THE HAMILTON PROJECT

Advancing Opportunity, Prosperity and Growth

DISCUSSION PAPER 2008-08 JULY 2008

Philip J. Weiser

The Untapped Promise of Wireless Spectrum

THE BROOKINGS INSTITUTION

The Hamilton Project seeks to advance America's promise of opportunity, prosperity, and growth. The Project's economic strategy reflects a judgment that long-term prosperity is best achieved by making economic growth broad-based, by enhancing individual economic security, and by embracing a role for effective government in making needed public investments. Our strategy—strikingly different from the theories driving economic policy in recent years—calls for fiscal discipline and for increased public investment in key growth-enhancing areas. The Project will put forward innovative policy ideas from leading economic thinkers throughout the United States—ideas based on experience and evidence, not ideology and doctrine—to introduce new, sometimes controversial, policy options into the national debate with the goal of improving our country's economic policy.

The Project is named after Alexander Hamilton, the nation's first treasury secretary, who laid the foundation for the modern American economy. Consistent with the guiding principles of the Project, Hamilton stood for sound fiscal policy, believed that broad-based opportunity for advancement would drive American economic growth, and recognized that "prudent aids and encouragements on the part of government" are necessary to enhance and guide market forces.

THE HAMILTON PROJECT

THE HAMILTON PROJECT
Advancing Opportunity, Prosperity and Growth

The Untapped Promise of Wireless Spectrum

Philip J. Weiser
University of Colorado

July 2008

This discussion paper is a proposal from the author. As emphasized in The Hamilton Project's original strategy paper, the Project was designed in part to provide a forum for leading thinkers across the nation to put forward innovative and potentially important economic policy ideas that share the Project's broad goals of promoting economic growth, broad-based participation in growth, and economic security. The authors are invited to express their own ideas in discussion papers, whether or not the Project's staff or advisory council agrees with the specific proposals. This discussion paper is offered in that spirit.

THE BROOKINGS INSTITUTION
JULY 2008

Abstract

The public "airwaves," or the radio spectrum, are a tremendously valuable asset that remains partially untapped by entrepreneurs and users. Over the past twenty-five years, the explosion of the cellular industry and wireless technology more generally has placed a premium on access to spectrum. Nonetheless, our spectrum policy has failed to facilitate an optimal and efficient use of this important resource—meaning that spectrum is often left unused at the same time that there is a great demand for access to it.

This paper sets forth a new direction for spectrum policy reform. At the broadest level, it calls on policymakers to judge the Federal Communications Commission's (FCC's) success by whether it can spur the more efficient use of spectrum. To advance this objective, this paper highlights the importance of measuring how spectrum is being used, identifying blocks of unused spectrum, and encouraging greater leasing arrangements to gain access to otherwise unused or underused blocks of spectrum. In particular, it calls on the FCC to begin measuring the use or disuse of spectrum, to establish an accessible database that profiles all spectrum licensees, to encourage greater amounts of spectrum leasing, and to invite the public to evaluate which spectrum licenses are not being used. In short, this set of initiatives would address the current policy failure to hold licensees accountable for their failure to use licensed spectrum and create incentives for licensees to lease unused or underused spectrum.

This paper also calls for regulatory reform to catalyze more efficient uses of spectrum by providing greater flexibility to spectrum license holders than what is allowed under today's antiquated regulatory regime. Under current regulations, restrictions on how license holders can use spectrum often delays or prevents firms from developing or deploying innovative wireless technologies. To change this dynamic, the paper outlines two directions for reform. First, it sets out a conceptual framework for enabling spectrum now dedicated to UHF TV broadcasting to be transferred to uses that are more valuable (e.g., wireless broadband). Second, it explains how the FCC should be reformed to oversee spectrum use through an increased emphasis on after-the-fact oversight (i.e., monitoring how the radio spectrum is used in practice) as opposed to its legacy of closely prescribed before-the-fact rules.

Contents

1. Introduction

Many Americans take for granted or fail to appreciate fully the dramatic emergence of wireless services as a central part of our communications ecosystem. Over the past twenty-five years, wireless services have enabled consumers and businesses to function more much efficiently in numerous ways—avoiding wired infrastructure by using Wi-Fi or Bluetooth technology to connect computer and consumer electronics products; adopting Smartphone technologies, such as a Blackberry or iPhone, to stay connected on the road; and enjoying mobile broadband connectivity from the so-called third generation cell phones. Indeed, for most consumers under thirty, the whole idea of landline telephone service is archaic. Going forward, wireless technology, such as the vaunted WiMAX standard, promises to deliver broadband connections to millions of Americans who currently lack access to broadband technology.

Wireless technology and the use of wireless communications greatly shape how people around the world communicate. Just twenty-five years ago, AT&T thought so little of the value of wireless spectrum—i.e., the "air waves" for wireless communications—that it allowed the Bell Companies to take the licenses to provide cellular telephone services as part of the AT&T break-up.[1] Having later realized its mistake, AT&T purchased McCaw Cellular in the early 1990s for $11 billion. When AT&T sold out to SBC Communications in 2005, the value of the entire company—now without its wireless component (which was spun off as AT&T Wireless)—was less than the value of Nextel, a wireless provider that did not even exist at the time of the AT&T breakup.

For many entrepreneurs looking for opportunities to develop and deploy innovative wireless technologies, the biggest hurdle to a successful business venture is gaining access to wireless spectrum. This hurdle not only constrains technological development and the adoption of new products and services, but it also undermines economic growth and productivity. Given the importance of wireless technology to our economy and the opportunity for continued innovation in this area, policymakers should closely examine spectrum policy to ask whether it is serving its intended purpose of ensuring that the wireless spectrum is being used efficiently and productively.

During the winter of 2008, the Federal Communications Commission (FCC) claimed an enormous victory in its spectrum policy responsibilities after it conducted the most successful auction of wireless spectrum in its history.[2] The spectrum licenses auctioned off by the FCC were so desirable because they are widely viewed as "beachfront property." In particular, the radio frequencies that will become available once TV broadcasters turn off their analog transmission systems and begin broadcasting solely in a digital format are uniquely valuable because they enable radio waves to propagate very effectively (meaning that fewer transmitters are needed relative to systems that use other radio frequencies located at higher frequencies). Compared with the results of previous auctions, the so-called 700-Megahertz (MHz) auction was an enormous success, with FCC Chairman Kevin Martin proudly proclaiming that the $19 billion raised for the U.S. Treasury was more than the entire amount of money collected by all of the previous spectrum auc-

1. This paper will use the terms "radio spectrum," "wireless spectrum," and "spectrum" interchangeably.
2. In particular, the FCC auctioned off licenses to use 52 Megahertz (MHz) of spectrum in the 700 MHz band. The wireless spectrum is defined by the frequency of how radio waves propagate at any given part of the spectrum. The frequency of radio waves is measured in "Hertz" (or "Hz" for short), in honor of Heinrich Hertz, a leading radio researcher in the 1800s. Under this system of measurement, one kHz is one thousand Hz, one MHz is 1 million Hz, and one GHz is 1 billion Hz.

tions to date. Stated differently, several companies together paid almost $20 billion to use the same amount of spectrum that had been used historically by the UHF TV channels 61 to 69.

The recent auction can also be viewed as a call to further action. In a point often underappreciated by federal policymakers, the large sums paid by those prevailing in the auction is not necessarily a positive sign insofar as it reveals the considerable demand for spectrum and the inability of many companies to gain access to this valuable resource. Notably, the wireless spectrum is not, on almost any account, being used intensely. One cause of the inefficient use of the spectrum is the continuation of many antiquated regulatory policies. Viewed in this light, the recent auction is not a cause for celebration, but rather a cause for concern: if the spectrum is so valuable, why are policymakers not able to implement additional strategies to free up its use? The answer is two-fold. First, many incumbent users are comfortable with (and often protected from competition by) a regime that restricts the supply of spectrum. Second, radio technology is often viewed as mysterious and its regulation is often so arcane that only the most diligent observers understand what is at stake in spectrum policy debates.

If the radio spectrum were being used intensely at all times, there would be little left for the government to do in order to spur greater use of this resource. As this paper explains, however, spectrum is often left unused at the same time that there is a great demand for access to it. This means that policymakers should focus on developing and implementing strategies for providing improved access to spectrum. At the broadest level, policymakers should judge the FCC's success by whether it can spur the more efficient use of spectrum. To do so, the FCC should identify and implement reforms that promote awareness of the existing users of spectrum, their current use of the resource, and their willingness to lease it to others. In addition, the FCC should provide greater flexibility than what is allowed under today's antiquated regulatory regime, which restricts permissible uses of the spectrum in ways that either delay or prevent firms from developing or deploying innovative wireless technologies.

This paper seeks to highlight both the importance of and existing opportunities to reform spectrum policy along the lines discussed above. To do so, it identifies a series of reforms in spectrum management to promote a greater awareness of how spectrum is being used and increase the efficiency of spectrum use by providing greater flexibility in how spectrum can be used.

- To promote greater awareness of how spectrum is and is not used, the FCC should establish an accessible database that profiles all spectrum licensees, encourages greater amounts of spectrum leasing, and invites the public to evaluate which spectrum licenses are not being used. This set of initiatives would address the current policy failure to hold licensees accountable for their failure to use licensed spectrum and would create incentives for licensees to lease spectrum that they are not using. Such a step would catalyze uses of spectrum that are more efficient.

- To facilitate greater flexibility in the use of spectrum, Congress should reform spectrum policy to allow UHF TV broadcasters, along with other spectrum licensees, to sell their heretofore-restricted spectrum licenses at an auction that would enable this spectrum to be put to potentially far more valuable uses. As explained below, this concept can be implemented in any number of ways that can protect important social goals while enabling spectrum to be used more effectively.

- To manage spectrum more efficiently, the FCC or a replacement agency should be rechartered. At present, the regulation of spectrum—like the FCC's practices more generally—is subject to be a legislative-like array of bargaining processes. Both for spectrum left unlicensed (i.e., as a com-

mons) and licensed in a manner that gives rise to property-like rights, the FCC can act much more effectively, expeditiously, and predictably. In particular, whereas the FCC generally guards against interference between competing users by insisting on before-the-fact protections against interference, it could enable more efficient spectrum use by relying increasingly on after-the-fact oversight (i.e., monitoring how the radio spectrum is used in practice).

This paper proceeds in five parts. In section 2, I explain the nature of spectrum regulation and why access to wireless spectrum is crucial to our economy. In section 3, I explain my proposal for how the FCC can identify more precisely how spectrum is currently being used and enable the public to evaluate whether current licensees are actually using the spectrum assigned to them. In section 4, I suggest that the U.S. Congress should view the transition to digital television as only a first step, recognizing the huge gains to consumers that can be facilitated through the additional shift of spectrum from UHF TV broadcasting to other uses (namely, wireless broadband). In section 5, I highlight that the FCC needs to move away from its legacy command-and-control model of regulation to become a more effective dispute resolution body and to seek to enable spectrum-based innovation. Finally, section 6 offers a brief conclusion.

2. Background

The administrative rigidities of the current model of spectrum regulation result in the vast underuse or lack of use of spectrum. In one scenario, a licensee owns a license to use spectrum in a wide area, but will only use it in a narrower area. In another scenario, a spectrum licensee owns a license that it might use at some point at some time, but leaves the spectrum unused for the near future. In yet another common scenario, parts of the spectrum fall between licenses—including the "guard bands"—and are, by design, left unused. Finally, in the most common scenario, the licensee only uses its spectrum periodically, leaving it unused for long periods.

Taken together, the scenarios outlined above mean that, even in the most populous parts of the country, vast parts of spectrum are not used at any particular point in time. Documenting this fact, one study reported that "during a four-day period in New York City, only 13 percent of spectrum between 30 MHz and 2.9 GHz was occupied at one time or another" (Government Accountability Office [GAO] 2005, 13, citing McHenry and McCloskey 2004). To be sure, there are legitimate reasons for leaving spectrum unused where the "white spaces" in the spectrum represent either efficient approaches to mitigating interference or where the spectrum is kept available (but unused) for a party that needs it available on a moment's notice. In other cases, however, unused spectrum in the face of substantial demand for the resource raises an important policy concern: unlike other resources (say, mineral rights), spectrum cannot be stored and does not increase in value because a party holds on to it and does not use it or allow it to be used.

The conventional wisdom on spectrum policy is that little can be done about the shortage of available spectrum. This view emphasizes that essentially all of the radio frequencies between 30 MHz and 3 GHz—the sweet spot of the "radio spectrum"—are already allocated to particular uses and assigned to individual licensees.[3] As Dale Hatfield and I have explained elsewhere (Weiser and Hatfield 2008), this part of the spectrum is particularly desirable because "the physical dimensions of the antennas required for such transmissions are reasonably sized, transmitting and receiving devices are low in cost, and, most fundamentally, the radio waves in such frequencies are less susceptible to being blocked or weakened by natural or manmade obstacles such as hilly terrain or tall buildings" (558).

