THE UNFINISHED RADIO REVOLUTION: EIGHT PERSPECTIVES ON WIRELESS INTERFERENCE

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Change is in the air: there are likely to be significant new spectrum allocations as a result of the National Broadband Plan, and the march of technology keeps offering new ways to increase the capacity of wireless systems. However, the revolution begun by the end of "command and control" radio licensing and the shift to a more hands-off regime of flexible-use auctioned licenses and unlicensed operation is incomplete. For example, while there is wide agreement on the importance of flexible

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use, the debate over the merits of property rights versus open access have left largely untouched the important matter of defining the optimal operating permissions and governance regime for any new allocations.

The following papers were presented at a half-day conference in Washington, D.C. on Friday, November 12, 2010. The conference set out to address the key unanswered question: How should radio operating rights be defined, assigned, and enforced in order to obtain the maximum benefit from wireless operations? The event was organized by Silicon Flatirons, IEEE-USA, and ITIF, and co-sponsored by CTIA, New America Foundation, and FCBA. Reports summarizing the conference and the post-event roundtable discussion are also available.[1]

This event built on a summit on cross-channel interference at Silicon Flatirons in 2009 that analyzed some of the thorny recent radio interference cases.[2] As the summit showed, inter-licensee conflict is greatest across boundaries of different uses, and the increasing diversity of radio uses and users will only serve to amplify this problem.[3] The definition of cross-channel rights and responsibilities has, to date, been ad hoc; this approach is no longer sustainable given the increasing diversity of uses and users, and the need to pack operations ever closer together in order to meet the demand for wireless capacity.

The conference brought together leading economic and legal thinkers to reframe the discussion and grapple with the neglected questions, such as: Not just debating licenses vs. sharing vs. collective use, but designing an optimum rights regime for whichever of these modes is used; not just who should share with whom, but the rules, rights and procedures that would govern and motivate sharing; and not just whether spectrum is being used efficiently today, but what kinds of rights and processes would motivate the most intensive use.

The first paper frames the problem. Here, Goodman looks at the state of play in wireless regulation and concludes that analysts are coming to consensus in many areas.[4] She takes five lessons from recent experience: (1) Things take longer when no one can be held accountable for interference; (2) a failure or inability to deal with the receiver side of

1. Matthew Montgomery, *The Unfinished Radio Revolution: New Approaches to Handling Wireless Interference*, SILICON FLATIRONS CTR., (Nov. 12, 2010), *available at* http://www.silicon-flatirons.org/documents/conferences/2010.11.12-862/TheUnfinishedRadioRevolution.pdf; Kaleb Sieh, *Perspectives on Radio Operating Rights*, SILICON FLATIRONS CTR. (Nov. 12, 2010), *available at* http://www.silicon-flatirons.org/documents/conferences/2010.11.12-862/PerspectivesonRadioOperatingRights.pdf.

2. J. Pierre de Vries, *Radio Regulation Summit: Defining Inter Channel Operating Rules*, SILICON FLATIRONS CTR. (Dec. 2, 2009), *available at* http://www.silicon-flatirons.org/documents/misc/OOBSummit/Inter-channelSummitReportv1.0.1.pdf.

3. *Id.*

4. *See infra* pp. 505-08.

the equation produces sub-optimal entitlements; (3) harmful interference should be a yield sign, not a stop sign; (4) confusing efficient spectrum use with distributional issues is recipe for delay; and (5) the consideration of values associated with spectrum use other than efficiency is under-developed.

The next five papers each make proposals for improving rights definitions. Rosston and Wallsten begin by advancing the importance of a regulatory framework that starts with clear rules, such as using resulting emission rather than transmit power, and allows parties to negotiate efficiency-enhancing changes to those rules.[5] They observe that while well-defined rules are important for both licensed and unlicensed bands, the latter may require stricter rules because trades to maximize efficiency could be prohibitively costly given the diffuse and amorphous group of rights holders. Calabrese continues by arguing for an updated radio regulation regime that promotes pervasive connectivity by defining explicit transmit rights and permissible interference on a band-by-service basis, and recording explicit rights and actual operating parameters of licensees in a public database.[6] This, he argues, will lead to access rights that are more definite, more transparent, and more intensive.

Kwerel and Williams then propose that the FCC revisit its general policy of providing incumbents (those licensed first) protection against any interference resulting from subsequent rule changes since its sequential approach to accommodating change coupled with its interference protection policy toward incumbent uses can be detrimental to putting spectrum to its highest value use.[7] They make two recommendations: Future allocations should self-protect against projected, not just current, adjacent band interference; adjacent band interference protection for incumbents should not be static, but be reduced over time.

De Vries and Sieh argue that the overarching goal of spectrum policy should be to maximize concurrent operation, not minimizing harmful interference; delegate management of interference to operators; and define, assign and enforce entitlements in a way that facilitates transactions.[8] To this end, they propose that the regulator articulates operating rights by using probabilistic resulting-energy transmission permissions and reception protections, stipulate the remedies that attach to an entitlement (i.e. injunctions or damages) when it is issued, and separate its roles as rule maker defining entitlements from adjudicator deciding disputes. Wrapping up the proposals, Feld highlights the

5. *See infra* pp. 509-11.
6. *See infra* pp. 512-15.
7. *See infra* pp. 516-18.
8. *See infra* pp. 519-22.

problem of violations of radio regulations and how many of these share elements of the adverse possession doctrine in real property law.[9] He recommends that wireless policy makers develop a mechanism similar to adverse possession and deal with exceptional cases by developing a set of guiding principles rather than through ad hoc rule making.

The final two papers delve into the practical considerations. Jacobs recognizes the importance of clarifying radio operating rights, but emphasizes the difficulty of the task.[10] Many complex implementation questions have to be addressed, and the dynamic nature of technology and incommensurable policy values attached to different services further complicates matters. He encourages establishing a protection level for new licensees to minimize transition costs, and encourages the FCC to generalize the principles and criteria it uses to set the protection level and measurement approach in order to foster a more transparent and predictable set of rights for future proceedings.

Rath argues that defining the theoretical framework for radio operating rights must be informed by the experience licensees have gained resolving interference issues in an increasingly complex and market-oriented RF environment.[11] She gives two examples: the success of clear, enforceable and negotiable rights, such as those governing mobile wireless, that allow for private agreements; and the need for additional enforcement assistance to prevent unauthorized operator-to-licensee interference from sources such as signal boosters.

9. *See infra* pp. 523-25.
10. *See infra* pp. 526-27.
11. *See infra* pp. 528-30.

PROGRESS TOWARD RATIONAL SPECTRUM RIGHTS: ARE WE GETTING ANYWHERE?

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Analysts from legal, economic, and engineering disciplines have supplied plenty of commentary in the past decade on what ails U.S. spectrum management. At this conference, we have offered a number of competing proposals for how to define the rights of spectrum users to emit signals, the responsibilities of spectrum users to reject noise, how spectrum rights and responsibilities should be recorded, and how conflicts over interference ought to be adjudicated.[13] We have also provided differing views on the proper balance between the prevention of conflicting spectrum uses (frequently called *ex ante* protections) and the resolution of conflicting uses after the fact (*ex post* dispute resolution), as well as varying suggestions for public and private institutional roles.[14]

Notwithstanding difference in the details, it seems that analysts are converging on some important consensus conclusions.[15] These include the following:

- We need much more spectrum made available for mobile broadband
- We need a combination of exclusive rights and shared rights to access spectrum, recognizing that sometimes we will want "easements" or low impact access to spectrum that has otherwise been assigned for exclusive use, sometimes we will want commons spectrum for unlicensed innovation, and sometimes we will want tightly controlled access for specific rights holders
- More intensive use will and should mean more conflicts over spectrum use
- These conflicts should be prevented before the fact by some combination of FCC zoning of compatible uses and industry performance standards
- These conflicts should be addressed after the fact with expedited adjudications and arbitrations, which depend on the creation of the appropriate administrative apparatus (in both private and public institutions)

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13. *See* Montgomery, *supra* note 1.

