Towards a Property Rights Approach to Communications Spectrum

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The United States' traditional command-and-control administration of spectrum distorts technological change, prevents value maximization of spectrum, and delays consumer access to new technologies. Extensive technological change and increased demand for wireless communications have exposed the economic inefficiencies and welfare losses generated by the traditional spectrum administration, and have forced spectrum regulators to begin a gradual deregulation of spectrum licensing. These deregulatory steps have been hesitant and limited. To properly prepare the telecommunications sector for current and future technological development, the U.S. should implement a property rights approach to spectrum. A property rights approach would ameliorate the economic inefficiencies of traditional spectrum regulation by allowing spectrum holders to decide the appropriate use for the spectrum and to transfer the spectrum to other users. Moreover, license holders could protect their spectrum from interference in common-law courts through tort law. Recent experiments in New Zealand and Guatemala reveal that spectrum property rights, when implemented through careful legislation and a sophisticated auction process, are an immediately viable option for spectrum management

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Introduction

These days, E.T. would be trying to phone home with a cellular phone—not because it is fashionable, but because of sheer probability. Around the world, whether in developed or developing nations, more wireless phones are added per year than wireline phones.[1] Coupled with increased demand for other wireless communications solutions, this trend has resulted in a revolutionary increase in the demand for overall spectrum usage. This demand requires technological, as well as regulatory, solutions.

Recent technological innovations have increased the efficiency of spectrum bands currently in use and allowed these bands to be switched from low-value uses (e.g., outside broadcast relays) to high-value uses (e.g., wireless local access).[2] Equipment that previously was limited to a particular band can now be utilized relatively efficiently in various bands. However, regulatory change predictably has lagged behind these technological and demand changes. The traditional method of awarding a license to operate a given service in a given band has become a barrier to innovation, since new technology allows the utilization of that band for an alternative, and probably more lucrative, use. Thus, increased

1 *See* DONALDSON, LUFKIN & JENRETTE, WIRELESS COMMUNICATIONS INDUSTRY 49-50 (Spring 1998).

2 *See* Howard Shelanski & Peter Huber, *Administrative Creation of Property Rights to Radio Spectrum*, 41 J.L. & ECON. 25 (forthcoming 1999) (working copy on file with author) (observing that the technology now exists to provide "multiple uses of a single medium," thus permitting shifts from low-value to high-value uses).

technological flexibility has exposed the ossified structure of spectrum regulation and requires regulatory changes to prevent ever-increasing welfare losses.

The increased demand for spectrum has increased its political value, enhancing the incentives of regulators to maintain the command-and-control system in order to use spectrum to maximize political support. Accordingly, regulators have attempted to handle the technological revolution through administrative means, reallocating license holders onto alternative bands and auctioning cellular, personal communications systems (PCS), direct broadcast satellite (DBS), multipoint distribution systems (MDS) and other licenses, while simultaneously protecting incumbents, especially broadcasters.[3] By forcing new technologies into the existing administrative system for spectrum allocation, regulators have generated large rents for incumbents (both wireless and wireline operators),[4] while competition in the global telecommunications market has been restrained.

The purpose of this article is fourfold. First, we review the administrative command-and-control system used historically to allocate spectrum, analyze its associated inefficiencies, and explore administrators' interests in perpetuating this system. Second, we provide what we believe are the blueprints for a property rights approach to the allocation of spectrum. Third, we analyze the experiences of New Zealand and Guatemala in implementing spectrum property rights systems. Fourth, we outline ways that the United States might accelerate the transition to a full property rights system, utilizing lessons from both home and abroad.

I. Administrative Spectrum Allocation

A. *Historical Evolution*

Presenting a detailed account of the evolution of U.S. spectrum administration is beyond the scope of this paper, and would merely duplicate excellent existing treatises.[5] Instead, we present a brief summary of the three stages of U.S. administration of the spectrum: homesteading, command-and-control, and creeping deregulation.

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3 *See infra* notes 69-76 and accompanying text.

4 *See infra* note 61 and accompanying text.

5 *See, e.g.*, MICHAEL K. KELLOGG ET AL., FEDERAL BROADBAND LAW (1996) [hereinafter KELLOGG ET AL., BROADBAND LAW]; MICHAEL K. KELLOGG ET AL., FEDERAL TELECOMMUNICATIONS LAW (1992 & Supp. 1995) [hereinafter KELLOGG ET AL, TELECOMMUNICATIONS LAW]; *see also* Thomas W. Hazlett, *The Rationality of U.S. Regulation of the Broadcast Spectrum*, 33 J.L. & ECON. 133, 135-65 (1990) (discussing early U.S. spectrum development and the creation of the U.S. command-and-control regulatory structure).

1. Homesteading

The period from 1912 to 1927 is sometimes referred to as the homesteading period.[6] The Radio Act of 1912 reserved certain bands exclusively for military or maritime usage yet left vast portions of the electromagnetic spectrum free to the first occupant.[7] A homesteader would simply apply for a license from the Department of Commerce, whose authority was limited to choosing a frequency that would minimize interference.[8] Despite these statutory limitations, then-Secretary of Commerce Herbert Hoover attempted to ration frequency allocations,[9] leading to the *Hoover v. Intercity Radio Co.* decision, in which the D.C. Court of Appeals held that the Secretary of Commerce lacked the discretion to deny frequency licenses.[10] Hoover's continued attempts to ration frequency led to the *U.S. v. Zenith Radio Corp.*[11] decision in early 1926,[12] in which a federal court in Illinois ruled that the Department of Commerce had no power to regulate broadcast frequency or power.[13]

As broadcasters multiplied in the aftermath of *Zenith*, it became apparent that some mechanism was necessary to mitigate the growing interference problems. One possible solution was the development of spectrum property rights, and in 1926 a state court in Illinois set forth the basic outline of spectrum property rights in the *Tribune Co. v. Oak Leaves Broadcasting Station* decision.[14] Applying common law principles, the Illinois court held that a new broadcaster was wrongfully trespassing on the assigned frequency of an incumbent radio station.[15] The *Tribune* decision was a common-sense, common law response to the massive proliferation of radio stations spurred by the holding in *Zenith*, and "had the courts been given a chance . . . this simple idea would have created property rights in the stratosphere, much as the common law had developed comparable principles 40,000 feet lower—rules of easement, trespass and so on."[16]

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6 *See* KELLOGG ET AL., BROADBAND LAW, *supra* note 5, § 4.6.1, at 236.

7 Radio Act of 1912, ch. 287, §§ 1-5, 37 Stat. 302, *repealed by* Radio Act of 1927, ch. 169, 44 Stat. 1162. *See also* Hazlett, supra note 5, at 135 (stating that "the Secretary [of Commerce] took no payment and issued no exclusive frequency rights . . . [leaving] many radio stations [to] roam[] the spectrum at will").

8 *See* Radio Act of 1912 § 2; *see also* Hoover v. Intercity Radio Co., 286 F. 1003, 1007 (D.C. Cir. 1923).

9 *See* Hazlett, *supra* note 5, at 139.

10 *See Intercity Radio*, 286 F. at 1006-07.

11 12 F.2d 614 (N.D. Ill. 1926).

12 *See* Hazlett, *supra* note 5, at 141.

13 *See Zenith*, 12 F.2d at 617.

14 Tribune Co. v. Oak Leaves Broad. Station (Ill. Cir. Ct. 1926), *reprinted in* 68 CONG. REC. 215-19 (1926).

15 *See id.*

16 KELLOGG ET AL., BROADBAND LAW, *supra* note 5, § 4.6.1, at 238.

2. Command-and-Control

Secretary Hoover staunchly opposed the homesteading approach, favoring instead the creation of a command-and-control administrative system.[17] With the support of President Calvin Coolidge, Hoover's lobbying efforts resulted in the enactment of the Radio Act of 1927.[18] The Act created a regulatory agency, the precursor of today's Federal Communications Commission (FCC),[19] to administer spectrum allocation according to "public convenience, interest or necessity."[20] Regulation of the airwaves was further entrenched by the Supreme Court's 1943 decision in *National Broadcasting Co. v. United States*,[21] in which the Court affirmed the regulatory authority of the FCC to preserve the public interest against injurious competition among broadcasters on the grounds that broadcast spectrum is a physically scarce medium.[22]

Over time, the command-and-control system increased in complexity, adopting a distinct regulatory approach, including different licensing procedures, for almost every application of the spectrum.[23] The different application processes, however, followed a similar pattern. Parties interested in a portion of spectrum would petition the FCC for an allocation.[24] After numerous rounds of public comments, the FCC would consent to an allocation and announce a timeline for license applications.[25] Each applicant would also submit voluminous studies extolling the public interest benefits of her application.[26] After much deliberation, the FCC would issue operating licenses specifying the location for the approved

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17 *See Hearings on H.R. 7357 Before the Comm. on Merchant Marine & Fisheries*, 68th Cong. 10 (1924) [hereinafter *Hearings on H.R. 7357*] (statement of Hon. Herbert Hoover, Secretary, Department of Commerce).

18 Radio Act of 1927, ch. 169, 44 Stat. 1162 (codified as amended in scattered sections of 47 U.S.C.). For a discussion of the role of the lobbying efforts of President Coolidge and Secretary Hoover in the passage of the Radio Act of 1927, see SYDNEY W. HEAD, BROADCASTING IN AMERICA 158-59 (6th ed. 1990).

19 *See* Radio Act of 1927 § 3.

20 *Id.* § 9; *see also Hearings on H.R. 7357*, at 8 (stating that "more authority must be exerted in the interest of every user").

21 319 U.S. 190 (1943).