Reflecting the conventional wisdom that there are no available opportunities for firms to gain access to wide swaths of such spectrum after the recent auction, both media outlets and policymakers routinely referred to the auction of radio frequencies in the 700 MHz band as a unique opportunity for firms to gain access to spectrum because those frequencies would be "the last up for auction for decades," as Kim Hart wrote in the *Washington Post* on July 30, 2007 ("FCC to Rule on Wireless Auction").

The conventional wisdom about the lack of availability of spectrum is simply wrong. By focusing on the recent auction as the last best chance to enable firms to gain access to spectrum, policymakers and commentators have downplayed the opportunities, still significant, to facilitate access to this important resource. In particular, by implementing a set of reforms to the current regulatory framework, policymakers could enable the spectrum to be used more efficiently than it is today. A fundamental premise for further spectrum policy reform is that the widespread use of spectrum is more hypothetical than real. Consider, for example, that over the past five

3. Despite the fact that the radio spectrum continues to expand as scientific breakthroughs develop the potential for using ever-higher radio frequencies, the most valuable part of the spectrum remains the frequencies between 30 MHz and 3 GHz (Weiser and Hatfield 2008). Those unfamiliar with the FCC's spectrum management regime and how spectrum rights are assigned to individual licensees should see Nuechterlein and Weiser 2005.

years, while firms were waiting to pay billions for additional spectrum licenses in the 700 MHz band, there were very few UHF television broadcasters using this spectrum. Nonetheless, our system of spectrum regulation barred the owners of those stations from selling or leasing the right to use this spectrum to a firm that would use it for a different purpose—say, wireless telephone service or wireless broadband.

The federal government was not always content with the relative lack of use of the radio spectrum. In 2002, an interagency Spectrum Policy Task Force released a report calling for regulatory reform in this area and championing a number of new initiatives (Spectrum Policy Task Force 2002). In announcing the report, Chairman Michael Powell underscored that the goal of the initiatives that the report called for therein was, among other things, to end the legacy of spectrum regulation that created "the 'mother may I' phenomenon—businesses must go to the FCC for permission before they can modify their spectrum plans to respond to consumer demand" (Powell 2002, 4–5). Unfortunately, the momentum of that initiative, which built on earlier spectrum policy reform efforts, was short lived; the FCC recently closed two of the signature dockets emerging from the report, declining to take any action in those cases or to propose alternative regulatory reform proposals.[4]

Pursuing new avenues for spectrum reform is crucial because facilitating greater access to spectrum can bolster U.S. competitiveness and productivity in the world economy. Notably, other parts of the world, particularly the European Union, have made a priority of ensuring that wireless firms enjoy access to spectrum. These nations are moving ahead with spectrum reform proposals that will facilitate more efficient and innovative uses of spectrum than the uses allowed under our current rules.[5] Before the recent auction, for example, Thomas Hazlett and Gregory Rosston reported in CNET that U.S. wireless companies enjoyed access to less than half the amount of wireless spectrum than is used by their European counterparts ("Why Airwaves Should be Deregulated", February 11, 2004). In a world economy, where businesses can choose to locate anywhere, the United States cannot afford to undermine the development of wireless services that businesses and consumers increasingly depend on more than their traditional landline connections. Similarly, given the importance that access to spectrum can play in enabling the development and deployment of a "third broadband pipe" to compete with the incumbent broadband providers (i.e., the telephone and cable companies), spectrum policy reform must be considered a crucial part of any effective broadband policy strategy.

To appreciate the cost of our antiquated model of spectrum regulation, consider the impact of spectrum policy on our nation's economy. One indicator of the value of freeing up access to spectrum is that the auction of licenses to use 50 MHz of spectrum garnered $19 billion. To be sure, if the market were flooded with available spectrum the value of the resource would decline. Nevertheless, it merits note that there is more spectrum where that 50 MHz came from. In particular, there is more than 200 MHz of spectrum that will continue to be used after the digital transition for UHF TV broadcasting (i.e., for channels 14–51). Valuing the spectrum based on the recent auction, it is worth $80 billion. As a technical matter, it could be put to a range of uses, including mobile video services, wireless telephone and data services, and wireless broadband services.

To base the value the economic impact of underused spectrum on the possible revenues that would be raised via an auction understates greatly the social

4. Establishment of an Interference Temperature Metric to Quantify and Manage Interference and to Expand Available Unlicensed Operation in Certain Fixed, Mobile, and Satellite Frequency Bands, *Order*, 22 FCC Rcd. 8938, 8939 (2007); Interference Immunity Performance Specifications for Radio Receivers, *Order*, 22 FCC Rcd. 8941, 8941 (2007).
5. For a review of the U.K. reform initiatives, see Ofcom (2005, 2008).

and economic value that would result from freeing up this important resource. With respect to the recent 700 MHz auction, Tom Hazlett emphasized this point in remarking that "the dollars flowing to the Treasury are tantamount to loose change" compared to the fact that "the chunk of prime spectrum made available will fuel-inject the wireless turbines of the information economy" (Thomas Hazlett, "It's the Spectrum, Stupid," *Financial Times*, April 7, 2008). Attempting to quantify the impact of spectrum purchased at auction, former FCC economist Greg Rosston suggested that the social value of such spectrum is ten times the amount paid for the license (Rosston 2001).

Regardless of the precise economic impact, however, it is clear that, when spectrum is difficult to come by, firms will charge more for wireless services and wireless innovators will find it more difficult to gain access to spectrum. Consumers are thus deprived of additional or potential competition in this market, meaning that they are paying higher prices for services than they would be if more of the spectrum was available sooner. For example, on the blog Giga Omni Media, Katie Fehrenbacher reported that the lack of available spectrum has prevented T-Mobile from rolling out higher-speed wireless broadband services after such services were technologically available and in the company's economic interest ("T-Mobile US Launching 3G, Finally," October 6, 2006). Consequently, consumers were forced to pay higher prices for such services than they would have if more spectrum were available to T-Mobile earlier.

The limited spectrum available for firms like T-Mobile also influences the nature and pace of innovation in this marketplace. As Marguerite Reardon reported in CNET, T-Mobile, more so than its more established (and wireline affiliated) competitors, has aggressively put its spectrum to novel uses, including an early support for Smartphone technologies developed by Palm (at a time when other carriers were skeptical of the technology) and a willingness to experiment with new disruptive technologies, such as its Hotspot@Home service ("T-Mobile Betting on 3G to Close on High-Speed Competitors," April 14, 2008). Unfortunately, the artificial scarcity in spectrum available for wireless services is not a new phenomenon. In 1992, for example, an FCC study reported that TV licenses in Los Angeles were sold at a cost of $1 million to $6 million per megahertz and cellular licenses were sold at amounts up to $166 million per megahertz (Kwerel and Williams 1992). That study further reported that the artificial restriction on selling TV licenses in Los Angeles to cellular telephony providers prevented consumers in Los Angeles from gaining close to $1 billion dollars in consumer surplus as a result of increased competition in that market.[6]

Even accounting for the economic benefits that would come from facilitating competition and enhanced service offerings fails to state fully the value of freeing up more spectrum. Notably, the true value of increased access to spectrum is impossible to calculate accurately because our imagination and the best predictions using what we know today is unlikely to capture the longer-term benefits that will arise as a result of technological change in this dynamic area. In particular, freeing up spectrum for new users and allowing innovators to develop new products and services creates huge opportunities for entrepreneurs. Even if we cannot know for sure where the new growth opportunities in wireless services will come from, the past several years—during which time use of wireless products and services continued to increase dramatically—underscore that we are in the midst of a revolution in how people communicate.[7]

6. The actual amount of social gain is undoubtedly lower than the $1 billion figure in light of the subsequent FCC authorization of a number of other entrants into the cellular telephone market (i.e., Kwerel and Williams' 1992 study assumed no additional entry). See Kwerel and Williams 1992, vii.
7. According to a recent report commissioned by Ofcom, the U.K. regulator, net economic benefit to the U.K. economy provided by the use of radio spectrum increased by 50 percent from 2002 to 2006 (Europe Economics 2006).

To appreciate how technological development is tied to spectrum regulation, consider the case of wireless telephone service.[8] By the 1970s, cellular telephone service had emerged as a viable technology, but the FCC moved slowly to provide spectrum for this service, finally authorizing two licenses for wireless telephone service in local areas in 1983. Notably, AT&T viewed the demand for this technology with skepticism, relying on a report by McKinsey and Company that there would be fewer than 1 million wireless telephone customers by 2000. The demand for wireless services grew rapidly in the mid-1990s after the so-called PCS auctions, which truly opened the market for wireless telephone services by allowing new entrants into the market, enabling the rollout of the second generation (i.e., digital) service, and spurring the established providers to respond to the competition by lowering their prices and improving the quality of their services.

By the time 2000 rolled around, McKinsey's prediction was proven to be off by a factor of one hundred, and wireless telephone services had emerged as a $9 billion (and growing) industry. By 2006, there were more than 200 million subscribers to wireless services, using their "phones" not merely for voice calls, but also to access the Internet, download music and ring tones, play games, watch TV, and take digital photos, making the wireless telephone a virtual digital Swiss army knife. Looking back, it is safe to say that the decisions by the FCC to slow roll the development of this technology (by limiting the amount of spectrum available to it) was costly to society. On one account, the delays in rolling out wireless services cost the U.S. economy roughly $33 billion in lost productivity gains (Hausman 1997).

The development of low-powered wireless technologies over the past twenty years offers another impressive case study of the unforeseen benefits that can arise from making spectrum available to entrepreneurs and technologists. In 1985, the FCC authorized, as a secondary use, "unlicensed" services that could operate at low power in the so-called ISM band that was dedicated to industrial equipment that used spectrum. In the wake of this decision, developers created an array of technologies, ranging from garage door openers to baby monitors to cordless phone to wireless networking devices (e.g., Wi-Fi and Bluetooth technology). Traditionally, the spectrum made available for this technology was referred to as a "junk band" and viewed as unusable for traditional wireless services. But taking advantage of an opportunity to experiment with this spectrum, which was available to all developers and did not require a license to use, a variety of technologies were developed and marketed, creating billion-dollar industries in new industries—from cordless phones to wireless networking.[9]

8. This telling relies on the account offered in Christopher Rhoads' account, "AT&T's Inventions Fueled the Tech Boom, Its Own Fall," in the *Wall Street Journal*, February 2, 2005.
9. For a discussion of the development of such technologies using unlicensed spectrum, see Carter, Lahjoui, and McNeil 2003; Marcus 2008.

3. An Inventory of Spectrum and Spurring Secondary Markets

The supposed unavailability of spectrum for new technologies and the high price of spectrum licenses mask the reality that wireless spectrum is a vastly underutilized resource. There are, for example, hundreds—if not thousands—of Wireless Internet Service Providers (WISPs) around the United States who are providing service using unlicensed wireless spectrum to deliver broadband via technologies like Wi-Fi or WiMAX, but are often unable to gain access to licensed spectrum. Consequently, such providers continue to rely solely on unlicensed spectrum—which offers no protections against interference and does not enable providers to guarantee levels of service quality—even if there is unused or vastly underused wireless spectrum available in their service territory. This limitation is significant not only because of the limits on operational effectiveness, but also because the absence of licensed spectrum often means that such firms cannot raise funding. Similarly, other potential users of wireless technology, including those interested in maintaining video surveillance systems (including law enforcement agencies), might also be interested in leasing spectrum, but such opportunities are often not readily available.

The failure of a robust secondary market in spectrum to emerge may reflect the difficulty in locating relevant licensees, a general reluctance of licensees to enter into such transactions, or a judgment (whether conscious or not) by the licensees that such transactions are not worth the effort. In any event, the net result is that a socially valuable resource—wireless spectrum—goes unused, meaning that new wireless technologies are not developed or not effectively used. In some cases, it means that wireless broadband to unserved or underserved areas is not deployed. One possible culprit that could account for the lack of a secondary market is that licensees strategically withhold access to spectrum for any number of reasons—to limit competition, increase the value of their spectrum licenses (by perpetrating an artificial state of scarcity), or to ensure that spectrum is available to it without the possible limitations imposed by a contract to lease access to it. The reforms proposed below, however, do not address the possibility of strategic behavior, which raises a number of challenging issues (to the extent that it is responsible for the relative lack of use of spectrum).