14. *Id.*

15. *See generally*, FCC, *Connecting America: The National Broadband Plan*, March 17, 2010; *See* Philip J. Weiser & Dale Hatfield, *Spectrum Policy Reform and the Next Frontier of Property Rights*, 15 GEO. MASON L. REV. 549 (2008); Ellen P. Goodman, *Spectrum Rights in the Telecosm to Come*, 41 SAN DIEGO L. REV. 269 (2004).

- Efficient conflict resolution requires that initial entitlements be stated precisely in the license (or license-free allocation) at the outset, and be further articulated in what will be an evolving "common law" allocating responsibilities for mitigating interference
- What the right rule is for allocating responsibilities in any particular spectrum dispute will depend on the kind of services at issue, the relative ability of the parties to address the problem at the receiver or the transmitter, and other public interests (externalities) that may be implicated
- Spectrum use entitlements, both initial and post-dispute, should be made transparent in publicly accessible and user-friendly registries.

While these conclusions have been gestating, battles have played out over the allocation of spectrum for unlicensed and exclusive use, and over the modification of existing licenses to allow for more intensive (and valued) spectrum use.[16] One cannot say that spectrum management has changed much over the past decade or that we have made a great deal of progress in implementing the conclusions stated above. Spectrum management is still pretty much the same as it always has been: highly conservative, protective of incumbents, without clear entitlements and dispute resolution procedures, lacking in the regularity and transparency that would facilitate secondary markets, and, most especially, bogged down in questions of fairness, windfall, strained readings of the public interest, and competitive advantage.

That said, this Commission has made several notable recent decisions to free up spectrum for new uses by modifying existing entitlements and mediating between potential spectrum conflicts. These include the order opening up TV band "white spaces" available for unlicensed fixed and mobile wireless usage,[17] the decision removing obstacles to mobile wireless use of spectrum adjacent to satellite radio,[18] and the proposal to open satellite spectrum to terrestrial wireless use.[19]

16. *See, e.g.*, Thomas W. Hazlett, *Tragedy TV: Rights Fragmentation and the Junk Band Problem*, 53 Ariz. L. J. 83 (2011) (arguing for more licensed spectrum); Kevin Werbach, *The Wasteland: Anticommons, White Spaces, and the Fallacy of Spectrum*, 53 Ariz. L. J. 213 (2011) (arguing for more license-free spectrum); Ellen P. Goodman, *Spectrum Auctions and the Public Interest,* 7 J. TELECOMM. & HIGH TECH. L. 343 (2009) (arguing for spectrum auction design that better accommodates public interest burdens).

17. Unlicensed Operation in the TV Broadcast Bands, *Second Report & Order & Memorandum Opinion & Order*, 23 FCC Rcd. 16807 (Nov. 14, 2008).

18. Amendment of Part 27 of the Commission's Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band, *Report & Order & Second Report & Order*, FCC 10-82 (May 20, 2010).

19. Fixed and Mobile Services in the Mobile Satellite Service Bands, *Notice of Proposed*

There were some innovations on the spectrum management front here and they are worth building on. The most important decision yet to come will probably concern the reallocation of broadcast spectrum for broadband use.

What can we learn from recent experiences? What would it take to accelerate progress?:

1. *Things take longer when no one can be held accountable for interference.* One of the complications of unlicensed use, however desirable it may be, is that it's hard to assign responsibility for interference. This difficulty buttresses the already existing tendency towards conservative allocations and is one of the reasons the White Spaces decision took so long. Innovative "zoning," revocable certifications and registrations, and a certain amount of reciprocity for interference prevention ease this problem. Underexplored is the role that interference insurance might play.

2. *Failure or inability to deal with the receiver side of the equation produces sub-optimal entitlements.* Whether or not incumbents should have the obligation to improve receiver performance will depend on many factors, including the type of network deployed and the state and pace of technological innovation. Much more clear is that the FCC should have the authority to mandate receiver performance, or to mandate compliance with industry-set standards.

3. *Harmful interference should be a yield sign, not a stop sign.* The FCC continues to use predicted harmful interference as a gatekeeper to spectrum entry.[20] The concept is in effect *both* a tool to define rights (new entrant may not cause harmful interference) *and* a tool to assign liability (new entrant is responsible for harmful interference it does cause). Instead, the notion of harmful interference should be, among other elements, what gives a spectrum user a "cause of action" to seek redress. Whether the harm is actually redressable, and by what means, should be separate questions.

4. *Confusing efficient spectrum use with distributional issues is a recipe for delay.* The public interest in spectrum exploitation and the public (and competitor) interests in preventing licensees from getting windfall benefits are distinct. Whether or not spectrum rights should be expanded, who should get to take advantage of expanded rights, and what they should have to pay for them are all separate issues and should be handled separately, with mechanisms for redistribution of benefits where necessary.

Rulemaking & Notice of Inquiry, FCC 10-126 (July 15, 2010).

20. 47 C.F.R. § 15.5(b) (2009).

5. *Consideration of values associated with spectrum use other than efficiency is under-developed.* Reallocation of broadcast spectrum in particular will touch on values that are baked into the current allocation, such as universal service, noncommercial set-asides, and distributed access rights. As with distributional issues, these considerations are conceptually separate from efficient spectrum exploitation, but will need to be dealt with.

ECONOMIC PRINCIPLES FOR *EX ANTE* RULES FOR RADIO

GREGORY ROSSTON AND SCOTT WALLSTEN[21]

In September 2009, Silicon Flatirons hosted a conference featuring a number of relatively recent case studies of radio regulation and interference.[22] The studies highlighted substantial disputes about rights and responsibilities of radio operation in various bands despite apparently detailed *ex ante* rules by the Federal Communications Commission regarding interference.[23] In each case the parties disagreed about whether the transmitter or the receiver "caused" the interference and if so, whether that party was operating within its rights as defined by the FCC.[24]

These case studies highlight the importance of a regulatory framework that facilitates efficient negotiations between licensees to solve problems by minimizing transactions costs. Such a regulatory framework would start with clear rules and allow parties to negotiate efficiency-enhancing changes to those rules.

Well-Defined Rights and/or Rules

Spectrum users are more likely to invest if they understand their own and others' rights well enough to be reasonably sure their long-lived equipment and infrastructure investments will continue to operate without harmful interference from other users, and that their transmissions will not be shut down because they interfere with other users' transmissions.

Focusing on emissions into other bands, the cause of harm to adjacent licensees, rather than on transmission power—which is but one potential cause of harm—should increase certainty and help align incentives with minimizing the transaction costs of adapting behavior. If emissions interfere with an adjacent licensee's transmissions, several solutions not involving the FCC become possible that are not possible,

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22. *See* Silicon Flatirons Ctr., Telecommunications Regulation in Comparative Perspective, Conference, Sept. 9, 2009, http://www.silicon-flatirons.org/events.php?id=681 (last visited Jan. 15, 2011).

