POLICING THE SPECTRUM COMMONS

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I. Introduction

Some of the bands of spectrum originally designed for unlicensed uses (such as garage door openers) were widely regarded as "garbage bands." As for the band of frequencies around 2.4 gigahertz (GHz), for example, many industry observers concluded that the assorted unlicensed uses—mostly industrial, non-communications uses like microwave ovens—crowded the spectrum sufficiently such that no reliable service could operate in that range. Undettered by the crowded nature of the spectrum, the Institute of Electrical and Electronics Engineers (IEEE) developed a standard for wireless broadband that would operate in the 2.4 GHz band of spectrum. The subsequent success of the 802.11 standard, popularly known as Wi-Fi, has demonstrated that unlicensed spectrum can be big business.[1] In 2003 alone, for example, equipment manufacturers sold more than $2.5 billion in Wi-Fi-related devices.[2] And in 2004, it is expected that "public Wi-Fi hot spots will increase [] to almost 140,000 worldwide, with some 30 million users."[3] To top it off, wireless broadband using unlicensed spectrum is now being touted as a financially viable approach to delivering broadband services to rural areas.[4] Not bad for a garbage band.[5]

Wi-Fi's commercial success has raised a series of important questions for policymakers and has forced the Federal Communications Commission ("FCC") to take seriously the promise of technologies that use "commons access spectrum," such as the unlicensed 2.4 GHz band that facilitated the success of Wi-Fi.[6] First, advocates of a

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[1] *See, e.g.*, Wiley Rein & Fielding, Wi-Fi – The Shape of Things to Come? (July 2002), available at http://www.wrf.com/db30/cgi-bin/pubs/WiFi_Primer_Final.pdf.

[2] Insight Research Corporation, Wi-Fi Market Forecast, available at http://www.enterprisewirelesstechnology.com/page.cfm/link=62.

[3] Nikhil Hutheesing, *Wi-Fi Buys*, FORBES.COM (June 6, 2004), available at http://www.forbes.com/wireless/2004/06/03/cz_nh_wifi04_buys.html.

[4] *See* Mingliu Zhang & Richard S. Wolff, Crossing the Digital Divide: Cost-Effective Broadband Wireless Access for Rural and Remote Areas (2004), available at http://www.coe.montana.edu/ee/rwolff/Divide-rev4.pdf (concluding that based on "reasonable assumptions for equipment costs, customer adoption rates, services prices and market share, a Wi-Fi-based broadband Internet access network is financial viable in a rural area"); *see, e.g.*, Stephen Lawson, *Wi-Fi Brings Broadband to Rural Washington*, INFOWORLD (August 23, 2004), available at http://www.infoworld.com/article/04/08/23/HNwifiwash_1.html (reporting on use of Wi-Fi system in 2.4 GHz band to provide wireless broadband service over a 3,700 square mile area in rural Washington and providing estimate of 8,000 such offerings throughout the United States).

[5] Significantly, the 2.4 GHz band (along with other bands such the 900 MHz band) supports an array of other unlicensed uses, ranging from cordless phones to garage door openers. For purposes of this paper, however, we will focus on wireless broadband applications. For a discussion of the array of uses of unlicensed spectrum, see Kenneth R. Carter et al., Unlicensed and Unshackled: A Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues, Federal Communications Commission, OSP Working Paper Series (No. 39) (May 2003), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-234741A1.pdf.

[6] In general, the term "commons access spectrum" is used interchangeably with "unlicensed spectrum." There are, however, alternative licensing arrangements—i.e., licensing widespread spectrum access by rule

"spectrum commons" are now pressing the FCC to make available additional bands of commons access spectrum, including for a next generation "WiMAX" technology. Second, Wi-Fi's success raises the question of whether commons access spectrum can be used effectively to provide commercial services, such as those now offered by "wireless Internet Service Providers," or WISPs, who use commons access spectrum to offer broadband services to customers. Third, as WISPs and other firms using commons access spectrum begin to provide broadband services (particularly in rural areas), the FCC is evaluating whether commons access spectrum, as a common resource owned by no individual firm, is prone to overuse and "tragedy of the commons"-type concerns. Fourth, as the FCC adapts to the demands placed on it with respect to commons access spectrum, it has begun to consider whether new models of regulation are warranted, including how to address tragedy of the commons-type concerns.

Proponents of increased commons access spectrum have not developed careful solutions for ensuring that commons access spectrum can be used to provide commercial services without confronting tragedy of the commons-like concerns.[7] At best, they have suggested that social norms, cooperation on developing the relevant protocols (through standard setting bodies like the IEEE), or the FCC's current regime for certifying technologies (i.e., its Part 15 rules) can prevent such problems from emerging.[8] Those more mindful of the need to guard against behavior that would undermine the viability of such services have suggested that common law courts can adjudicate tort actions to police the use of commons access spectrum.[9] Yet others have suggested that local property owners should be permitted to manage commons access spectrum on their premises or that the FCC should establish certain etiquette standards (such as "listen before you talk") to prevent tragedy of the commons-like concerns.[10] In all events, however, the debate over how—if at all—to regulate access to the spectrum commons is only beginning.[11]

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or providing members of the public with "non-exclusive licenses"—that afford parties access to spectrum in a very similar manner to unlicensed spectrum. To encompass this broader concept of commons access, we will use the term "commons access spectrum" to refer to all spectrum bands that are open to public use (or at least to categories of the public) unless we refer specifically to unlicensed bands, such as the 2.4 GHz band. Moreover, some commentators refer to "open spectrum" or "open access spectrum," but we prefer using the commons concept to underscore that "commons access spectrum" may include certain restrictions whereas open access generally suggests unrestricted access.

[7] Yochai Benkler, a leading advocate of a spectrum commons approach, readily acknowledges that he has not addressed such issues and that they are "an important area of study." Yochai Benkler, *Overcoming Agoraphobia: Building the Commons of the Digitally Networked Environment*, 11 HARV. J.L. & TECH. 287, 361 (1998); *see also* Stuart Buck, *Replacing Spectrum Auctions With A Spectrum Commons*, 2002 STAN. TECH. L. REV. 2, ¶39 (noting that Benkler's advocacy of a spectrum commons is not coupled with a description "in any great detail" of the measures necessary to make it work).

[8] *See, e.g.*, Stuart Buck, *Replacing Spectrum Auctions With A Spectrum Commons*, 2002 STAN. TECH. L. REV. 2.

[9] *See, e.g.*, Kevin Werbach, *Supercommons: Toward a Unified Theory of Wireless Communication*, 82 TEX. L. REV. 863 (2004).

[10] *See* TAN __, __.

[11] We note that there are two other forms of spectrum commons that we will not address explicitly in this paper, although those contexts raise some related issues to the ones we address here. In particular, the FCC has begun to consider whether to make available "spectrum underlays" within licensed bands (such as those made available for ultrawideband technology) and whether to authorize opportunistic uses of otherwise licensed spectrum when not being used by the licensee. *See* First Report and Order, *Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, 17 FCC Rcd. 10505 (2002)

This paper both underscores the imperative of and develops the analytical framework for regulating the use of commons access spectrum. In particular, it rejects the argument by many spectrum commons advocates that commons access spectrum can prosper without FCC oversight and argues that the FCC should develop a regulatory program that integrates the efforts of end user groups, interested companies, private standard setting bodies, and its own enforcement tools.[12] Historically speaking, the FCC's strategy for enforcing limits on the uses of commons access spectrum has focused on equipment certification requirements, specialized rules of operation, and, in some rare cases, penalizing those who use spectrum illegally. But where standards are increasingly embedded in software and users are not easily identified, this approach needs to be refined.

In short, we focus on two central reforms: developing additional proactive measures to limit the potential for interference and improving the FCC's system of back-end enforcement. To set the stage for these reforms, Part II outlines the basics of the current spectrum management regime and Part III discusses the alternative possible approaches—i.e., other than public regulation—for policing commons access spectrum. In recommending regulation of commons access spectrum (in Part IV), we recognize that the measures we propose will require considerable effort to implement, but we believe that a failure to address these issues would be the Achilles' heel of the commons model of spectrum management. At the same time, we recognize that if the FCC institutes overly restrictive regulations of commons access spectrum, it may risk sacrificing some of the benefits of commons access spectrum and allow such spectrum to fall prey to some of the failings of the legacy command and control model.

II. The Radio Spectrum and the Current Spectrum Management Regime

To understand the issues raised by the debate over how to police the spectrum commons, we must first outline the structure of the current regulatory system. Part of the challenge facing the FCC as it seeks to adapt to the changing technologies that make possible more efficient uses of spectrum is both that its statutory authority to regulate spectrum dates back to the 1930s and that reforming regulation invariably threatens incumbent interests. But before we can explain the current regulatory model, we must first explain what the "radio spectrum" is.

A. A Succinct Primer on Spectrum Technology

The radio spectrum refers to electromagnetic waves that travel through space within a frequency range of 3,000 cycles-per-second and 400 billion cycles-per-second. These "frequencies," which are measured in Hertz and abbreviated as "Hz," form the basis of wireless communications. In particular, a given range of frequencies can be used

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(authorizing underlays for ultrawideband); Notice of Proposed Rulemaking, *Facilitating Opportunities for Flexible, Efficient, and Reliable Spectrum Use Employing Cognitive Radio Technologies*, 18 FCC Rcd 26,859, ¶ 36 (2003) (inquiring into possible uses of cognitive radios to facilitate opportunistic uses of licensed spectrum). Similarly, we do not discuss the issues raised by "private commons" that are managed by a firm with a spectrum license.