22 *Id.* at 213, 216-17. The physical scarcity rationale was reaffirmed by the Supreme Court, despite substantial technological change, in 1969, *see* Red Lion Broadcast. Co. v. FCC, 395 U.S. 367, 375-77 (1969), and later in 1984, *see* FCC v. League of Women Voters, 468 U.S. 364, 376 (1984). Other courts have since found the scarcity logic less compelling. *See, e.g.*, Telecommunications Research and Action Ctr. v. FCC, 801 F.2d 501, 508 (D.C. Cir. 1986) ("Since scarcity is a universal fact, it can hardly explain regulation in one context and not another.").

23 For example, the process required to obtain a television license is different from the process to obtain a cellular license. *See* HEAD, *supra* note 18, at 397-98.

24 *See id.*

25 *See id.*

26 *See* Michael E. Katz, *Interview With an Umpire*, *in* 1996 ANNUAL REVIEW: THE EMERGING WORLD OF WIRELESS TELECOMMUNICATIONS 5 (Institute for Information Studies ed., 1996) [hereinafter EMERGING WORLD].

transmitter, the type of technology to be used, the requisite operational parameters, and the use to which the spectrum was to be put.[27]

Although the FCC developed new licensing procedures as technology developed, the command-and-control system for spectrum administration remained in place, largely unchanged, until the 1980s.

3. Creeping Deregulation

The introduction of cellular services in the United States resulted in a flood of applications that slowed the FCC's administrative process from a mere crawl to a grinding halt,[28] thereby exposing the inefficiencies built in to the existing spectrum administration. Ultimately, the demand for cellular communications unleashed the forces that have led to the reform and partial deregulation of the licensing process for cellular and wireless services.

Although the cellular concept originated at Bell Laboratories in 1947,[29] the FCC did not initiate a frequency allocation process for cellular service until 1974.[30] After the success of experimental licenses in Washington, D.C. and Chicago, the FCC decided in 1981 to license cellular service on a nationwide commercial basis.[31] Growth proceeded slowly due to the regulatory maze at the FCC,[32] which held comparative hearings to determine who among the many applicants would best serve the public interest, convenience, and necessity.[33] After awarding licenses in the thirty largest markets (with two licenses per market), the FCC realized that issuance of licenses for the remaining 704 markets would have dragged on for years. Consequently, in November, 1982, the FCC decided to issue cellular licenses by lottery—a radical departure from the public-interest hearing approach.[34]

As demand for all forms of wireless communications increased by the late 1980s,[35] the FCC could no longer deny that the inefficiencies of the

27 *See* HEAD, *supra* note 18, at 366.

28 For a detailed and entertaining account of the introduction of wireless services, see generally Lewis J. Paper, *Getting Personal: The Politics of the Wireless Revolution, in* EMERGING WORLD, *supra* note 26.

29 *See* RAJAN KURUPPILLAI ET AL., WIRELESS PCS 5 (1997).

30 *See* In re An Inquiry Relative to the Future Use of the Frequency Band 806-960 MHz, 46 F.C.C.2d 752 (1974).

31 *See* In re An Inquiry into the Use of the Bands 825-845 MHz and 870-890 MHz for Cellular Communications Systems, 86 F.C.C.2d 469 (1981).

32 *See* Paper, *supra* note 28, at 23.

33 In *Ashbacker Radio Corp. v. FCC*, 326 U.S. 327 (1945), the Supreme Court held that if two bona fide license applications are mutually exclusive, the applicants are entitled to a comparative hearing.

34 *See* In re An Inquiry into the Use of the Bands 825-845 MHz and 870-890 MHz for Cellular Communications Systems, 90 F.C.C.2d 571 (1982).

35 *See* Lawrence J. Moushin, *Current Developments in Wireless Communications, in* TELECOMMUNICATIONS POLICY AND REGULATION 1990, at 53, 54-55 (PLI Patents, Copyrights,

administrative system were reducing consumer welfare. Not only had the FCC resorted to frequency assignments by lottery,[36] but its own internal analysis revealed that restricting the use to which one could put a particular frequency band generated large social costs.[37] In response to these inefficiencies, the FCC initiated various deregulatory reforms, although it limited this increased freedom to carefully controlled dollops. One such reform was the grant to licensees of a little more freedom in deciding how to use their licenses. Another such reform was adopted pursuant to Congress's 1993 decision to grant the FCC authority to auction licenses in the 1.9 gigahertz (GHz) band for PCS.[38] Following this determination, the FCC decided in 1996 to allow PCS licensees to disaggregate spectrum by geography and frequency,[39] and to allow the winners of a soon-to-be-held auction of new spectrum (general wireless communication services, or GWCS) to offer whatever services made business sense.[40]

Despite these reforms, deregulation to date has been unevenly applied. While holders of GWCS licenses possess something resembling a true property right, broadcasting remains subject to the traditional command-and-control system. Other types of spectrum, such as the original 800 megahertz (MHz) cellular bands, are left with a hybrid legacy of vague property rights and continuing command-and-control regulation. FCC regulation of the spectrum today is characterized by a patchwork of distinct, and analytically contradictory, administrative regimes for different technologies.

B. *Inefficiencies of Administrative Spectrum Allocation*

The perpetuation of command-and-control spectrum administration in the U.S. lowers consumer welfare by preventing license-holders from maximizing the value of their spectrum. Essentially, the existing administrative system restricts value maximization by restricting license

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Trademarks, and Literary Property Course Handbook Series No. G4-3874, 1991) (discussing spectrum demand created by new wireless communication technologies).

36 *See* In re An Inquiry into the Use of the Bands 825-845 MHz and 870-890 MHz for Cellular Communications Systems, 90 F.C.C.2d 571 (1982).

37 *See generally* EVAN R. KWEREL & JOHN R. WILLIAMS, CHANGING CHANNELS: VOLUNTARY REALLOCATION OF UHF TELEVISION SPECTRUM (Office of Plans & Policies, FCC Working Paper No. 27, 1992).

38 *See* H.R. BUDGET COMMITTEE REPORT NO. 103-111, at 245-70 (1993).

39 *See* In re Geographic Partitioning and Spectrum Disaggregation by Commercial Mobile Radio Licensees, 11 F.C.C.R. 21,831 (1996).

40 *See* In re Allocation of Spectrum Below 5 GHz Transferred from Federal Government Use, 11 F.C.C.R. 624 (1995). The 25 MHz of spectrum in the 4660-4685 MHz band was transferred from federal government to private sector use and was allocated to the fixed and mobile services in the First Report and Order in this proceeding, adopted February 7, 1995. *See* In re Allocation of Spectrum Below 5 GHz Transferred from Federal Government Use, 10 F.C.C.R. 4769 (1995).

transferability and the application of certain technology. To the extent that value is not maximized, consumer welfare is diminished.[41]

The welfare costs generated by the current administrative allocation of spectrum take various forms. First, by assigning frequencies to particular uses, the current spectrum administration distorts technological change, leading equipment producers to develop equipment for the allowed use, irrespective of whether that is the most efficient way of utilizing the given spectrum. The fact that equipment innovation tends to conform to regulatory specifications implies that we currently have a stock of equipment that can be utilized less flexibly across frequency bands than would have been the case if the market had determined the use for each frequency band.

Second, by restricting license resale, the administrative system prevents value maximization in the use of spectrum. For example, despite the fact that the cellular spectrum is in the same frequency neighborhood as the TV spectrum, the FCC does not permit spectrum originally assigned to UHF TV to be used for other higher-value purposes, such as cellular telephony.[42] The social welfare cost of this single restriction is enormous. In a ground-breaking study, FCC economists estimated that, in Los Angeles alone, as of 1992 "[t]he voluntary reallocation of a single UHF television channel from broadcasting operations to a third cellular system would likely increase social welfare by over one billion dollars."[43] This estimate reflects the reallocation of a mere six MHz, given that in 1992 a single MHz zoned for UHF TV could have been purchased for $6 million, while a nearly identical MHz zoned for cellular service would have been valued at $70-$160 million.[44] The higher valuation of this spectrum when used for a different purpose illustrates the large social cost generated by administrative restrictions on spectrum assignability.

Third, the inherent passivity and slowness of the command-and-control system delays consumer access to new technology. Recall our previous discussion of the introduction of cellular service in the United States.[45] It took about two decades for the FCC to authorize cellular service and "pry loose 110 MHz of upper UHF TV from the broadcasters."[46] In 1981, the FCC licensed commercial cellular radio

41 Spectrum licenses are really nothing more than factors of production, and as with any factor of production, preventing a Pareto-superior transaction will generally tend to reduce social welfare.

42 *See* KWEREL & WILLIAMS, *supra* note 37, at 2.

43 *Id.* at 8.

44 *See id.* at 8.

45 *See supra* notes 28-34 and accompanying text.

46 GEORGE CALHOUN, WIRELESS ACCESS AND THE LOCAL TELEPHONE NETWORK 580 (1992). Calhoun points out that that the FCC fashioned SMR, cellular and other allocations from this single concession from broadcasters. *See id.*

telephone service, designating forty MHz of spectrum in the 800 MHz frequency band for two competing cellular systems in each market.[47] However, the FCC decided to use the process of comparative hearings for the first thirty markets, whenever there was more than one applicant (and there were many such cases).[48] Although the slowness of the process induced the FCC to hold lotteries for the remaining markets,[49] operation did not begin for most major markets until 1984, by which time the technical framework for cellular put in place by the FCC was becoming obsolete.[50] Rural markets experienced even greater delays; the issuance of licenses for rural cellular systems did not begin until 1989, and was not fully completed until 1997.[51]

Thus, the inefficiency of the FCC's regulatory regime significantly impeded the growth of cellular services in the U.S., as compared to other countries.[52] In the Nordic countries, for example, cellular technology was introduced earlier, with Sweden and Norway initiating service in 1981, and Denmark and Finland in 1982.[53] As a consequence of the earlier introduction of cellular service, the current penetration in the Nordic countries stands at roughly twice that of the United States. These penetration rates are outlined in Table 1.[54]

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47 *See* In re An Inquiry into the Use of Bands 825-845 MHz & 870-890 MHz for Cellular Communications Systems, 86 F.C.C.2d 469, 478 (1981).