23. The bands in the case studies included 800 MHz, AWS-BAS, AWS-3 and WCS/DARS.

24. *See, e.g.,* Improving Public Safety Communications in the 800 MHz Band, *Report & Order*, WT Dkt. No. 02-55, 19 FCC Rcd. 14,969 (2004); Lynette Lun, *M2Z asks FCC to reject more AWS-3 interference tests*, FIERCE WIRELESS (Aug. 15, 2008), http://www.fiercewireless.com/story/m2z-asks-fcc-reject-more-aws-3-interference-tests/2008-08-15.

or at least not likely, today. For example, the licensee could continue to operate in the same way while the adjacent licensee installs receiver filters to ensure its transmissions still work. Alternatively, if the receiver technology is expensive relative to simply reducing emissions from the transmitter, the adjacent licensee could negotiate with the transmitter to change the technology used. Today, such an outcome is not likely because the parties rely on the FCC to change the rules in favor of one party or another, as well as the difficulty in coming to complete agreements when the FCC has the ability to void the same.[25]

In the spectrum context, the well-known Coase Theorem implies that if transaction costs are zero, or simply less than the transaction costs of other options, parties will agree to an efficient solution to the interference problem.[26] In our example, the transmitter would agree to pay to replace the receiver since that is mutually beneficial. The real world, however, is rife with transactions costs, but policy can improve efficiency by reducing these transactions costs.

Licensees that desire to make trades with neighbors can adapt or make trades to allow for different standards that then become part of their new operating rights. However, to facilitate transactions, the rules need to be set and the FCC must credibly commit to not change those rules in response to political or other pressure. While credible commitments are difficult for regulatory agencies, courts tend to protect against *ex post* rule changes when firms make long-lived investments.[27]

Well-defined rules are important for both licensed and unlicensed bands. Unlicensed bands may require stricter rules because trades of the sort described above could be prohibitively costly given the diffuse and amorphous group of rights holders. Because trading of rights and changing technology is more difficult with unlicensed bands, setting up a rational and clear set of rules in advance is more important for unlicensed bands than for licensed bands.

Application to the Case Studies

One key problem with the historic method of radio regulation based on transmitter power has been its difficulties in dealing with technological change, as exemplified by the dispute between Nextel and the public safety community over the 800 MHz transmissions.[28] The

25. *See, e.g,* Matthew Lasar, *Wireless Companies Blast Sirius XM in Spectrum Controversy*, RADIO SURVIVOR (Apr. 9, 2010), http://www.radiosurvivor.com/2010/04/09/wireless-companies-blast-sirius-xm-in-spectrum-controversy.

26. *See* Ronald H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960).

27. *See, e.g.,* Penn Cent. Transp. Co. v. City of New York, 438 U.S. 104, 124 (1978); United States v. Chrysler Corp., 158 F.3d 1350 (D.C. Cir. 1998).

28. FCC, Improving Public Safety Communications in the 800 MHz Band, *Report & Order,* WT Dkt. No. 02-55 (July 2004).

FCC wrote rules for 800 MHz private radios with maximum power limits for "high-tower, high-power" sites.[29] The spectrum allocated to "private radio" was nearly identical in its physical properties to the spectrum allocated to cellular service.[30] Nextel (then FleetCall) convinced the FCC to change the private radio rules so that Nextel could function as a CMRS provider and use "low-tower, low-power" cellular architecture.[31] The low power sites did not exceed the power limits of the high power high tower sites, but nonetheless interfered with public safety receivers operating on adjacent channels.[32]

The rules for 800 MHz transmission could have minimized interference between CMRS providers and public safety providers by requiring Nextel to continue to only use high-tower, high-power sites. But that would have disallowed the technological advances and prevented more efficient use of the spectrum.

The FCC could also have allowed the new technology but only if the CMRS licensees negotiated with the public safety entities for the new rights. Flexibility created by clearly defining the rights upfront and allowing changes to the rights upon agreement by the licensees could have led to a mutually agreeable situation.

Finally, and perhaps the best course, would have been to define initially the rights of 800 MHz licensees differently. Rather than designating technology or transmission power, the rights could have explicitly established a maximum level of emissions into adjacent channels. The private radio licensees and the public safety entities would have both known the rules when they began to construct their adjacent systems and acquire their radios. If Nextel had then decided to use a technology that increased emissions into the adjacent channels, it would have known that it would have to negotiate with the public safety agencies if its new transmission method did not comply with the emission limits. If Nextel's new technology complied with the emissions rules, then the public safety agencies would either have to adapt their receivers or negotiate with Nextel. In both cases, the efficient method of reducing interference would have been selected by negotiation between the parties. Of course, this in part depends on the ability to strike a deal with one or a small number of parties on each side, as transaction costs generally increase with the number of parties needed to reach agreement, all other things being equal.

29. *Id.*
30. *Id.*
31. *Id.*
32. *Id.*

THE NEED FOR WELL-DEFINED YET NON-EXCLUSIVE RADIO OPERATING RIGHTS

MICHAEL CALABRESE[33]

Introduction

As mobile computing becomes ubiquitous, the resulting exponential growth in demand for wireless data transport will strain current spectrum allocation and commercial business models to the breaking point. Silos of exclusively-licensed and lightly-used spectrum will no longer be tolerable. The imperative of increasingly efficient use of spectrum on both an exclusive and shared basis suggests that we need to redefine access rights to spectrum capacity over the next decade to be:

- ***More definite***: Rights to transmit *and* levels of protection from third parties (both co-channel and adjacent channel) should be made *explicit* conditions of new and renewed licenses, and subject to secondary-market transactions.
- ***More transparent***: The definition of these access rights and the operating parameters of all deployments on a licensed band should be registered in a publicly accessible database that can be used to facilitate decentralized coordination and negotiation, as well as opportunistic access to unused spectrum capacity.
- ***More intensive***: Since both shared access to underutilized bands *and* an exponential increase in spectrum re-use will be needed to meet expected consumer data demand, a licensee's affirmative access rights must not preclude the use of any remaining capacity by third parties on a non-interfering basis. Radio rights should conform to a 'use it or share it' ethos.

In short, the FCC needs to return to the unfinished challenge defined by its own 2002 Spectrum Policy Task Force ("SPTF"): To quantify permissible levels of interference on a service-by-band basis.[34] Although Commission staff agreed with a consensus among industry commenters that the "interference temperature" measurements suggested

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34. *See* Press Release, FCC, Spectrum Policy Task Force Presents Recommendations for Spectrum Policy Reform (Nov. 7, 2002), http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228542A1.pdf (listing out the SPTF's recommendations, including the "creation of a quantitative standard for acceptable interference").

by the SPTF appeared unworkable,[35] the concept of quantifying the explicit transmit rights and reception protection that a licensee can count on—on a probabilistic and not absolute basis—would better permit private parties to self-manage issues of interference and shared band access. In contrast, the continued use of a case-by-case, *ex post* adjudication of interference claims will increasingly cause uncertainty, delay, and under-investment.

Outdated Assumptions of Command & Control Interference Protection

Today's spectrum allocations and radio operating rights continue to reflect a dichotomy between the relative availability of spectrum and technology that existed during the first half-century or more of spectrum licensing—but which has nearly reversed itself today. When government licensed broadcast radio and television in the first half of the twentieth century, spectrum was plentiful but technology was primitive. Both assignments and rights reflected an industrial policy goal to stimulate the mass-market penetration of very low-cost reception devices (radios, TVs, and later, analog cell phones) in a context of relative spectrum abundance. Since there was spectrum enough to allocate guard bands several times larger than the actual channels in use, the cost of receivers could be minimized and a precedent set that receivers would not be expected to tolerate any degree of interference from other uses.