[12] In this sense, we build on some of the conclusions offered by Ellen Goodman. *See* Ellen P. Goodman, *Spectrum Rights in the Telecosm To Come*, 41 SAN DIEGO L. REV. 269, 403-04 (2004) (calling for greater development of the necessary regulatory strategy to facilitate the effective use of commons spectrum).

to communicate information over distances without wires or other physical media. In the case of analog cellular services, for example, a voice channel of 30,000 Hz (or 30 kiloHz, or kHz) can provide sufficient bandwidth to establish a reliable communications link.[13] Significantly, a provider can use a particular 30 kHZ channel to provide analog cellular service on one day and then still have the same amount of radio spectrum available for use tomorrow, meaning that spectrum is infinitely renewable.[14]

The radio spectrum can be shared in its frequency, time, and space dimensions. In theory at least, additional users of spectrum can always be accommodated—particularly through the use of smart "cognitive radio" technologies (discussed below) that enable enormous flexibility in spectrum use. But even taking advantage of such technologies, there are practical considerations in terms of cost and complexity that limit the number of users that can be served in a given geographic area at one time and, in that sense, the radio spectrum is a scarce resource. Thus, despite being infinitely renewable, spectrum often has significant economic value, especially in geographic areas with intense demand for wireless communications.

When commentators discuss the radio spectrum, they generally focus on the set of frequencies that are most suitable for commercial uses. Notably, because different frequency ranges ("bands") within the radio spectrum have different technical characteristics, some bands are more attractive for particular purposes than others. In particular, most notable uses of spectrum rely on the frequencies between 300 MHz and 3 GHz because the physical dimensions of the required antennas are reasonable, the associated transmitting and receiving devices are less costly, and, more fundamentally, the radio waves are less susceptible to being blocked or attenuated by natural or manmade obstacles such as hilly terrain or tall buildings. But technological change can overcome such obstacles and the range of usable spectrum has thus expanded over time.

When commentators use the term "spectrum management," they generally refer to the broad array of activities associated with the regulation of this somewhat unusual natural resource. The term thus includes activities such as (1) *allocating* bands of frequencies for certain purposes (e.g., television broadcasting, terrestrial mobile radio services, or unlicensed spectrum not designated for a particular use); (2) *assigning* the licenses that authorize individuals or firms to use particular bands of spectrum (e.g., generally through an auction process); (3) *developing the rules* and regulations (e.g., maximum transmitter power) that govern the use of a channel or group of channels within a band in a specified geographical area; and (4) *enforcing* the associated rules and regulations once they are adopted. As we discuss below, advocates of a spectrum commons generally focus on the first two functions—i.e., allocation and assignment—and downplay or ignore the issues associated with the last two—i.e., service rules and enforcement.

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[13] One KHz is one thousand Hz, one MHz is one million Hz, and one GHz is one billion Hz. Historically, the greater number of frequencies used for a particular communications link correlated with greater power levels and increased bandwidth. Accordingly, a transmission for a broadcast television station uses 6 MHz, or 200 hundred times as much bandwidth as an analog cellular voice channel. As we discuss below, new digital technologies have begun to undermine these historic patterns of spectrum usage.

[14] Like air or water, however, the radio spectrum resource can be "polluted" by interference generated by natural sources of electromagnetic waves (e.g., lightning strokes) or by spurious emissions from radio transmitters or other man-made devices (e.g., florescent lights).

B. The FCC's Spectrum Management Regime

In 1934, when Congress created the FCC (in the Communications Act of 1934) and instituted an approach for regulating access to the radio spectrum, the concept of "spectrum management" generally equated with the role of overseeing licenses to operate broadcast stations (initially for radio and later for television). But over 70 years later, the importance of wireless technologies that use the spectrum—and the FCC's management of that resource—goes well beyond what Congress envisioned in 1934. Unfortunately, the 1934 Act continues to form the basis of spectrum policy, as the FCC still mostly uses the generations old "command and control" model of regulation that tightly prescribes what users can and cannot do with a spectrum license.

Under the legacy command and control model, companies live and die by the FCC's decisions about how the spectrum can be used. Consequently, the allocation of spectrum for particular uses and the development of specific technical and service rules governing those allocations is a crucial determinant of industry structure and performance. In the mobile telephone industry, for example, the FCC initially allocated only enough spectrum for two operators in each geographic area and it generally restricted the uses permitted under other spectrum licenses so that the bands not previously designated for mobile telephony could not be used to compete against the two authorized providers. In this environment, innovation in wireless technologies is inhibited, as FCC Chairman Powell put it in 2002, "by 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."[15]

Over the last fifty years, as firms increasingly sought access to spectrum to provide new services, the command and control model came under increasing criticism. Traditionally, the FCC made spectrum available by reallocating spectrum from lower value to higher value uses. Using this technique, the FCC follows the "wise man theory of regulation," under which it is deemed "capable of deciding what [uses of spectrum are] best for the public."[16] The FCC, for example, has long reserved wide swaths of spectrum for use by the broadcasters (including the often underused UHF frequencies) even while mobile telephone operators clamored for more spectrum. The reason for the FCC's limited success in reallocating spectrum already designated for particular uses is readily understandable: few incumbent licensees will give up an entitlement to use spectrum without getting something in return. To use the economic term, the fight among incumbent and potential users of spectrum is a form of *rent seeking* in that spectrum licensees (and would-be licensees) press vigorously for regulatory decisions that give rise to economic rents for themselves.[17]

The limitations of the command and control model have long troubled observers of the FCC's legacy spectrum management regime. In particular, Nobel Laureate Ronald Coase observed in the 1950s that the FCC's command and control regulation of spectrum

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[15] Michael K. Powell, Broadband Migration III: New Directions in Wireless Policy (October 30, 2002), available at http://www.fcc.gov/Speeches/Powell/2002/spmkp212.html.

[16] Douglas W. Webbink, *Frequency Spectrum Deregulation Alternatives*, FCC WORKING PAPER 10 (October 1980), available at http:/www.fcc.gov/Bureaus/OPP/working_papers/oppwp2.pdf.

[17] For a discussion of the rent-seeking aspects of spectrum regulation, see Thomas W. Hazlett, *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 HARV. J.L. & TECH. 335 (2001).

prevented numerous "win-win" (or, in economic terms, "pareto efficient") trades from taking place.[18] Notably, if the FCC allowed incumbent licensees—such as UHF broadcasters—to sell or lease their spectrum licenses free of any use restrictions, more productive users of the spectrum—say, mobile telephone operators—could purchase those licenses and thereby enhance consumer welfare. Indeed, from the 1950s until the 1990s, the FCC's failure to embrace this "property rights" model gave rise to a cottage industry of scholarship that castigated the agency for its misdirected regulation of spectrum.[19] As the next Section makes clear, however, the FCC has not only begun to act on such proposals, it also has begun to consider other fundamental reforms of its traditional spectrum management regime.

C. Beyond Command and Control and the Commons Model

Over forty years after Coase first argued for it, the FCC is beginning to reform its traditional spectrum management regime and to treat licenses in a more property-like manner. In particular, the FCC began to heed such calls for reform in the early 1990s and, following the congressional cue to use auctions to assign spectrum licensees, the agency has embarked on a number of initiatives to move spectrum policy towards a property rights model.[20] Moreover, in its recent Spectrum Policy Task Force Report, the FCC signaled its interest in moving in that direction and has since followed up its rhetoric with a Secondary Markets initiative.[21] To date, however, the market-based reforms have confronted a series of obstacles, many of which relate to the difficult question of how to transition from a command-and-control framework to a market-based one. In particular, policymakers continue to debate whether (1) to allow incumbent licensees additional freedom to sell or lease their rights to others who place a greater value on the spectrum; or (2) to prevent incumbent providers from reaping "windfalls" from the enhanced value of the additional flexibility—at the risk of leading those incumbents to maintain their grip on their spectrum.[22]

Around the same time that the FCC initiated a number of market-based reforms, a notable list of commentators, including Internet pioneer David Reed and law professors Yochai Benkler and Lawrence Lessig, began arguing for a model of spectrum

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[18] *See* Ronald Coase, *The Federal Communications Commission*, 2 J. LAW & ECON. 1 (1959).

[19] *See* Ellen P. Goodman, *Spectrum Rights in the Telecosm To Come*, 41 SAN DIEGO L. REV. 269, 271 n.3 (2004) (listing property rights advocates).

[20] *See* JONATHAN E. NUECHTERLEIN & PHILIP J. WEISER, DIGITAL CROSSROADS: AMERICAN TELECOMMUNICATIONS POLICY IN THE INTERNET AGE __ (forthcoming 2005) ("DIGITAL CROSSROADS").

[21] Federal Communications Commission, Spectrum Policy Task Force Report, ET Docket No. 02-135 (Nov. 15, 2002), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228542A1.pdf; Report and Order, *Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets*, 18 FCC Rcd. 20,604 (2003).

[22] For a discussion of the transitional challenges in moving toward the property rights model, see DIGITAL CROSSROADS, *supra*, at __; *see also* Gerald R. Faulhaber & David Farber, *Spectrum Management: Property Rights, Markets, and The Commons* (http://rider.wharton.upenn.edu/~faulhabe/SPECTRUM_MANAGEMENTv51.pdf) ("*Spectrum Management*"); Evan Kwerel & John Williams, *A Proposal for a Rapid Transition to Market Allocation of Spectrum*, OPP WORKING PAPER SERIES NO. 38, at iv (FCC 2002) (http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228552A1.pdf).

management based on treating spectrum as a "commons."[23] Under this model, which builds off of the FCC's reservation of swaths of spectrum as unlicensed (such as the 2.4 GHz band), anyone can gain access to a block of spectrum or set of channels subject only to certain basic rules. Such a "spectrum commons" approach is thus somewhat analogous to grazing lands that are used in common by herdsmen in a community or to public parks or hunting lands that can be accessed by anyone. And by pushing for such a model of spectrum management, commons advocates have joined forces with property rights advocates in criticizing the command and control model, but have advocated a different prescription for addressing the rigidities and inefficiencies it causes.