The proposals outlined in this part of the paper address and seek to overcome the inertial forces that often drive decisionmaking at companies and reinforce the status quo. All too often, companies underuse assets like spectrum licenses because it is too difficult or does not seem worth the trouble to reevaluate their current business practices. In the case of railroads, utilities, and other spectrum licensees, for example, it may well be easier to do nothing than to take affirmative efforts to facilitate spectrum-leasing arrangements. As explained below, there are a number of policy reforms that can change this equation and thereby promote the more effective use of spectrum. Indeed, from the results of past programs it seems clear that such efforts can identify some low-hanging fruit and facilitate a far more efficient use of spectrum (FCC 2004b). One example is when FCC officials engaged in a simple letter-writing campaign to a select and limited number of licensees asking if they were using their licenses; in response, a number of licensees replied that they were not using their licensed spectrum and were willing to give back their licenses.

As a formal matter, the FCC has largely welcomed and encouraged the leasing of spectrum in a large number of bands where a party has exclusive control of wireless spectrum.[10] As a practical manner, however, there is still nothing approaching a vibrant spot market for spectrum. To be sure, Cantor Fitzgerald has already developed a clearinghouse for leased access to spectrum, and other firms, like Spectrum Bridge, are trying to do so. To date, however, such

firms have reportedly encountered a series of difficulties; consequently, more than four years after the FCC authorized secondary markets, it is important to ask why spectrum is still vastly underused and not traded more regularly in a secondary market. Moreover, as discussed below, the FCC should seek to develop policies to spur the more efficient use of licensed spectrum.

A. Spurring Identification of Unused Spectrum

To rectify the lack of an effective secondary market in spectrum, the FCC should seek to develop a greater level of awareness of how spectrum is being used. To that end, the FCC should develop an easily accessible and transparent database that identifies (and exposes) all licensed bands of spectrum, a contact person for the licensee, and stated terms for the opportunity to lease access to the relevant band of spectrum.[11] Significantly, with the aid of an easy-to-use database, entrepreneurs, policymakers, and ordinary citizens could evaluate the practical uses of spectrum, analyze its shortcomings, and promote better use of this resource (through policy reforms and business strategies).

Imposing this requirement would create an important counterweight to the inertial lack of interest on the part of many companies in evaluating opportunities to lease their spectrum. Moreover, this initiative would not require the FCC to impose any specific terms of dealing on the relevant licensees because the licensees would be able to propose whatever terms they judged reasonable and appropriate. In practice, however, many licensees fail to do this under the current regime and thus, by requiring licensees to set some appropriate terms for leasing, the FCC can nudge companies to consider the virtue of entering into such arrangements (Swire 2002; Thaler and Sunstein 2008).[12]

To enforce a requirement that licensees post the terms under which they would make spectrum available for lease, the FCC could use a number of different strategies. One strategy would be to impose a penalty default rule under which any licensee that fails to state its terms for an available lease would be deemed to offer such a lease free of charge for a set period (say, one year).[13] The effect of this requirement would be to encourage firms to post the terms at which they would be willing to lease spectrum. Those firms that failed to post terms would be highly motivated to do so after the initial period during which they leased access to their spectrum at no cost. A less imposing requirement would be to use a default rule that, based on some available benchmarks, offered a constructive

10. Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets, *Second Report & Order, Order on Reconsideration, & Second Further Notice of Proposed Rulemaking*, 19 FCC Rcd. 17,503, 17,549 (2004). For a discussion of the order and a listing of the relevant bands where parties can lease access, see Spectrum Bridge Inc., Spectrum Bridge Analysis of FCC Secondary Markets Positions, Policies and Comments (2008), available at http://www.spectrumbridge.com/app/webroot/files/pdf/whitepapers/Spectrum_Bridge_analysis_of_FCC_secondary_markets_iniatives.pdf.
11. Such spectrum registries exist (at least in some form) in Australia and New Zealand. See Australian Communications Authority n.d. A similar registry has been proposed for the United Kingdom (Cave 2002). The FCC has recognized that such a registry would help facilitate effective spectrum trading, but has not developed one. In particular, the FCC has recognized that intensive spectrum leasing within the existing administrative regime "would require tradeoffs in multiple dimensions—e.g., time, space, geography, type of use, and technology—and that, in the absence of an effective facilitator, search costs would be high." ("Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets," 18 F.C.C. Rcd. 20,604, 20,692 2003). See also Goodman 2004 at 320, who concludes that "[u]nless government or some sort of accredited private party were to develop a registry of spectrum ownership interests, the costs of title searches and related barriers to entry would likely be high."
12. Along these lines, Swire argues that the requirement that financial services firms develop and notify customers of their privacy policies had the salutary effect of spurring firms to deliberate as to their appropriate privacy policies, whereas many firms had no such policies before the law was adopted.
13. For a discussion of the role of penalty defaults in changing conduct for the better and eliciting socially valuable information, see Ayres and Gertner 1989. A more extreme response, used in some other contexts, would be to hold a licensee in violation of the terms of its license for failing to provide such information, risking a forfeiture of it as a consequence. See *United States v. Locke*, 471 U.S. 84, 105-07 (1985) (rejecting constitutional challenge to a forfeiture where a mining claim holder failed to file a notice of intent to continue working the claim) and *Texaco, Inc. v. Short*, 454 U.S. 516, 529 (1982) (upholding judgment that interest in severed mineral interest lapsed where owner failed to file a statement of claim pursuant to state statute).

lease rate in the event that a party failed to post its own specific terms and conditions.

The FCC, as the licensor, is in a unique position to facilitate the development of such a data set. In so doing, it should make the data in a form that will enable third parties—be they large firms or individuals—to manipulate (or mash up) the data to raise awareness about how spectrum is being used or underused and facilitate more market transactions.

The opportunity to facilitate greater levels of transparency and public engagement in how spectrum is being used could unleash a variety of productive forces. At present, the FCC not only fails to make available this information in an accessible and understandable format, but it also prevents such information from being picked up on Google searches. Thus, the FCC has dramatically ignored Justice Brandeis' dictum that "sunlight is said to be the best of disinfectants" (Brandeis 1914, 62). To be sure, government has generally ignored the opportunities unleashed by what some have termed "Wikinomics" (Tapscott and Williams 2006), but increasing numbers of user-generated content offerings underscore that little can be lost by facilitating such developments and much can be gained. Indeed, groups of ordinary citizens have combined information related to a variety of topics, such as crime rates in Chicago neighborhoods and L.A. communities at risk of fire violations, as L. Gordon Crovitz discusses in the *Wall Street Journal* ("From Wikinomics to Government 2.0," May 12, 2008). Such opportunities are bound to increase because recent technical advances make possible not only enhanced forms of search, but also the ability to cross-index one set of data with another and to represent data creatively (including using technologies like Google maps).

It is quite plausible (and indeed likely) that information about spectrum ownership and use (or lack of such ownership) can be employed in interesting ways to facilitate market activity, raise awareness of how spectrum is used (or not used), and enforce social norms about reasonable and productive spectrum use. Such norms have yet to take root and encourage more efficient spectrum use more widely, but they are significant and effective in regulating the use of spectrum among particular communities of users, such as amateur radio operators (i.e., ham radio operators).[14]

Developing an accessible database on spectrum licenses may sound like an obvious role for the FCC to perform. As of yet, however, it has failed to do so. Indeed, the agency's lack of focus on careful recordkeeping is notorious. Consider, for example, that in response to a recent GAO study on how it managed its enforcement processes (including spectrum-related ones), the GAO noted that the agency uses five separate databases to track complaints (GAO 2008). In responding to that investigation, moreover, the agency "acknowledged that it had to review 'about 46,000 paper case files'" to determine why investigations were closed with no action," as John Dunbar writes in *USA Today* ("Report Faults FCC on Complaint Tracking," March 13, 2008). Cynthia Brumfield notes in the blog IP Democracy that FCC information is generally available only to the most knowledgeable observers, who must know the exact docket number to find relevant information ("The FCC is the Worst Communicator in Washington," September 5, 2007).

B. Creating a More Effective Strategy for Identifying Unused Spectrum

To spur the more effective use of spectrum, the FCC should not stop at developing—or contracting for the development of—a comprehensive database and requiring parties to make clear whether they are willing to lease spectrum. Rather, it should also establish a regime to ensure that spectrum is being used. In the case of other valuable resources like minerals and water, Congress and state legislatures

14. See Weiser and Hatfield 2005, 663 and 675–77, for a discussion of the literature on social norms, and 681–82 for a discussion on a ham radio case study.

routinely ask leaseholders or licensees to establish their productive use of a valuable resource, requiring firms who fail to do so to forfeit their claim (e.g., *United States v. Locke* 1985). Similarly, the U.S. government apparently spends more than $150 million per year to evaluate the production of crops and exactly how those crops are used (Allred 2008). In the case of spectrum, however, there is only limited (if any) oversight as to whether and how the resource is being used.

To provide a more effective form of oversight, the FCC should institute a new program, a new program based on the qui tam concept, which is used in the False Claims Act (31 U.S.C. § 3729–3733) to address, to address a wide variety of efforts to defraud the federal government.[15] Under the False Claims Act, individual "relators" are encouraged to identify fraudulent conduct and to report it to the government in return for some share of any recovered sums. In the spectrum context, the government could use an analogous model to encourage private oversight of spectrum. In particular, the government could encourage firms and individuals to oversee the use of particular bands of spectrum in given geographic areas by subjecting the spectrum in question to forfeiture if left in disuse, and awarding the relator a temporary right to use the spectrum as well as transferable bidding credits for a subsequent auction.

To ensure that this qui tam–like model works effectively, the FCC should institute a "shot clock" that governs the filing of claims that particular bands are not being used. Under this clock, the FCC would have a limited period (say, three months) to determine if the relator established a prima facie case. This case would be made if the relevant spectrum license was not obtained at auction and was not in use at any point in the relevant geographic period for a sustained period of time (say, sixty days). If the FCC ruled that such a case was established, it would then have an additional period of time (say, one hundred twenty days) to determine whether the licensee could justify the lack of use of the spectrum license. (For cases involving a particularly long period of disuse, the burden on the licensee seeking to avoid forfeiture would increase.) It is essential that the FCC be required to act within specified periods because the FCC is notorious for leaving cases undecided for years.[16] To be sure, my proposed time frame is less than the traditional time period for deeming a licensee to have forfeited its license through disuse (one hundred eighty versus three hundred sixty days) (Amendment of Parts 1 & 90 of the Commission's Rules Concerning the Construction, Licensing, & Operation of Private Land Mobile Radio Stations, 6 FCC Rcd. 7297, 7299, 1991). In that case, though, a license cancels automatically as a means of "strik[ing] a balance between the licensee's need for operational flexibility and [the public's] need to ensure efficient utilization of authorized channels" (ibid.). In the procedure above, by contrast, there would merely be an evaluation of the use of the license, allowing for, as discussed below, an inquiry into whether particular circumstances (such as a build-out requirement schedule) justify the conduct of the licensee.

In return for identifying a spectrum license that is returned to the government, the relator would be granted a two-fold benefit. First, the relator would be granted a temporary (and transferable) experimental license to use the relevant spectrum.[17] Second, assuming the FCC was able to auction off the relevant spectrum, the relator would be awarded a

15. For a discussion of the qui tam concept, see Pacini and Hood 2007.
16. See, e.g., *Kay v. FCC* 2005. Note, however, that the petition under finder's preference program in that case was left unadjudicated for seven years.
17. The term "experimental license" is misleading insofar as such licenses are not necessarily limited to use for experiments and can be used for purposes other than mere technical experiments. See, e.g., "Implementing a Nationwide, Broadband, Interoperable Public Safety Network in the 700 MHz Band" 2007, 22 FCC Rcd. 20,912, 20,912–13. In practice, experimental licenses are often used interchangeably with a special temporary authority license, even though they are formally and theoretically distinct tools at the Commission's disposal (ibid.).

transferable bidding credit for that auction. Relative to the funds raised in such an auction as well as the social value of putting unused spectrum to work, the payoffs to the relators—like the bounties paid as part of the qui tam regime used to combat official corruption—are a small price to pay, and constitute sound and prudent investment in economic growth and productivity.