The policy of protecting receivers from "harmful interference" became simultaneously absolute (rather than probabilistic or contingent) and vague (since it was defined service-by-service, and only *ex post* in reaction to complaints). Moreover, the concept of licensing *exclusive* access to a channel or band presumed that (a) technology and governance rules could not support the shared use of underutilized capacity, except perhaps where there was no protection from interference at all (viz., on designated unlicensed bands); and (b) there were still sufficient allocations and assignments available to meet the public's need for new services and overall communications capacity.[36]

All of these precepts continue to underlie the licensing of radio operating rights—whether to commercial users by the FCC, or to federal users by NTIA—and all are outdated obstacles to an exponential increase in mobile communications capacity.

35. FCC, 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, *Report & Order*, ET Dkt. No. 03-237 (May 4, 2007), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-07-78A1.pdf.

36. *See, e.g.,* FCC, Wireless Operations in the 3650-3700 MHz Band, *Report & Order & Memorandum Opinion & Order*, ET Dkt. No. 04-151 (Mar. 16, 2005) (suggesting that a non-exclusive licensing approach would accommodate more wireless ISPs by employing technology and coordination that avoids harmful interference).

An Updated Radio Rights Regime

An updated conception of radio operating rights should be based on policy goals that promote pervasive connectivity. It will be far more important to put rules in place that spur innovation and maximize communications capacity than it is to minimize interference per se. Indeed, one of the most oft-quoted passages from Ronald Coase's 1959 article *The Federal Communications Commission* made this point:

> It is sometimes implied that the aim of regulation in the radio industry should be to minimize interference. But this would be wrong. The aim should be to maximize output.[37]

Meeting society's demand for mobile communications capacity will require a concept of radio operating rights and governance that may seem contradictory by today's standards. We need to simultaneously make spectrum use rights more like property (more explicit and certain for the period granted) while also making the overall communications capacity of the spectrum less like property (non-exclusive and open for shared access). That is, we need to provide licensees certainty and flexibility concerning their operating rights—thereby facilitating private negotiations and transactions—while also reserving any unused spectrum capacity to the public itself. Since the public interest in government excluding others from a band (i.e., licensing) lies entirely in the use of the spectrum to communicate, it is the licensee's service—viz., its actual use of the band's capacity—that deserves protection, not its non-use.[38]

In practice, I believe this can be achieved by a combination of definitional *and* governance changes:

1. **Define explicit transmit rights and permissible interference on a band-by-service basis.**

For new and renewed licenses, the Commission should make the complete set of transmission rights (e.g., transmit power, out-of-band emissions) explicit. The Commission should also define the level of protection the licensee can expect for its own operations, although this

37. Ronald H. Coase, *The Federal Communications Commission*, 2 J. L. & ECON. 1, 27 (1959).

38. Of course, this follows from both the statutory definition of the FCC's licensing authority, as well as the Commission's fairly recent and explicit rejection of the argument that it does not have the legal right to authorize users of Ultra Wideband devices to emit energy in licensed PCS bands. Rejecting Sprint's claim that its license rights presume exclusive rights to emit on the band, the Commission firmly stated that "spectrum is not, and has never been, exclusive to Sprint or to any other licensee or user." Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, *First Report & Order*, FCC Rcd. 10,505, ¶ 271 (2002).

should be defined in probabilistic rather than absolute terms. These rights, when first defined, would need to be defined service-by-band and as consistent as possible with neighboring adjacent- and co-channel licensees.

2. **Combine explicit rights and actual operating parameters of licensees in a public database.**

If key policy goals are to maximize useable spectrum capacity and facilitate innovation, then we should want complete transparency into both what licensees have a right to do and *what they actually are doing*. This enables other licensees to design their systems, to change the use of a band, or to attempt to coordinate and/or negotiate with other users. It also enables other potential users to employ dynamic spectrum access technologies or protocols to make use of *unused capacity* without causing harmful interference. Depending on the band, this dynamic access could be based on secondary market transactions, or it could be opportunistic and/or unlicensed. Access to any band with a primary user must be conditional; but a centralized, online information registry "enables secondary users to execute more aggressive spectrum access algorithms at acceptably low risk."[39]

The current opaque and uncertain definition of rights for incumbents and potential entrants alike deters both innovation and more intensive and efficient use of the public's spectrum resource. It is critical to keep in mind that spectrum is an infinitely-renewable public resource, and from second-to-second any capacity that goes unused is wasted. A more definite, transparent, and explicitly non-exclusive definition of spectrum use rights on a band-by-band basis will be critical to supplying the capacity for pervasive connectivity.

39. John M. Chapin & William H. Lehr, *The Path to Market Success for Dynamic Spectrum Access Technology*, IEEE COMMC'NS MAG., May 2007, at 96, 100. Australia established a centralized online device database along these lines as part of its 1997 adoption of Space-Centric Management as a tool to define a complete set of explicit transmit rights for all new licenses to encourage certainty and industry self-regulation. *See* Michael Whittaker, *Authorising Dynamic Spectrum Access Under Space-Centric Management*, FUTURESPACE (Feb. 2009), http://www.futurepace.com.au/_lib/pdf/DSA.pdf.

FORWARD-LOOKING INTERFERENCE REGULATION[40]

EVAN KWEREL AND JOHN WILLIAMS[41]

To facilitate the transition of spectrum to its highest valued use under a flexible licensing regime, we propose that the FCC revisit its general policy of providing incumbents (those licensed first) protection against any interference resulting from subsequent rule changes. It is well known that limiting spectrum licensees to providing specific services using specific technologies ("command and control") can seriously retard the adoption of new highly valuable technologies, such as cellular telephones.[42] The FCC has recognized this and since the early 1990s has been providing for service and technological flexibility for most newly allocated bands.[43]

What is less well known is that the FCC's sequential approach to accommodating change coupled with its interference protection policy toward incumbent uses can also be detrimental to putting spectrum to its highest value use. When considering a new allocation or request for a change in interference rules, the Commission generally considers one item at a time assuming everything else will remain as is.

Rules protecting the adjacent band incumbents are based on a long tradition in spectrum management that incumbents have the right to virtually absolute protection from interference from new users.[44] Because of this, incumbents generally feel little or no pressure from the regulator to improve filtering or implement other additional mitigation measures. The additional limits imposed on the flexible use band are based on an interference model using the incumbent's system parameters and

40. A more detailed exposition can be found at Position Papers, *The Unfinished Radio Revolution: New Approaches to Handling Wireless Interference*, SILICON FLATIRONS CTR., Nov. 12, 2010, http://www.silicon-flatirons.org/documents/conferences/2010.11.12-862/Compendium.pdf.

41. Evan Kwerel is a Senior Economic Advisor at the FCC. John Williams is a consultant at Ambit. The opinions expressed in this paper are those of the authors and do not necessarily represent the views of the FCC or any other members of its staff.

42. *See generally* Coase, *supra* note 37; *see also* M. CAVE ET AL., ESSENTIALS OF MODERN SPECTRUM MANAGEMENT 4-8 (2007).

43. *See* Personal Communications Services, 47 C.F.R. pt. 24.