In advocating for a commons model, many commentators highlight the increasing significance of digital technologies that use spectrum efficiently and avoid interference in ways that earlier, "dumb" radios could not. Two notable examples of such technologies are "spread spectrum" and "cognitive radios," both of which can be used to avoid creating large "white spaces" (i.e., unused or underused bands) in the spectrum. Spread spectrum employs digital technologies to spread signals over a wide band of spectrum, sometimes enabling the signals to avoid particular channels depending on which frequencies are being used.[24] Cognitive radios are a distinct innovation that may or may not be used in conjunction with spread spectrum. Such radios enable users to manipulate transmission devices—or for devices to be programmed to self-adjust—so that they can operate at any frequency, power level, modulation technique, or transmission format.[25] Significantly, such radios will be defined and controlled by software (i.e., "software defined radios") as opposed to the traditional hardware-based (and "hard-wired") radios.[26] To be sure, these technologies typically involve some tradeoffs in terms of quality, equipment complexity, or battery life (as opposed to traditional spectrum technologies), but as the price of computing power continues to fall, these techniques are likely to become increasingly important.

In arguing for increased swaths of commons access spectrum, commons model advocates point to the success of devices using the 2.4 GHz band. Like the 2.4 GHz band, a block of spectrum can be designated as commons access spectrum so that any member of the public can use it. Unlike spectrum regulated under the command and control or property rights model, however, users of commons access spectrum have no assurance against interference from other such users. Moreover, users of commons access spectrum must comply with specified technical standards (e.g., maximum power restrictions) and, in some cases, specialized requirements (e.g., do not transmit on a

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[23] For an early articulation of this position, see Yochai Benkler, *Overcoming Agoraphobia: Building the Commons of the Digitally Networked Environment*, 11 HARV. J.L. & TECH. 287 (1998). For later ones, see David Reed, Why Spectrum is Not Property, The Case for an Entirely New Regime of Wireless Communications Policy (Feb. 27, 2001), available at http://www.reed.com/dprframeweb/dprframe.asp?section=paper&fn=openspec.html; LAWRENCE LESSIG, THE FUTURE OF IDEAS 222 (2001).

[24] The two most common types of spread spectrum, direct sequence spread spectrum and frequency hopping spread spectrum, both involve the widening of the basic signal and fall within the FCC's definition of the term. *See* 47 C.F.R. § 2.1.

[25] *See generally* Notice of Proposed Rulemaking, *Facilitating Opportunities for Flexible, Efficient, and Reliable Spectrum Use Employing Cognitive Radio Technologies*, 18 FCC Rcd 26,859 (2003).

[26] The FCC recognized the development of software defined radios and set forth a certification policy for them in Report and Order, *Authorization and Use of Software Defined Radios*, 16 FCC Rcd 17373 (2001).

particular channel if you detect that it is already in use). Such requirements are set forth in the FCC's Part 15 rules, which are generally enforced through a certification regime whereby manufacturers must demonstrate that their device (say, a baby monitor, cordless phone, or garage door opener) satisfies a number of specifications. Finally, the Part 15 rules require that any unlicensed device cease operating if it causes interference to its licensed counterparts.

The traditional Part 15 regime, which governs the use of unlicensed devices, is a paradigm of regulatory minimalism. The central goal of this regime is to enable users of unlicensed spectrum to operate without causing harmful interference to licensed uses. Traditionally, the Part 15 rules have regulated the permissible power requirements of any authorized device to safeguard against such concerns and have assigned liability to manufacturers for failing to follow the applicable certification requirements. In a notable revision of these rules in the late 1980s and early 1990s, the FCC raised the power level requirements to facilitate the use of spread spectrum technology in certain unlicensed bands and added additional bands for unlicensed uses.[27] In addition to spurring the development of more sophisticated cordless telephones, these decisions also set the stage for the explosive growth of Wi-Fi systems.

The success of Wi-Fi systems using the 2.4 GHz band reflects a virtuous cycle that continues to drive adoption of the technology. In particular, with the initial Wi-Fi standards in place and the continuing rapid growth (and falling prices) of the necessary equipment, entrepreneurs have recognized an opportunity to offer broadband access to the general public through wireless access points located at high traffic volume locations such as airports and other transportation hubs, hotel lobbies, and coffee shops. Sometimes the access is offered for free as a way of attracting customers to the location (e.g., the coffee shop) or in exchange for a one-time charge or a longer term subscription. In addition, WISPs and other entrepreneurs have recognized the possibility of using basically the same technology but with more sophisticated external antennas to extend broadband internet access to homes or small businesses that were not able to get DSL or cable modem service via wired facilities. For example, a WISP in a small farming community might install an access point with a relatively sophisticated antenna on a high structure such as a water tower and thereby offer high speed internet access to an entire cluster of homes and small businesses. Because no radio license is required, only the use of widely available, competitively priced, approved equipment, these WISPs can roll out service quickly and at low cost. Various manufacturers have recognized this as a potentially large market and have developed even more sophisticated, "carrier-class" systems that operate over an extended range using commons access spectrum.

Commons advocates point to the spectacular success of Wi-Fi as a harbinger of what can be expected under a commons model of spectrum management. In particular, they argue that the technical architecture of technologies using commons access spectrum can promote innovation far more rapidly than spectrum subject to the traditional command-and-control or even a property rights model. To do so, they point to the Internet's architecture as a model for spectrum, highlighting that in the Internet environment, anyone can create a new service by installing software residing in

[27] *See, e.g.*, First Report and Order, *Revision of Part 15 of the Rules Regarding the Operation of Radio Frequency Devices Without an Individual License*, 4 FCC Rcd 3494 ¶ 130 (1989).

computers (e.g., in clients and servers) external to the "dumb" portion of the network controlled by the carrier or provider. Indeed, the most popular applications that have driven the success of the Internet–email, the Worldwide Web, Instant Messaging, and file sharing to name just the most prominent–have evolved in exactly this way.[28] In short, not only do advocates of the spectrum commons approach envision using decentralized intelligence to dramatically increase the efficient use of spectrum (through shared access based on new technologies), but also as a way of shifting greater control over service development (as well as content creation, distribution, and consumption decisions) to the general public.

Whereas the initial success of the spectrum commons approach largely reflected a happy historical accident, policymakers are now giving this model of spectrum management a closer look. When the FCC reserved spectrum at 2.4 GHz for unlicensed uses, for example, it had no idea that such spectrum would facilitate wireless broadband applications like Wi-Fi. But in the current spectrum policy debates, there is a widespread awareness that the FCC's decisions about making available more commons access spectrum (i.e., whether as unlicensed, licensed to a class of users by rule, or available to all under a non-exclusive license) could spur increased broadband connectivity. The FCC's Spectrum Policy Task Force Report, for example, recognized the commons model as a peer to the property rights model that had long been the sole rival to the traditional command-and-control approach.[29] And major information technology companies like Intel are picking up the mantle of arguing for increased commons access spectrum, advocating, for example, that the FCC designate frequencies in the 700 MHz range—now used by UHF stations—as unlicensed spectrum.[30] Indeed, the FCC has recognized that WISPs have requested additional spectrum for unlicensed uses at higher power levels to enable them to provide "broadband access networks serving individual customers in sparsely populated areas."[31]

At present, the FCC has only begun to recognize that it may to reform its regulation of commons access spectrum to protect commons access users from interfering with one another. As commercial providers like WISPs increasingly offer services using commons access spectrum, however, the FCC will need take seriously the argument that the commons model of spectrum management—at least without additional

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[28] As Andrew Odlyzko has observed, "[i]n spite of many attempts, the established service providers and their suppliers have an abysmal record in innovation in user services . . . . The real 'killer apps,' such as email, the Web, browsers, search engines, IM, and Napster, have all come from users." ANDREW ODLYZKO, TELECOM DOGMA AND SPECTRUM ALLOCATIONS 7 (June 20, 2004) (http://wirelessunleashed.com/papers/TelecomDogmas.pdf).

[29] *See* Policy Statement, *Principles for Promoting Efficient Use of Spectrum By Encouraging the Development of Secondary Markets*, 15 FCC Rcd. 24178, 24181 (2000) ("[T]he best way to realize maximum benefits from the spectrum is to permit and promote the operation of market forces in determining how spectrum is used."); *see also* News Release, *FCC Issues Guiding Principles for Spectrum Management* (Nov. 18, 1999) (not even mentioning unlicensed uses), available at http://www.fcc.gov/Bureaus/Engineering_Technology/News_Releases/1999/nret9007.html.

[30] Michael Singer, *Intel: Spectrum is the New Frontier*, INTERNET NEWS.COM (July 30, 2004), available at http://www.internetnews.com/wireless/article.php/3388811.

[31] Press Release, FCC Begins Rulemaking Proposing To Allow Wireless Broadband Operations in The 3650-3700 MHz Band, 2004 WL 828417 (Apr. 15, 2004).

regulatory oversight—will give rise to the famed "tragedy of the commons."[32] On this argument, a resource that is designated for common usage is prone to despoliation as individual users increase their consumption of the resource without taking care to ensure that they do not overuse the resource.[33] In the spectrum context, a notable concern is that users of commons access spectrum will increase the performance of communications links by increasing their transmitter power, but at the expense of causing more interference to—and reducing the performance of—links operated by other users. Faced with diminished performance, other users will then retaliate by raising their own transmitter powers to compensate for the increased interference. With this concern in mind, the FCC should look for ways to prevent such vicious cycles before embracing fully the commons model of spectrum management.

III. Ensuring A Sustainable Spectrum Commons

The regulatory debate over whether a spectrum commons can avoid tragedy of the commons-type concerns is only beginning and commentators have just begun to address this question. The resolution of this issue will depend on whether some form of regulation can prevent users of commons access spectrum from descending into mutually antagonistic forms of behavior like that described above. Notably, regulation can take a variety of forms, including (1) social norms that limit certain types of behavior; (2) market ordering that creates incentives for and against certain types of behavior; (3) technical architectures that limit the range of possible behavior; and (4) traditional law enforcement that punishes certain types of behavior.[34] In general, commons advocates focus on some combination of the first three modes of regulation, often contending that FCC regulation is unnecessary or only minimally necessary to enable the commons model of spectrum management to succeed. To evaluate this claim, we consider each of the first three modes in turn and judge whether they prevented tragedy of the commons-type concerns in the commons-like "ham radio" (formally known as the amateur radio service) and citizen's band (CB) spectrum.

