ARTICLES

WIRELESS TELECOMMUNICATIONS: SPECTRUM AS A CRITICAL RESOURCE

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I. INTRODUCTION

Telecommunications services have always been a mix of wireline services, such as wireline telephone, cable television, and Internet access, and wireless services, such as AM/FM radio, broadcast television, and microwave-satellite transmission of electronic signals. Each mode of service has certain properties, both beneficial and detrimental. Wireline has the potential for almost unlimited capacity, such as the use of multigigabit fiber optics, but requires that the service be delivered to a particular location. Wireless frees the customer from being tied to a specific location, allowing service to be rendered wherever the customer is, but suffers from fading or nonexistent connections and possible privacy concerns. The mix between wireline mode and wireless mode is in constant flux; recently, however, the focus of the market has been shifting toward wireless. Cellular telephony has exploded worldwide, and after a slow start, the market penetration has increased dramatically.[1] Meanwhile, the number of wired access lines in the United States has been declining, for the first time since the Great Depression.[2]

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1. *See* J. Gregory Sidak, *The Failure of Good Intentions: The WorldCom Fraud and the Collapse of American Telecommunications After Deregulation*, 20 YALE J. ON REG. 207, 220–22 & 222 fig.4 (2003).

2. Simon Romero, *When the Cellphone Is the Home Phone*, N.Y. TIMES, Aug. 29, 2002, at G1.

The ability of engineers and innovative firms to bring new and compelling wireless telecommunications applications to an ever-communicating market is very impressive, and bodes well for even greater applications in the future. But even the cleverest of engineers cannot escape the one critical resource absolutely required for wireless services to be deployed: electromagnetic spectrum. Wireless services and devices are all radios, emitting electromagnetic radiation into free space and receiving such radiation. If other nearby transmitters are emitting radiation at the same frequency, the intended receivers will be unable to disentangle the signal they wish to receive from the spurious "interfering" signal. Fundamental to wireless technology is the need to solve this potential interference problem.[3] Since the birth of radio in the 1920s, the interference problem has been solved by government licensing of transmission rights; each licensee is permitted to transmit from a particular place at a particular frequency at a maximum power for a particular application (for example, broadcast radio or police dispatch).[4] Licensing has traditionally been a highly bureaucratic and political process. The outcome, all agree, has been a hugely inefficient use of spectrum resulting from this "command and control" regulatory allocation of a scarce resource.[5]

Unfortunately, just as the demand for wireless services is skyrocketing, the supply of available spectrum is running short. Unable to recover underutilized spectrum, the government has little to release for new uses.

While the command and control model has few defenders, there is sharp disagreement in the United States about what regime should succeed it.[6] For years, economists, following Ronald Coase, have favored placing all licenses into the market, permitting both private and public licensees to buy, sell, trade, aggregate, and disaggregate spectrum rights, in a manner

3. Interference is defined as "the effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radiocommunication system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy." 47 C.F.R. § 2.1(c) (2005).

4. *See generally* Ronald H. Coase, *The Federal Communications Commission*, 2 J.L. & ECON. 1 (1959).

5. Philip J. Weiser & Dale N. Hatfield, *Policing the Spectrum Commons*, 74 FORDHAM L. REV. 663, 671 (2005). This command and control system has been undergoing change over the last fifteen years. For example, in the early 1990s, Congress permitted auctions of spectrum licenses used to offer digital cellular radio services. *Id.* at 670.

6. *See* SPECTRUM POLICY TASK FORCE, FCC, REPORT OF THE SPECTRUM RIGHTS AND RESPONSIBILITIES WORKING GROUP 2–3 (2002), *available at* http://www.fcc.gov/sptf/files/SRRWG FinalReport.pdf [hereinafter SPECTRUM TASK FORCE].

unfettered by government-imposed use restrictions.[7] Let the market work its magic, the advocates say, and artificial scarcity will rapidly disappear, giving us more than enough spectrum for many new wireless services. On the other side of the debate are legal scholars and some technocrats who point to new wireless technologies such as cognitive radio and ultra-wideband that can potentially manage the interference problem without the need for licenses.[8] Their solution is to create a "commons" in spectrum with no property rights.[9] Let the hardware work its magic, the advocates say, and artificial scarcity will rapidly disappear.