48 *See supra* note 33 and accompanying text.

49 *See* FCC, REPORT TO CONGRESS ON SPECTRUM AUCTIONS, FCC 97-353, at 7 (1997) [hereinafter FCC REPORT TO CONGRESS].

50 *See* CALHOUN, *supra* note 46, at 580.

51 *See* KELLOGG ET AL., TELECOMMUNICATIONS LAW, *supra* note 5, § 13.51, at 676. The rural cellular licensing was completed with the FCC's 1997 cellular unserved auction. *See* FCC REPORT TO CONGRESS, *supra* note 49, at 11 tbl.1. For an overview of the cellular licensing timeline and the relative speed of different licensing methods, see FCC REPORT TO CONGRESS, *supra* note 49, at 6-10 & app. E (1997).

52 *See* CALHOUN, *supra* note 46, at 580.

53 *See* DONALDSON, LUFKIN & JENRETTE, *supra* note 1, at 64-65; *see also* G. Todd Hardy, *Emerging Wireless Technologies: PCN and DBS*, *in* CABLE TELEVISION LAW 1991, 337, 394 n.3 (PLI Patents, Copyrights, Trademarks, and Literary Property Course Handbook Series G4-3863, 1991) (describing Sweden, Norway and Finland as having "mature" cellular markets in comparison to those in the U.S.).

54 Data from DONALDSON, LUFKIN & JENRETTE, *supra* note 1, at 64-65.

TABLE 1
Comparison of Cellular Penetration Rates in Selected Countries

Country	Start Year	Penetration (1/4/98)
Finland	1982	44.9%
Norway	1981	40.2%
Sweden	1981	39.4%
Denmark	1982	30.2%
United States	**1984**	**25.1%**
Italy	1985	23.3%
United Kingdom	1985	15.5%
Germany	1985	11.5%
France	1985	11.3%

By distorting technological change, preventing value-maximization of spectrum, and delaying consumer access to new technology, the current command-and-control administrative system generates significant consumer welfare costs. A property rights system would ameliorate these inefficiencies by tapping the self-interest of spectrum holders, allowing them to determine the most effective, and lucrative, use for the spectrum they hold.

C. *Administrative Resistance to a Property Rights Approach*

As illustrated above, the FCC saddles society with a significant loss in welfare by restricting access, usage, and transfer of spectrum. Regulators defend such restrictions primarily by arguing that they are necessary to prevent interference in the spectrum. However, interference could be prevented just as effectively by a property rights system enforced through tort law. In fact, it is far more likely that regulators' real interest in perpetuating the existing spectrum administration stems from their desire to maintain the steady flow of political rents generated by control over

spectrum.

The rationale offered for restricting access is the traditional "tragedy of the commons" argument.[55] Without access restrictions, regulators assert, operators will interfere with one another as they did during the "free for all" period in the early 1900s.[56] Regulators also impose usage restrictions that tie the right to use a specific spectrum to a particular application and technology,[57] arguing that without usage limitations the potential for interference is too great. However, few, if any, good reasons exist for limiting the uses enterprising spectrum holders may find for the specific bands.

The interference rationale also provides little support for government restrictions on the transfer of licenses, given that the aggregate number of licenses would remain the same, but the licenses would merely be transferred to operators able to maximize the value of the corresponding spectrum. Rather than increasing interference, such trades provide a mechanism for the market to correct mistakes that may have been made in the initial command-and-control allocation, and help direct spectrum to its most profitable use. Thus, there is scant economic justification for restricting the transfer of spectrum rights.[58]

Moreover, irrespective of the merits of the interference arguments themselves, limiting interference does not require traditional command-and-control regulation. A much simpler method, which we discuss in more detail below, is to create a full-fledged spectrum property right,[59] granting the spectrum holder the right to use a particular band in any way in a particular geographic area, subject to certain limits on outputs, such as signal to noise ratios.[60] Once a property rights system is implemented,

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55 *See generally* Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243 (1968).

56 For a good discussion of this period, see Hazlett, *supra* note 5, at 135-65.

57 *See, e.g.*, In re Allocation of Spectrum Below 5 GHz Transferred from Federal Government Use, 10 F.C.C.R. 4769, ¶ 4, at 4772 (1995).

58 One possible non-economic explanation for regulators' desire to restrict resale of licenses is their desire to shield themselves from public criticism when operators who initially received spectrum allocations, often for only a nominal fee, immediately resold them for millions of dollars on the open market. By forcing the licensee to build out the license, and wait a respectable amount of time before selling the property, it becomes difficult to disentangle the original value of the spectrum from the value of the assets and customer base added by the licensee, and to determine how much of the original licensee's gains resulted from business acumen, as opposed to regulatory fiat. In this way, the regulator can insulate herself from charges that a national resource was given away.

59 Many commentators have suggested various property rights systems. *See, e.g.*, PETER HUBER, LAW AND DISORDER IN CYBERSPACE: ABOLISH THE FCC AND LET COMMON LAW RULE THE TELECOSM (1997); Robert J. Crandall, *New Zealand Spectrum Policy: A Model for the United States?*, 41 J.L. & ECON. (forthcoming 1999) (working copy on file with author); Arthur S. De Vany et al., *A Property System for Market Allocation of the Electromagnetic Spectrum: A Legal-Economic-Engineering Study*, 21 STAN. L. REV. 1499 (1969); Mark S. Fowler & Daniel L. Brenner, *A Marketplace Approach to Broadcast Regulation*, 60 TEX. L. REV. 207 (1982); Hazlett, *supra* note 5; Comment, *"Public Interest" and the Market in Color Television Regulation*, 18 U. CHI. L. REV. 802 (1951).

60 *See* De Vany et al., *supra* note 59, at 145-62. The output is the strength of the broadcast

interference could be handled through access to tort law. As long as individuals or entities may be sued and fined for trespassing on another's spectrum rights, spectrum users will have incentives to respect the rights of their spectrum neighbors.

Given that the interference rationale does not justify access, usage, and resale restrictions on spectrum, political economy considerations explain more accurately why restrictions on spectrum utilization are almost ubiquitous regulatory forms: Their purpose is to redistribute rents or garner political power.[61] These considerations explain why a regulator might oppose a minor change that would surely seem to promote consumer welfare. The regulator has it in her power to protect the rents of incumbent providers threatened by the change, or, alternatively, to extract some of the substantial windfall gains accruing to the licensee from the modification. The extraction of these rents can take various forms; since the licensee is willing to pay for the license modification, payments may take the form of direct monetary transfers to the treasury, political payments contributions, or any combination of the two.

The FCC's approach to the licensing of high-definition television (HDTV) provides an excellent example. By many estimates, the HDTV spectrum was worth tens of billions of dollars to incumbent U.S. broadcasters.[62] Proceeds from license sales, however, do not remain with the FCC, but are passed on to the Treasury Department.[63] A considerable divergence therefore exists between the FCC's private interest and the societal interest, causing regulators to make decisions that maximize their own welfare. Thus, while raising billions by auctioning spare TV frequencies might ensure the agency some fleeting praise during the congressional budget process, continuing control over the allocation of the HDTV spectrum empowers regulators to bargain with the private sector for politically important concessions. For example, it is plausible to

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signal in the licensee's coverage area and in neighboring areas. An interference problem arises when licensee A's signal in area B is so strong relative to licensee B's own signal that the signal-to-noise ratio experienced by B's receivers is unacceptable. Thus, interference provisions are better specified in terms of outputs.

61 For a foundational exposition of this account of economic regulation, see George J. Stigler, *The Theory of Economic Regulation*, 2 BELL J. ECON. & MGMT. SCI. 3 (1971); *see also* sources cited *infra* note 65.

62 *See, e.g.*, Charles Platt, *The Great HDTV Swindle*, WIRED, Feb. 1997, at 57, 60 (noting that the FCC estimated the value of the HDTV spectrum at $11-70 billion); *cf. Digital Television: Before the Senate Comm. on Commerce, Science, and Transp.*, 105th Cong. (1997) (statement of Reed Hundt, Chairman, FCC) (criticizing the Congressional Budget Office estimate of $10 billion for the value of the HDTV spectrum).

63 *See Comments on the FCC's Fiscal Year 1998 Budget Estimates: Before the House Subcomm. on Commerce, Justice, State, and Judiciary of the Comm. on Appropriations*, 105th Cong., *available in* 1997 FCC LEXIS 1300, *17-18 (1997) (statement of Reed Hundt, Chairman, FCC) (arguing that, since FCC auction proceeds are immediately deposited with the Treasury Department, collection responsibility should be turned over to the Treasury Department as well).

imagine that the TV industry might be more likely to agree to a V-chip (allowing parents to screen children's TV viewing patterns), despite its belief that depictions of sex and violence sell quite well, if it could obtain in return a few dozens of MHz of HDTV, at least nominally for free. Likewise, regulators could endear themselves both to politicians and to the broadcast industry by guaranteeing free airtime to political incumbents in return for ceding vast swaths of spectrum to broadcasters at no charge.[64] The regulator's prospects of promotion to a more powerful agency or a high-powered private sector job may also suddenly improve. Even if government were monolithic, it is not difficult to imagine that the lure of free propaganda on private airwaves might induce a government to give immensely valuable "ethereal real estate" to broadcasters.[65]

In short, regulators resist deregulating spectrum, including removing license restrictions, as a means of perpetuating their own importance, if not their very existence. Implementing a property rights system would remove the ability of politicians to use spectrum allocation for political benefits, and would put a large proportion of the regulatory staff, not to mention lobbyists and lawyers, out of work.[66] As one commentator noted, "genuine deregulation would disrupt the cozy codependence that has existed for decades between broadcasters and Congress, and Congress and the FCC, and the FCC and broadcasters."[67]

Fortunately, the swelling demand for spectrum brought on by extensive technological change has forced the FCC to deregulate some areas of spectrum administration. In particular, the FCC has been bending its procedures in response to substantial pressure from wireless operators who have lobbied the FCC to relax its rules concerning license resale, band fragmentation, and usage changes.[68] For example, the FCC has

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64 *See* Mark Landler, *Capitol Hill Fiat on HDTV Isn't the Last Word*, N.Y. TIMES, July 1, 1996, at D1 (quoting a speech by FCC Chairman Reed Hundt suggesting that broadcasters devote at least 5% of the airtime on these channels to, for example, children's programs or free time for political candidates). Eventually the FCC settled on extracting three hours of children's educational programming per week. *See* Harry A. Jersell, *The Fall of the First*, BROADCASTING & CABLE, Aug. 12, 1996, at 11.