A. Social Norms

The importance of social norms as a form of regulating the use of commons access spectrum is potentially enormous. For years, commentators often invoked the tragedy of the commons concern without investigating whether actual commons gave rise to such concerns.[35] But recent scholarship has reversed this trend and suggested that commons regimes can operate effectively under certain circumstances. In particular, Robert Ellickson famously observed that ranchers in Shasta County settled disputes with

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[32] *See* Stuart Benjamin, *Spectrum Abundance and the Choice Between Private and Public Control*, 78 N.Y.U. L. REV. 2007, 2031 (2003).
[33] *See* Garrett Hardin, *The Tragedy Of the Commons*, 162 SCI. 1243 (1968).
[34] *See* Lawrence Lessig, *The New Chicago School*, 27 J. LEGAL STUD. 661 (1998).
[35] The tragedy of the commons concern is closely associated with the underlying phenomenon of the "free rider problem" whereby individuals decline to take any action that would advance the collective interest. On this account, individuals only safeguard their narrow self interest, which means that any collective action issues—such as maintaining common property—are unlikely to be addressed effectively. For the classic argument that the free rider problem has this impact, see MANCUR OLSON, THE LOGIC OF COLLECTION ACTION 2 (1965) (arguing that "rational, self-interested individuals will not act to achieve their common or group interests").

one another through a series of social norms about how to use such property—even in the absence of formal legal rules to govern their behavior.[36]

To explain the collaboration necessary to maintain a commons, students of game theory have advanced the argument that participants act very differently—and are far more likely to cooperate—when engaged in a repeat playing game. In such games, participants may well realize that if they deviate from a norm of cooperation in one instance, it might well come back to haunt them in another one.[37] Indeed, in some communities—whether neighboring ranchers or businesses—the resort to legal formalities and self-interested behavior is unlikely to be constructive; as Stewart Macaulay quoted a purchasing sales agent over forty years ago, "'you don't read legalistic contract clauses at each other if you ever want to do business again.'"[38] Not surprisingly, Macaulay's landmark study of business relations found that the most common type of dispute to end up in an appellate court is a fight over the ending of a business relationship—i.e., an action for the wrongful termination of a franchise agreement.[39]

In short, the game theory literature suggests that social norms that address and prevent counterproductive behavior may well arise in repeat games situations, but there are no such guarantees where parties are not likely to interact with one another on a regular basis.[40] Moreover, social norms are also effective in environments where a firm's reputation plays an important role in discouraging tragedy of the commons-like behavior.[41] Consequently, the combination of repeated interaction between parties and widespread reputation effects can help to explain how certain markets, such as diamond trading, are characterized by a remarkable degree of trust and a commitment by firms not to press their legal rights to the hilt.[42] At the same time, the absence of such forces in

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[36] ROBERT C. ELLICKSON, ORDER WITHOUT LAW: HOW NEIGHORS SETTLE DISPUTES (1991).

[37] *See* ROBERT AXELROD, THE EVOLUTION OF COOPERATION (1984) (repeated interaction between two players will lead to cooperation); David Hirshleifer & Eric Rasmusen, *Cooperation in a Repeated Prisoners' Dilemma with Ostracism*, 12 J. ECON. BEHAV. & ORG. 87, 90-94 (1989) (same).

[38] Stewart Macauley, *Non-Contractual Relations in Business: A Preliminary Study*, 28 AM. SOC. REV. 55, 61 (1963).

[39] *Id.*

[40] *See* Eric Posner, *The Regulation of Groups: The Influence of Legal and Nonlegal Sanctions on Collective Action*, 63 U. CHI. L. REV. 133 (1996). There are still important unanswered questions about how social norms work in practice, including how they are developed, how quick they adapt to serve their purpose, and how they are enforced, but we can assume for our purposes that such norms are reasonably effective in regulating behavior under certain conditions. *See, e.g.*, Richard H. McAdams, *The Origin, Development, and Regulation of Norms*, 96 MICH. L. REV. 338, 352 (1997) (highlighting how the effort necessary to enforce social norms presents a collection action problem of itself).

[41] *See* Jason Scott Johnston, *The Statute of Frauds and Business Norms: A Testable Game-Theoretic Model*, 144 U. PA. L. REV. 1859, 1874-75 (1996) ("Within suitably dense and homogenous communities, the harm to the breacher's reputation and lost future dealings with third parties that she will suffer when the aggrieved party tells others in the community about her breach may supplant the second party sanction of relationship termination."); Lewis A. Kornhauser, *Reliance, Reputation, and Breach of Contract*, 26 J. L. & ECON. 691, 699 (1983) ("[I]n a simple world with reputations, the rule of law does not matter.").

[42] *See* Lisa Bernstein, *Opting Out of the Legal System: Extralegal Contractual Relations in the Diamond Industry*, 21 J. LEGAL STUD. 115, 126-27 & n.26 (1992) (citing Leon Finker, Inc. v. Schlussel, 469 F. Supp. 674 (S.D.N.Y. 1979)) (noting that, in the diamond industry, patent infringement suits are accepted, but

other contexts explains why legal enforcement can and may well be necessary to ensure that individuals act in a constructive fashion.[43]

In the wireless context, the significance of social norms is quite obvious. For two neighbors, for example, concerns about interference in spectrum usage can often be resolved amicably and effectively. Moreover, equipment manufacturers have strong incentives both to minimize interference with related equipment and to enable users to identify what users are degrading one another's uses of commons access spectrum. Moving to the analogy of the public park, the role of social norms can be quite powerful where local neighbors are all able to know who does and who does not, say, clean up after their dog—and that they all benefit from following certain established social norms.[44] Indeed, social sanctions—be they collective shunning or "tit for tat" behaviors (say, not cleaning up after one's dog on a neighbor's property)—can be remarkably effective means of encouraging compliance with a social norm (in this case, cleaning up after one's dog). In the spectrum context, there are reports both that users of Wi-Fi-like services and users of air-to-ground radio channels—i.e., in contexts of limited numbers of users who are known by one another—have worked with one another constructively to avoid interference. But when anonymous users send signals that travel wide distances in dense areas, there are strong reasons to believe that social norms will break down. After all, when only small communities of individuals used the Internet to communicate with one another, "Netiquette" was a plausible means of curbing spam; in today's Internet environment, however, social norms about email usage barely make a dent in stemming the tide of spam.[45]

B. Free Market Solutions

For many Internet age problems like spam, some commentators argue that free market solutions can solve collective challenges and obviate the need for public regulation.[46] More generally, some commentators argue that "[c]ompetitive private institutions offer the potential for the development of mechanisms that can reduce the cost of achieving communication, coordination, and commitment to support transactions on the Internet."[47] In the spam context, for example, there are commercial services that maintain a "blackhole" list of ISPs who send copious amounts of spam as well as filtering programs that users can install to regulate who can send them email. But such solutions are proving to be imperfect at best, with some suggesting that such techniques are actually blocking up to 35% of legitimate email and only 25% of spam messages.[48] After

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contract suits are not); *see also* Lisa Bernstein, *Merchant Law in a Merchant Court: Rethinking the Code's Search for Immanent Business Norms*, 44 U. PA. L. REV. 1765, 1799-1800 (1996).

[43] *See* Robert E. Scott, *A Theory of Self-Enforcing Indefinite Agreements*, 103 COLUM. L. REV. 1643, 1644, 1647 (2003) (noting that conditions of repeat playing games and significant reputation effects are "stringent" and when those conditions are not met, "legal enforcement is necessary").

[44] ELINOR OSTROM, GOVERNING THE COMMONS THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION 136, 138-39 (1990).

[45] Paul K. Ohm, *On Regulating The Internet: Usenet, A Case Study*, 46 UCLA L. REV. 1941, 1983-84 (1999) (describing Netiquette).

[46] *See* David Post, *What Larry Doesn't Get: Code, Law, and Liberty in Cyberspace*, 52 STAN. L. REV. 1439, 1440-42 (2000) (arguing for market responses to spam).

[47] Gillian K. Hadfield, *Privatizing Commercial Law: Lessons From ICANN*, 6 J. SMALL & EMERGING BUS. L. 257, 287 (2002).

[48] William G. Schwab, *Take Back Your In Box*, 14 WTR-EXPERIENCE 34, 35 (2004).

years of hesitating in part because of claims that market solutions could address the issue, Congress finally instituted a legal regime to regulate spam—the CAN SPAM Act of 2003[49]—although its effectiveness remains to be seen.