In the face of the overwhelming growth in the demand for wireless services, it is clear that the United States needs to move away from the bureaucratic command and control model. But do we move to a market model based on property rights in licenses, or do we move to an open commons model based on hardware standards enforced by a regulatory agency? Not only must the regime choice be resolved quickly, so that we may get on with the opportunities that await, but it also must be resolved correctly, so that new technologies and new demands undreamed of today can fulfill the promise of enormous social and economic value portended by wireless.

II. THE PROMISE OF WIRELESS

Radio technology is nothing new; it is over one hundred years old, with commercial deployment over eighty years old.[10] Why the excitement? What is it about wireless that has transformed the market? And why now?

There are two properties of wireless that lead to substantial advantages over wired communications: (1) the infrastructure to communicate is much less costly, and (2) the services are mobile.

7. *See, e.g.*, Evan Kwerel & John Williams, *A Proposal for a Rapid Transition to Market Allocation of Spectrum* (FCC, Office of Plans & Policy, Working Paper No. 38, 2002), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228552A-1.pdf.

8. *See, e.g.*, Yochai Benkler, *Overcoming Agoraphobia: Building the Commons of the Digitally Networked Environment*, 11 HARV. J.L. & TECH. 287, 394 (1998) ("Providing an appropriate regulatory space for unlicensed wireless operations is the only available option for allowing the development of unowned information infrastructure.").

9. *See supra* Part IV.

10. *See* Public Broadcasting Service, A Science Odyssey: People and Discoveries: KDKA Begins to Broadcast, http://www.pbs.org/wgbh/aso/databank/entries/dt20ra.html (last visited Apr. 10, 2006).

A. INFRASTRUCTURE

Wired communications require not only a receiving unit and a transmitting unit—for example, a wired telephone is both: a "transceiver"—but also a physical network infrastructure to transmit the signal. This could be the telephone network or the cable television network. Wired service also requires wires to and from every location of a transceiver, and wires across the country and the world to carry those signals. This huge infrastructure is extremely capital intensive and highly distributed geographically. For decades, it was so expensive to build such networks that they were considered a natural monopoly—too expensive to duplicate and therefore not a likely candidate for the competitive market.[11]

With wireless, this huge wired network infrastructure is simply not needed. A radio station can build a transmitter tower, its customers can buy a radio, and without any more infrastructure than this, communications can take place.[12] A very good example is the mass distribution of cable television. Much of the United States has been wired for cable television since the mid-1980s, a build-out that required large capital investments over decades.[13] In the early 1990s, satellite operators launched direct broadcast satellite ("DBS") service, in which television signals were distributed direct from a satellite to homes equipped with small antennas.[14] Without creating any infrastructure (other than the transmitter and receivers), DBS could distribute subscription television to most homes in the United States wirelessly.[15] Today, some firms hope to provide customers with broadband access via terrestrial-fixed wireless transmitters,

11. *See, e.g.*, ALFRED KAHN, THE ECONOMICS OF REGULATION: PRINCIPLES AND INSTITUTIONS 127–51 (1988).

12. Wireless technologies on the horizon, but not commercially deployed, such as mesh networks, may do away with all infrastructure, even towers, and rely on each handset to relay messages to other handsets to complete a communication. Benkler, *supra* note 8, at 294–95. In this extreme form, the handsets also collectively constitute the infrastructure. Some military field systems are based on this model. *See* Stuart Minor Benjamin, *Spectrum Abundance and the Choice Between Private and Public Control*, 78 N.Y.U. L. Rev. 2007, 2024 (2003).

13. *See* National Cable & Telecommunications Association, Industry Overview: History of Cable Television, http://www.ncta.com/Docs/pagecontent.cfm?pageID=96 (last visited Mar. 25, 2006).

14. *See* Direct Broadcast Satellite, http://www.museum.tv/archives/etv/D/htmlD/directbroadc/directbroadc.htm (last visited Mar. 25, 2006).