65 We refer readers to the sizable literature on rational choice theory that explains government policy as the outcome of policymakers' attempts to maximize reelection chances, power, budget, etc. *See, e.g.*, PETER A. ARANSON, AMERICAN GOVERNMENT: STRATEGY AND CHOICE (1981); DENNIS MUELLER, PUBLIC CHOICE (2d ed., 1989); GLEN O. ROBINSON, AMERICAN BUREAUCRACY: PUBLIC CHOICE AND PUBLIC LAW 80-87 (1991).

66 While it might increase the workload on judges, it is likely than many fewer lawyers would be needed to litigate these cases than to navigate the FCC's byzantine regulations.

67 Platt, *supra* note 62, at 191.

68 The Commission received submissions from over 50 organizations and individuals in response to a notice and rulemaking on the regulatory status of Specialized Mobile Radio (SMR) systems, including submissions from twenty-eight congressmen, including Senators Burns, D'Amato, Feinstein, Gramm, Helms, Lieberman, and Specter. *See* In re Amendment of Part 90 of the Commission's Rules To Facilitate Future Development of SMR Systems in the 800 MHz Frequency Band, 12 F.C.C.R. 19,079, app. A, at 19,175 (1997).

allowed both the partitioning of spectrum bands and their sublease and resale to third parties for an increasing number of telecommunications applications, such as broadband PCS,[69] Multipoint Distribution Service (MDS),[70] 800 MHz and 900 MHz Specialized Mobile Radio (SMR),[71] 39 GHz fixed point-to-point microwave,[72] Wireless Communications Service (WCS),[73] Local Multipoint Distribution Service (LMDS),[74] Direct Broadcast Satellite (DBS)[75] and Maritime Services.[76] The FCC is considering extending geographic partitioning and spectrum disaggregation to other services, including paging,[77] cellular service,[78] GWCS,[79] and narrowband PCS.[80] The FCC has also allowed Nextel to provide wireless digital service over frequencies that were originally licensed for radio dispatch services[81] and has granted PCS licensees substantial flexibility in their technologies to design and implement PCS systems.[82]

The FCC also has responded to increased spectrum demand through expanded use of spectrum license auctions. The congressional mandate to

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69 *See* In re Commission's Rules to Establish New Personal Communications Services, 9 F.C.C.R. 4957, ¶¶ 157-158, at 5020 (1994).

70 *See* In re Amendment of Parts 21 and 74 of the Commission's Rules with Regard to Filing Procedures in the Multipoint Distribution Service and in the Instructional Television Fixed Service, 10 F.C.C.R. 9589, ¶¶ 46-47, at 9614-15 (1995).

71 *See* In re Amendment of Part 90 of the Commission's Rules To Facilitate Future Development of SMR Systems in the 800 MHz Frequency Band, 12 F.C.C.R. 19,079, ¶¶ 138-227, at 19,127-53 (1997).

72 *See* In re Amendment of the Commission's Rules Regarding the 37.0-38.6 GHz and 38.6-40.0 GHz Bands, 12 F.C.C.R. 18,600, ¶ 70-74, at 18,634-36 (1997).

73 *See* In re Amendment of the Commission's Rules To Establish Part 27, the Wireless Communications Service, 12 F.C.C.R. 10,785, ¶¶ 92-103, at 10,834-39 (Supp. 1997).

74 *See* In re Rulemaking To Amend Parts 1, 2, 21, and 25 of the Commission's Rules To Redesignate the 27.5-29.5 GHz Frequency Band, To Reallocate the 29.5-30.0 GHz Frequency Band, To Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services, 13 F.C.C.R. 11,655 (1998).

75 *See* In re Revision of Rules and Policies for the Direct Broadcast Satellite Service, 11 F.C.C.R. 9712, ¶¶ 179-180, at 9785 (1995), *aff'd sub nom.* DIRECTV, Inc. v. FCC, 110 F.3d 816 (D.C. Cir. 1997).

76 *See* In re Amendment of the Commission's Rules Concerning Maritime Communications, FCC 98-151, *available in* 1998 FCC LEXIS 3381, ¶ 37-43, at *52 (1998).

77 *See* In re Revision of Part 22 and Part 90 of the Commission's Rules To Facilitate Future Development of Paging Systems, 12 F.C.C.R. 2732, ¶¶ 188-194, at 2815-18, ¶¶ 203-218, at 2821-26 (1997).

78 *See* In re Geographic Partitioning and Spectrum Disaggregation by Commercial Mobile Radio Service Licensees, 11 F.C.C.R. 21,831, ¶ 95, at 21,876 (1996).

79 *See id.* ¶ 96, at 21,876. *See also* In re Allocation of Spectrum Below 5 GHz Transferred from Federal Government Use, 11 F.C.C.R. 624, ¶ 105, at 665 (1995).

80 *See* In re Amendment of the Commission's Rules To Establish New Personal Communications Services, Narrowband PCS, 12 F.C.C.R. 12,972, ¶¶ 87-99, at 13,014-18 (1997).

81 *See* In re Amendment of Part 90 of the Commission's Rules To Facilitate Future Development of SMR Systems in the 800 MHz Frequency Band, 8 F.C.C.R. 3950, ¶ 4, at 3951 (1993).

82 *See* In re Amendment of the Commission's Rules To Establish New Personal Communications Services, 8 F.C.C.R. 7700, ¶¶ 135-186, at 7755-78 (1993).

auction spectrum was introduced in the budget bill of 1993.[83] Although pundits and scholars alike have attached much importance to the shift towards auctions,[84] it is unclear whether auctions by themselves are that important a regulatory change. Auctions are clearly superior to the prior procedures for assigning spectrum licenses—whether by lotteries or by administrative hearings—in that they reduce some of the transaction costs associated with transferring the licenses to those that can best use them, particularly if the FCC continues to restrict the ease with which licenses can be transferred. However, auctioning service licenses does not change the overall nature of the FCC spectrum allocation, which still restricts access and usage changes. Although the licensee will probably be the operator with the highest *current* valuation for the object, the licensee will still be restricted in her ability to change services, to fragment the spectrum, and in general to adapt to future technological and market conditions.

The FCC's recent deregulatory steps serve the FCC's interest by addressing pressure for licensing reform without altering the FCC's control over key access, usage, and transfer decisions. Although the FCC's limited deregulation has enhanced short-term consumer welfare to some degree, this modest reform more problematically has allowed the FCC to leave the command-and-control system largely in place, preventing long-term value maximization of the spectrum. Accordingly, what the U.S. needs is a more drastic change in its regulatory approach, similar to the property rights approaches implemented in Guatemala and New Zealand. We examine their experiences in Part III.

II. A Property Rights Approach to Spectrum Allocation

A. *Overview*

The idea of a property rights approach to spectrum allocation is not new. The first to suggest a property rights approach was Leo Herzel in his 1951 article on the regulation of color television.[85] Professor Herzel's ideas did not fare well, nor did Ronald Coase's writings on the subject.[86] Indeed, it took thirty-seven years for these ideas to take root in any piece

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83 *See* Omnibus Budget Reconciliation Act of 1993, 47 U.S.C. § 309(j)(1) (1994).

84 *See, e.g.*, Nicholas W. Allard, *The New Spectrum Auction Law*, 18 SETON HALL LEG. J. 13 (1993).

85 *See* Comment, *supra* note 59, at 811-16. For Herzel's assessment of how he reached his conclusions, see Leo Herzel, *My 1951 Color Television Article*, 41 J.L. & ECON. (forthcoming 1999).

86 *See* R.H. Coase, *The Federal Communications Commission*, 2 J.L. & ECON. 1 (1959); *see also* Ronald Coase, *Comment on Thomas W. Hazlett*, 41 J.L. & ECON. (forthcoming 1999) (containing Coase's assessment of his FCC article).

of legislation. The first legislation that utilized the idea of a property rights approach to spectrum use was the 1989 Radio Communications Act of New Zealand, which introduced the concept of tradable rights as a substitute for administrative licensing schemes.[87] Seven years later, El Salvador and Guatemala introduced legislation expanding the idea of tradable rights.[88] Differing from New Zealand, in both El Salvador and Guatemala all spectrum currently unassigned to broadcasters became subject to licensing under unrestricted tradable permits.

B. *The Basic Building Blocks*

To understand the importance of these regulatory changes, we must first identify the structural foundation that will permit the development of a market for unrestricted tradable permits in spectrum. There are three basic building blocks for the creation of a working market in tradable spectrum permits: (1) the right to sell, fragment, or lease the spectrum (i.e. the right to property); (2) the right to use the assigned spectrum, as opposed to the right to provide a service; and (3) the handling of interference problems (i.e. the prevention of trespassing). We discuss them in turn.