For market-based solutions designed to limit interference between uses of commons access spectrum to render public regulation unnecessary, they will need to prove more effective than they have thus far in the battle against spam (which is, admittedly, an imperfect analogy). At this point, however, firms have only begun to develop such technologies, so it is too early to tell how effective they will be in facilitating effective use of commons access spectrum. Consider, for example, Propogate Network's "swarm logic software," which enables different access points to communicate with one another to choose non-conflicting frequencies or adjust their power levels to eliminate overlap.[50] If this technology were able to reach a critical mass of adoption, even in localized areas, it could conceivably minimize any transaction costs necessary to adapt to neighboring uses of commons access spectrum. And for neighboring buildings with scores of Wi-Fi transmitters, such technologies could prove very important, as they would ensure that different signals did not overlap and interfere with each other, thereby slowing data transmission and possibly triggering the destructive cycle of behavior noted above. Moreover, one can also imagine related technologies that would lower enforcement costs by enabling neighbors to identify those who deviated from accepted social norms in using commons access spectrum. Indeed, collective efforts—such as the Broadband Access Network Coordination (BANC)—have already taken root to facilitate joint and controlled efforts to limit interference.[51]

Another marketplace response worth following is the effort by the Wi-Fi Alliance to develop a community of equipment developers, service providers, and users of commons access spectrum all of whom will be certified as good actors. Like the case with informational privacy for those engaging in Internet commerce, members of this community have a stake in building the confidence of the customers who use (or might use) either equipment or services that rely on commons access spectrum. In this case, the initiative appears to stem (at least in part) from a dispute between two companies where Broadcom claimed that products manufactured by Atheros prevented Broadcom's products from working properly. To prevent future such episodes and to ensure that all companies who produce Wi-Fi-related equipment do so in a manner that does not impede the operation of equipment from manufactured by other vendors, the Wi-Fi Alliance has threatened to withhold or revoke the certification—and the right to use its logo—from those any offending companies.[52] At this point, however, the Alliance has not begun policing such possible abuses, so it is too early to tell what type of impact its policy will have. Nonetheless, at least based on the case of Internet privacy, the Alliance is likely to confront a number of challenges—ranging from effective consumer education efforts to

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[49] *See* 15 U.S.C. § 7701.
[50] *See* http://www.propagatenetworks.com.
[51] *See* Broadband Access Network Coordination, available at http://www.wbanc.com; Gerri Blackwell, *BANC on Non-Interference*, WI-FI PLANET (February 6, 2004), available at http://www.wi-fiplanet.com/columns/article.php/1781_3318281_1.
[52] Mark Hackman, *Wi-Fi Group Cracks Down on Incompatible Extensions*, PC WEEK (June 19, 2004), available at http://www.pcmag.com/article2/0,1759,1625097,00.asp.

reliable self-regulatory efforts—that will need to be addressed for this initiative (or others like it) to be effective.[53]

In essence, the challenge confronting market-based responses to interference concerns related to the use of commons access spectrum is whether they will be able to overcome the distance and large number issues that prevent social norms from addressing such concerns effectively. To be sure, marketplace developments are likely to enhance the abilities of parties who can easily contact—or at least are reasonably proximate to—one another to work out mutually acceptable arrangements. But where parties are not so easily identified, just like the spammers who are easily able to hide from the solutions aimed at limiting their effectiveness, it is quite likely that any privately developed approaches will fall short in preventing tragedy of the commons-type concerns. Like in the spam context, the challenge in addressing the behavior of bad actors—whether malicious or simply maximizing their own economic advantage—is that they are not interested in cooperating with a collective solution that would be in the interests of the entire community of users of commons access spectrum. This challenge is exacerbated when there are disparate interests using disparate devices operating disparate services.

C. Architecture

In analogizing the potential for commons access spectrum to succeed in a manner similar to the Internet, many commons advocates suggest that the development of the basic protocols that facilitate technologies such as Wi-Fi can be self-enforcing in terms of their effectiveness in combating destructive behavior. On this argument, the network effects phenomenon—where certain technologies become entrenched because they facilitate a wide variety of uses dependent on them[54]—can ensure that a suite of protocols not only are widely adopted, but are adhered to. The challenge in developing protocols that can limit interfering uses is that engineers have proved ingenious in circumventing all sorts of protocols that would otherwise limit behavior condemned by the original inventor. Moreover, this argument overlooks that the basic design ethos of the Internet is *not* to limit the potential uses of its basic enabling technologies. Rather, the Internet pioneers embraced an "end-to-end" ethos that shifts control to the edges of the network precisely so that users can introduce new innovations regardless of their effect on others or their social impact.[55]

In short, the effectiveness of technical architectures in limiting the potential for interfering uses of commons access spectrum depends on a regulatory regime that requires all equipment to be certified as compliant with certain basic protocols. The current certification regime, embodied in the FCC's Part 15 rules, only safeguards the rights of licensed spectrum users and provides no protection to commons access users. Indeed, a "Wi-Fi Hog," which undermined all Wi-Fi systems in a particular area but did

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[53] Paul M. Schwartz, *Beyond Lessig's Code For Internet Privacy: Cyberspace Filters, Privacy-Control, and Fair Information Practices*, 2000 WIS. L. REV. 743, 767-69.

[54] *See, e.g.*, Michael Katz and Carl Shapiro, *Technology Adoption In The Presence of Network Externalities*, 92 J. POL. ECON. 822 (1986).

[55] Stated simply, the end-to-end ethos is a commitment to (1) openness (both in terms of its basic standards and in the culture of the standard-setting organizations themselves); (2) modularity and protocol layering; and (3) a shifting of control over the relevant applications to the edge of the network. *See* Dale Hatfield, *Preface*, 8 COMMLAW CONSPECTUS 1, 1 (2000).

not disrupt any licensed users, satisfies Part 15's requirements.[56] Moreover, even if all developers of Wi-Fi transmitters agreed to certain protocols to prevent destructive uses such as the Wi-Fi Hog, it would not be difficult for skilled hackers to circumvent such limitations. Indeed, as transmitters increasingly rely on software, the possibilities for "hard-wiring" protections against noxious uses into the equipment itself will quickly evaporate.[57] Consequently, without a back-end enforcement regime of some kind, the flexibility made possible by software defined radios will not only increase the efficient use of spectrum, but will also facilitate counter-productive uses of flexible radios.

D. Case Studies: The CB and Ham Radio Experiences

In arguing for a spectrum commons approach, a number of commentators have suggested that past experiences with commons access spectrum underscore that the above techniques—social norms, marketplace responses, and technical architecture—can limit the potential for destructive behavior. In particular, Stuart Buck and Ting, Bauer, and Wildman make this very argument.[58] As we discuss below, however, their accounts of these episodes overstates the success of these technologies, minimizes the degree to which tragedy of the commons-type behavior took place in the absence of governmental protections against them, and fails to appreciate the unique circumstances that made cooperation possible in those instances.

1. Ham Radio

What is notable is that in the ham radio environment, volunteer leaders have taken on the role of policing the use of the spectrum. In many parts of the country, voluntary "spectrum management leaders," who call themselves the amateur auxiliary of the FCC, are able to police illegal conduct somewhat effectively by using an implicit threat—with official looking notifications—that they will spur FCC action to go after bad actors who fail to heed their warnings.[59] Significantly, such leaders are taken seriously by ham operators and thus, when the observer sends a registered letter saying that an operator does not get back on the air, the channel will be given to someone else, it generally triggers a response. In addition to the importance of official observers who work in conjunction with the FCC, a distinct group of frequency coordinators oversees the use of repeaters in ham radio transmissions, thereby facilitating coordination between different users.

In arguing for an increased reliance on the commons model, Stuart Buck invokes the example of ham radio—or more precisely, the development of similar practices at the

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[56] This Wi-Fi Hog is not a hypothetical device, but one that has already been invented. *See* http://www.mle.ie/~jonah/projects/wifihog.html.

[57] The flexibility of software defined radios built using open source software will be particularly amenable to modification—for good and for ill. *See, e.g.*, Sam Williams, *Radio Free Software*, SALON.COM (Dec. 18, 2002) ("We're pretty much turning all hardware problems into software problems [and] want to facilitate evolution in the radio area.") (quoting Eric Blossom, Founder of the GNU Radio Project), available at http://www.salon.com/tech/feature/2002/12/18/gnu_radio/print.html.

[58] Carol Ting et al., The U.S. Experience With Non-traditional Approaches to Spectrum Management, TPRC (2003); Buck, supra note __.

[59] Dave Hassler, Observing the Official Observers, available at http://www2.arrl.org/qst/2003/07/0307047.pdf; *see also* The Amateur Auxillary of the FCC, available at http://www.arrl.org/FandES/field/org/am_aux.html.

dawn of ham radio's development.[60] As Buck acknowledges, however, this history—as the CB radio saga underscores—most significantly demonstrates that *under certain conditions*, social norms and forms of private enforcement can obviate the need for public enforcement. Indeed, the FCC's decision to ban the sale of amplifiers separate from a radio transmission devices underscore the fragility of commons access spectrum environments protected only by social norms and private oversight.[61]

2. The CB Radio Saga

For a brief period in the mid-1970s, the use of citizen's band (CB) radios broke through to the public consciousness. Prior to that time, the band was largely used by distinct communities of enthusiasts and, more famously, truckers (think "10-4, good buddy"). Once the band became more popular, and attracted a more diverse community of users, the previous social norms broke down (including a commitment to refrain from vulgar language and harassment) and users began, among other things, attaching amplifiers to their transmitters to make themselves, in effect, broadcasters. The crowding out of the previous informal communications thus soon boomeranged and the brief explosion of popularity for CB radios ended once new users discovered that the advertised attraction of informal communication among enthusiasts had been displaced.

In evaluating the rise and fall of CB radio, Ting, Bauer, and Wildman choose to focus on the flip side of the story. Rather than suggest that the overuse of the band and the rise of amplifiers confirms concerns about tragedy of the commons-like results, they argue that the relative success and workability of the band before and after its rise in popularity actually undermines the case for tragedy of the commons-type concerns. As they put it, "[i]nterference caused by illegally amplified signals has always been and still is a common complaint [among CB users but], unlike during its peak, channel congestion is not a problem anyone, even in metropolitan areas."[62] Moreover, to the extent that individuals violate FCC rules for using this band, they acknowledge that those violations almost invariable go unaddressed, as "the FCC has never devoted sufficient resources to [] deter violations of its usage rules or violations of its technical specifications."[63]

In short, the lack of effective enforcement by the FCC undoubtedly contributed to the rising complaints about interference during CB radio's peak years of 1974-1976 and the dramatic falloff in users after that time frame. In particular, the number of complaints escalated from 30,000 to 100,000 during that time. In explaining this fact, Ting, Bauer, and Wildman suggest that the misbehavior was confined to a small subset of users who, in violation of the rules of the band, acted as broadcasters rather than individual communicators.[64] Even accepting this explanation, however, the bottom line of the CB radio story is that—as game theory would predict—outside entrants into a community who faced neither social norm pressures nor legal enforcement were prone to disruptive

[60] Buck, supra note __, at para. 80.
[61] *Modification of Parts 2 and 15 of the Commission's Rules for Unlicensed Devices and Equipment Approval*, ET Docket No. 03-201, paras 26-28 (July 12, 2004).
[62] Carol Ting et al, *The U.S. Experience With Non-Traditional Approaches To Spectrum Management* 6, available at http://quello.msu.edu/wp/wp-03-05.pdf.
[63] *Id.* at 12.
[64] *Id.* at 17.

behavior and thus limited the potential of that form of commons access spectrum.[65] By analogy, if the story of CB radio's rise and fall were to be repeated for WISPs, most observers would consider the FCC's effort to promote WISPs to be a failure.