44. Incumbent users are generally protected from harmful interference with no time limit on such protection. Harmful interference is defined in 47 C.F.R. § 2.1 as interference "which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service." The only exception I can think of is where incumbents are being cleared from a band that is being repurposed for flexible use. For example, incumbent point-to-point systems in the PCS band were protected for a period of time, during which time they could negotiate a premium payment to clear, after which time they were required to vacate as long as the new PCS licensee covered the actual cost of a replacement service. To my knowledge, the FCC has never sunsetted restrictions imposed to protect adjacent band incumbents.

parameters of "expected" use for the flexible licensees.[45] This often results in additional power and other restrictions on the flexible use band that are significantly more stringent than those that apply between flexible use bands, with the effect of reducing the functionality of that band.[46]

Future allocations should self-protect against projected adjacent band interference

When a new allocation is made and there are no incumbents in an adjacent band or the band is lightly used under a command/control type allocation, the FCC should require that licensees self protect against interference exposure from adjacent band(s), *assuming* that those bands would be licensed under the flexible use model. We propose that the interference rules and assumptions protecting the new allocation from interference from the adjacent bands be designed in such a way as to preserve as much as possible the full potential of the adjacent bands for future use under a flexible licensing regime. So, if the adjacent band has a high potential for transition to flexible use, it would not be subjected to technical limits (power, permissible classes of stations, etc) more stringent than would normally apply between adjacent flexible use bands. Since this policy may, in some cases, raise the cost of a new allocation, it should be accompanied with a commitment by the FCC to actually transition the adjacent bands to a flexible regime.

This would internalize the total spectrum cost of accommodating the new use rather than passing some or most of that cost off to someone else. It would also provide better incentives to build more interference-robust systems upfront when it is most efficient to do so. It would also make transparent the opportunity cost of any new allocation in terms of its impact on the spectrum whereas current policy which assumes an adjacent band that is now sparsely populated would remain so hides the full cost of a new allocation.

Adjacent band interference protection for incumbents should not be static

When the FCC establishes a new flexible use allocation, power and other restrictions are often imposed on that band to protect incumbents in adjacent bands.[47] These restrictions can be more stringent than would normally apply between flexible-use bands.[48] While such restrictions may

45. Service Rules for Advanced Wireless Services in the 1.7 GHz and 2.1 GHz Bands, *Report & Order*, FCC 03-251, ¶ 87, 112-131 (Nov. 25, 2003), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-03-251A1.pdf (describing interference protections for incumbents adjacent to the AWS-1 bands).

46. *Id.*

47. *Id.*

48. *Id.*

be equitable to protect the investments of incumbents, they can greatly reduce the potential value of the newly allocated band. Under these static protection policies, incumbents have little incentive to implement even low cost measures to protect themselves since the benefits would go to someone else. Bargaining between new licensees and incumbents in adjacent bands is also generally ineffective due to high transaction costs. The resulting economic loss worsens over time as the value of adjacent spectrum increases and the cost of mitigation technology decreases.

To address this, we propose that when a new flexible use allocation is made and there are incumbents in an adjacent band, restrictions imposed on the new allocation to protect adjacent incumbents against interference be reduced over time to mirror the same protections provided between adjacent flexible use bands.

We would also extend this approach retroactively within the valuable 300 to 3000 MHz range to restore functionality to bands that are good candidates for flexible use. Any stringent power or other restrictions that currently apply to those bands designed to protect adjacent band incumbents (limited to bands within the FCC's jurisdiction) would be reduced to the same level as applies between flexible use bands. Again, this would be accompanied by a commitment by the FCC to actually transition those candidate bands to flexible use so that the benefits can be realized.

Market failures justifying changing interference regulation

Why not rely on the market to efficiently resolve these interference problems? What are the market failures that would justify such a policy change? First, when not all rights have been assigned there is nobody to negotiate with. When an adjacent band is not licensed or not all the rights are assigned (*e.g.,* bands with traditional services such as broadcasting where there is "white space") a new licensee in an adjacent band has no one to negotiate with to design a system that minimizes the total cost of interference. You can't negotiate with future licensees. The direct solution would be to assign all rights. But when most of the spectrum is occupied with traditionally licensed users this is difficult. Kwerel and Williams (2002) address this issue.[49]

Second, even when most rights have been assigned, but many licensees must agree to negotiate a change in the rules, holdout problems, free riding, and generally high transactions costs may prevent achievement of a deal that potentially could make all parties better off.

49. *See* Evan Kwerel & John Williams, *A Proposal for a Rapid Transition to Market Allocation of Spectrum* (FCC Office of Plans and Policy, Working Paper No. 38. Nov. 2002).

THE THREE PS: A RESULTING ENERGY APPROACH TO RADIO OPERATING RIGHTS[50]

J. PIERRE DE VRIES[51] AND KALEB A. SIEH[52]

The radio revolution is incomplete. The shift from "command and control" radio licensing to a more hands-off regime of flexible-use auctioned licenses and unlicensed operation is well under way, but the vital question of how radio operating rights should be defined, assigned and enforced in order to resolve interference disputes and obtain the maximum benefit from wireless operations remains largely unanswered.

The ambiguous definition of rights is a long-standing problem. For example, the FCC's 2002 Spectrum Policy Task Force noted a widespread sentiment that "the Commission's most difficult, controversial, and unsatisfactorily resolved cases have resulted from situations in which the extent of an incumbent's spectrum rights and interference rights, and its limitation on impacting other bands or users, were not clearly understood by the incumbent, by a new service provider, and even by this Commission."[53]

A review of U.S. interference conflicts stemming from unclear cross-channel rights reveals instances where: two (or more) licensees are both operating within their licenses but unable to operate concurrently (800 MHz);[54] the FCC changes the license rights after auction but before renewal (WCS/SDARS);[55] lack of clarity concerning cross-channel protections leads to protracted proceedings (AWS-3);[56] and a new

50. A more detailed exposition can be found at J. Pierre de Vries & Kaleb A. Sieh, *Increasing Concurrent Operation by Unambiguously Defining and Delegating Radio Rights* (Oct. 6, 2010) http://papers.ssrn.com/abstract=1704194.

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53. FCC SPECTRUM POLICY TASK FORCE, REPORT OF THE SPECTRUM RIGHTS AND RESPONSIBILITIES WORKING GROUP (2002), *available at* www.fcc.gov/sptf/files/SRRWGFinalReport.doc.

54. Improving Public Safety Communications in the 800 MHz Band, *Report & Order, Fifth Report & Order, Fourth Memorandum Opinion & Order, & Order*, WT Dkt. 02-55, ¶ 13, 15 (July 2004).

55. Amendment of Part 27 of the Commission's Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band, *Report and Order and Second Report and Order*, WT Dkt. No. 07- 293, ¶ 5 (May 2010).

56. *See* M2Z Networks, Inc., Application for License and Authority to Provide National Broadband Radio Service in the 2155-2175 MHz Band (2006), *available at* http://fjallfoss.fcc.gov/ecfs/document/view?id=6518725080; *see also* PR Newswire, *FCC Terminates AWS-3 Rulemaking to Auction Spectrum with Free Broadband Requirement; Breaks National Broadband Plan Commitment*, Sept. 1, 2010, http://www.prnewswire.com/news-releases/fcc-terminates-aws-3-rulemaking-to-auction-spectrum-with-free-broadband-requirement-breaks-national-broadband-plan-commitment-101967093.html (last visited Jan. 11, 2011).

entrant discovers an unforeseen need to remedy harm to adjacent channel incumbents (AWS-1/BAS).[57] Inter-operator conflict is greatest across boundaries between different service types and the increasing diversity of radio uses and users, as well as the need to pack operations ever closer together, will only serve to amplify the problem.