1. Right to Property

The traditional administrative assignment of spectrum rights specifies the use for the spectrum, the frequency band, the time of broadcasting, the power and location of the transmitting facility (including, where appropriate, its directionality), and the location of the receiving antenna.[89] This right could be construed as property if it could be sold at will.[90]

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87 *See* Radiocommunications Act, 1989, No. 148 (vol. 4. page 2297) (N.Z.). For a discussion of the New Zealand auctions, see Crandall, *supra* note 59.

88 The authors helped design the reforms of the telecommunication sectors and draft the telecommunications laws passed in 1996 by the legislatures of both countries. *See* Ley de Telecomunicaciones, D.O., 9 de octobre de 1996 (El Sal.); Ley General de Telecomunicaciones, D.C.A., 18 de noviembre de 1996 (Guat.).

89 *See, e.g.*, 47 C.F.R. §§ 22.900-22.967 (1997). Note that PCS are regulated differently and are subject to Part 24 of the Code of Federal Regulations, *see* 47 C.F.R. §§ 24.200-24.253 (1997), while SMR providers are regulated under Part 90, *see* 47 C.F.R. §§ 90.601-90.913 (1997). Broadcast services are subject to an entirely different set of rules under Part 73. *See* 47 C.F.R. §§ 73.1-73.4280 (1997).

90 Some rights would not have greater value in alternative use. For example, a right to a point-to-point transmission over a certain frequency from the headquarters of a particular company to one of its branches would have very little value in alternative use, as a buyer interested in using that right for an alternative use also will have to obtain the right to retransmit from the two end-points to the two end-points in which the buyer is interested. Under other conditions, a right could be very valuable, in particular if the permits involve broadcasting services, like radio, TV, satellite, or mobile telephony licenses of any sort.

By contrast, a property rights approach to the spectrum simply would grant the right to transmit over a particular frequency band over a particular geographic area. This right, however, is not enough to assure flexibility and innovation. For spectrum to be transferred to its highest value use, this right must be transferable, as well as fragmentable, which in turn requires that the right be specified not in terms of service, but rather in terms of usage or outputs.

2. Right to Use

Traditional licensing regimes award the licensee the right to provide a specific service using a particular frequency band—and nothing more. For example, UHF TV licensees only have the right to provide UHF TV broadcasting over the designated frequencies.[91] Should the licensee desire to use the same airwaves to provide a service not expressly permitted by federal regulations, specific authorization must be obtained from the FCC.

Under a property rights system, this right to provide a service would be replaced by a general right to use, granting the licensee the ultimate choice of application of the spectrum. Only in the absence of usage restrictions can a licensee maximize the value of spectrum. Additionally, the right to determine to what use the spectrum will be put is an important driving force behind the development of new technologies.

To some extent, shifting towards a right to use would be one of the most drastic departures from the standard administrative allocation process. As discussed previously, only recently, and only for very specified spectrum bands, has the FCC provided some service flexibility to licensees.[92] However, even in the case of PCS, the license is restricted to the provision of commercial radio service—traditional broadcasting (such as TV or radio) is expressly prohibited.[93] Although this does not cause a problem at present, as this is currently the highest value usage for those radio frequencies, it might in the future, when a higher value use is discovered for that spectrum. Although the FCC has moved to some extent towards a right-of-use doctrine, the move has been haphazard, hesitant, and ad-hoc.

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91 *See supra* note 42 and accompanying text.

92 The FCC, for example, reclassified SMR licenses as Commercial Mobile Radio Service (CMRS) licenses, permitting dynamic sharing and interconnection to the Public Switch Telephone Network (PSTN) of dispatch radio channels. *See* Omnibus Budget Reconciliation Act of 1993, 47 U.S.C. § 332 (1994).

93 *See* 47 C.F.R. § 24.229(d) (1997) (setting forth the spectrum allocations for commercial radio service); § 24.3 (expressly prohibiting PCS licensees from engaging in "broadcasting as defined by the Communications Act").

3. Handling Interference

The laws of physics do not allow for an easy definition of the boundaries of the right to transmit. This is particularly problematic for two of the three dimensions of the right: the geographic area and the spectrum band. However, as discussed below, interference problems could be handled under a property rights system by specifying a reference signal strength and a maximum signal strength for broadcasts, and allowing right holders themselves to utilize tort law to protect their broadcast rights against trespassers.

The important characteristic of a broadcast signal is the received signal to noise ratio (SNR), because its information content (broadly speaking, its quality to the end user) is a logarithmic function of the received signal to noise ratio, as specified by Shannon's Law:[94] As the signal progressively weakens relative to surrounding noise, degradation accelerates. Currently, part of the FCC's engineering function is to provide SNR protection.[95] When a request for a new transmitter license comes in, the FCC plugs into its engineering models data on all the surrounding transmitters, plus the new one,[96] and attempts to compute whether existing licensees' SNR will be adversely affected and whether sufficiently good SNR can be given to the petitioner.[97]

Under a property rights system, detailed SNR engineering by regulators is rendered unnecessary by simply distributing the SNR rights and letting the spectrum holders determine how to use their spectrum without infringing on their neighbors' rights. A right holder's basic limits are the rights of the other right holders. Each holder's right to transmit free of interference limits the spectrum uses of other right holders. However, the concept "free of interference" is not well defined, and will depend on the power level at which individual spectrum holders choose to broadcast. A right holder who uses her spectrum for a very low power application will receive interference from multiple sources. Thus, to avoid being interfered with, and to avoid interfering with others, the right to transmit over a particular geographic area, time, and spectrum band must be limited by a set of minimal technical parameters.

The necessary technical parameters are the reference signal strength and the maximum signal strength. The first parameter, reference signal strength, is measured in practice by the field strength (FS).[98] Provided that

94 "Shannon's Law" is set forth in C.E. Shannon, *A Mathematical Theory of Communication* (pts. 1 & 2), 27 BELL SYS. TECH. J. 379 (1948); 27 BELL SYS. TECH. J. 623 (1948).

95 *See* 47 C.F.R § 24.237 (1997).

96 *See id.*

97 *See, e.g.* In re Commission's Rules To Establish New Personal Communications Services, 9 F.C.C.R. 4957, ¶ 186, at 5030 (1994).

98 The FCC often prescribes maximum field-strength limits. *See* 47 C.F.R. § 27.55 (1997).

the right holder maintains her minimum FS, she enjoys a right to the minimum acceptable SNR. These two parameters, in turn, determine the maximum strength of the background noise.

The second parameter, maximum signal strength, is necessary because noise from multiple sources is cumulative, and it would be difficult to determine what source is creating the quality degradation. This noise externality would rapidly escalate power levels, as users try to drown out background noise with ever increasing transmitter power. The chain of events is very similar to a crowded cocktail party, where very soon everyone has to shout to make themselves heard over the din. The spectrum property right, therefore, needs to specify a maximum signal strength, measured in terms of outputs, rather than inputs. Instead of the detailed FCC-type regulation of antenna heights and transmitter power, it is simpler to specify (1) a maximum field strength at the boundary of the coverage area (to protect geographically adjacent users of the same frequency from co-channel interference), and (2) maximum levels of out-of-band emissions (to protect users of adjacent frequency bands in the same area from adjacent channel interference).

The framework described above provides a natural definition of a coverage area, which could be specified in terms of a certain FS.[99] Unfortunately, it remains unclear what the "natural" SNR should be for a particular frequency band at a particular time of day in a particular geographic location. Thus, some residual regulatory engineering is necessary to craft the original rights, in order to ensure that the set of original rights is not conflicting and that the defined rights are actually useful. But that is as much as needs to be stipulated. A right holder would be left to decide if she wanted to maintain the minimum FS (and thus enjoy the minimum SNR protection), and whether to do this through many small transmitters, or one large one.[100] A right holder transmitting in a geographic area and in a spectrum band with no "neighbors," whether in the spectrum dial or in the geographic area, can increase power substantially without creating injurious interference. If, however, a new right holder shows up next door, then the original right holder will have to adjust her transmission to avoid interfering with her new neighbor.

To have a well functioning market for transmission rights, right holders must be able to enforce such rights. The right to be free from

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In the case of PCS, the field-strength limit is 47 dBuV/m. *See* 47 C.F.R. § 24.236 (1997).

99 The FCC already uses the field-strength contour concept to evaluate potential duopoly situations and violations of cross-ownership restrictions, by examining the overlap of the so-called Grade B contours (computed in accordance with 47 C.F.R. § 73.684 (1997)). *See* 47 C.F.R. § 73.3555 (1997).

100 Changes to these technical restrictions could be adopted as long as "neighboring" spectrum holders do not object.

injurious interference—i.e. the right to exclude[101]—would be defined in terms of the technical characteristics of the spectrum right. Since the Supreme Court's 1943 decision in *FCC v. National Broadcasting Commission (KOA)*,[102] exclusive spectrum assignments have been recognized as legally enforceable rights.[103] Thus, clear liability and appropriate penalties would be sufficient for private enforcement. In the same way that companies sue each other for patent violation or for theft of industrial secrets, or individuals sue one another for injuries arising from car accidents, companies could sue each other for prejudicial interference and obtain compensation for damages. It has long been suggested that market forces, in conjunction with contracts and property rights (with privately enforceable protection), would limit interference successfully, and in any case demonstrably better than the government has in the past.[104] Furthermore, under a property rights system, right holders could collect damages from trespassers. Thus, unlike the current system, right holders would have an extra incentive to find and prosecute those broadcasters that interfere with their transmission rights.