C. Limitations and Counterarguments

In considering the proposal outlined above, seasoned telecommunications policy observers will appreciate that it not only follows a precedent used to ensure the efficient and effective use of other natural resources (such as water rights [Neuman 1998]), but it also revives an abandoned FCC program known as "the finder's preference." Notably, the finder's preference program relied on the same premise as the relator model outlined above—i.e., that the FCC's enforcement apparatus is notoriously limited, meaning that the rules requiring the active use of licensed spectrum are underenforced. To encourage individuals or firms to participate in that program, the FCC awarded them a dispositive preference if they identified spectrum left unused in a particular band (Hatfield 1995).[18]

The FCC's abandonment of the finder's preference program in 1996 highlights a number of key lessons for the proposal outlined above. The first key point is that the program worked insofar as a number of finders identified unused spectrum. In particular, the FCC granted 369 requests between 1991 and 1996—out of a total of nine hundred reviewed (of the 1,427 applications filed) (Amendment of Part 90 Concerning the Commission's Finder's Preference Rules, Notice of Proposed Rule Making, 11 FCC Rcd. 13,016, 13,019, 1996). Second, the finder's preference program, which was implemented before auctions became the norm, made the mistake of assuming that the finder could put the spectrum to better use than the previous licensee could. Whereas that flaw of the program was a principal reason for its termination, the program proposed above would assign the license via an auction and thus suffer from no such flaw (Amendment of Part 90 Concerning the Commission's Finder's Preference Rules, Report & Order, 13 FCC Rcd. 23,816, 23,820, 1998). Finally, the FCC's other reason for terminating the program—that "the administrative resources necessary to sustain [it] are better dedicated to other Commission channel recovery efforts" (ibid., at 23,816)—may well look differently in light of the potential auction revenue that could be used to support FCC administrative efforts directed at ensuring more efficient use of spectrum.

For any enforcement program that evaluates the actual use of spectrum to be successful, the federal government must invest in oversight mechanisms. Consequently, the use of a qui tam–like process is a cost effective adjunct to the FCC's own enforcement efforts. In addition, the FCC should commission more studies to evaluate the use of spectrum and should step up its own enforcement efforts. But whether the FCC initiates its own action or adjudicates ones brought by relators, it will still need to dedicate "considerable Commission staff" to the undertaking (ibid., at 23,819). Given the enormous value of spectrum, there are few efforts that are more important in terms of FCC resources. Indeed, given the ability to free up additional spectrum for auction, investing in such efforts will more than pay for themselves—not to mention generate considerable economic activity and innovation that will occur on account of the available spectrum. To be sure, the FCC's institutional failings are unlikely to be corrected by increased funds alone. Although discussing the necessary institutional reforms to enable the FCC to operate more effectively is beyond the scope of this paper, Section 5 discusses briefly some of the reforms necessary to redirect the mission and operations of the FCC.

Like any regulatory or legal system, the qui tam–like

18. See also *Kay v. FCC* 2005 at 1344 (outlining finder's preference rule and explaining that the purpose of the regime was to supplement the Commission's "own enforcement activities with the self-interested policing efforts of those in the private land mobile radio industry").

proposal could be subject to abuse. In particular, as the FCC recognized in adopting its initial finder's preference system, there is the potential that a "finder may harass competitors with false complaints or make unsubstantiated allegations against all licensees in a particular market in the hope that one of the allegations will prove correct."[19] It is unclear whether that concern ever materialized in that context, and whether the FCC had to follow through on its threat to "take appropriate action" in such cases (or whether that threat deterred such behavior), but the FCC should impose—along the lines of the Digital Millennium Copyright Act of 1998 (17 U.S.C. § 512(f) [2006]), which provides that misrepresentations will be liable for damages, including attorneys' fees—a penalty for those entities who abuse this procedure by filing allegations in bad faith or without any basis in law or fact. On the other side of the equation, spectrum licensees could thwart the goals of this oversight regime by transmitting "white noise" as a technical means of meeting a use requirement, but undermining the goal of putting the spectrum to productive use. In practice, however, it would seem more straightforward for parties to comply with the use requirement by leasing access to the spectrum, thereby promoting the effective use of the spectrum and raising funds in the process. Nonetheless, if parties engaged in such a gambit, the FCC would likely need to deem the transmission of white noise a qualifying use—lest it venture into a thicket of line drawing problems of what constitutes a real use of spectrum.

Learning from the finder's preference experience, the system outlined above would need to have certain limitations. First, as noted, it would not apply to spectrum purchased at auction within the past ten years. This limitation rests on the premise that the purchase of a spectrum license at a competitive auction provides parties with a powerful built-in incentive to use it, thus undermining the case for the type of oversight outlined above. Second, it would not necessarily apply to federal government spectrum. To be sure, there is a powerful rationale for federal government spectrum to be subject to some form of oversight and such a proposal might ultimately be appropriate in some modified form, but in light of the ongoing initiatives to address concerns about the underuse of government spectrum, it makes sense to allow those programs to take effect before instituting a program along the lines above.[20]

Third, as for spectrum used by state and local governments, the proposal outlined above would need to be implemented differently in this context. Like the finder's preference model, which applied to such spectrum, there is a virtue in instituting some form of oversight (6 FCC Rcd. at 7303–04.). In the original model, however, any unused spectrum would continue to be licensed to governmental entities, albeit reassigned to another entity. I would suggest a similar approach here, but such an approach would need to be coupled with some form of incentive for the relator who could not receive a transferable bidding credit related to the discovered spectrum. Moreover, if the FCC builds on its recent precedent of welcoming the leasing—on an interruptible basis—of public safety spectrum to private providers of wireless service, this measure would operate in tandem with that one to encourage more efficient use of spectrum.[21]

The fourth challenge is how such a program would interact with the FCC's build-out requirements, which mandate that licensed spectrum be used with a specified period of time (say, five years). In some

19. Amendment of Parts 1 & 90 of the Commission's Rules Concerning the Construction, Licensing, & Operation of Private Land Mobile Radio Stations, 6 FCC Rcd. 7297, 7309, 1991.
20. The National Telecommunication and Information Administration recently released its strategic plan to spur more effective use of the federal government's vast spectrum holdings (National Telecommunications and Information Administration 2008). Moreover, the Office of Management and Budget (OMB) has stated that government users of spectrum should create a shadow price to value their use of spectrum (OMB 2007). In so doing, OMB has established the important principle that government users must value their use of spectrum, but, as of this writing, it remains to be seen how effectively this requirement will be enforced.
21. Service Rules for the 698-746, 747-762, & 777-792 MHz Bands, *Second Report & Order*, 22 FCC Rcd. 15,289, 15,291-93, 2007

cases, the FCC has imposed such requirements in a nominal fashion, such as in the WCS spectrum bands, where the agency suggested that as few as "four permanent links per one million people. . . at the ten-year renewal mark would constitute substantial service."[22] In other cases, the FCC has granted licensees substantial waivers in terms of the relevant requirements.[23] In any event, given the FCC's minimal enforcement apparatus and the inherent difficulty in mandating that parties act against their self-interest, the legacy build-out requirement is often an ineffective tool for ensuring that spectrum is used more effectively.

The build-out requirement constitutes a potentially challenging obstacle to the institution of the proposal outlined above insofar as parties may well assert that compliance with the relevant build-out requirement justifies their lack of use of their spectrum license. As an initial matter, it is quite possible that many licensees required to defend their failure to use their licensed spectrum also violated the relevant build-out requirement. In any event, even when a build-out requirement would purport to give a licensee a defense for an otherwise unjustifiable failure to use a spectrum license, the FCC could modify the build-out requirement rules to remove such a defense.

The fifth challenge is that the need to establish disuse throughout the entire geographic area of a spectrum license for a large area presents a potentially challenging burden for any relator. To be sure, spectrum-monitoring equipment is becoming cheaper,[24] but for licenses for large areas, the qui tam-like program would be difficult to implement if the burden imposed on relators was a thorough monitoring of the entire area. A means of addressing this concern is thus to recognize that the development of a prima facie case is far different than establishing the case that the spectrum license should be forfeited entirely. Notably, as with other areas of the law, some degree of evidence (say, monitoring of a number of areas) could give rise to a prima facie case that shifts the burden to the licensee to demonstrate that it is using its licensed spectrum. In the absence of evidence by the licensee that it is using its license at all, the FCC could thus infer that it had failed to do so entirely—even without imposing that burden entirely on the relator.

The challenge of establishing disuse throughout an extensive geographic area for spectrum licenses highlights another possible permutation of this proposal. It is quite possible, for example, that a spectrum licensee is using a part of its geographic area effectively, but ignoring other areas altogether. To adapt a relator-like model to address this issue, the FCC would need to institute a "keep-what-you-use" rule. Notably, the FCC is moving in that direction and, in the recent 700 MHz auction, imposed such a rule, thereby facilitating the development of smaller licenses when a licensee opts only to use a part of a larger license.[25]

In short, there are too few checks on how spectrum is used and policymakers must do more to ensure that the spectrum is used rather than lie fallow. Unlike other assets, such as mineral rights or even water rights, spectrum is not an asset that can be stored for another day. If spectrum at a particular location at a particular time is not used today, it will not enable additional spectrum to be used tomorrow. This means that government policy should place a premium on getting spectrum into the hands of firms or individuals who can use it. Consequently, the twin proposals outlined above—encouraging the development and institution of a more effective data-monitoring system about who owns spectrum licensees (and at what terms they will make them available for lease) as well as a private monitoring system that incentivizes relators to determine if spectrum licenses are being used at all—would provide an important form of oversight and accountability that does not exist today.

22. Amendment of the Commission's Rules To Establish Part 27, the Wireless Communications Service ("WCS"), *Report & Order*, 12 FCC Rcd. 10,785, 10844 at ¶ 113, 1997.
23. See, e.g., FCC 2008b. In that matter, Progeny sought an extension on the ground that there is a lack of M-LMS equipment, noting that the FCC has granted other licensees' extensions for the same reason.
24. For a discussion of how spectrum users can discover interference on their own by utilizing spectrum analyzers, see Anritsu 2007.
25. Service Rules for the 698-746, 747-762 & 777-792 MHz Bands, 22 FCC Rcd. 15289, 15349, Para 157. ("For those [areas] in which the end-of-term performance requirements have not been met, the unused portion of the license will terminate automatically without Commission action and will become available for reassignment by the Commission subject to the 'keep-what-you-use' rules described below.")

4. Liberating the UHF Broadcast Spectrum

A second crucial failing of spectrum policy is that certain services used by only a few, such as UHF broadcasting, hold on to valuable spectrum when other services that are in high demand, such as wireless broadband, are unable to gain access to spectrum.[26] The short explanation for this state of affairs is that licensees are prohibited by law from transferring their licenses to others who would use the spectrum in more socially valuable ways. This prohibition on spectrum trading—and the use of command-and-control regulation that rigidly prescribes the allowable uses of spectrum—is the phenomenon originally criticized by Nobel Laureate Ronald Coase in his classic *Federal Communications Commission* article (which he credits as setting forth the basis of the now-famous Coase Theorem) (Coase 1959). Unfortunately, almost forty years after that article, some of Coase's criticisms of spectrum regulation are still valid. As discussed in this part of the paper, one critical reform of spectrum policy would be to liberalize the regulation of UHF television broadcast spectrum and allow licensees to sell their licenses for other uses under a new regulatory framework.

A. Rethinking the UHF TV Broadcast Regulation

The use of the wireless spectrum to deliver TV signals over-the-air reflects a series of policy decisions made in the middle part of the past century. Today, approximately 86 percent (and rising) of all Americans watch their TV programs over distribution systems provided by cable, satellite, or telephone companies (FCC 2007). This means that only a relatively small number of households watch television programs delivered "over the air."[27] In a reflection of the limited value of UHF broadcasting as a standalone service, some UHF broadcasters asked for permission to turn off their over-the-air service in the analog format before the date of the digital transition—even though consumers who view TV over-the-air are still relying on this format—because their electricity costs outstripped the value associated with the customers who view the programming delivered by those stations over-the-air.[28] Consequently, at least with respect to some UHF TV broadcasters, they would be interested in selling off their transmission rights if given the right opportunity and entrepreneurs eager for access to spectrum could put this resource to more socially valuable uses.

In defense of the legacy regulatory regime, the prohibition on spectrum trading rests on a twin set of concerns. First, many are concerned that were UHF TV broadcasters allowed to sell their licenses to the highest bidder, they would reap unjustified windfalls by selling spectrum licenses that they obtained without participating in an auction on the theory that they would use it for TV broadcasting. Second, some question whether spectrum liberalization would undermine the preservation of over-the-air television as a source of information

26. In using the term "UHF Broadcast" or "UHF TV" spectrum, this paper refers to the stations broadcasting above channel 13, which was the end of the traditional VHF channels. It does not, therefore, refer to the use of UHF or VHF spectrum as such, but rather, the legacy service associated with it.
27. Even this statistic, however, is misleading insofar as the programs generally watched over the air are the major networks that are delivered, in the vast majority of cases, via VHF channels (i.e., 2–13). For UHF broadcast stations, by contrast, there are generally (as discussed in Part I) either a limited number of them to begin with or they reach a much smaller audience. To be sure, there are exceptions and, to that end, the proposal developed herein seeks to provide a means of enabling the underused spectrum to be put to better use while allowing currently valuable uses of broadcast spectrum to continue.
28. As Dave Hurd, the chief engineer at one such station (WNVT-TV), reported to Broadcast Engineering, "the move will save [us] about $5,000 per month in electricity expenses—necessary to operate the analog system alone. The station is not worried about losing viewers because most people in the station's northern Virginia coverage area are getting their TV via cable or satellite" ("Hard Economics Cause WNVT to Return to Analog Spectrum," July 21, 2003). See also Broadcast Engineering's report "FCC says 'No' to Early Analog Signal Turnoff" which reports on request to turn off analog transmission system (February 13, 2005).

and entertainment for those who cannot afford to pay for cable or satellite television. Both concerns, as discussed below, can be addressed. In so doing, moreover, the spectrum could be put to much more efficient uses.