IV. Public Regulation and Moving Beyond The Traditional Part 15 Regime

As Part III explained, non-public regulation is unlikely to be fully effective in guarding against tragedy of the commons-type concerns.[66] In terms of the role of social norms, we believe that they are quite promising, but that they will be of limited effectiveness in addressing relations between distant and anonymous users of commons access spectrum. As for market forces, there are strong reasons to question their effectiveness insofar as they will likely operate in both directions—not only protecting cooperative behavior, but in creating incentives for "cheating" and not getting caught. Finally, as for designing specific technical architectures, the increased uses of software defined and more flexible radios will facilitate the circumvention of prescribed protocols, making it important to oversee the behavior of individual users, and not simply that of equipment manufacturers. In short, the success of the commons model is likely to depend, at least in part, on the ability of regulation to guard against the tragedy of the commons and counterproductive uses of commons access spectrum.

The mere fact that forces other than legal regulation are unlikely to be fully effective in addressing tragedy of the commons-like concerns does not mean that the role of social norms, technical architectures, and marketplace responses is unimportant. Rather, it simply suggests that, on their own and without the backstop of law enforcement, they are unlikely to address such concerns effectively. To be sure, even without law enforcement assistance, it is quite possible that commons access spectrum could still be used effectively. But as rival commercial services utilize commons access spectrum and the distance of uses for commons access spectrum continues to expand—and the record for a Wi-Fi transmission is already in excess of 55 miles[67]—the need for public regulation is likely to become more pronounced. Indeed, the FCC appears to

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[65] The FCC adopted the broader explanation of congestion—i.e., without assigning blame to a limited class of users—in evaluating the unfortunate fate of CB radio. *See* Notice of Inquiry, *Creation of an Additional Personal Radio Service*, 72 F.C.C.2d 453, 455 (1979) (explaining that "complaints that the level of congestion (at least in major urban areas) has reached the point where reliable communications area becoming increasingly difficult to achieve").

[66] In evaluating the effectiveness of non-public regulatory approaches, we have declined to evaluate whether they are open to criticism on other grounds, such as being illegitimate or an undemocratic means of developing information policy. Such arguments, for example, are commonly leveled at the Internet Corporation for Assigned Numbers and Names (ICANN), which is a private, non-profit corporation that manages access to the Internet's domain name system. *See, e.g.*, Jonathan Weinberg, *ICANN and the Problem of Legitimacy*, 50 DUKE L.J. 187 (2000); *see also* Steven L. Schwarcz, *Private Ordering*, 97 NW. U. L. REV. 319, 322, 329 (2002) (observing that "commercial private ordering is rarely restricted" by traditional safeguards that confer legitimacy on public bodies, but that "[w]here efficiency is the sole goal of regulation, unrestricted private ordering can be legitimate"); *but see* Jonathan R. Macey, *Public and Private Ordering and the Production of Legitimate and Illegitimate Legal Rules*, 82 CORNELL L. REV. 1123, 1125 (1997) (suggesting that private ordering is more likely to produce legitimate rules and thus should be preferred over public ordering).

[67] Kim Zetter ,*Wi-Fi Shootout in the Desert*, WIRED (Aug. 3, 2004), available at http://www.wired.com/news/culture/0,1284,64440,00.html.

recognize the need to act in this area, as evidenced by Chairman Powell's remark that such regulations are necessary to "protect against interference meltdown,"[68] such as those caused by tragedy of the commons-like concerns.

In developing its regulatory regime for commons access spectrum, the FCC should recognize the importance of these non-regulatory protections against interference, work in tandem with them where possible, and be sure not to displace them. Significantly, there is a risk that external rules and monitoring by the FCC could, if not carefully developed, prove counterproductive by crowding out constructive cooperative initiatives such as those discussed above.[69] In general, the FCC's regulatory tools for ensuring cooperation in the use of commons access spectrum fall into two categories: proactive requirements and reactive enforcement measures. Before discussing these options, however, we will first address two proposals for taking the job of enforcement responsibility away from the FCC.

A. Alternatives to FCC Regulation

To date, two principal proposals challenge the possible role that the FCC should play in overseeing the use of commons access spectrum. One proposal, which draws its inspiration from the property rights model, would be to allow either local property owners or those who aggregate such rights to police the use of commons access spectrum. Another proposal would be to treat abusive uses of commons access spectrum as common law violations to be addressed in judicial forums. After explaining how each proposal deviates from existing law, we will explain why we view them as inferior to a regulatory regime superintended by the FCC.

1. The FCC's Exclusive Jurisdiction Over Spectrum

Increasingly, rival users of commons access spectrum are looking to different authorities to settle disputes between them. If, for example, rival services using commons access spectrum at airports bring complaints to the airport authorities, that authority will be tempted to adjudicate such disputes and regulate commons access spectrum use at airports like other concessions. Similarly, if a user is unable to use her device at home because a neighbor's device is incompatible—and they are unable to resolve their dispute amicably—the frustrated user might be tempted to bring an action in court claiming that her neighbor's use of commons access spectrum constitutes a "nuisance" and should be enjoined. In either case, however, the airport authority or the court would lack jurisdiction over the dispute, as the Communications Act clearly assigns such matters to the FCC.

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[68] *Powell Tells CES That FCC Must Understand and Protect VoIP This Year*, Communications Daily (January 12, 2004).

[69] *See* Elinor Ostrom, *Collective Action and the Evolution of Social Norms*, 14 J. ECON PERS. 137, 147 (2000) (reporting on experiments that demonstrate this possibility).

As a legal matter, it is generally accepted that the FCC enjoys exclusive authority over spectrum matters.[70] In particular, the courts have regularly concluded that the FCC's authority in this area "preempts the entire field" of possible regulation, thereby ousting any other regulatory efforts in this area.[71] In so doing, they have paid heed to the relevant legislative history of Congress' last enactment in this area (i.e., the House Conference Report of the Communications Amendments Act of 1982), which explained that "exclusive jurisdiction over [radio frequency interference] incidents (including pre-emption of state and local regulation of such phenomena) lies with the FCC."[72] Consequently, when individuals have brought actions claiming that a particular operator's transmissions interfered with their home appliances and thus constituted a nuisance, the courts have declined to hear such cases.[73]

On the normative level, some argue that the FCC's stranglehold on spectrum should be addressed by Congress as soon as possible. To be sure, the FCC's management of spectrum has been and continues to be highly imperfect, but we are even less sanguine about a model of purely private ordering or common law development. In terms of private ordering, the airport authority case is one of the more plausible contexts in which a band manager could ensure some level of cooperation over a broader geographic area, but even that environment underscores a risk of leaving the oversight of commons access spectrum to local landowners. In particular, airport authorities are likely to view their managerial role as an opportunity to collect rents from those wishing to operate Wi-Fi-like services. Reflecting this concern, the Industrial Telecommunications Association urged the FCC to reject a petition by airport authorities to oversee such spectrum, explaining that "the 'sole motivational goal' of those efforts 'is to increase airport revenue.'"[74] In line with its long line of precedent, the FCC Staff accepted this

[70] We say "generally accepted" because, although the Supreme Court has not addressed the matter, all federal courts of appeals to have considered the matter have agreed that the FCC enjoys complete authority in this area. *See, e.g.*, Freeman v. Burlington Broadcasters, Inc., 204 F.3d 311, 320 (2d Cir. 2000) (reviewing authority and concluding "that federal law has preempted the field of [radio frequency] interference regulation"), *cert denied*, 531 U.S. 917 (2000); Memorandum Opinion and Order, *Petition of Cingular Wireless L.L.C. for A Declaratory Ruling*, 18 FCC Rcd 13,126 ¶ 13 (2003) ("The Commission and the federal courts have consistently found that the Commission's authority in the area of [radio frequency interference] is exclusive and any attempt by State or local governments to regulate in the area of [radio frequency interference] is preempted.").

[71] *See* Rice v. Sante Fe Elevator Corp., 331 U.S. 218, 230 (1947) (field preemption appropriate when federal regulatory regime "so pervasive" and federal interest "so dominant" as to leave no room for state regulation).

[72] H.R. Conf. Rep. No. 97-765, at 23 (1982), reprinted in 1982 U.S.C.C.A.N. 2261, 2267; *see also id.* at 33, 1982 U.S.C.C.A.N. at 2277 ("[T]he Conferees intend that regulation of [radio frequency interference] phenomena shall be imposed only by the Commission.").

[73] *See, e.g.*, Broyde v. Gotham Tower, Inc., 13 F.3d 994, 996 (6th Cir. 1994) (ruling that nuisance action, based upon allegations that radio signals exceeded federal standards, could not be brought in federal or state court and noting that all courts to consider the matter have so held).