C. *The Government's Role Under a Property Rights Approach*

The government would still retain a limited role under a property rights approach. As discussed earlier,[105] some regulatory engineering would be necessary to craft the new spectrum property rights. Additionally, an official record of who owns what portion of the spectrum would still have to be maintained.[106] Although the FCC in theory could serve as the adjudicator of spectrum property rights disputes, more than a half-century of micromanaging broadcasters, common carriers, and wireless operators would not pass away easily. Indeed, this concern has led Peter Huber to argue that the FCC should be abolished and that all spectrum matters should be delegated to common law.[107]

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101 *See* Kaiser Aetna v. United States, 444 U.S. 164, 176 (1979) ("[The right to exclude is] one of the most essential sticks in the bundle of rights that are commonly characterized as property.").

102 319 U.S. 239 (1943).

103 *See id.*

104 *See* Fowler & Brenner, *supra* note 59, at 207-26 (containing former Chairman of the FCC Mark Fowler's critique of the social inefficiency of the current administrative system).

105 *See supra* note 100 and accompanying text.

106 The FCC has recognized this important role and has stepped up its efforts to increase the availability of spectrum licensing information. *See* In re Biennial Regulatory Review—Amendment of Parts 0, 1, 13, 22, 24, 26, 27, 80, 87, 90, 95, 97, and 101 of the Commission's Rules To Facilitate the Development and Use of the Universal Licensing System in the Wireless Telecommunications Services, 13 F.C.C.R. 21,027, ¶ 143, at 21,091 (1998). While this record-keeping function also arguably could be delegated to private entities, a public information clearinghouse may exhibit strong returns to scale as well as public good characteristics. Additionally, one might want to avoid conflicting attribution of property rights by two or more competing private registries.

107 *See* HUBER, *supra* note 59.

We believe the responsibility for adjudicating spectrum property rights disputes should lie with the judiciary.[108] Lay courts could take advantage of the FCC's knowledge of spectrum interference issues by appointing FCC staff members as Special Masters. However, legislation may be required to counteract the D.C. Circuit's recent ruling in *United States v. Microsoft Corp.*,[109] which held that the "browser war" litigation was not complex enough to warrant the appointment of a Special Master.[110]

III. International Experience with the Introduction of Spectrum Property Rights

Reviewing the international experience with spectrum property rights is a useful first step in determining how the U.S. might engineer the transition to a full-fledged property rights system. The experiences of New Zealand and Guatemala, in particular, may illuminate advantages and disadvantages of differing approaches to important elements of a property rights system, such as the initial assignment of spectrum rights, the policing of interference, and the relative productivity of spectrum uses.

A. *The New Zealand Experience*

New Zealand's 1989 Radiocommunications Act established the first experiment with spectrum property rights.[111] The Act authorized the Ministry of Commerce to introduce tradable rights as a substitute for the traditional administrative assignment process.[112] This scheme has been called the "spectrum management" approach.[113] In this approach, spectrum segments are sold to spectrum managers, who in turn resell or rent to third parties the right to utilize their spectrum.[114]

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108 If the courts prove ineffective adjudicators of spectrum disputes, alternative methods of resolving prejudicial interference could be designed. For example, Guatemala developed an administrative procedure to resolve interference disputes. *See* Reglamento para la explotación de sistemas satelitales en Guatemala, D.C.A, 2 de septiembre de 1998 (Guat.). To make this process effective, all transmission devices have to be registered with the spectrum agency, so that presumed violators could be identified. *See id.* art 15.

109 147 F.3d 935 (D.C. Cir. 1998).

110 *See Microsoft*, 147 F.3d at 956 (vacating the appointment of Special Master Lawrence Lessig by Order of Reference to Special Master in *United States v. Microsoft Corp.*, 980 F.Supp. 537, 545 (D.D.C. 1997)). The Appeals Court noted that "'A reference to a master shall be the exception and not the rule. In actions . . . to be tried without a jury, save in matters of account and of difficult computation of damages, a reference shall be made only upon a showing that some exceptional condition requires it.'" *Microsoft*, 147 F.3d at 953 n.21 (quoting FED. R. CIV. P. 53(b)).

111 *See* Radiocommunications Act, 1989, No. 148 (vol. 4, page 2297) (N.Z.).

112 *See* Radiocommunications Act § 12 (N.Z.).

113 *See* Crandall, *supra* note 59, at 23.

114 *See* Radiocommunications Act § 98 (N.Z.).

Since the passage of the 1989 Radiocommunications Act, New Zealand has moved relatively slowly toward a property rights system. It has sold only a small amount of the spectrum to private individuals under the spectrum management approach, using mostly simultaneous second (and later, first) price auctions.[115] Most spectrum, however, is still allocated under the old administrative process.[116]

Although the initiative has succeeded in transferring the administration of segments of the broadcasting spectrum to the private sector, there have been substantial problems. First, spectrum managers thus far have failed to do much management, with few resale or rent transactions taking place.[117] Crandall reports that the Multipoint Distribution Service (MDS) management rights lie almost completely fallow,[118] despite the fact that their holders each paid up to $800,000 for the rights.[119]

Second, the sealed-bid auction mechanism utilized by the Ministry of Commerce created substantial price differences for similar rights.[120] Due to the second price mechanism employed in this auction, the winner with the highest bid would only be required to pay the amount of the second-highest bid. As a result, some bidders paid less than half their winning bid,[121] and one bidder even obtained a license for zero price.[122]

Although the reasons underlying the malfunctioning of the auction system are clear, the lack of substantial subsequent private reassignment of the spectrum is less easily explained. One possible explanation is that the spectrum management approach may have been applied in the wrong bands. Another possibility is that the bands for which spectrum management would work best are those where the standard administrative assignment would be most difficult, such as point-to-point uses. Alternatively, it could simply be the case that there was little total demand in New Zealand for the spectrum carrying the property rights. Indeed, New Zealand's low population density[123] suggests a general lack of spectrum

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115 *See* Crandall, *supra* note 59, at 11-12.

116 *See* Crandall, *supra* note 59, at 10-11.

117 *See* Crandall, *supra* note 59, at 24.

118 There have been only minor uses for non-video transmission. *See* Crandall, *supra* note 59, at 22.

119 *See* NEW ZEALAND MINISTRY OF COMMERCE, RADIOCOMMUNICATIONS ACT REVIEW DISCUSSION PAPER: PRELIMINARY CONCLUSIONS, app. 2 (1995), *available in* <http://www.moc.govt.nz/rsm/act_review/actr_96.html> (visited Dec. 4, 1998) [hereinafter N.Z. DISCUSSION PAPER].

120 *See* Crandall, *supra* note 59, at 11-12.

121 *See* John McMillan, *Selling Spectrum Rights*, J. ECON. PERSP., Summer 1994, at 145, 148.

122 This was the case of a college student who bid for a TV license for a small city. Since no one else bid, the license was granted at the price of the putative second-highest bid, i.e. zero price. *See id.*

123 The population density of New Zealand is only 34 persons per square mile. *See* THE

scarcity, with large quantities of spectrum still subject to traditional administrative assignment.

In summary, the New Zealand experiment most convincingly illustrates potential pitfalls in implementing a property rights approach. New Zealand's experience does not, however, offer much guidance for the implementation of a property rights system in the U.S., because (1) the system was only implemented in certain limited bands, (2) the auction process had deficiencies, and (3) the country itself has a quite low population density, suggesting a relatively small degree of spectrum scarcity. In these three respects, Guatemala's experience may be more instructive, especially as Guatemala benefited from the practical auction experience of New Zealand, Australia, and, especially, the United States and Mexico.

B. *The Guatemala Experience*

In 1996, the Guatemalan National Assembly enacted a new telecommunications law,[124] completely deregulating the spectrum market,[125] allowing free entry into all segments of telecommunications,[126] and requiring operators to grant competitive interconnection.[127] A key part of the Act required that all new spectrum allocations be made through a property rights system.[128] Spectrum rights are now granted in fully transferable and fragmentable frequency usage titles (Títulos de Usufructo de Frecuencias, or TUFs).[129] The TUFs have no service limitation, but carry technical limitations to protect against prejudicial interference.[130]

The basic building block of Guatemala's approach to the spectrum is that all spectrum not currently assigned to the government,[131] to radio and TV stations,[132] or to other license holders,[133] and not set aside as "free," can be requested by any person.[134] If the regulatory agency determines that a request does not infringe on any other existing license holders' rights, a

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WORLD ALMANAC AND BOOK OF FACTS 1998, 803 (Robert Famighetti et al. eds.). By contrast, the population density of the U.S. is 72 persons per square mile. *See id.* at 832.

124 *See* Ley General de Telecomunicaciones, D.C.A., 14 de noviembre de 1996 (Guat.).

125 *See id.* arts. 22 & 26.

126 *See id.* art. 51.

127 *See id.* art. 28.

128 *See id.* art. 54.

129 *See id.* arts. 54-57.

130 *See id.* art. 57.

131 *See id.* art. 95.

132 Radio and TV stations were grandfathered, and were granted fully transferable rights of use to their spectrum bands. *See id.* art. 96.

133 Private concession holders could only continue those services they were actually providing at the time of enactment, and would not be able to renew their concession upon expiration. *See id.* art. 94.

134 *See id.* art. 54.

period of public comment begins, allowing other interested parties to object to the granting of the right.[135] Objections may be raised for two reasons. First, the objector may already own a right that would be violated by the request.[136] If such a protest is substantiated, the request is not granted.[137] Second, the objector may also want a portion of the requested spectrum,[138] in which case the regulator must initiate an auction procedure.[139] The law requires that, if fragmentation would promote competition, regulators must auction the requested spectrum in a fragmented fashion, following a simultaneous, ascending multiple-round auction format.[140]

Since the law entered into effect in January, 1997, the regulatory agency has received more than 10,000 requests for spectrum use rights.[141] Although the law provides approximately four months as the maximum interval between request and auction,[142] the law does not penalize the agency for delays. As a consequence, the auction process has been somewhat attenuated. Nevertheless, the Guatemalan Superintendencia de Telecomunicaciones has accomplished the laudable feat of conducting thirty-eight spectrum auctions in its brief two years of existence.[143]

1. The Specialized Mobile Radio Auction[144]

The first auction began on June 2, 1997, and lasted for approximately two weeks.[145] The auction was for 20.8 MHz of nationwide spectrum in the 800 MHz range, which currently is used in the region for "trunking" or

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135 *See id.* art. 61.