Current radio operating rights are uncertain due to: the use of the harmful interference criterion;[58] technical parameters that do not define the bounds of allowed operation objectively;[59] the regulator's willingness to alter operating rights at any time during the term of the license;[60] and ineffective delegation to operators of the means and incentives to negotiate bilateral resolutions.[61] This has led to protracted conflicts and unexpected costs, which in turn inhibit innovation and investment.

Scholars seeking quick ways to build coherent and efficient property rights systems for developing countries have derived best practices and key elements from what they consider successful property rights systems. According to one analysis, a successful real property rights system should: (1) capture, describe, and organize the most economically and socially useful aspects of an asset; (2) have formal rules for the description and organization of this information; (3) preserve the information in a recording system; and (4) be tilted towards protecting transactions.[62] Importantly, the rules should be clear and enforced in an efficient and predictable manner.

In this spirit, our approach is based on three principles: (1) aim regulation at maximizing concurrent operation, not minimizing harmful interference; (2) delegate management of interference to operators; and (3) define, assign and enforce entitlements in a way that facilitates transactions.

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57. *See The Society for Broadcast Engineers, Petition for Reconsideration*, WT Dkt. No. 02-353, ¶ 6 (Mar. 8, 2007); *see also* 47 C.F.R. § 27.1133 (2003).

58. *See* 47 C.F.R. § 2.102(f) (2003); *see also* 47 C.F.R. § 27.1133.

59. FCC SPECTRUM POLICY TASK FORCE, *supra* note 53 (noting that "the Commission's most difficult, controversial, and unsatisfactorily resolved cases have resulted from situations in which the extent of an incumbent's spectrum rights and interference rights, and its limitation on impacting other bands or users, were not clearly understood by the incumbent, by a new service provider, and even by this Commission").

60. FCC, Amendment of Part 27 of the Commission's Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band, *Report & Order & Second Report & Order*, WT Dkt. No. 07- 293, ¶160.

61. *See* J. Pierre de Vries & Kaleb A. Sieh, *The Three Ps: A Resulting Energy Approach That Increases Concurrent Operation By Delegating the Optimization of Operating Rights*, 15 (Oct. 2010), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1704194.

62. HERNANDO DE SOTO, THE MYSTERY OF CAPITAL: WHY CAPITALISM TRIUMPHS IN THE WEST AND FAILS EVERYWHERE ELSE (2000); *see also*, Hernando de Soto, *Mystery of Capital,* 38 FINANCE & DEV. no. 1, Mar. 2001, at 29.

Define radio operating rights through probabilistic permissions and protections, without reference to harmful interference

We propose that operating rights should be articulated using probabilistic transmission permissions and reception protections ("The Three Ps"). Since the radio propagation environment changes constantly, parameter values should be defined probabilistically as a percentage of times and locations. Transmission permissions should be based on resulting field strength over a range of locations and frequencies, rather than the radiated power at a transmitter. Reception protections should state the maximum outside electromagnetic energy an operator can expect over a location/frequency profile; protection levels are an undertaking by the regulator to implement these ceilings when making other allocations, but importantly do not form an entitlement against other, existing operators. This formulation of operating rights does not require a definition of harmful interference. Quantifying and addressing harmful interference remains a very important topic, but is delegated to operators and, should negotiation fail, adjudicators.

Limit the ability of the rule maker to adjust rights

Since the initial entitlement point is unlikely to be optimal, or remain optimal for very long, the regulator should do all it can to facilitate adjustment of rights after the fact. In this process, the number of parties to a negotiation should be limited, both through rights assignments that minimize the number of recipients as much as possible, and by the regulator enabling direct bargaining between the parties. The regulator should stipulate the remedies that attach to an entitlement (i.e. injunctions or damages) when it is issued, and not decide such things *post hoc* in its capacity as an adjudicator. The regulator should clearly separate rulemaking, where it plays an essential role in defining entitlements, from the enforcement/remedy phase where its role, if a court is not available, should be limited to adjudication on the basis of existing rules. Notably, the regulator should refrain, to the extent possible, from rulemaking when acting as an adjudicator.

Record entitlements in a public registry

In the radio license context, the full and complete description of every entitlement—including owner, Three P operating parameters, fixed station locations if applicable, and waivers if any—should be recorded in a public registry. And finally, the regulator should refrain from changing the rules, or adding new ones, in the middle of the game. After defining operating rights, parameters, and remedies in a license, the regulator should leave entitlements unchanged until renewal. However, those same

rights, parameters and remedies should be allowed to adjust though negotiation between operators.

The fruits of the radio regulation revolution can thus be gained by an objective articulation of the rights in an operating license, and the effective delegation of negotiation and dispute resolution to operators.

SPECTRUM "PROPERTY RIGHTS" AND THE DOCTRINE OF ADVERSE POSSESSION

HAROLD FELD*

Since the introduction of auctions and the wider acceptance of secondary market transactions, those favoring a market-based approach for spectrum access[63] have focused on the definition of spectrum property rights as the means to maximize the efficient development of spectrum.[64] But even if one accepts the basic premise that defined and easily traded spectrum property rights enhance overall development of wireless services and technologies, it does not follow that simply defining and enforcing these rights will resolve all problems that will emerge. The doctrines of real property include significant exceptions based on common good and common reliance,[65] and one should expect similar exceptions to emerge for similar reasons in spectrum policy.

Of particular relevance, the doctrine of "adverse possession" provides circumstances under which the right of a property holder yields to a squatter.[66] This exception amounts to a recognition by the law that at a certain threshold the rights of the owner yield to the reliance interest of the community generally and the "facts on the ground." By embracing, defining, and limiting this narrow exception to the right of an owner to expel a trespasser, property law creates a necessary safety valve for dealing with extraordinary circumstances while simultaneously preserving the stability and predictability that make property rights useful.

This basic concept has important lessons for spectrum policy and definitions of spectrum property rights.

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* Legal Director of Public Knowledge, http://www.publicknowledge.org.

63. *See* Coase, *supra* note 37.

64. *See* SPECTRUM POLICY TASK FORCE REPORT SEEKS PUBLIC COMMENT ON ISSUES RELATED TO COMMISSION'S SPECTRUM POLICIES PUBLIC NOTICE, 17 FCC Rcd. 10560 (June 6, 2002); *see also* Phil Weiser & Dale Hatfield, *Spectrum Policy Reform and the Next Frontier of Property Rights*, 60 GEO. MASON L. REV. 549 (2008) [hereinafter *Spectrum Policy Reform*] (describing difficulty in establishing clear definition of spectrum property rights but arguing for necessity of overcoming difficulties).

65. For example, the government may force a sale of the property at fair market value for public purposes. *See* Kelo v. City of New London, 545 U.S. 469 (2005). The doctrine of nuisance constrains the ability of a landowner from certain uses of the land that would interfere with a neighbor's quiet enjoyment. Further, in cases where new development of land may deprive the owner of a neighboring plot ready access, the common law typically required the property owner to provide to his neighbor an easement for access and egress.

66. *See* BLACK'S LAW DICTIONARY 59 (8th ed. 2004) (defining adverse possession).

Examples of Difficulties Despite Clear Definitions of Spectrum Rights: The 800 MHz Rebanding and the 700 MHz Wireless Microphone Order

Two examples illustrate how exceptional circumstances can arise and the value of defining a set of principles that both cabin the exception and provide a roadmap for resolution.