[74] Bob Brewlin, *Airlines Win Wi-Fi Management Battle With Airports*, COMPUTERWORLD (June 25, 2004), available at http://www.computerworld.com/mobiletopics/mobile/wifi/story/0,10801,94124,00.html.

argument and concluded that only it, and not airport authorities, had exclusive jurisdiction over the commons access spectrum within airport terminals.[75]

To their credit, the ability of airport authorities to effectively coordinate the use of commons access spectrum makes their claim to such oversight more compelling than the argument that individuals should be afforded oversight over commons access spectrum on the real estate they own. In particular, for a would-be WISP, such a regime would force it to acquire easements from all in a neighborhood before providing service to any customer. Such a requirement would not only create enormous transactions costs, it would also invite hold-out type behavior—i.e., to be the last property owners to sign up (and reap a premium for finally doing so)—because it would not be easy to avoid transmitting a signal that would cross a non-consenting property owner's domain. To be sure, if one believed that commons access spectrum could only be used in the home, this proposal might have some merit,[76] but the increasing distances that can be reached using even today's technologies undermine that argument.

The second alternative to the FCC is common law courts. Notably, Kevin Werbach recently advanced a version of an argument previously promoted by Peter Huber, arguing that common law courts can oversee access to spectrum.[77] Huber, however, maintains that courts can enforce property rights to use spectrum whereby Werbach argues that courts can ensure that individuals and firms use commons access spectrum without unduly interfering with one another. The essence of Huber's argument, and presumably Werbach's as well, is that the FCC is unable to manage questions of spectrum interference effectively. To Huber, for example, such authority invites micromanaging, as the FCC is as an "army of federal employees hanging around indefinitely to meddle and mess up" the industry.[78]

To date, the courts who have evaluated whether to proceed in such actions have recognized that the issues involved in spectrum management are highly technical and that there is a great need for national uniformity and consensus. After all, equipment manufacturers and service providers rely on pre-set rules to develop their offerings and would confront considerable uncertainty if left to defend them in the various forums that different litigants might select. In short, courts lack both the expertise and ability to

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[75] Public Notice, *Commission Staff Clarifies FCC's Role Regarding Radio Interference Matters and Its Rules Regarding Customer Antennas and Other Unlicensed Equipment*, DA 04-1844, 1 (June 24, 2004) , available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-04-1844A1.pdf ("[T]he FCC has exclusive authority to resolve matters of radio frequency interference [RFI] when unlicensed devices are being used, regardless of venue."); *id.* at 2 ("We also affirm that the consumer protections for the installation and use of consumer antennas under the FCC's Over-the-Air Reception Devices (OTARD) rules apply to unlicensed devices.").

[76] This appears to be Thomas Hazlett's assumption. *See* Thomas Hazlett, *Missing The Next (Radio) Wave*, BARRONS (Aug. 2, 2004), available at www.manhattan-institute.org/html/_barrons-missing_the_next.htm (arguing that the key to success of unlicensed uses are control of the relevant space and that broader applications for unlicensed spectrum are misguided).

[77] *See* Werbach, supra note __; PETER W. HUBER, LAW AND DISORDER IN CYBERSPACE: ABOLISH THE FCC AND LET COMMON LAW RULE THE TELECOSM (1997).

[78] PETER HUBER *ET AL*., FEDERAL TELECOMMUNICATIONS LAW 402-03 (2d ed. 1999).

develop determinate rules that the FCC possesses.[79] And to the extent that the FCC makes substantive misjudgments in this area, we view that as an argument for better regulatory strategies, not a different institutional actor.

Even if courts could develop more determinate and expertly guided rules for spectrum policy (say, as the Federal Circuit has for patent policy), there are two other notable reasons to opt for a model of public regulatory enforcement. First, as we will discuss below, the FCC enjoys the ability to work in tandem with the non-legal forces discussed above and to develop proactive approaches in ways that courts cannot. Second, the ability of private actors to remedy nuisance-like violations is notoriously difficult, as they must internalize the relevant enforcement costs. To be sure, there are solutions to this dilemma—including class actions or public prosecutors—but one effective mechanism of addressing this issue is to authorize agency oversight, as, say, the Federal Trade Commission does for consumer protection issues.

B. Proactive Requirements Superintended by the FCC

In regulating commons access spectrum, the FCC's legacy regime centers on enforcing a set of certification requirements that restrict power levels and thereby guard against interference to licensed operators. As the importance to the economy of commons access spectrum increases, and as it is used to provide carrier-level services, the FCC will face increasing pressure to develop measures that will limit interference between rival users of commons access spectrum. Building off of its Part 15 rules certification regime, there are two notable proactive requirements that the FCC is now considering to address such concerns: (1) the imposition of spectrum etiquette rules; and (2) database registration requirements. We will discuss each in turn.

1. Etiquette standards

The FCC first experimented with the use of a prescribed etiquette standard for equipment using commons access spectrum when it established the rules for unlicensed PCS spectrum in the early 1990s. In particular, it mandated that all unlicensed PCS equipment must "monitor the spectrum before transmitting and to use a specific transmission format"—i.e., such devices must "listen before they talk."[80] Later, after the American National Standards Institute (ANSI) developed a measurement procedure to ensure that manufacturers complied with such requirements, the FCC incorporated this procedure into its rules.[81]

As commons access spectrum applications have proliferated, the FCC has begun to consider whether it should mandate spectrum etiquettes more broadly. In particular, in considering how it can reform its rules governing commons access spectrum in order to facilitate wireless broadband, the FCC asked whether it should impose certain etiquette standards. In response, Microsoft advocated a set of etiquette standards—including "listening before you talk," ceasing "transmissions if there is no information to be sent" and using "the minimum transmit power necessary to complete a communications

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[79] *See* Philip J. Weiser, *Federal Common Law, Cooperative Federalism, and the Enforcement of the Telecom Act*, 76 N.Y.U. L. REV. 1692, 1715-18 (2001); DIGITAL CROSSROADS, *supra*, ch. 12.
[80] *Review of Part 15*, 16 FCC Rcd 18,205 ¶ 33 (2001).
[81] *Review of Part 15 and Other Parts of the Commission's Rules*, 18 FCC Rcd 14,741, 14,781 (2003).

link"[82]—on all uses of commons access spectrum in order to limit interference. To date, Microsoft's proposal has proved quite controversial, with a number of commentators arguing that for bands already replete with commons access uses (such as the 2.4 GHz band), these requirements would prove quite costly. After acknowledging such concerns, the FCC declined to implement any such proposal, but suggested that such a proposal had merit for bands yet to be dedicated to commons access uses and indicated that it would consider the concept seriously in the future.[83]

As to new bands, the primary concern voiced by critics of spectrum etiquette requirements is that they are likely to limit innovation by demanding compliance with a particular standard. In short, detailed restrictions—no matter how well intended or well crafted—can reduce the ability of the inventors and others to innovate without seeking changes in the associated rules and regulations. Whether to develop such etiquette standards thus becomes a difficult question, as more restrictive requirements—which could limit the ability of innovators to use licensed spectrum quickly and effectively—may well trade off long term innovation in favor of short term utilization. Indeed, the codification of certain etiquette standards to govern the use of commons access spectrum would undermine the freewheeling development that has traditionally governed such spectrum and facilitated experimentation and innovation. Consequently, we recommend striking a balance by preserving certain bands of spectrum for more wide-ranging uses while experimenting with etiquette standards on other bands. In particular, we believe that it would be a mistake to impose "listen before talk" (and other spectrum etiquette) requirements on all bands, but such measures clearly have merit insofar as they can enable WISPs to provide levels of service quality associated with carrier-class service.

For the FCC, the challenges associated with standard setting (including those associated with setting etiquette standards) are familiar ones from the transition to digital television (among other such efforts). In setting telecommunications standards such as an etiquette standard that governs commons access spectrum, the FCC should be careful to institute only functional requirements and, where possible, to utilize the experience of established standard setting bodies to define and enforce the relevant criteria. Over recent years, the FCC's standard setting oversight has moved in this very direction both in superintending aspects of the transition to digital television and in other areas as well, such as the enforcement of its Part 68 Rules that govern what equipment may be attached to the telephone network.[84]

Managed optimally, the FCC's use of standard setting bodies to develop the necessary spectrum etiquette standards can both leverage the expertise of such standard setting bodies and maintain a degree of oversight to be sure that such standards are adopted. Left to their own devices, by contrast, standard setting bodies may fail to adopt or be able to enforce compliance with a particular standard, as they lack any formal

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[82] *See Modification of Parts 2 and 15 of the Commission's Rules for Unlicensed Devices and Equipment Approval*, 2004 WL 1542207, ¶53 (2004) (describing Microsoft's proposal); *see also* Comments of Microsoft Corp., *Modification of Parts 2 and 15 of the Commission's Rules for Unlicensed Devices and Equipment Approval* (Jan. 23, 2004), available at http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6515583646.

[83] *Id.*, ¶54.

[84] For a fuller explication of this point, see DIGITAL CROSSROADS, *supra*, ch. 11.

authority.[85] Finally, the FCC also is in a position to ensure that standards developed by standard setting bodies are adopted based on a fair process. Moreover, in supporting this model, the government may well need to fund the collective development (and enforcement, as discussed below) of such standards, as they facilitate collective benefits—i.e., efficient use of spectrum—that are not internalized fully by any individual user of spectrum.[86] In pursuing this model, however, the government should realize that developing and enforcing proactive requirements embodied in spectrum etiquette rules might, if managed ineffectively, replicate the failings of the command and control model—i.e., its associated rigidities, inflexibility to change, and invitations to rent-seeking behavior.

2. Registration Requirements

Over the last twenty years, the FCC has increasingly moved away from the laissez faire Part 15 regime to adopt limitations that could increase its confidence that devices using commons access spectrum will not interfere with licensed uses and, in some cases, commons access ones. In addition to the development of etiquette rules, another innovation is the use of registry whereby anyone interested in using a particular band must register their commitment to do so. In substance, this regime imposes a licensing requirement—and a non-exclusive one, to be precise—that all users must provide certain information before using the designated spectrum. In the so called "millimeter wave" proceeding, for example, the FCC adopted such a requirement, instituting a site-specific coordination and registration process that would be superintended by a third party entity that would serve as a clearinghouse for access to this spectrum.[87] In theory, this approach will provide an effective means of facilitating cooperation and creating incentives for good behavior (as well as a significant stick to punish bad behavior).