136 *See id.*

137 *See id.*

138 *See id.*

139 *See id.*

140 *See id.* art. 62.

141 The Guatemalan regulator posts a list of the most recently received requests at Website of Superintendencia de Telecommunicaciones de Guatemala (visited Dec. 10, 1998) <http://www.sigloxxi.com/SIT_GUA/Sit091198/solicitud.html>.

142 *See* Ley General de Telecomunicaciones, art. 62 (Guat.)

143 The Superintendencia has conducted 38 auctions at the time of this writing. *See* Website of Superintendencia de Telecommunicaciones de Guatemala (visited Dec. 10, 1998) <<http://168.234.153.31/SIT_GUA/indexsp.html>. The last auction at the time of writing was SP-38, which closed on October 27, 1998. The auctioned frequencies were in the 400 MHz band, most likely for private land mobile radio, although the only restrictions placed on the rightholders were that they maintain their broadcasts within the prescribed frequencies and with a maximum radiated power of 50 dBm, being guaranteed a SNR protection of -90 dBm. *See* Website of Superintendencia de Telecommunicaciones de Guatemala (visited Dec. 10, 1998) <http://www.sigloxxi.com/SIT_GUA/Sit091198/resSIT-SP38.html>.

144 Little documentation exists with respect to Guatemala's SMR auction or the FM auctions. Notes on the results of these auctions are on file with the authors, who participated in the development of Guatemala's property rights approach to spectrum, including the auction process.

145 *See* Website of Superintendencia de Telecommunicaciones de Guatemala (visited Dec. 10, 1998) <http://168.234.153.31/SIT_GUA/indexesp.html>.

SMR. The 20.8 MHz of spectrum were fragmented in pairs of outbound and inbound bands, and also in two types of band pairs, seven of one MHz each and twelve of 200 kilohertz (kHz) each. The one MHz bands and the 200 kHz bands were contiguous. Initially, there were eleven bidders—ten companies, including the national telecommunications company, GUATEL, and one individual. The bidders deposited payments that allowed them collectively to bid initially for more than sixty MHz.[146] The auction ended after two weeks of intense bidding, with total payments of almost $3 million (17.2 million Quetzals). Seven out of the initial eleven bidders won at least one lot.

It is interesting to compare this result to auction results in the United States. The population of Guatemala is approximately eleven million people; its average per capita income is just over U.S. $3,000.[147] Thus, on a per MHz-POP basis,[148] the Guatemala auction resulted in a value of approximately 1.2 U.S. cents per MHz-POP. A similar auction in the United States has resulted in 24.5 U.S. cents per MHz-POP.[149]

146 Essentially, this meant that the initial expressions of interest indicated that there was a weighted average of 2.9 interested bidders for every property (sixty MHz divided by the 20.8 MHz available in the auction). As prices increased in the auction, bidders dropped out until only valid bids for 20.8 MHz remained.

147 *See* THE WORLD ALMANAC AND BOOK OF FACTS 1998, *supra* note 123, at 707.

148 MHz-POP is a convenient way of expressing the "capacity" of a license. It is the product of the available MHz in the license and the number of inhabitants in that license territory (i.e. MHz x population).

149 The FCC's SMR auction consisted of 20 ten-channel blocks (10 x 2 x 12.5 kHz = 250 kHz per block) in the 900 MHz band in each major trading area. The auction lasted 168 rounds, closing in April, 1996. Notably, incumbent licensees in the band retained the right to operate under their *existing* licenses and the right to co-channel and adjacent channel interference protection. The new licensees were awarded the right to authorize expansion of existing systems. The FCC published as part of the bidders' package its estimates of the extent of incumbency for each block, while disclaiming any responsibility for the accuracy of this information, cautioning bidders to do their own research. The FCC estimated that on average only three of the nominal five MHz were usable. *See* SMR Fact Sheet <http://www.fcc.gov/wth/auctions/smr/smr1fact.html> (visited Jan. 10, 1998).

TABLE 2
Comparison of SMR Auction Results in the United States and Guatemala

Country	GDP Per Capita (U.S. $)	Population (millions)	MHz-POPs Auctioned (millions)	Auction Proceeds (U.S. $ millions)	SMR price (¢/MHz-POP)
United States	27,607	266	830.7	204	24.6
Guatemala	3,080	11.3	235.0	2.8	1.2
Ratio	9x				20.5x
U.S. Premium					**2.3x**

Although the spectrum bands auctioned are not directly comparable due to variations in equipment standards,[150] the comparison illustrates the importance of the property rights approach. Adjusting roughly for the very large differences in personal income, the realized price per MHz-POP in the United States was just over twice that in Guatemala. This premium can be understood, in part, as resulting from a number of factors: (1) the higher fragmentation of the spectrum offered in the U.S. auction, where the blocks auctioned were much narrower; (2) the relative scarcity of SMR spectrum in the United States (Guatemala auctioned over six times as much effective spectrum);[151] (3) the higher proportion of the U.S. population employed in the finance, insurance, and retail (FIRE) trades;[152]

150 SMR commonly operates in either the 800 MHz or the 900 MHz band. Systems in the 800 MHz band use two paired 25 kHz channels, while 900 MHz band systems use two paired 12.5 kHz channels. Because of the different sizes of the channel bandwidths between the 800 MHz and 900 MHz systems, traditional SMR equipment is band-specific. *See* CARLO CARDILLI ET AL., LAW AND ECONOMICS CONSULTING GROUP ASSESSMENT OF MARKET VALUES OF CANADIAN CELLULAR, PCS AND ESMR LICENSES 5-6 (1997) (report on file with author). Narrower channel bandwidths also tend to result in better spectrum utilization.

151 Guatemala auctioned 20.8 MHz, *see supra* note 145 and accompanying text, while the U.S. auctioned three effective MHz, *see supra* note 149.

152 *See* CARDILLI ET AL., *supra* note 150, at 19 (illustrating empirically that the value of SMR spectrum in the U.S. auctions bears a strong positive correlation to the proportion of the labor force employed in the FIRE sectors); *cf.* PATRICK S. MORETON & PABLO T. SPILLER, MULTI-LICENSE BIDDING STRATEGIES IN THE FCC BROADBAND PCS SPECTRUM AUCTION (U.C. Berkeley working paper, Jan. 1997) (on file with author) (containing analysis of the impact of FIRE employment on PCS license valuations and finding limited evidence of a positive correlation).

and (4) environmental factors, such as the greater monetary, political, and regulatory stability of the United States.

The four factors above suggest that auction prices in U.S. auctions should carry an enormous premium compared to similar auctions in Guatemala. Thus, it is perhaps surprising that Guatemalan auction prices were even in the same ballpark. Guatemala's higher population density (approximately three times that of the United States[153]) must have helped,[154] as well as its lack of wireline penetration. We believe, however, that the most important factor that placed the Guatemalan auction prices at a comparable level to U.S. auction prices was the unique property rights that were for sale.

Winners in Guatemalan auctions knew, for instance, that they could resell airtime on their "enhanced" SMR (ESMR) systems to any group of users. Perhaps more importantly, they knew they could resell their licenses, in whole or in part, to other potential operators. In fact, although the prior utilization of these frequencies in Guatemala was exclusively for non-interconnected SMR, at least one of the winners of the one MHz bands declared its intention to deploy fixed wireless applications, while others announced their intention to deploy advanced ESMR systems to grab a slice of the large cellular market.[155]

2. The FM Auctions

On August 4, 1997, Guatemala initiated a second round of auctions. In total, thirty-three FM regional and city range radio stations were auctioned, including some stations located in the nation's capital. A total of thirty-seven bidders registered, with nineteen bidders winning various radio holdings.[156] The government raised a total of $3 million from the auction.

It is interesting to compare these numbers with those derived from New Zealand's massive radio station auctions. New Zealand, with a per capita income three times that of Guatemala,[157] obtained only slightly more than $6 million for more than 300 AM and FM stations, or the

153 Guatemala's population density is 275 persons per square mile, *see* THE WORLD ALMANAC AND BOOK OF FACTS 1998, *supra* note 123, at 707.

154 *Cf.* CARDILLI ET AL., *supra* note 150, at 19 (demonstrating that the value of SMR spectrum in the United States was strongly related to the population density of the license area).

155 While cellular represents one in seven Guatemalan access lines, there is currently only one operator providing only analog (AMPS) service.

156 *See* Website of Superintendencia de Telecommunicaciones de Guatemala (visited Dec. 10, 1998) <http://168.234.153.31/SIT_GUA/indexsp.html>.

157 New Zealand's per capita income is approximately $18,300, *see* THE WORLD ALMANAC AND BOOK OF FACTS 1998, *supra* note 123, at 803, compared to a per capita income of $3,300 in Guatemala, *see* THE WORLD ALMANAC AND BOOK OF FACTS 1998, *supra* note 123, at 707.

equivalent of less than $18,000 per station.[158] Guatemala, by contrast, obtained approximately $60,000 per station. These two values are difficult to compare, as the Guatemalan stations auctions were all FM, while those sold in New Zealand were a mixture of AM and FM.[159] Additionally, the extra value obtained in Guatemala may reflect an artificial radio scarcity created by regulators. However, the flexibility of the Guatemalan TUFs auctioned are in large measure responsible for the striking disparity between the prices obtained at the Guatemalan and New Zealand auctions.