In 2004, the FCC resolved a long-standing interference dispute between Nextel (later Sprint Nextel) and the public safety community resulting from the interference to public safety systems caused by Nextel's commercial operations in the 800 MHz band.[67] Despite clear definitions of rights and FCC support for market-based resolution of interference complaints, the problem eventually grew to involve millions of subscribers and thousands of public safety systems.[68] After a lengthy proceeding, the FCC required Sprint Nextel to transfer its operations to a different band.[69]

It is tempting to blame the FCC for its failure to enforce the "property rights" of public safety licensees by requiring immediate shut down of Nextel's systems. But the true nature of the problem only became clear when Nextel operations expanded dramatically, so that shutting it down would have imposed significant costs on millions of subscribers. At the same time, FCC rules and the public interest required that the FCC protect public safety licensees from Nextel's "trespass." The FCC therefore imposed a solution that had nothing to do with the definition or enforcement of property rights and everything to do with finding a working balance among the competing interests.

The FCC found itself faced with a similar situation with regard to the illegal use of wireless microphones in the broadcast television bands.[70] Since the 1970s, the FCC had permitted only television and cable program producers (and a limited number of others) to operate in these bands.[71] Unfortunately, manufacturers and retailers had sold hundreds of thousands (if not more) of wireless microphones operating on the 700 MHz band to numerous unauthorized venues ranging from Broadway theaters to megachurches to karaoke bars.[72] Because these unauthorized users did not cause interference with broadcast television, their increasing

67. Improving Public Safety Communications in the 800 MHz Band, *Fifth Report & Order, Fourth Memorandum Opinion & Order*, 19 FCC Rcd. 14,969 (2004). The history is summarized in ¶¶ 13-14, 36-46.

68. *Id.*

69. *Id.* ¶¶ 217-231.

70. *See generally*, FCC, Revisions to Rules Authorizing the Operation of Low Power Auxiliary Stations in the 698-806 MHz Band, *Order*, 25 FCC Rcd. 643 (Jan. 15, 2010) [hereinafter Wireless Microphone Order], *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-10-92A1.pdf.

71. *See* 47 C.F.R. § 74.832 (2005).

72. *See generally*, Wireless Microphone Order, *supra* note 70.

numbers went unnoticed until the FCC began a proceeding to authorize unlicensed use of unassigned television channels for broadband (the "broadcast white spaces") and to reallocate the 700 MHz band to commercial and public safety licensees as part of the transition to digital television.[73]

Wireless microphone users protested against their displacement from the 700 MHz band and potential interference from newly authorized white space devices.[74] Under the rights defined by the FCC's rules, the FCC should have simply ordered the wireless microphone "spectrum squatters" to cease operation or, at a minimum, suffer interference from authorized systems.[75] After two years, however, the FCC reluctantly concluded that the squatters had acquired an equity interest in continued operation despite their status as illegal operators.[76] Although proceedings continue, the FCC adopted a general solution that retroactively legalized the wireless microphone operators and allocated them channels off the 700 MHz band.[77]

Some Basic Lessons

In both these cases there was no doubt as to the "correct" answer under the existing definition of rights, and no further definition of rights would have prevented the situation from occurring. Nor as a practical matter could the FCC be expected to have prevented the problem through enforcement. By the time the situation reached a point where swift, widespread enforcement was necessary, it was too late.

Recognition that exceptional cases arise combined with a set of guiding principles would have allowed the FCC to solve these use conflicts in a straightforward manner, preventing years of delay. Instead, the FCC found itself confronted with an apparently irreconcilable conflict between enforcing the rights of the licensees and the practical consequences of such an action. As a result, it dealt with each situation as a unique circumstance requiring years to develop a solution.

Clear definitions of licensee rights, and access to swift enforcement mechanisms, will benefit all users of wireless by enhancing the ability of licensees to engage in efficient transactions. But situations will continue to arise, as they do in the real property context, where the rights of licensees must yield to other considerations. The law of real property deals with these situations by addressing them in a straightforward manner through mechanisms like the doctrine of adverse possession. Spectrum policy must learn to do the same.

73. *Id.*
74. *Id.*
75. *Id.*
76. *Id.*
77. *Id.*

HOW SHOULD RADIO OPERATING RIGHTS BE DEFINED, ASSIGNED, AND ENFORCED IN ORDER TO OBTAIN THE MAXIMUM BENEFIT FROM WIRELESS OPERATIONS?

BRUCE JACOBS[78]

I agree completely with the premise of J. Pierre de Vries's paper about the benefits of clarifying radio operating rights.[79] As someone who has been working on these issues since 1982 and has been advocating and negotiating on behalf of proponents of many new services, including Mobile Satellite Service (including its Ancillary Terrestrial Component), Satellite Radio (including terrestrial repeaters), Broadband Radio Service, Broadband over Powerline, and several others unfortunately too obscure to mention, I have seen firsthand the frustration with the delay that characterizes the current regulatory process of defining and redefining rights. Over the years, the process has improved, but for more optimal technology development and capital investment, we should continue to strive for a more predictable jurisprudence that can minimize the delay inherent in relatively *ad hoc* processes. Engineers need to know what filters must be developed and what power levels they can rely on in a deployment design and business people who are interested in investing or doing deals must be in a better position to judge their risks.

Ellen Goodman's San Diego Law Review article makes the excellent point that we cannot avoid defining such rights, regardless of whether the overall regime is one of command-and-control, shared access, exclusive use, or something else, and regardless of whether the remedy is injunctive relief or damages.[80] In any of these cases, harmful interference needs to be defined, including how it is to be measured.

I do not want to minimize the difficulty of the task. Let's take Pierre's reasonable proposal that rights be established based on field strength spectral density at X% of locations, Y% of the time.[81] How is that energy going to be measured? Ellen's article points out that there is no commonly agreed way to measure emissions levels in a given geographic area, which is understandable given the complexity. Do you use actual field measurements or a predictive model? If you take measurements, what antenna and receiver do you use? If you use a predictive model, which model is appropriate? What clutter database do you use? What separation distance should be assumed? What height should be used? In a mobile environment, where interference is often

78. Partner, Pilsbury Winthrop Shaw Pittman.
79. *See supra* pp. 519-22.
80. *See* Goodman, *supra* note 15.
81. *See supra* pp. 519-22.

fleeting, what probabilistic model should be used? The answers to each of these questions can have an enormous impact on the results and each needs to be addressed in order to establish the certainty that we are looking for.

The FCC has had good reason to prefer a more *ad hoc* approach, given the dynamic nature of technology and the varying policy implications of each case. For instance, adoption of Pierre's suggested regime would involve an enormous potential reallocation of value depending on the level of protection (i.e. field strength spectral density at X% of locations, Y% of the time) set for the first time for existing licensees. Given the billions of dollars invested in legacy systems deployed under the current regime, those decisions would be enormously controversial and the potential transition quite costly. Moreover, would the new level be uniform for all services or would it account for differences in real or perceived protection levels? Does spectrum used for satellite services that necessarily deploy more sensitive receivers have the same protection as that used for terrestrial fixed services that typically operate with more link margin? How about services like Radio Astronomy? The enormity of the task is obvious.

Given these challenges, it is not clear to me what is the most realistic way to make either incremental or more radical improvement. I like Pierre's suggestion that the FCC try to establish a protection level for new licensees (along with an approach to measurement), in which case there will not be the same transition costs and potential reallocation of value as there would be for legacy systems. I also would encourage the FCC, despite the complexity of the task and the potential limits on its flexibility, to consider attempting to generalize the principles and criteria it uses to set the protection level and measurement approach, to foster a more transparent and predictable set of rights for future proceedings. One starting point might be a compilation of the existing body of FCC decisions defining harmful interference and how it is measured, to see what lessons they offer on defining and measuring harmful interference. The FCC's past decisions, although not always as transparent as they might be (at least to us non-engineers), may provide a valuable starting point for developing a more predictable jurisprudence and for advancing the process of establishing greater predictability. This and other aspects of the effort to develop such a jurisprudence might be undertaken with the assistance of, as Mike Marcus suggests, the National Academy of Sciences, or of interested parties with something to gain from greater predictability.