The use of a registration regime for a spectrum commons raises a host of issues that the FCC will need to consider carefully in the years ahead. In discussing a registration regime, for example, the cautionary tale of ICANN immediately comes to mind. In that case, a government-sponsored—but not regulated—entity gained control over the important role of overseeing domain names.[88] But like a stock exchange's role in facilitating the raising of capital, and unlike ICANN's role *vis a vis* domain names, the registration regime envisioned by the FCC would not cover access to all spectrum. In this sense, the FCC could facilitate competition between registrars and oversee registrars in a manner similar to how the Securities and Exchange Commission oversees the stock exchanges. Of course, as observers of the recent wave of scandals are aware, that model is not without cautionary tales either, as it can, for example, enable the registrar to limit competition or extract rents that raise the price paid by end users.

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[85] For a discussion of this model of standards development, see Philip J. Weiser, *Standard Setting, Internet Governance, and Self-Regulation*, 28 N. KENT. L.J. 822 (2001).

[86] *See* Philip J. Weiser, *The Internet, Innovation, and Intellectual Property Policy*, 103 COLUM. L. REV. 534, 573-75 (2003).

[87] *Allocations and Service Rules for The 71-76 GHz, 81-86 GHz and 92-95 GHz Bands*, 18 FCC Rcd 23,318 ¶¶ 48-51 (2003)

[88] Among other things, ICANN's status as a government-sponsored, but not regulated registrar gives rise to a series of nettlesome issues. *See* MILTON MUELLER, RULING THE ROOT (2002); Jonathan Zittrain, *Book Review, What's In A Name*, 55 FED. COMM. L.J. 153, 155 (2003).

C. Reactive Measures Superintended By the FCC

Whereas the proactive measures discussed above are more recent innovations, the FCC's traditional enforcement efforts related to commons access spectrum has involved the reactive role of ensuring compliance with the Part 15 certification requirements.[89] But as noted above, there are lots of scenarios—ranging from incompatible equipment to a Wi-Fi-Hog to intentional jamming—that can compromise the use of commons access spectrum. In part, Wi-Fi's open standard leaves it vulnerable to hacking of all kinds, including intentional jamming using off the shelf equipment.[90] Indeed, even certified equipment can easily be used—either unintentionally (e.g., hogging) or intentionally (e.g., jamming)—to disturb adjacent commons access spectrum uses. Consequently, a question for the FCC is whether it will take on the role of prosecuting cases of jamming. Although the FCC's Chief Engineer has indicated that the agency intends to "get serious" about unauthorized use of commons access spectrum and will "go after abusers of unlicensed spectrum,"[91] neither its relevant rules nor its enforcement apparatus have been set up to do this job.

Under its broad enabling authority, the FCC is free to regulate behavior between users of commons access spectrum. The FCC could, for example, begin enforcing certain broad standards—such as no willful and malicious interference—or specific rules (like etiquette standards). To do so, it would simply use its authority under the Communications Act to "govern[] the interference potential of devices" using radio frequencies.[92] More particularly, it could enforce the Act's command, in the commons access spectrum environment, that "[n]o person shall willfully or maliciously interfere with or cause interference to any radio communications of any station licensed or authorized" by the FCC.[93] But construing users of commons access spectrum as authorized operators and enforcing this command effectively—something the FCC has yet to do—will present the agency with a number of challenges.

For a number of reasons, the devices that use commons access spectrum are fundamentally different than their licensed spectrum counterparts, making enforcement efforts measurably more difficult. First, the sheer number of devices involved and the decentralized nature of the networks make it difficult to carryout enforcement activities. Thus, like the issues related to digital content distributed illegally via the Internet, it will often be difficult for enforcement authorities (either public agencies or private actors) to track down relevant violators and demonstrate their violation of the relevant requirements.[94] Second, unlike the audible or visible forms of interference associated with traditional radio and television broadcasting, interference in a data network may manifest itself in the form of slower or more erratic performance, often making the source of the degradation difficult to ascertain. For example, slower data downloads

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[89] *See, e.g.*, Datel Design and Development, Inc., 19 FCC Rcd. 17 (2004) (fining Datel Design and Development $10,000 for importing equipment that radiated emissions beyond that authorized by the Part 15 rules).

[90] *See* Patrick Gray, *New Flaw Takes Wi-Fi Off The Air*, THE REGISTER (May 13, 2004), http://www.theregister.co.uk/2004/05/13/wifi_security_flaw.

[91] *OET Chief Sees Potential Solution For "White Spaces" TV Proposal*, Communications Daily (April 19, 2004).

[92] 47 U.S.C. § 302a.

[93] 47 U.S.C. § 333.

[94] *See, e.g.*, Verizon v. RIAA Internet Services, 351 F.3d 1229 (D.C. Cir. 2003).

might be caused by a legally operated, close-by cordless telephone or an illegal data network device operating at high power system a kilometer away. Third, distinguishing between benign hogging (e.g., based on inferior equipment) and malevolent jamming will not always be easy—let alone demonstrable for enforcement purposes.[95] Finally, to engage in effective enforcement efforts, the FCC—possibly in conjunction with other actors—will need to invest in monitoring equipment and be sufficiently effective to create real deterrent effects, as the recording industry has attempted to do with questionable success. Notably, in the CB radio case discussed above, the failure of the FCC to pursue effective enforcement efforts contributed to the use of illegal amplifiers and the unfortunate fate of that service.

As the FCC considers how to devise an effective enforcement regime to prevent certain uses of commons access spectrum, it is critical that it look to enlist good actors in local communities to assist their efforts. In so doing, it can follow the model used in the ham radio environment discussed above in which the FCC empowers voluntary overseers by backing up their exercise of unofficial authority.[96] Indeed, the model of empowering private individuals to work together to solve disputes before entering the fray is one the FCC has employed in other contexts. In particular, the FCC has long facilitated such cooperation among users of licensed spectrum by demanding that parties work together to coordinate their use of a set of frequencies—i.e., to establish operating procedures for those using the same spectrum—through the coordination and licensing requirements set forth in Part 101 of its rules.[97] In effect, the Part 101 rules empower private frequency coordinators to settle disputes cooperatively by insisting that the relevant parties work through issues cooperatively before bringing them to the FCC for resolution.[98] Significantly, this regime succeeded in spurring the establishment of cooperative institutions that enable self-enforcement through a collective memory and a market for reputation that requires actors to act reasonably over time.[99] In short, this regime reflects an excellent model of using public regulation to instigate and enforce private ordering, reflecting the possibilities for facilitating private cooperation to ensure that a common resource is protected and used appropriately.[100]

To enforce adherence to proactive requirements, as well as to oversee malicious uses of commons access spectrum, the FCC should both enhance its own spectrum

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[95] This challenge relates more generally to the difficulties associated with defining "harmful interference." *See* R. Paul Margie, *Can You Hear Me Now?: Getter Better Reception From The FCC's Spectrum Policy*, 2003 STAN. TECH. L. REV. 5.

[96] http://www.colossus.org/n8fn/fcc.html (quoting FCC official as stating that "[t]he volunteer work of these Official Observers is a critical element of the Commission's enforcement program,").

[97] *See generally* Reorganization and Revision of Parts 1, 2, 21, and 94 of the Rules to Establish A New Part 101 Governing Terrestial Microwave Fixed Radio Services, 11 FCC Rcd 13,449 (1996).

[98] Schroeder Manatee Ranch, 16 FCC Rcd 5722 ¶ 3 (2001) (under the relevant FCC rules, licensees "are expected to cooperate in the use of frequencies and resolve any 'harmful interference' by mutually satisfactory arrangements").

[99] For an example of an association that facilitates reputational sanctions, see Lisa Bernstein, *Private Commerical Law in the Cotton Industry: Creating Cooperation Through Rules, Norms, and Institutions*, 99 MICH. L. REV. 1724 (2001).

[100] ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION 136, 138-39 (1990) (detailing how a collective institution for water management arose).

enforcement capabilities as well as empower other entities to do so.[101] In particular, standard setting bodies, the frequency coordinators and the volunteer coordinators in the ham radio environment all provide models for the FCC to utilize in the commons access spectrum context. A critical challenge for the FCC in this context is to select entities to aid its enforcement efforts. In some contexts, such as standard setting bodies, there will be obvious candidates, such as the IEEE. In others, social norm entrepreneurs will self-select for such responsibility. Finally, the FCC can consider delegating such responsibility to registrars or band managers who would be overseen by the FCC. Given the minimal experience with the above approaches, the FCC would do well to utilize all of the above models to determine which works best.

V. Conclusion

The promise of the spectrum commons approach is one of the more exciting and unanticipated developments in information policy. As the FCC moves ahead to build on the initial unexpected success of this model, it should consider carefully what measures it should take to guard against tragedy of the commons-like concerns. In an increasingly technologically dynamic environment, there are numerous challenges that the FCC will face in developing an effective model for reliable enforcement. As we discuss, no one single approach—and particularly no approach that does not involve FCC oversight—is likely to be successful. Consequently, the FCC should continue moving ahead to implement different proactive and reactive measures that will provide users of commons access spectrum important assurances that new services and products will not be compromised either by bad actors or poorly coordinated services. If it fails to do so, however, it risks allowing the promise of WISP-like services to follow the unfortunate boom-and-bust path of CB radio.

[101] Stuart Buck argues for a spectrum commons with rules enforced by local management associations. *See* Buck, *supra* note __, at para 76. While we believe that such an approach must be coupled with other measures as well, both his argument and our endorsement of such a point appreciate that there are considerable benefits to relying on subsidiary entities to enforce basic standards announced by the FCC. *See* Philip J. Weiser, *Federal Common Law, Cooperative Federalism, and the Enforcement of the Telecom Act*, 76 N.Y.U. L. Rev. 1692, 1698-1703 (2001).