The reality, as explained above, is that the spectrum dedicated to UHF TV broadcasting has less value as a medium for transmitting TV signals than it does for an array of other uses. That does not mean, however, that the stations themselves are not valuable. Rather, it means that much of their value is created because, by virtue of broadcasting over-the-air using the UHF spectrum, those stations are assured of a "must carry" right to cable television systems and, in many cases, satellite TV as well.[29] This is the case, for example, with station WWAC-TV, an Atlantic City UHF TV station that according to Broadcast Engineering only served only 2,677 households over the air, but reached 575,000 cable subscribers ("FCC Grants Atlantic City Station WWAC-TV Request to Turn off NTSC," October 11, 2002).

To facilitate win-win trades between UHF TV broadcasters and other higher-value uses of spectrum (such as wireless broadband providers), I recommend a two-part program. First, such trades should be facilitated through a government-managed auction process, and subject to some form of a windfall tax. From a policy perspective, the most critical aspect of this tax is that it should be high enough to address the concern of unfair windfalls, but not too high such that it renders unprofitable or undesirable sales of UHF TV spectrum licenses. Second, as an incentive to make such trades, the UHF broadcaster should also be afforded the opportunity to exercise its must-carry right for some continuing period after it sold its right to use the radio spectrum (and thus be able to demonstrate the value of its content for purposes of a commercial carriage agreement with the relevant cable and satellite providers). This transitional right to have programs carried on cable and satellite platforms would create a powerful incentive for stations with limited over-the-air viewership to consider selling their underlying transmission rights. Such stations would also receive greater value than through any standalone right to lease access to its spectrum because its spectrum would be reassigned through an auction process that would include numerous other UHF TV licenses.[30]

The reason that the auction would create a unique revenue opportunity for UHF TV license holders is that the FCC could use the auction process to make the licenses more attractive to bidders. First, because the repacking of the licenses would enable larger units to be created, the purchasers would be able to buy licenses that might well cover more geographic territory or contiguous spectrum—each of which commands a premium. Second, the licenses would be, almost certainly, rezoned for lower power uses (see Section 5 below), which would remove the need for some of the existing guard bands that are used to protect against interference. To be sure, to the extent that licensees at other parts of the spectrum were invited to participate in this auction (and I would recommend that they should be), the FCC would need to develop a formula for evaluating the relative worth of a MHz/POP at different parts of the spectrum. Finally, to the extent that the FCC reserved some portion of the freed-up spectrum as a "commons" (see 4.B below), that would necessarily restrict to some degree the available payment for the license at an auction.

The proposal outlined above would draw on some of the insights behind the big bang proposal developed by Evan Kwerel and John Williams, two FCC officials well versed in spectrum policy (Kwerel and

29. For a discussion of and more background on the "must carry rules," see Nuechterlein and Weiser 2005, 365–66.
30. Under the Telecommunications Act of 1996, TV broadcasters are permitted to lease access to their "digital TV" spectrum for other services in return for a payment to the government. Telecommunications Act of 1996, Pub. L. No. 104-104, § 336(a)(2), 47 U.S.C. § 336 (1996). This opportunity, however, has not proven to be attractive because, among other reasons, the broadcasters must continue using a portion of the spectrum to broadcast over-the-air television and must comply with the service rules developed for TV broadcasting.

Williams 2002). Like the Kwerel and Williams proposal, my proposal would give incumbent spectrum licensees one year's notice to place their spectrum licenses into a pool available for bidders. Participation in the Kwerel and Williams proposal would be voluntary and designed as a one-time option to induce participation. My UHF proposal would be similar, with the voluntary design enhanced by a requirement that those not participating continue with their current use for at least five more years and with no guarantee that any must-carry right would be available once a window for another such auction was authorized. Under this framework, presumably only those UHF TV stations providing a truly valuable service—say, public TV stations, network affiliates using UHF TV channels, and other assorted popular stations—would decline to participate.

In advancing a new proposal for how to regulate the UHF spectrum, I acknowledge that the path to reform is fraught with a number of legal, economic, and technical hurdles. Consider, for example, that UHF TV licenses are not the only entities now using this spectrum. Notably, some UHF spectrum is currently used by "translators" (that relay UHF TV signals to more remote areas), wireless microphones, and Low Power TV licensees. The use of UHF TV spectrum by such entities admittedly raises additional implementation issues that must be addressed in order to put my proposal into practice. Given the amount of value that can be unlocked by facilitating the use of this spectrum by other entities, however, I am reasonably confident that such concerns can be addressed. Nonetheless, because this paper does not attempt to address all such implementation challenges, it is important to view this proposal as providing a "conceptual framework" for a new direction for spectrum policy reform and not a refined proposal.

This proposal is admittedly less necessary than it once was because the digital television transition will enable the UHF TV spectrum to be used more efficiently. Nonetheless, even after the transition is complete, there will still be a large amount of unused UHF TV spectrum. To be sure, some of the UHF TV spectrum is intentionally left unused to protect against interference by competing TV stations, but lower-powered services, with appropriate safeguards, can still use such spectrum without creating such interference.[31] Consequently, it is an unfortunate state of affairs that, after the digital television transition, the vacancy rates for TV stations will vary from 20 to 30 percent in coastal and more densely populated markets (such as Trenton, New Jersey) to 70 percent in more remote areas (like Columbia, South Carolina) (Free Press and New America Foundation 2006).

The case of Colorado's UHF stations exemplifies the extent of the unused spectrum and the huge opportunities for liberalizing the use of the UHF broadcast TV spectrum. Under the current spectrum management plan, certain channels are left "unused" since channels in adjacent states as well as adjacent channels in Colorado depend on those channels not being used as a means of protecting their transmissions from interference. If, however, the relevant rights to use (or not use) spectrum were assigned to the protected stations, they would be in a position to appreciate the economic value of the spectrum and enable the spectrum to be put to use either by selling their right to operate or by developing cooperative arrangements that will enable this spectrum to be used. One company, for example, reportedly paid around $55 million in the recent auction for a 12 MHz regional license covering the Denver-Boulder metropolitan area (FCC 2008a), meaning that the spectrum now dedicated to unused channels 25–28 could be worth as much as $110 million. If, moreover, the same type of transaction would make sense for Entravision (a Spanish-language station) and could be engineered

31. Reply Comments of New America Foundation to the *First Report & Order & Further Notice of Proposed Rule Making* in Unlicensed Operation in the TV Broadcast Bands, 21 FCC Rcd 12,266 (Sept. 5, 2007), http://www.newamerica.net/publications/resources/2007/reply_comments_oet_unlicensed_device_testing.

successfully, it could sell the right to use Channels 48–51, with an equivalent amount and value of spectrum involved.

To be fair, the "repacking" of the UHF TV spectrum after the digital television transition will ensure a more effective use of the relevant spectrum bands and thus addresses, to some degree, the longstanding concerns about the relative inefficient use of spectrum by UHF TV analog broadcasting.[32] Nonetheless, it seems clear that some such inefficiencies and white spaces will continue after the digital transition. Consequently, for example, WISPs are unable to use this precious spectrum to provide wireless broadband in rural parts of the state even where such operations would not remotely interfere with the relevant transmissions.

B. Reexamining the White Spaces Debate

The opportunity to transform the use of the UHF TV spectrum along the lines discussed above would change the nature of one of the hottest debates in spectrum policy today. Accepting as political reality or destiny that UHF TV broadcasting will continue indefinitely, a coalition of technology companies have suggested that this spectrum could be used more effectively if the parts of this spectrum left unused—the so-called white spaces—could be authorized for unlicensed uses.[33] This debate is now four years old. On March 28, 2008, *Thomson Financial News* reported that the FCC is continuing to flirt with different proposals to authorize this spectrum for use by unlicensed devices and test equipment designed to allow the use of such spectrum without interfering with existing transmissions ("White Spaces' Test Device Breaks Again"). In a wrinkle in this debate, some parties, including the cellular providers, are now suggesting that the white spaces be auctioned off to the highest bidder. Under either formulation, the white spaces proposals would leave intact the current UHF TV assignments, thereby preventing a large amount of spectrum from being made available for more socially valuable uses.

My proposal, in contrast, seeks to transform radically the debate on white spaces by removing the reason that so many white spaces exist. In particular, the proposal would likely enable a wide swath of UHF spectrum to be made available for other uses. For the spectrum not freed up under this proposal (i.e., maintained for UHF broadcasting), there would still be an opportunity to introduce some form of access to the white spaces of the spectrum. Moreover, some portion of the spectrum freed up as a result of my proposal should be reserved for unlicensed spectrum.

The white spaces debate is not merely about the virtues of creating more licensed or unlicensed bands of spectrum. Rather, there are a number of users of UHF TV spectrum who are concerned that additional users will disrupt the operation of their legacy devices. In terms of wireless microphones, for example, there are certain products now in the marketplace that could be adversely affected by a more intensive use of this spectrum. Nilay Patel reports that, in the medical telemetry context, there is a similar concern that certain legacy devices could be adversely impacted by new technologies that use existing white spaces used by such equipment ("White Space Networking Could Disrupt Hospital Telemetry Systems," Engadget, April 28, 2008).

There are two responses to the concern about legacy devices. First, as suggested by some advocates of using the white spaces for unlicensed devices (namely, Google), there are strategies for protecting legacy devices and those strategies could be adapted to my

32. For one such indictment, see Peha 2007.

33. Invoking rhetoric evocative of the conventional wisdom that there is no spectrum left for innovators to gain access to, Craig Mundie, Microsoft's chief research and strategy officer, suggested to reporter Peter Kaplan that "[w]hite space activity today is sort of our last hope to get some good spectrum" ("Gates Urges U.S. to Free Up More Spectrum for Wi-Fi," Reuters, March 13, 2008, 2).

proposal as well (Google 2008). Second, and more fundamentally, it is critical that established legacy uses—particularly ones that do not use spectrum intensively—not be allowed to prevent socially valuable reforms of spectrum policy. Particularly where such reforms can raise public funds through a windfall tax, there should be adequate means of addressing concerns about legacy users without allowing such users to veto technological progress.

To be sure, there might well need to be some adjustments to my proposal to align it with public policies that support small broadcast TV stations. Given the thrust of my proposal, any TV station would need to agree to participate in the auction in order to be affected. If Congress is concerned about losing the delivery of over-the-air TV stations that it deems socially valuable, it could restrict the eligibility of stations by preventing certain licensees from participating and imposing a set of restrictions to limit the eligibility (say, to those stations that could demonstrate a minimal level of over-the-air viewership). Similarly, Congress could prevent certain types of stations, such as public television, from participating in the auction. I would urge some caution in imposing such limitations, however, as certain licensees (like public television stations) might well be able to use this opportunity to attract needed revenue and, at the same time, transition to more efficient transmission systems—both over the air and by means of other technologies (including the delivery of video content over the Internet).

5. Transforming the Culture of Spectrum Regulation

One of the most formidable barriers to the effective use of spectrum is the FCC itself. The agency's history of spectrum management provides a rich series of case studies to illustrate the hazards of what economists call "rent-seeking" behavior—the use of the regulatory process to protect economic rents (either by awarding valuable rights to incumbent firms, preventing entry of competitors, or both).[34] To take one particularly poignant example, the inventor of FM radio technology (Columbia University Engineering Professor Edwin Howard Armstrong) spent more than twenty years fighting the established AM broadcasting incumbents at the FCC while his patents on the technology expired. Left broke and disheartened by the whole affair, Armstrong committed suicide in 1954, despondent that "'by means of restrictive regulations and slippery measures, a superior scientific advancement could be overwhelmed by the shoddy and the expedient'" (Hazlett 2001, 412–13, quoting Lessing 1954).