DEFINING RADIO RIGHTS: THEORY AND PRACTICE

CHARLA M. RATH[82]

For years, academics and other researchers have been struggling with the question of how to define radio operating rights. As demand for spectrum grows, and as this conference demonstrates, many are seeking to develop a more robust theoretical framework for defining, assigning and enforcing such rights. It is equally important, however, to investigate current practice with respect to interference rights and consider how licensees resolve interference scenarios in today's marketplace. A framework cannot rely solely on analysis of the intractable large-scale issues such as the competing interference claims often contained in de novo spectrum allocation proceedings, but should explore how licensees, with the flexibility to do so, trade rights and resolve innumerable local interference issues.

To that end, what is it like to provide an itinerant, dynamic consumer service that operates 24/7, reaches 289 million Americans and depends on a difficult to manage resource that is federally regulated? Verizon Wireless has nearly 100 million customers, more than 1500 mobile licenses (not to mention thousands more microwave licenses), tens of thousands of cell sites transmitting on several frequencies and tens of thousands of miles of RF borders and boundaries.[83] In order to constantly improve our service to the customer, and because interference is a costly drag on our network's capabilities, we must deal with issues of rights and interference on a daily basis. It is critical to our business that we are able to negotiate and resolve quickly most, if not all, rights and interference issues without seeking intervention or assistance of the Federal Communications Commission.

There has been some discussion in the literature as to the usefulness of applying the lessons learned about these kinds of negotiations to the larger question of defining interference rights.[84] It is not practical within

82. Vice President – Public Policy, Verizon.

83. Press Release, Verizon, Verizon Reports Strong 4Q and Year-End 2010 Results, Highlighted by Cash Flow, Wireless and FIOS Growth (Jan. 25, 2011), http://www22.verizon.com/investor/newsatglance/news.htm?dID=6303&dDocName=NEWS_1107&xCategory=News; *Spectrum Dashboard*, REBOOT.FCC.GOV, http://reboot.fcc.gov/reform/systems/spectrum-dashboard (last visited May 25, 2011); *see also FCC Universal Licensing System*, FCC, http://wireless.fcc.gov/uls (last visited May 25, 2011); Ex Parte Letter from Verizon Wireless to FCC, EB Dkt. No. 06-119 and WC Dkt. No. 06-63 (filed Sept. 4, 2007).

84. *See, e.g.*, *Spectrum Policy Reform*, *supra* note 64; Thomas W. Hazlett, *A Law & Economics Approach to Spectrum Property Rights: A Response to Weiser and Hatfield*, 15 GEO. MASON L. REV. 975 (2008). *See also* Philip J. Weiser & Dale N. Hatfield, *Property Rights in Spectrum: A Reply to Hazlett*, 15 GEO. MASON L. REV. 1025 (2008); Thomas W. Hazlett, *A Rejoinder to Weiser and Hatfield on Spectrum Rights*, 15 GEO. MASON L. REV. 1031 (2008).

the limited scope of this short paper to consider the details of wireless carriers' rights and experience with interference management. Two areas illustrate, however, why any discussion of radio operating rights can benefit from a better understanding of licensees' market based approach to rights and interference management: first, where the individual licensee has clear, enforceable rights and is permitted to negotiate extensions of these rights and second, where the class of licensees has enforceable rights, but needs additional regulatory clarity in order to resolve interference issues.

Clear, Enforceable, Negotiable Rights – FCC Rules Allow for Private Agreements

Unlike most radio services, the rules governing mobile wireless carriers permit private rights negotiations. Under the Commission's PCS rules (and AWS and 700 MHz rules) parties can agree to a higher field strength than is outlined in the rules.[85] Commission rules also permit cellular licensees to negotiate service area boundary extensions agreements with neighboring licensees.[86] Wireless carriers' thousands of licenses and thousands of miles of adjacent and co-channel boundaries create a laboratory for evaluating whether this successful approach to interference "rights" negotiations is pertinent to a larger radio operating rights framework.

Under current rules, licensees negotiate to extend rights into each others' licensed spectrum on a daily basis. These are not massive, one-time negotiations between companies, but involve hundreds of individual negotiations between companies' engineers who are tasked with the day-to-day operations of the network. And, although mobile wireless licensees are, for the most part, "stable and 'repeat players,'"[87] this does not mean interests are always aligned or that licensees always get what they want or need. Indeed, not all negotiations are symmetrical or mutual—in our case, we attempt reciprocity when we seek to extend RF borders, but these negotiations can be difficult and carriers (including Verizon Wireless) do not always achieve their goals. That said, because the rights of both licensees are clear, there is no benefit to seeking regulatory redress. Instead, we manage the process in the market and

85. 47 C.F.R. § 24.236 (1994). The Commission's Part 27 rules, which cover both AWS 1 and 700 MHz spectrum licenses, also permit these kinds of field strength agreements. 47 C.F.R. § 27.55(a)(2008).

86. 47 C.F.R. § 22.912 (2003). Unlike PCS, new cellular agreements that extend the boundaries of a cellular licensee's coverage are considered a major modification to the license and thus must be approved by the FCC. Moreover, these agreements are more cumbersome than the PCS field strength agreements in that they often need to be renegotiated when the licensee changes technology.

87. *Spectrum Policy Reform*, *supra* note 64, at 589.

look to other ways to gain the rights to spectrum we need to operate—typically through spectrum purchase or lease.

Unauthorized Operator-to-Licensee Interference—Need for Additional Enforcement Assistance

Licensees also deal with thousands of instances of interference from unauthorized operations each year. Again, licensees' efforts to resolve these issues are very much local and generally do not involve the FCC. If we can locate the source of harmful interference, we can often work with the owner of the property or transmitter to address the problem. However, some cases may require FCC intervention, such as in 2006 when a signal booster installed in a Manhattan office building interfered with about 200 Verizon Wireless cell sites in New York and New Jersey.[88] Although most instances of booster interference are smaller in scale, they still can be difficult to resolve—the source may be nearly impossible to identify if installed in a moving vehicle or boat for example. Interference from these and other sources costs carriers thousands of hours to investigate and, where possible, to resolve. In the case of boosters licensees are not seeking individual relief, but are asking the Commission to confirm licensee rights and take a strong stance on the marketing of these devices, so that licensees can address these interference issues more forcefully in the marketplace.[89]

Final Thought

Getting the right theoretical framework to define radio operating rights is important, but the exercise must be informed by the experience licensees have gained resolving interference issues in an increasingly complex and market-oriented RF environment.

88. Radio signal boosters, repeaters or amplifiers that are marketed and used without a wireless carrier's authorization are a growing and serious cause of harmful interference to wireless networks.

89. *See* Comments and Reply Comments of CTIA in *Wireless Telecommunications Bureau Seeks Comment on Petitions Regarding the Use of Signal Boosters and Other Signal Amplifications Techniques Used with Wireless Services,* WT Dkt. No. 10-4; DA 10-14 (Jan. 6, 2010); *see also* Comments and Reply Comments of Verizon Wireless. Specifically, Verizon Wireless has asked that the Commission (l) confirm that signal boosters cannot be operated without a license or licensee approval, and (2) declare that signal boosters cannot be sold to entities not authorized to operate them.