3. Assessing Guatemala's Experience: The Viability of a Property Rights Approach

The Guatemalan experience is interesting because it is the first experiment to implement successfully a total property rights approach to spectrum utilization. It is difficult to judge the relative success of New Zealand's property rights experiment to date, given early flaws in New Zealand's auction process and the limited nature of the spectrum auctioned. Guatemala's approach, by contrast, has already proven feasible, even though it began only recently: The private sector has been willing to bid large amounts, even though the system for protecting against interference is novel and as yet untested. Furthermore, participation in the auctions has been widespread. The eleven participants in the SMR auctions, and the thirty-seven participants in the radio station auctions, show the value of spectrum fragmentation, particularly in what may be relatively thin markets.[160]

Guatemala's experience illustrates that property rights in spectrum, if implemented through careful legislation and a sophisticated auction process, are an immediately viable option for spectrum management. Moreover, the success of the Guatemalan TUFs in unlocking spectrum value suggests that eliminating access, usage, and transfer restrictions on

158 *See* Crandall, *supra* note 59, at 12-13. This number also includes the proceeds from the sale of over 50 UHF TV licenses, suggesting that the actual value of the radio stations was even less than $18,000. *See id.*

159 FM stations can be quite valuable, as FM subcarrier techniques can allow substantial one-way audio or data transmission, such as paging, news, stock prices, sports scores, elevator music, second language programming, and so on. Of the 200 kHz available in a standard FM radio slot, over 40 kHz are unused by standard FM transmission and available for data transmission, permitting a data stream of 100 kb/s or more, depending on the subcarrier technique used. *See* DANIEL MINOLI, TELECOMMUNICATIONS TECHNOLOGY HANDBOOK 256-66 (1991). Of course, the Guatemalan property rights approach would allow a right holder to use the entire 200 kHz slot for data transmission if she so wished.

160 Indeed, the lack of spectrum fragmentation may have been the basic strategic failure of the second-price auctions in New Zealand. The government of New Zealand chose to auction management rights for large spectrum blocks, *see* Crandall, *supra* note 59, at 11, and "some potential bidders may have avoided the New Zealand auction of the first three cellular bands because they believed they could not compete with Telecom New Zealand or Bell South," *see id.* at 18.

U.S. spectrum through similar rights could promote value-maximization of U.S. spectrum.

IV. Toward a Property Rights System in the United States

The FCC has recognized some of the advantages generated by spectrum property rights, and has begun edging toward a property rights system. The FCC introduced auctions for communications spectrum in the early 1990s, and pioneered the sequential multiple-round format in 1995,[161] culminating in the extremely successful auction for the PCS A- and B-blocks.[162] In these PCS auctions, the FCC implicitly granted what many consider enormous usage flexibility to licensees, including allowing licensees to choose important transmission standards.[163] In the WCS auction, the FCC even abandoned traditional buildout requirements.[164] Due to the tremendous revenue PCS generated, vigorous debate ensued in 1997 as to whether TV broadcasters should pay for the HDTV spectrum.[165] The FCC recently has taken further liberalizing steps. For example, the FCC allowed PCS licenses to be sliced and diced as holders see fit,[166] recognizing that this freedom promotes better utilization of the spectrum. Moreover, under pressure from the likely mass default in the PCS C-block, the FCC might allow licensees even more latitude so that they can generate sufficient revenue to avoid default.[167]

Despite these encouraging steps, however, the FCC has shied away from any large-scale revision of the existing spectrum administration to a property rights approach. Consequently, even for PCS licenses, where the most substantial deregulation has occurred, the administrative process still lurks in the background: The licenses eventually expire, and the FCC has

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161 *See* FCC REPORT TO CONGRESS, *supra* note 49, at 8-10 (discussing the history of FCC spectrum auctions).

162 *See id.* at 10 (observing that the Broadband PCS auctions raised over $7.7 billion).

163 *See* In re Amendment of the Commission's Rules To Establish New Personal Communications Services, 9 F.C.C.R. 4957, ¶ 5, at 4960 (1994) (permitting "providers [to] have the flexibility to determine the amount of spectrum needed for their particular services").

164 *See* In re Amendment of the Commission's Rules To Establish Part 27, the Wireless Communications Service, 12 F.C.C.R. 10,785, ¶¶ 111-114, at 11,010 (Supp. 1997). Generally speaking, buildout requirements prevent stockpiling by requiring that the spectrum must be used, and a certain percentage of the market served, within a specified amount of time, generally five years. However, for WCS licensees offering fixed, point-to-point services, the FCC indicated that as few as "four permanent links per one million people . . . at the ten-year mark would constitute substantial service." *Id.* ¶ 113, at 10,788. In effect, with this decision, the FCC has retained buildout requirements for WCS licenses in name only.

165 The contrasting views in this debate are summarized in CONGRESSIONAL BUDGET OFFICE, WHERE DO WE GO FROM HERE? THE FCC AUCTIONS AND THE FUTURE OF RADIO SPECTRUM MANAGEMENT 2-4 (1997).

166 *See* In re Geographic Partitioning and Spectrum Disaggregation by Commercial Mobile Radio Service Licensees, 11 F.C.C.R. 21,831, ¶ 5, at 21,839 (1996).

167 *See* Arthur De Vany, *Implementing a Market-Based Spectrum Policy*, 41 J.L. & ECON. (forthcoming 1999).

the discretion to deny renewal. Furthermore, licensees cannot put the spectrum to a different and more valuable use following an evolution in technology. The system is, therefore, still quite distant from an efficient property rights system.

To achieve an orderly transition to a property rights solution, the U.S. must take three fundamental steps. First, the government should formally designate spectrum as property that can be owned and registered, and for which titles are issued.[168] Second, the boundaries of the rights enjoyed by property holders should be defined broadly.[169] Third, it should be made explicit that any use of the spectrum is permitted, subject to the requirements of applicable laws.

Although the FCC could, in theory, implement the transition to a property rights system by its own initiative, it is unlikely that the FCC's self-interest, and instinct for self-preservation, will allow it to do so. Consequently, it is likely that the adoption of a property rights approach to spectrum in the U.S. could only be accomplished by an Act of Congress wiping away the decades of administrative tradition stemming from the 1927 Radio Act.[170]

Although Congress could approach such legislation in a variety of fashions, the legislation should, at a minimum, mandate the three requirements stated above. In addition, such legislation ideally would outline the transition to the property rights system. First, such legislation should require the FCC to grant full property rights according to a preset schedule, mandating that the FCC publicly auction fully transferable warrants, each enabling an existing specific operating license to be converted to a full property right. Although only the license holder could combine the license with the warrant, it is likely that enough savvy arbitrageurs would participate in such an auction to allow the government to capture a fair portion of the value of the warrant. The government would get something instead of nothing, which is what it receives today in most cases, while license holders could always simply choose not to buy the warrants. In any case, the warrants would quickly be traded and provide a direct measure of the value locked in the essence of the spectrum property right.[171]

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168 In this context it is important to note that the FCC "believes that FCC licenses are not 'property' subject to the bankruptcy code." FCC REPORT TO CONGRESS, *supra* note 49, at 39.

169 While this concept appears relatively straightforward, its application to spectrum, where one must determine minimum signal to noise ratio and maximum field strength, raises difficult issues. While this ultimately is best left to engineers, a rough analogy can be drawn with the rules that a condominium might adopt: inhabitants may play any sort of music at any volume, provided that (1) the volume at the boundary of each inhabitant's property does not exceed a given decibel rating, and (2) any occupant who had moved in earlier would be entitled to a degree of peace and quiet that preserved her rights.

170 Ch. 169, 44 Stat. 1162 (codified as amended in scattered sections of 47 U.S.C.).

171 This is a second-best solution, as both arbitrageurs and incumbents would capture some

Second, such legislation optimally should strip the FCC of its enforcement responsibilities, which would then clearly fall to the judicial branch. The legislation also should establish a framework to guide the judiciary, including an explicit definition of the initial standard for injurious interference similar to that provided in the Guatemalan legislation.[172] This framework would facilitate courts' ability to adjudicate spectrum interference disputes, and absolve courts of the obligation to create comprehensive doctrine overnight.

Conclusion

Technological change and demand forces have exposed the economic inefficiencies and welfare losses generated by the traditional spectrum administration, and have unleashed mounting pressures on spectrum regulators. In response to mounting pressures from spectrum users, regulators have begun abandoning—albeit slowly—the detailed regulation they favor.

Although these developments push the regulatory agenda toward property rights, they remain quite distant from what we perceive as the ultimate reform needed to adjust the telecommunications sector to the current and future technological onslaught: full-fledged property rights in spectrum. Two pioneering countries have taken the lead, and we should view these as bold experiments. While the New Zealand experiment has been slow to bear fruit, for reasons largely outside the scope of this paper, the Guatemalan experiment is proceeding in earnest, on track to become the most ambitious spectrum privatization ever. The experiences in these countries over the next five to ten years may demonstrate the substantial welfare gains associated with such an approach, increasing the pressure on regulators from other countries to follow on their bold path.

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rents. Moreover, this method presents the possibility of a holdout problem (an inability by the warrant holder to come to terms with the license holder). Nonetheless, even the auction of such warrants would be Pareto-optimal in comparison to the status quo, as all parties would be better off.

172 In fact, Congress has used this approach before, notably in the Cable Television Consumer Protection and Competition Act of 1992, Pub L. No. 102-385, 106 Stat. 1460 (codified as amended in scattered sections of 47 U.S.C.). In this legislation, Congress took the unusual step of defining explicitly four criteria, including three quantitative criteria, to distinguish competitive from non-competitive cable systems. *See* 47 U.S.C. § 543(*l*)(1) (1994). Only the rates of non-competitive cable systems remain subject to regulation. *See id.* § 543(a)(2).