For spectrum to be used more effectively, Congress must charter a new mission and structure for the FCC's spectrum management regime or authorize the spectrum to be managed by a new agency entirely. For too much of its history, the FCC has rewarded "the art of spectrum lobbying" that the AM radio incumbents practiced so effectively during the middle part of the twentieth century. (Snider 2007) Indeed, the legacy mindset of the FCC was that incumbent services needed to be protected from competition. For years, for example, the FCC maintained as legal doctrine the premise that new broadcast stations should not be authorized if they would endanger the financial health of existing stations.[35]

Today, however, the FCC needs to adopt the exact opposite mindset—it should focus on how to spur the greatest possible usage of spectrum. In particular, the FCC needs to balance the cost of potential future interference (as managed by interference mitigation strategies) with the benefits of more intensive use of the spectrum. Moreover, whereas the FCC historically minimized the use of spectrum by adopting highly conservative measures to guard against possible interference, the challenge today is to ensure the more efficient uses of spectrum even if that means allowing for the possibility of more interference. To do so, the FCC must become more comfortable with and competent at using after-the-fact oversight to evaluate whether interference happens in fact—as opposed to the FCC's historic reliance on overly protective measures that seek to avoid even the hint of possible interference. In short, for the FCC (or a replacement agency) to manage spectrum effectively, it must adopt a new mission and reform its institutional processes.

A. The Foibles of Spectrum Regulation

Any effective spectrum reform program must ensure that the rights to use spectrum are defined and enforced effectively. Currently, the boundaries of the right to use spectrum are left ambiguous and subject to time-consuming and costly proceedings at the FCC, constituting, in effect, a tax on the efficient use of spectrum. Spectrum rights are defined and enforced almost entirely through front-end proceedings that can go on interminably, require political clout to be resolved, and place the burden of proof on the party seeking to use the spectrum more efficiently.

34. Thomas Hazlett (2001b) catalogues many such examples.
35. See Carroll Broad. Co. v. FCC, 258 F.2d 440, 443 (D.C. Cir. 1958) (holding that additional stations should not be assigned if they could endanger the vitality of current ones); but see Policies Regarding Detrimental Effects of Proposed New Broadcasting Stations on Existing Stations, *Report & Order*, 3 FCC Rcd. 638, 638 (1988) (abolishing *Carroll* doctrine).

Various examples show that the terms of FCC granted licenses are very prescriptive and require licensees to petition inefficiently for flexibility on the front end. Consider, for instance, that Qualcomm's spectrum license that it uses to provide its MediaFLO service, which is being offered today in some markets, delivers video content to cellular phones via spectrum that Qualcomm purchased at an auction.[36] As it evaluated how the service would work in practice, Qualcomm concluded that the service *might* create interference with adjacent services and petitioned the FCC for guidance, suggesting several measures that would limit any possible interference to a negligible level. Qualcomm filed this petition because the FCC's spectrum management regime provides little flexibility for firms to roll out new services and generally refuses to address interference issues if they arise.

Despite being a well-heeled, firmly established, and respected company, it took Qualcomm and its lobbyists twenty months to receive a response from the FCC that included a decision that authorized it to roll out this service and a roadmap for doing so. By FCC time, the decision came at the speed of light (especially compared to the still-unresolved DARS/WCS dispute that I discuss below). Unfortunately, its value is limited because it did not provide any form of general guidance, but rather offered the equivalent of a ticket "good for this ride only." By so doing, the FCC made clear that any analogous request would need to be brought to it for a decision based on the broad public interest standard and a case-by-case determination system notorious for its rent-seeking (i.e., delay-inducing) behavior. As Thomas Hazlett colorfully put it, the FCC has historically declined to move away from a system that creates "a moral hazard for incumbents who are rewarded for raising interference complaints simply to block competition" (Hazlett 2003, 486).

For a second case of how the FCC's lack of well-defined rights in spectrum undermines the more efficient use of this valuable resource, consider the now very long-running battle between the Digital Audio Radio Service (DARS) licensees (who use the spectrum for satellite radio) and the Wireless Communications Service (WCS) licensees (who may well use the spectrum for wireless broadband). The dispute arises because the DARS licenses are sandwiched between 15 MHz blocks allocated to WCS, and the technology used by the two systems threatens to interfere with one another's services. In particular, the terrestrial repeater network of the DARS system (which enables satellite radio to be transmitted more effectively in urban areas) operates at a much higher power level than the technology authorized for the WCS licenses (at 40 kilowatts compared with the FCC-mandated 2 kilowatt power cap for WCS companies), meaning that the services in the WCS band are likely to face considerable interference from "out of band" emissions. The dispute between the WCS and DARS licensees over what protections against interference should be instituted has raged on since the DARS licensees were granted special temporary authority to operate in 2001.[37]

Since 2001, each side in the DARS-WCS dispute has marshaled a number of proposals to address the issue and—as of this writing—it remains undecided. During this entire period, the WCS spectrum remains unused and, according to the WCS licenses, unusable.[38] Here, like the Qualcomm example, the FCC's insistence on deciding each case with specifically tailored rules on interference protection creates a bottleneck that prevents spectrum from being used efficiently. Given the premium placed on arguing for front-end regulatory protections, parties are less invested in (and indeed are discouraged from) acknowledging or developing available technological solutions. This means, for example,

36. Qualcomm Incorporated Petition for Declaratory Ruling, *Order*, 21 FCC Rcd. 11,683, 11,684 (2006). Qualcomm planned to offer between 50 and 100 local and national channels either in real time or in clip-casting for later viewing. *Id.*
37. Sirius Satellite Radio, Inc., *Order & Authorization*, 16 FCC Rcd. 16,773, 16773 (2001).
38. Indeed, not only has the FCC failed to decide the relevant issues, it reportedly scuttled—by threatening unrelated conditions—a merger between the licensees that would have addressed the interference concerns.

that parties are reluctant to acknowledge that, with stricter requirements on power levels, the licensee could still deliver an effective service by using more repeaters (or transmitters), a more dense architecture (such as a cellular-type system) or less sensitive (and more expensive) receivers (i.e., ones that can filter out other signals). Rather, parties are generally motivated to claim, as the WCS licensees have, that without more protective rules against interference they cannot offer a service at all.

The legacy regulatory framework engenders unnecessary administrative costs and delay, as shown by the case of the authorization of satellite providers to use their spectrum for both satellite and terrestrial uses under the FCC's "Ancillary Terrestrial Component" decision.[39] Under the FCC's practices, a firm asking for new uses of spectrum must specify the particular technology it has in mind. To that end, Globalstar, a satellite operator who sought the ancillary terrestrial component authority, suggested that it would be using its spectrum with a technology known as CDMA. Thus, under the terms of the FCC's decision granting it that authority, Globalstar is only authorized to use CDMA technology—even if the technology it would rather use (WiMAX) would not create materially different power levels or a notably different likelihood of interference. As a result of this regime, Open Range, a licensee of Globalstar, is now forced to wait at least three to four months—and quite possibly longer—just to receive authority to use a different technology that will not detrimentally affect neighboring licensees in any material fashion.[40] In short, this sort of rule only creates value for the lawyers versed in the FCC's processes and serves neither to avoid interference nor to promote the efficient use of spectrum.

The Qualcomm, WCS/DARS, and satellite spectrum case studies underscore a lesson about spectrum management that Ronald Coase (1959) offered more than forty years ago: if the FCC would define rights to use the spectrum effectively, parties could operate with greater flexibility and, where necessary, bargain with one another to reach an efficient outcome. By contrast, if the FCC insists on micromanaging the particular uses of spectrum, parties will have the incentive to seek relief at the agency. After all, why attempt to reach a bargain when it may well be cheaper to get one's way at the agency? Unfortunately, under the current system, where the FCC allows proceedings to go on for years, the spectrum remains unused or vastly underused while parties attempt to gain a favorable result from the FCC. By contrast, as highlighted by the satellite spectrum case, a focus on ends (i.e., power density) would facilitate a far more efficient use of spectrum than one focused on means (i.e., the particular technologies used by a licensee).

A second and related aspect of the FCC's flawed system of spectrum management is that not only does it fail to define more particularized rights to use the spectrum, but also it insists on an overly conservative system of spectrum regulation. A hallmark of this system, for example, is the use of guard bands between different transmitters. In the case of television broadcasting, this practice is particularly easy to appreciate—if there is a Channel 3 in Philadelphia, there will not be one in New York, lest some households will be unable to receive either transmission (as the rival signals will interfere with one another). To be sure, more sophisticated (and expensive) transmitting and receiving equipment could solve this problem, but the FCC's system of interference management was predicated on the use of cheap equipment and the view that spectrum

39. Spectrum and Service Rules for Ancillary Terrestrial Components in the 1.612.4 GHz Big LEO Bands, *Second Order on Reconsideration, Second Report & Order, & Notice of Proposed Rulemaking*, 22 FCC Rcd. 19,733, 19,745 (2007).
40. Ibid. at 19,745–49, re: extra time needed for comment period.

could be used inefficiently to avoid interference. Even if this was once a sound policy, it clearly is no longer appropriate.

A third shortcoming of the FCC's spectrum management regime is that it often fails to welcome and spur the use of advanced radio technologies such as "smart radio" systems. To its credit, the FCC has, in some cases, endeavored to ensure that the spectrum is used more effectively (notably, based on a tighter repacking of the spectrum after the digital television transition). In most cases, however, the absence of economic incentives—in the form of allowing spectrum trading or incentives for interference avoidance—for more efficient spectrum use leaves spectrum vastly underused. Stated differently, if all parties can argue for greater levels of interference protection, they will do so; if, by contrast, they are encouraged to engineer ways to tolerate and manage interference—and be paid for doing so—they will take advantage of that opportunity.

A particularly instructive case study of the nature of the spectrum regulation game under the current regime is the episode involving the regulation of low power FM.[41] Finding minimal risk of interference, the FCC authorized community groups to use the "spaces" between stations on the FM dial to operate radio stations that would bring new and diverse programming to the public. The National Association of Broadcasting (NAB), however, took the position that any possible interference was too much and conducted a set of tests under the worst of all conditions, evaluating whether any receivers—say, the cheapest ones in strategically selected locations—would be affected adversely by the new stations. Reflecting NAB's lobbying power, Congress acted on its complaint and, in a rare move, overruled the FCC. Several years later, an independent study validated the FCC's earlier conclusions, determining that there "appears to be no public interest reason" for the restrictions that Congress imposed on the FCC's low power licensing program and recommended that Congress reconsider its decision (FCC 2004a, 4). To date, however, the congressional decision remains in place and the possibility of new low-powered stations remain the victim of the old spectrum regulation game.

The low power FM saga underscores a crucial fact about interference. In particular, interference is a slippery concept because it reflects the interaction of both the transmitted radio signals and the affected receivers. In most cases, interference can be avoided by upgrading or altering either the transmission system or the affected receivers. Consequently, a crucial challenge for policymakers is to institute a regulatory regime that provides licensees with the incentive and ability to negotiate with one another to mitigate interference in the most efficient fashion possible. Under such a regime, the key role for the government is to define and enforce the relevant property right.

As noted above, interference results from the interaction of the transmission system and the relevant receiver. In technical terms, the issues are sometimes referred to as "the adjacent channel leakage ratio" (ACLR) from the undesired transmitter and the "adjacent channel selectivity" (ACS) of the receiver. For a good discussion of these concepts, see Comments of Society of Broadcast Engineers (Society of Broadcast Engineers 2003). As that document explains, a very effective transmission filtering system—to minimize the ACLR—can be undermined by a crude and unsophisticated receiver. Similarly, even sophisticated and relatively expensive receivers can be undermined by an ineffective transmission system. Ideally, the relevant regulatory requirement provides for a benchmark level of protection—what is expected of transmission systems and of receivers—that gives rise to bargaining between the two parties to adjust the level to the socially optimum amount. In principle, as highlighted by the Coase

41. The description below reflects the discussion of the issue in Nuechterlein and Weiser 2005, 240–42.

Theorem discussed above, the establishment of the property right will enable the parties to agree on a greater or lesser level of protection than that defined by the regulator, based on whether it is cheaper to upgrade the relevant receivers or improve the transmission system. Notably, this model of bargaining assumes—not always correctly—that the spectrum licensee can control and manage the quality of the receivers used in connection with its service. Similarly, as noted below, a licensee invariably prefers an entitlement closer to its optimal state of affairs—spending less on a transmission system or on upgrading its receivers—and can be expected in engage in "rent-seeking" behavior to avoid having to incur any such costs and to ensure that any relevant competitors have to incur such costs.