15. To have reception in the United States, the home must have a clear view of the southern sky. *See* Smart Computing, Direct Broadcast Satellite: TV & More, http://www.smartcomputing.com/editorial/article.asp?article=articles/archive/g0806/41g06/41g06.asp&guid= (last visited Mar. 11, 2006). In heavily wooded areas or cities, many homes may not be able to receive DBS signals without building a rather expensive antenna.

bypassing cable modems and digital subscriber line ("DSL") service, which both require wired infrastructure.[16]

B. MOBILITY

The most obvious benefit of wireless is that the user is untethered from the transceiver. In the static world of the last century, it was likely that an individual would be either at home or at the office; thus, the individual had two phones, one to cover each situation. Even today, registering or applying for a service or a good usually requires revealing both a home and a business phone number. Increasingly, professionals ask that they be contacted on their wireless phone. A highly mobile workforce (and population in general) needs to be able to reach others and be reached at all times, wherever they might be.[17] Being tethered to a specific phone location, or even several phone locations, is too constraining and inefficient. This represents a change in our relationship with communication devices; a transceiver now is associated with an individual, not a location.[18] Family members no longer have to share the household phone; each household member can now have his or her own phone, doing away with the need for the awkward "teenager" phone. The use of cell phones on the go is so ubiquitous that it is now perceived as a traffic danger, as more drivers "multitask," driving while talking.[19] Wireless is leading a shift from "place" as the communications node to "person" as the communications node.

Mobility, however, comes in various flavors, not all of which are quite as mobile as one might think. Full mobility generally implies that the service can be used while the customer is actually moving: in a car, on a train, and perhaps in an airplane. Technically, this is a demanding feature, and while digital cell phones have it, some forms of data services do not. For example, early versions of the much-ballyhooed—but so far

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16. The benefits of reduced infrastructure deployment costs are explained thoroughly in Benjamin, *supra* note 12, at 2039–41.

17. Phones designed for a mobile population, such as hotel phones and coin phones, have shown declining usage as travelers have opted for their cell phones instead. *See* Choi Kyong-ae, *Mobile Phones Drive Out Street Phone Booths*, KOREA TIMES, Aug. 15, 2004, *available at* http://times.hankooki.com/lpage/tech/200408/kt2004081519333011790.htm; *Payphones Face the Axe*, BRISTOL EVENING POST (U.K.), Apr. 21, 2004, at 20.

18. *See* Romero, *supra* note 2.

19. *See* Zay N. Smith, *Cell Phoning and Driving Turns the Young into Old*, CHI. SUN-TIMES, Feb. 20, 2005, at 30.

undelivered to the public—WiMAX[20] technology for computer data service (wireless broadband) only work as long as the computer is not actually moving while connected.[21] The technology, however, will permit the customer to connect at different locations throughout its coverage.[22] Regardless of the form it takes, wireless mobility brings features and functions not available through traditional wireline services.

The business market for wireless communications has grown rapidly, including voice, email (for example, Blackberry service), and more recently, computer data services (for example, Verizon's Broadband Access service).[23] The primary target in the business market is the mobile professional—for example, salespersons and consultants, medical professionals, and service personnel.[24] Anyone who works away from the office or plant is a likely user of business-oriented wireless. Most employees, however, are stationary and well-served by internal wired corporate networks, augmented by on-site Wi-Fi access points.

Wireless technology targets not only people, but also things: GPS (global positioning system) transponders in containers of all shapes and sizes help logistic firms track shipments.[25] Should RFID (radio frequency identification) tags become widely distributed, individual products, perhaps even individual mobile employees, could be tracked wirelessly. It is likely, however, that further product development for the business market will be limited. The principal future expansion of the wireless business market will be in the small-to-medium enterprise market.[26]

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20. WiMAX has been touted as the wireless broadband solution of the future, with potentially ubiquitous deployment and a 30–45 mile range, compared to Wi-Fi's 100–200 foot range. Hopes for early deployment have not materialized, and as developers come to grips with actually building and deploying the technology—as opposed to *talking about* building and deploying it—the date of full rollout has been pushed to 2007, as of this writing. *See* Jeff Goldman, *Clarifying WiMax Certification*, WI-FI PLANET, Nov. 21, 2005, http://www.wi-fiplanet.com/columns/article.php/3565806.

21. *See, e.g.*, MICHAEL W. THELANDER, SIGNALS RESEARCH GROUP, WIMAX: OPPORTUNITIES AND CHALLENGES IN A WIRELESS WORLD 14 (2005), http://www.cdg.org/resources/white_papers/files/WiMAX%20July%202005.pdf.

22. WiMAX: Wireless Broadband for the World—An Interview with Jim Johnson, http://www.intel.com/netcomms/columns/jimj105.htm (last visited Mar. 25, 2006).

