value of these bands in their current state is not known and it is unlikely that the full value of commercial mobile broadband use would be realized through effective band agent negotiation. Assuming these proposals would increase consumer surplus,

the authors conservatively assume an increase for the harm claim threshold proposal equal to 2 percent of the baseline per megahertz value of mobile wireless service, and 5 percent of the baseline value from implementing the band agent proposal. Using a \$300 million per megahertz per year consumer surplus for mobile wireless as the baseline, their rough estimates indicate these reforms could yield a potential social value of \$9.6 billion per year.

Of course, implementing this framework is a major undertaking that is not without costs. The harm claim threshold proposal is new and will need to be tested and refined over time; there are also the costs to industry of retraining staff and acquiring measurement equipment that could approach \$50 million annually. The band agent regime carries the cost of creating new institutions since the agents represent a new layer of management. Since band agents will be introduced to remedy severe problems in fragmented bands that block the successful conclusion of socially beneficial negotiation, however, the authors expect the net result to be positive. Expediting decision making with band agents could have considerable social benefits.

Establishing a more-effective adjudication process would also entail the costs of investment in the appropriate infrastructure to establish that process, including the hiring and training of personnel.

Many of the benefits of the proposed reforms, particularly regarding adjudication, cannot be easily tied to per band valuations; indeed, the authors do not include the benefits of improved adjudication in their estimates at all. However, they contend that around \$10 billion per year is a reasonable prediction of the net monetary benefits of implementing these proposed policy reforms.

Conclusions

The federal government is now taking ambitious steps to move spectrum from less-efficient uses, such as over-the-air TV broadcasting, to more-efficient uses, such as wireless broadband. But to satisfy future demand by wireless service providers and innovators for access to spectrum, policymakers will need to implement a framework that supports the market-based management of wireless spectrum.

The pillars of a new framework for unlocking spectrum value that De Vries and Weiser outline present policymakers with concrete policy reforms that could provide economic benefits of roughly \$10 billion per year, not counting any of the revenue the federal government will gain from the operational framework’s less easily quantifiable benefits. These benefits include new spectrum-sharing initiatives, the dynamic benefits from an unprecedented level of flexibility in spectrum use, and more-efficient institutions.

Questions and Concerns

1. Why is the separation of wireless systems by wide frequency gaps, as government regulators have historically required, no longer economically efficient?

Two wireless systems can operate simultaneously in the same area by using different frequencies. Each transmitter broadcasts on its designated frequencies, and its respective receivers tune to those frequencies, filtering out signals on other frequencies. The ability of a receiver to tune out an unwanted signal depends, in part, on the investment in filtering technology, however. In the past, spacing out services in the frequency saved on the costs of receivers, but incurred opportunity costs by leaving wide frequency gaps. With demand for wireless spectrum increasing rapidly, the authors argue that the more economically efficient approach is to expect more from receivers.

2. What is the responsibility of the party experiencing interference on the spectrum under the proposed system of harm claim thresholds?

Under the proposed system of harm claim thresholds, an aggrieved party can bring a proceeding against an offending neighbor provided that it can show that the interference from a neighboring signal exceeds a specific field strength for more than a prespecified percentage of times and places in the measurement area, with a prescribed confidence level. Until the interference exceeds the threshold to trigger the harm claim, dealing with the interfering signal and its consequences is the responsibility of the party experiencing, rather than the party causing, the interference.

3. Could mandating receiver performance standards be a better way to incentivize improvements in system technology?

Receiver performance specifications are just one of many requirements that must be specified in order to define a wireless system. Others include transmitter performance, and the power, height, and spacing of transmit antennas. Constructing an entire wireless system requires making trade-offs between many design requirements, including the nature of the service to be delivered, cost constraints, quality of service requirements, and the radio interference environment. Imposing receiver performance mandates would require the FCC to take a position on these complex trade-offs for every product and every allocation in which an incentive for technological improvement is necessary. Such a situation would be cumbersome, if not infeasible.

4. What about just revitalizing the FCC's Enforcement Bureau?

The virtue of the authors' approach is that the agency can leverage its expertise in the spectrum area and take on this mission without any additional action by Congress. The authors believe that the lessons of history tell a cautionary tale, however: for years, the Enforcement Bureau has failed to act in an independent manner, and it has not allowed either administrative law judges or administrative judges to develop factual findings in spectrum disputes.

Highlights

In a new Hamilton Project discussion paper, Philip J. Weiser of the University of Colorado Law School and Silicon Flatirons Center, and J. Pierre de Vries of the Spectrum Policy Initiative, Silicon Flatirons Center, propose three major reforms to the regulatory structure of the wireless spectrum. While each of these proposals stands on its own, they integrate to form a package of policy proposals that transform the regulation of the wireless spectrum.

The Proposal

Define harm claim thresholds to reduce the ambiguity over responsibilities for interference harm. Authors J. Pierre de Vries and Philip J. Weiser explain how a system of harm claim thresholds could generate default spectrum rules that are clear enough to facilitate more bargaining between rights holders to reach the economically efficient trade-off between the rights of transmitters and receivers.

Introduce band agents to overcome the drawbacks of excessive fragmentation. To address the collective action problems created by fragmentation of spectrum rights among many holders, the authors propose that the Federal Communications Commission and National Telecommunications and Information Administration facilitate the establishment of band agents that can represent and even bind large groups of fragmented licensees.

Reform spectrum adjudication to improve the reliability and efficacy of dispute resolution. To advance important spectrum policy reforms, it is important to move adjudication from the current ad hoc, politically charged, and notice-and-comment-driven process to a more fact-based process. The authors put forth proposals that would resolve spectrum-related disputes in a timely fashion using judges with expertise in spectrum policy in the Federal Communications Commission and/or in a newly created Court of Spectrum Claims.

Benefits

Complementary spectrum policy reforms that address the lack of defined interference rights, band fragmentation, and the absence of any adjudication framework would facilitate more intensive use of spectrum by both existing and emerging wireless services. Such reforms could provide economic benefits of nearly \$10 billion per year in additional consumer surplus.



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