B. Toward a New Mission for Spectrum Regulation

As evinced in the Qualcomm case, there are considerable costs to a system of defining spectrum use rights on a case-by-case basis. Notably, in many spectrum bands the practice of using entirely front-end regulations to avoid interference means that large geographic areas are left without any service in order to avoid the possibility of interference. In Colorado, for example, the "aggressive" approach of authorizing two entities to use Channel 23—one in Glenwood Springs (in the western part of the state) and one in Sterling (in the northeast corner of the state)—still leaves considerable parts of the spectrum unused. In short, the reason for this inefficient assignment of the right to use the spectrum is that spectrum regulation is predicated on the types of hypothetical possible interference that might result to even a single unsophisticated receiver.[42]

My call for an increased emphasis on after-the-fact oversight is entirely consistent with and complements an effective use of front-end modeling. As I see it, the FCC should authorize an array of spectrum use rights—presumably ones that approximate existing expectations—and then implement a system to evaluate whether the expectations of the model were borne out in practice. Stated in more legalistic terms, the FCC's practice of adhering to a general definition of "harmful interference" and providing further guidance only on a purely case-by-case basis (as it did in the Qualcomm matter discussed above and has thus far failed to do in the WCS context) restricts the ability to use spectrum efficiently. By reforming this practice, the FCC could, as Paul Margie so effectively put it, "maximize total utility in each band rather than to minimize interference to any individual spectrum user" (Margie 2003, ¶67). And as the GAO explained, "[F]or most frequency bands [the] FCC allocates, the agency issues service rules to define the terms and conditions for spectrum use within the given bands. These rules typically specify eligibility standards as well as limitations on the services that the relevant entities may offer and the technologies and power levels they may use. These decisions can constrain users' ability to offer services and equipment of their choosing" (Hecker 2006, 7).

To enable regulators to institute an effective set of front-end models, it is critical that an after-the-fact oversight regime be put into practice. Since the front-end modeling regime has served as the only tool to protect licensees against interference, the general practice in the United States and elsewhere is to adopt overly conservative models.[43] Indeed, this strategy, which was used to great effect

42. It merits note that the FCC's legacy interference mitigation strategy is not required by the relevant statutory standard, but rather is borne out of a tradition of incumbent-protecting regulations. The relevant statutory provision authorizes the FCC to develop a regulatory regime to address the "interference potential of devices which in their operation are capable of emitting radio frequency energy . . . in sufficient degree to cause *harmful* interference." 47 U.S.C. § 302a(a) (2006) (emphasis added); see also 47 C.F.R. § 15.3(m) (2004) (defining "harmful interference" as "any emission, radiation or induction that endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radiocommunications service"). With respect to its authorization of unlicensed devices under the so-called Part 15 rules, the FCC has implemented this mandate through both before-the-fact requirements based on hypothetical models of spectrum use and an after-the-fact requirement that devices cease operation if harmful interference occurs (47 C.F.R. § 15.5(b) (2004); *id*. at § 15.5(c).) Nonetheless, even in the unlicensed context, the FCC has generally focused entirely on front-end restrictions on spectrum use and has eschewed after-the-fact mechanisms that focus on the use of spectrum in practice.

in the low power FM saga, remains the principal modus operandi at the FCC.[44] The institutional strategy for spectrum reform thus faces two formidable challenges: (1) creating more effective and particularized front end models; and (2) transitioning to the use of less conservative front-end models and a greater reliance on addressing interference concerns in practice as opposed to in theory. Some commentators have pointed to the successful use of flexible rules in the cellular environment (Hazlett 2001, 507). As Dale Hatfield and I discuss elsewhere, however, the cellular context is unique because of the particular technology of low powered, cellularized uses (which create limited interference to neighboring uses) and marketplace circumstances of a few major (and repeat) players (who are motivated to address interference issues cooperatively) (Weiser and Hatfield 2008, 588–89).

Even if we must be careful not to generalize too much from the cellular context, it remains a powerful example of the success of spectrum liberalization. In that context, the use of relatively low powered and cellularized systems means that stricter power density limits can be adhered to without much difficulty. Moreover, the nature of the relevant technology—i.e., the relative ease of "cell-splitting"—enables providers to work within an overall aggregate power requirement and manage their spectrum use effectively.

One solution suggested by the success of the regime used in the cellular context is to implement the models used in that environment across the wireless spectrum. This proposal, while attractive for its simplicity, would undermine numerous higher-powered uses of the spectrum. Higher-powered systems would quickly find themselves on the defensive in a world where all spectrum use rights were defined with reference to lower powered systems. A better solution, as Dale Hatfield and I explain elsewhere, is to provide for an array of models of spectrum use that, in effect, "zone" the spectrum and welcome a number of different types of uses in different parts of the spectrum (Weiser and Hatfield 2008, 553–54). Even under such an approach, we acknowledge, there are challenging issues that policymakers will face with respect to how to allow spectrum licensees maximum flexibility without increasing uncertainty and lack of protection for neighboring users (be they co-channel users or adjacent band users of spectrum). Such issues, which can be challenging as a technical matter, become very difficult to solve as a political matter because interested parties are well aware that the resolution of such issues will cost some of them (say, in the need to upgrade equipment). Consequently, policymakers will be required to make such decisions in the face of powerful political forces both for and against different rules governing interference management, making the development of a zoning system for spectrum no easy task.

In short, the challenges of developing a new policy framework are worth confronting as a means of overcoming the core flaw with the FCC's legacy model of spectrum management. The flaw is that the legacy framework adopts the view that every possible interference dispute needs to be resolved by tailoring a set of specific rules to address that dispute. In the case of the WCS/DARS context, for example, the lack of more generalized models of interference management (like the Qualcomm case) leaves the FCC with the unenviable task of tailoring a specific solution that can harmonize competing and specifically identified and authorized uses of the wireless spectrum. Rather than engage in this specific tailoring, the FCC needs to adopt a set of different models to govern interference management and allow parties to bargain within the framework of those rules to reach win-win bargains. By so doing, spectrum licensees could also be given

43. See Hatfield and Tenhula 2007, which states that models are typically based on "worst-case" scenarios, and hence, are overly conservative.

44. See Joiner, Paul, Cai and Drocella, who describe interference-based frequency assignment process designed to create more efficient use of spectrum.

the freedom to make a potentially efficiency-enhancing choice—operate within the confines of a more conservative model or be willing to be more aggressive on the condition that they would need to adjust their operations (and/or pay damages to adversely affected firms) if they created interference in practice.

With an effective system for evaluating the use of spectrum in practice, both the FCC and parties could move away from the legacy strategy of addressing all possible concerns up front. In its recent decision involving Broadband over Powerline (BPL), the FCC has experimented with the strategy of allowing more flexible uses of spectrum and addressing interference concerns after they arise. Ironically, in the judicial decision affirming the use of an after-the-fact strategy, the D.C. Circuit Court of Appeals overturned the FCC's order on other grounds, highlighting an instructive lesson for spectrum regulation in the process. With respect to the development of an after-the-fact oversight regime, the BPL decision required BPL providers to register their operation in a database, be capable of "notching" their operating power to respond to complaints of interference, avoid or adjust their use of particular frequencies, and shut down altogether if necessary.[45] On appeal, amateur radio operators (ham radio operators) claimed that the use of an after-the-fact oversight regime that would merely require a "notching" of power levels by BPL providers failed to sufficiently protect them against interference. The court rejected this claim, highlighting that the notching requirement, once implemented, would ensure that harmful interference did not take place.[46]

The FCC's rationale for adopting an after-the-fact review strategy in the BPL case bears notice and highlights the value of using this approach more broadly. In particular, the FCC justified its approach on the ground that it could both "promote and foster the development of [the] new technology [BPL] with its concomitant benefits while at the same time ensuring that existing licensed operations are protected from harmful interference."[47] Notably, the FCC took this action where it could explicitly foresee the social benefit in terms of technological development. In most cases, however, there will be technological benefits that are not easily foreseeable—as was the case with the advent of Wi-Fi, for example—and, unless the agency adopts the after-the-fact strategy more broadly, those breakthroughs will be delayed (or frustrated entirely). In particular, if the sponsor of the new technology requires flexibility not afforded under the existing service rules and needs to undertake a costly proceeding designed to implement an after-the-fact oversight regime designed to authorize that technology, that entrepreneur might decide that the effort is not worth the candle.

The reasons why the FCC's BPL Order was overturned by the D.C. Circuit underscore a number of the key failings of current spectrum policy practices. In essence, the D.C. Circuit expressed serious concerns about how the FCC developed its model for evaluating the use of the relevant spectrum bands. As the court explained, the FCC had failed to make available for evaluation the particular measurements that informed its judgment about how its regulatory strategy would work in practice and why it would be effective. By so doing, the FCC violated the Administrative Procedure Act's requirements that agencies must make public "the 'technical studies data' upon which the agency relies" in establishing binding regulations (*American Radio Relay League Inc. v. FCC* 2008a, 5). As the court underscored, "It would appear to be a fairly obvious proposition that studies upon which an agency

45. Amendment of Part 15 Regarding New Requirements and Measurement Guidelines for Access Broadband Over Power Line Systems, *Report & Order*, 19 FCC Rcd 21,265, 21,291-96 (2004).
46. American Radio Relay League, Inc. v. FCC, No. 06-1343, 2008 WL 1838387, 9-10 (D.C. Cir. Apr. 25, 2008), http://pacer.cadc.uscourts.gov/common/opinions/200804/06-1343-1112979.pdf.
47. Carrier Current Systems, Including Broadband Over Power Line Systems, *Notice of Proposed Rulemaking*, 19 FCC Rcd. 3335, 3355 (2004).

relies in promulgating a rule must be made available during the rulemaking in order to afford interested persons meaningful notice and an opportunity to comment" (ibid., 7). As the court concluded, "the Commission can point to no authority allowing it to rely on the [unpublished] studies in a rulemaking but hide from the public parts of the studies that may contain contrary evidence, inconvenient qualifications, or relevant explanations of the methodology employed" (ibid. 8).

What the D.C. Circuit left unsaid in the BPL decision is that the FCC's inclination not to make public the entire basis for its judgment reflects a more fundamental challenge in reforming spectrum policy. Both in terms of establishing front-end models for spectrum use and in superintending an after-the-fact oversight regime, the FCC (or another agency chartered to regulate spectrum) will need to adopt a rule-of-law mindset and escape from the legacy of legislative-like (and often secretive) deal making. To do so, however, will require institutional reforms in terms of how the agency functions, including an increased use of commissioning outside, independent studies that are put on the record, and independent adjudication by administrative law judges that are reviewed by the full FCC. To the extent that the agency proves resistant to such reforms, and evinces a continued willingness to act contrary to rule-of-law values, Congress will need to establish an alternative means of managing the spectrum.[48]

In short, the historic reliance on front-end safeguards over after-the-fact oversight is a trade-off that we are loath to make for other parts of our society and we should not tolerate it in the case of spectrum management. Imagine, for example, rules that limited the number of cars that could be licensed to drive out of fear of traffic congestion. Such a regime would surely accomplish its mission, but like rules limiting how spectrum could be used, it would have the unfortunate side effect of leaving many roads underused while would-be drivers were frustrated by the wait or expense of getting an artificially limited opportunity to drive. Given that the wireless spectrum provides the platform for an increasingly significant portion of our economy, it is critical that policymakers reorient their strategy to enable the most possible efficient and innovative uses of the spectrum, migrating away from the legacy of restricting and prescribing its use in a manner that undermines economic efficiency and innovation.

48. Some commentators see the FCC (or even another administrative agency) as inherently unable to confront this challenge. Consequently, they advocate a role for courts to play in this regard, often assuming away some of the technical challenges noted above (e.g., Spiller and Cardilli 1999). As Dale Hatfield and I discuss elsewhere, there are compelling reasons to believe that an expert agency—and not generalist judges—can better handle enforcement of spectrum property rights (Weiser and Hatfield 2008, 600–601).

6. Conclusion

Spectrum policy remains one of the most significant tools for economic progress to escape the attention of Congress. For the most part, Congress views spectrum policy as a beneficial and politically expedient means of raising revenue—i.e., through auction revenue. Ironically, it is the billions of dollars yielded by recent auctions that underscore the socially high price imposed by antiquated and ineffective spectrum regulations that limit access to wireless spectrum. Given the importance of spectrum to promoting the ongoing revolution in wireless technologies, policymakers should grasp the mantle of spectrum reform and resume the spectrum reform initiative that hit its apex with the issuance of the Spectrum Policy Task Force's report (2002). To be sure, spectrum reform will confront political obstacles and require a challenging reorientation of the FCC's legacy mindset. But given the economic opportunities that can result from undertaking the initiatives outlined above and others like them, such an effort is clearly worth the candle.

References

Allred, Elizabeth, Eddie Gouge, and Ian Maw. 2008. "R & D in the U.S. Department of Agriculture." American Association for the Advancement of Science (AAAS), Washington, DC. http://www.aaas.org/spp/rd/09pch10.htm.

American Radio Relay League Inc. v. FCC. 2008. No. 06-1343, 2008 WL 1838387 (D.C. Cir. April 25). http://pacer.cadc.uscourts.gov/common/opinions/200804/06-1343-1112979.pdf.

Anritsu. 2007. "Solving Your Radio Frequency Interference Problems." Author, Kanagawa, Japan. http://www.eu.anritsu.com/files/11410-00388.pdf.

Australian Communications and Media Authority. n.d. "Register of Radiocommunication Licenses." Author, Melbourne, Australia. http://web.acma.gov.au/pls/radcom/register_search.main_page.