23. *See* TelecomWeb, Are Americans Cutting the Cord?, http://www.telecomweb.com/news/1126553457.htm (last visited Mar. 25, 2006).

24. *See Verizon Wireless Announces Rollout of 3G Network to Atlanta*, BUS. WIRE, Sept. 22, 2004 [hereinafter *Rollout*]. *See also* Beckie Kelly Schuerenberg, *How Does Mobile Tech Measure Up?*, HEALTH DATA MGMT., July 2005, at 42 (noting that physicians are demanding specialized mobile hardware which they can take with them to where the patients are located).

25. *See Tech in Focus: Shipment Tracking*, COM. CARRIER J., Aug. 2005, at 42.

26. *See Rollout*, *supra* note 24.

The consumer market shows a great deal more promise for expanding wireless technologies. Developments in this market are occurring extremely rapidly. For example, consumers are buying ring-tones, downloading music, web surfing, keeping personal records via PDAs, and viewing videos on those tiny screens.[27] Data services such as Verizon's Broadband Access hint at higher bandwidth and more functionality to come.[28] Enriching consumer offerings appears to be the margin of competition today and into the near future. The success of this strategy has been tested in Korea and Japan, both of which are significantly ahead of the United States in deployment of advanced services.[29] The profitability of more and better consumer services is not completely clear at this stage, but manufacturers and service providers are busily competing on this dimension. Meanwhile, the rapid deployment of Wi-Fi in home networking has been a success for manufacturers selling products in the unlicensed bands, which need no wireless service provider.[30]

C. DRAWBACKS OF WIRELESS

The benefits of wireless are not without cost. The drawbacks of wireless are closely related to the complete dependence of wireless services on the use of spectrum. The drawbacks are of two forms: (1) access to spectrum may be difficult to obtain—currently, spectrum is in short supply and it is allocated bureaucratically;[31] and (2) wireless transmission traditionally has been noisier than wireline transmission.[32] The two issues are related; a shortage of spectrum may require communications to conserve on bandwidth, resulting in a higher noise level. For example, a two-way voice communication over a narrowband channel (for example, "walkie-talkie") may result in poor reception and the inability of communicating parties to understand one another.

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27. *See* Jerry Langton, *Tiny Devices Pack a Powerful Punch*, TORONTO STAR, Nov. 10, 2005, at K6 (discussing the Treo 650, Sony PSP, and Apple iPod).

28. *See* Brad Stone, Kay Itoi & Emily Flynn, *The Wireless World*, NEWSWEEK, June 2004, at 60.

29. *See* Moon Ihlwan, *Half the World's Hot Spots*, BUS. WK., Apr. 28, 2003, at 53; Kim Tae-gyu, *Korea's Wireless Internet Market Explodes*, KOREA TIMES, Nov. 5, 2004, *available at* http://times.hankooki.com/lpage/tech/200411/kt2004110418252711800.htm.

30. *See* FCC, ANNUAL REPORT AND ANALYSIS OF COMPETITIVE MARKET CONDITIONS WITH RESPECT TO COMMERCIAL MOBILE SERVICES 80–84 (2003), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-03-150A1.pdf (discussing deployment of Wi-Fi devices). *See also* Kevin Werbach, *Supercommons: Toward a Unified Theory of Wireless Communication*, 82 TEX. L. REV. 863, 958 (2004).

31. SPECTRUM TASK FORCE, *supra* note 6, at 3. *See also* Werbach, *supra* note 30, at 890, 970 (noting the spectrum drought and the fact that over ninety percent of spectrum below 3 GHz is subject to service-specific licenses).

32. *See* OCTASTIC, VOICE QUALITY IN WIRELESS NETWORKS 7–8 (2006), http://www.vectronics.co.il/_Uploads/137oct6100wp2002.pdf.

Recent technological developments have made significant strides in reducing these costs, primarily through digital radio. The original cellular telephone service ("AMPS") was analog, as was virtually all radio prior to 1980; it used a large swath of spectrum bandwidth and delivered noisy voice channels.[33] PCS, the digital version of cellular service, was introduced in the early 1990s.[34] It not only provided much clearer channels with minimal static, but also permitted more channels to be operated within a given bandwidth, by a factor of three to five.[35] Digital thus increased the utilization of bandwidth and increased the quality of the wireless transmission. It is arguable that the digitalization of radio, with its concomitant efficiency gains and quality gains, has turned two-way radio from the province of the military and the hobbyists into a mass market phenomenon of extraordinary scope.

The future of wireless will be driven by the ability of engineers to deliver ever more amazing capabilities to our mobile devices and the ability to provide the spectrum bandwidth required to reliably and clearly transmit information, both voice and data, to where we need it, when we need it. Of these two drivers, the evidence is overwhelming that the engineers are doing their part. Every day sees the introduction of services and products on cell phones and Wi-Fi networks. And as rapid as change has been in the United States, other countries are even more advanced. Mobile devices in Korea and Japan permit the viewing of movies and conducting two-way video conversations on advanced cell phones, as well as fast access to the World Wide Web and a vast array of information services.[36] For the last several years, East Asia has provided the model for the future of this business in the United States, and will continue to do so for at least the next few years.[37]

But what of the second driver, the ability to provide spectrum bandwidth? The picture here is much darker: beset by old regulations and resistance to change, and more importantly, by fundamental disagreements

33. For a general history of cellular radio technology, see John W. Berresford, *The Impact of Law and Regulation on Technology: The Case History of Cellular Radio*, 44 BUS. LAW. 721 (1989).

34. *See In re* Amendment of the Commission's Rules to Establish New Pers. Commc'ns Servs., 6 F.C.C.R. 6601 (1991).

35. *See* Nie Sen, Analog vs. Digital Wireless Technology (Aug. 10, 1999) (unpublished manuscript), *available at* http://www.tml.tkk.fi/Studies/Tik-110.300/1999/Wireless/analog_2.html.

36. *See* Tae-gyu, *supra* note 29. *See also* Patrick Marshall, *Has Phone Found Its Calling? Latest Models Let You Browse Web, Check Mail*, SEATTLE TIMES, Mar. 13, 2004, at E6 (reviewing Motorola's Internet-capable MPx200 cell phone); *supra* text accompanying note 29.

37. *See* Ihlwan, *supra* note 29.

as to the appropriate direction that change in spectrum management should take.[38]

III. INTERFERENCE AND SPECTRUM MANAGEMENT

The freedom that wireless brings depends on the ability to transmit radio energy (waves) from a transmitter through space to a receiver, and on the ability of the receiver to receive these signals in space with minimal interference from other signals.[39] The signals of wireless obviously are not contained in wires, which are generally privately owned and operated, but instead are transmitted through open space, and can be heard (or garbled) by anyone with a proper receiver. Every transmitter radiates power at a certain frequency—more accurately, a band of frequencies, for example, 1800.02–1800.03 MHz—at a certain location (for example, downtown Philadelphia, at a certain power (for example, 1 watt peak).[40] The width of the band—in the above example, 0.01 MHz, or 10 KHz—is the bandwidth of the signal, and is a rough measure of the information capacity of the signal.[41] A key element in transmission via a public space is freedom from interfering signals. If another transmitter is emitting radiation at the same frequency in the same location, then receivers will receive both waveforms and will be unable to distinguish between the two signals, resulting in an unintelligible signal and bad reception.[42]

This interference problem became evident in the early days of radio, when broadcasting was just taking off.[43] Signal interference in major radio markets caused significant difficulties, and the solution chosen at the time (1927) was that the government would control the airwaves (in the "public interest") and allocate frequencies to specific uses, such as police and fire department radios, AM radios, marine radiotelephones, and taxi dispatch.[44] Within each allocated band, the government—after 1934, the Federal

38. *See, e.g.*, SPECTRUM TASK FORCE, *supra* note 6, at 2.

39. *See, e.g.*, Weiser & Hatfield, *supra* note 5, at 666–68.

40. *See id.*

41. *See* C.E. Shannon, *A Mathematical Theory of Communication*, 27 BELL SYS. TECHNICAL J. 623, 639–42 (1948). Other factors affect information capacity, such as digital versus analog transmission, encryption of the information, presence of error-correction encoding, and the use of compression technologies, among others. *See, e.g.*, Werbach, *supra* note 30, at 869. Frequency bandwidth, however, acts as the principal constraint on information capacity. For a simplified but illuminating discussion of the tradeoffs between power, bandwidth, switching, and processing power, see George Gilder, *The New Rule of Wireless*, FORBES ASAP, Mar. 29, 1993, at 96–99.