Ayres, Ian, and Robert Gertner. 1989. "Filling Gaps in Incomplete Contracts: An Economic Theory of Default Rules." 99 *Yale Law Journal* 87, 90–95.

Brandeis, Louis D. 1914/1995. *Other People's Money and How the Bankers Use It*. Boston: Bedford Books of St. Martin's Press.

Carrier Current Systems. 2004. "Including Broadband Over Power Line Systems; Notice of Proposed Rulemaking." Federal Communications Commission, Washington, DC.

Carter, Kenneth R., Ahmed Lahjouji, and Neal McNeil. 2003. "Unlicensed and Unshackled: A Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues." OSP Working Paper No. 39, Federal Communications Commission, Washington, DC. http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-234741A1.pdf.

Cave, Martin. 2002. "Review of Radio Spectrum Management: An Independent Review for Department of Trade and Industry and HM Treasury 13." Department of Trade and Industry, Her Majesty's Treasury, London. http://www.ofcom.org.uk/static/archive/ra/spectrum-review/2002review/1_whole_job.pdf.

Coase, R. H. 1959. "The Federal Communications Commission." *2 Journal of Law and Economics* 1, 17–40.

Digital Millennium Copyright Act of 1998. 17 U.S.C. sec. 512(f).

Europe Economics. 2006. "Economic Impact of the Use of Radio Spectrum in the UK." http://www.ofcom.org.uk/research/radiocomms/reports/economic_spectrum_use/economic_impact.pdf.

Federal Communications Commission (FCC). 2004a. "FCC Report to the Congress on the Low Power FM Interference Testing Program." Pub. L. No. 106-553 4.

———. 2004b. "Wireless Telecommunications Bureau Lists Private Land Mobile Licenses Cancelled as a Result of the Spectrum Audit." (June 8.) http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-04-1553A1.pdf.

———. 2007. "FCC Adopts 13th Annual Report to Congress on Video Competition and Notice of Inquiry for the 14th Annual Report 3." (November 27.) http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-278454A1.pdf.

———. 2008a. "Auction 73 Bid Results." (March 18.) https://auctionbidding.fcc.gov/auction/index.htm?CFID=3646092&CFTOKEN=41262863&jsessionid=HHSvLZsJ3Mmz6ltH1LSvLbvk1DwSklyn9b3WzTMHynLTD6zvhB1F!-1279171738!-1932773479!1213820041659.

———. 2008b. "Wireless Telecommunications Bureau Seeks Comment of Request by Progeny LMS, LLC for Waiver of Location and Monitoring Service (LMS) Construction Rule." *Public Notice*, DA 08-1027, WT Dkt. No. 08-60, 2008 WL 1946039. (May 5.)

Free Press and New America Foundation. 2006. "Measuring the TV 'White Space' Available for Unlicensed Wireless Broadband." Michael Calabrese and Ben Scott, Washington, DC. http://www.newamerica.net/files/whitespace%20summary.pdf.

Goodman, Ellen. 2004. "Spectrum Rights in the Telecosm to Come." 41 *San Diego Law Review* 269, 320.

Google. 2008. "Ex Parte Comments of Google to the Report & Order & Further Notice of Proposed Rulemaking in Unlicensed Operation in the TV Broadcast Bands." ET Dkt. No. 04-186. (March 21.) http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6519868157.

Government Accountability Office (GAO). 2005. "Telecommunications: Strong Support for Extending FCC's Auction Authority Exists, but Little Agreement on Other Options to Improve Efficient Use of Spectrum." http://www.gao.gov/new.items/d06236.pdf.

———. 2008. "Telecommunications: FCC Has Made Some Progress in the Management of Its Enforcement Program but Faces Limitations, and Additional Actions Are Needed." http://www.gao.gov/new.items/d08125.pdf

Hatfield, Dale N. 1995. "Spectrum Issues for the 1990s: New Challenges for Spectrum Management." Annenberg Washington Program in Communications Policy Studies, Northwestern University, Washington DC. http://www.annenberg.northwestern.edu/pubs/spectrum/spec4a.htm.

Hatfield, Dale N., and Peter A. Tenhula. 2007. "The Potential Value of Decentralized Trunking as Regulatory Precedent for the Introduction of Dynamic Spectrum Access Technology 1." *IEEE Xplore*. http://ieeexplore.ieee.org/iel5/4221461/4221462/04221546.pdf?arnumber=4221546.

Hausman, Jerry A. 1997. "Valuing the Effect of Regulation on New Services in Telecommunications." Brookings Papers on Economic Activity, Microeconomics. Brookings Institution, Washington, DC.

Hazlett, Thomas W. 2001. "The Wireless Craze, the Unlimited Bandwidth Myth, the Spectrum Auction Faux Pas, and the Punchline to Ronald Coase's 'Big Joke': An Essay on Airwave Allocation Policy." 14 *Harvard Journal of Law and Technology* 335, 455–501.

Hecker, Jayetta Z. 2006. "Telecommunications: Options for and Barriers to Spectrum Reform." http://www.gao.gov/new.items/d06526t.pdf.

Joiner, Bernard, Alakananda Paul, Kim Cai, and Edward F. Drocella. 2007. "NTIA: Assessment of Federal and Non-Federal Land Mobile Radio Frequency Assignment Methodologies." http://www.ntia.doc.gov/osmhome/reports/2007/FreqAssignMethods_07_447.pdf.

Kay v. FCC 2005, 393 F.3d 1339, 1341 (D.C. Cir. 2005).

Kay v. FCC 2005, 393 F.3d 1339, 1341 (D.C. Cir. 2005).

Kwerel, Evan R., and John R. Williams. 1992. "Changing Channels: Voluntary Reallocation of the UHF Telecommunications Spectrum." Working Paper No. 27, Office of Plans and Policy, Federal Communications Commission, Washington, DC. http://www.fcc.gov/Bureaus/OPP/working_papers/oppwp27.pdf.

———. 2002. "A Proposal for a Rapid Transition to Market Allocation of Spectrum." Working Paper No. 38, Office of

Plans and Policy, Federal Communications Commission, Washington, DC. http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228552A1.pdf.
Lessing, Lawrence. 1954/1956. *Man of High Fidelity: Edwin Howard Armstrong*. Philadelphia: Lippincott.
Marcus, Michael J. 2008. "Wi-Fi and Bluetooth: The Path from Carter and Reagan-era Faith in Deregulation to Widespread Products Impacting Our World." The Genesis of Unlicensed Wireless Policy: An Information Economy Project Conference, George Mason University Law School, Fairfax, VA. (April 4.) http://www.iep.gmu.edu/documents/WiFi-rev.pdf.
Margie, R. Paul. 2003. "Can You Hear Me Now? Getting Better Reception from the FCC's Spectrum Policy." 5 *Stanford Technical Law Review* 67. http://stlr.stanford.edu/STLR/Articles/03_STLR_5/fsarticle.htm.
McHenry, Mark, and Dan McCloskey. 2004. "New York City Spectrum Occupancy Measurements." http://www.wtapas.org/final-papers/ChicagoSpectrum-McHenry-Session-I-1.pdf.
National Telecommunications and Information Administration. 2008. "Spectrum Management for the 21st Century: The President' Spectrum Policy Initiative." http://www.ntia.doc.gov/reports/2008/FederalStrategicSpectrumPlan2008.pdf.
Neuman, Janet C. 1998. "Beneficial Use, Waste, and Forfeiture: The Inefficient Search for Efficiency in Western Water Use." 28 *Environmental Law* 919, 928–31.
Nuechterlein, Jonathan E., and Philip J. Weiser. 2005. *Digital Crossroads: American Telecommunications Policy in the Internet Age*. Cambridge: MIT Press.
Ofcom. 2005. "Spectrum Framework Review: Implementation Plan." (January 13, 2005.) Author, London. http://www.ofcom.org.uk/consult/condocs/sfrip/sfip/sfr-plan.pdf.
———. 2008. "Progress on Key Spectrum Initiatives." (April 3.) Author, London. http://www.ofcom.org.uk/radiocomms/sfr/sfrprogress/sfrprogress.pdf.
Office of Management and Budget (OMB). 2007. "Preparation, Submission, and Execution of the Budget Section 33." Circular No. A-11. http://www.whitehouse.gov/omb/circulars/a11/current_year/a_11_2007.pdf.
Pacini, Carl, and Michael Bret Hood. 2007. "The Role of Qui Tam Actions under the False Claims Act in Preventing and Deterring Fraud Against Government." 15 *University of Miami Business Law Review* 273, 276–83.
Peha, Jon M. 2007. "The Debate Over TV 'White Space.'" http://www.ece.cmu.edu/~peha/white_space_crowncom07.pdf.
Powell, Michael K. 2002. "Remarks at the Silicon Flatirons Telecommunications Program." University of Colorado at Boulder: Broadband Migration III: New Directions in Wireless Policy. (October 30.) http://www.fcc.gov/Speeches/Powell/2002/spmkp212.html.
Rosston, Gregory L. 2001. "The Long and Winding Road: The FCC Paves the Path with Good Intentions." Stanford Institute for Economic Policy Research Discussion Paper No. 01-08, Stanford University, Stanford, CA. http://siepr.stanford.edu/Papers/pdf/01-08.pdf.
Snider, J. H. 2007. "The Art of Spectrum Lobbying: America's $480 Billion Spectrum Giveaway, How it Happened, and How to Prevent it from Recurring." Working Paper No. 19, New America Foundation, Washington, DC. http://www.newamerica.net/files/WorkingPaper19_SpectrumGiveaway_Snider.pdf.
Society of Broadcast Engineers. 2003. "Comments of Society of Broadcast Engineers to the Third Report & Order, Third Notice of Proposed Rulemaking & Second Memorandum Opinion & Order." 18 FCC Rcd. Author, Indianapolis, IN. http://www.sbe.org/FCCLiaison/+ET%2000-258.Master.2.pdf.
Spectrum Policy Task Force. 2002. "Report." ET Dkt No. 02-135, 3. Author, Federal Communications Commission, Washington, DC. http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228542A1.doc.
Spiller, Pablo T., and Carlo Cardilli. 1999. "Towards a Property Rights Approach to Communications Spectrum." 16 *Yale Journal on Regulation* 53, 83.
Swire, Peter P. 2002. "The Surprising Virtues of the New Financial Privacy Law." 86 *Minnesota Law Review* 1263, 1264–65.
Tapscott, Don, and Anthony D. Williams. 2006. *Wikinomics: How Mass Collaboration Changes Everything*. New York: Penguin Group.
Texaco, Inc. v. Short, 454 U.S. 516, 529 (1982).
Thaler, Richard H., and Cass R. Sunstein. 2008. *Nudge*. New Haven, CT: Yale University Press.
United States v. Locke. 1985. 471 U.S. 84, 105-07 1985.
Weiser, Philip J., and Dale Hatfield. 2005. "Policing the Spectrum Commons." 74 *Fordham Law Review* 663, 675–77.
———. 2008. "Spectrum Policy Reform and the Next Frontier for Property Rights." 15 *George Mason Law Review* 549, 558.

Acknowledgments

Thanks to Pierre de Vries, Ellen Goodman, Bruce Gotlieb, Dale Hatfield, Paul Kolodzy, Paul Margie, Darrin Mylet, Jon Peha, Adam Peters, and Howard Shelanski for helpful comments and encouragement and to Dan McCormick for first-rate research assistance.

Author

PHILIP J. WEISER

Professor Phil Weiser is a professor of law and telecommunications at the University of Colorado. At CU, he has worked to establish a national center of excellence in telecommunications and technology law, founding the Journal on Telecommunications & High Technology Law and the Silicon Flatirons Center for Law, Technology, and Entrepreneurship as well as writing and teaching in the areas of telecommunications and information policy. Over the last ten years, Weiser has co-authored two books (Digital Crossroads: American Telecommunications Policy in the Internet Age [MIT Press 2005] and Telecommunications Law and Policy [Carolina Academic Press 2006]), numerous articles, and has testified before both houses of Congress. Prior to joining the CU faculty, Professor Weiser served as senior counsel to the Assistant Attorney General in charge of the Antitrust Division at the United States Department of Justice, advising him primarily on telecommunications matters. Before his appointment at the Justice Department, Weiser served as a law clerk to Justices Byron R. White and Ruth Bader Ginsburg at the United States Supreme Court and to Judge David Ebel at the Tenth Circuit Court of Appeals. Weiser graduated with high honors from both the New York University School of Law and Swarthmore College.

THE HAMILTON PROJECT

ADVISORY COUNCIL

THE HAMILTON PROJECT

The Brookings Institution
1775 Massachusetts Ave., NW, Washington, DC 20036
(202) 797-6279 ▪ www.hamiltonproject.org

The Brookings Institution