42. *See* Werbach, *supra* note 30, at 869.

43. Coase, *supra* note 4, at 2–4.

44. *See* Werbach, *supra* note 30, at 867–71. *See also* Radio Act of 1927, Pub. L. No. 99-632, 44 Stat. 1162.

Communications Commission ("FCC")[45]—would assign specific frequency bands to individual users, who obtained operating licenses for specific frequency/ location/ power/ use bundles.[46] For example, the Yellow Cab Company of Philadelphia would be granted a license to operate at a specific frequency in the taxi dispatch band, in Philadelphia (generally at a specific tower location), at a certain power level, and only for the purpose of taxi dispatch.[47] Operating outside the license parameters was illegal and could result in a fine or license revocation.

IV. SPECTRUM MANAGEMENT BY BUREAUCRACY

Over the years, this bureaucratic and political form of resource allocation worked well enough. New uses such as broadcast television, garage door openers, cordless phones, and microwave ovens, arrived in a steady stream, but new developments in radio technology arrived even more quickly, allowing expansion of the usable spectrum to accommodate these new uses.[48] Unfortunately, the new demands for wireless services are significantly straining this capacity.[49] More particularly, the huge inefficiencies engendered by seventy-five years of bureaucratic spectrum management are manifest in the large swaths of spectrum that were licensed but never used.[50] Since spectrum is licensed, it cannot be used without the licensee's and the FCC's permission.[51] And even if the licensee would be interested in selling or leasing the spectrum, significant barriers exist to the bandwidth being put to its highest valued use. In particular, almost all spectrum licenses have use restrictions that specify the particular use to which that bandwidth must be put, such as taxi dispatch, broadcast television, and police radio.[52] The transfer of licenses, even subject to these

45. Communications Act of 1934, ch. 652, 48 Stat. 1064 (codified as amended at 47 U.S.C. §§ 151–614 (2000)). Radio spectrum for use by the federal government, such as the military, Federal Aviation Administration, and other government users, is managed by the Department of Commerce's National Telecommunications and Information Administration. Telecommunications Authorization Act of 1992, Pub. L. No. 102-538, 106 Stat. 3533, 3534 (codified as amended at 47 U.S.C. § 902 (2000 & Supp. 2002)).

46. Weiser & Hatfield, *supra* note 5, at 667–68.

47. *See id*.

48. *Id.* at 671–72.

49. *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, 556 (2001); Werbach, *supra* note 30, at 890.

50. For example, UHF is licensed for 330 MHz of spectrum but is not presently utilized in any commercially viable form.

51. 47 U.S.C. § 310(d) (2000).

52. A good example of this bureaucratic ossification of license use is evidenced by corporations invested in so called "wireless cable" which, upon discovering a more lucrative business model in

restrictions, is subject to FCC approval and scrutiny.[53] The unfortunate result is that cellular companies are straining within their bandwidth restrictions and are unable to obtain new bandwidth to expand their businesses, while large amounts of bandwidth tied up by UHF television broadcast licensees, for example, are serving no useful purpose whatsoever.[54]

In addition to licensed frequency bands, the FCC has also set aside certain bands for unlicensed devices, including cordless phones, garage door openers, and baby monitors.[55] Anyone can operate a device within these designated frequencies—again, each unlicensed band is restricted to certain uses—without a license.[56] Interference is controlled by the simple expedient of requiring the devices to operate at rather low power. Thus, the cordless phone in my home does not interfere with the cordless phone in my next door neighbor's home because the power is too low for the signal to reach my neighbor's cordless phone. Recently, unlicensed spectrum has been used to deploy Wi-Fi devices, a very popular means of creating an on-location network to access the Internet via a high-speed modem.[57] Again, the utilization of this spectrum varies: some unlicensed spectrum is heavily used, some is virtually empty.[58] And as with most licensed spectrum, no effort is made to measure the efficiency with which the spectrum is used, and apparently little effort, aside from auctions, is made to ensure that any spectrum is allocated to its highest valued use.

Bureaucratic allocation of spectrum is not the only source of the gross inefficiencies in spectrum use. The FCC is the locus of dispute resolution,[59] and when parties claim interference from other transmitters, the FCC is the body responsible for resolving such disputes, which often take years to

broadband wireless Internet access, were unable to convince the FCC to allow this deviation in use. *See* Hazlett, *supra* note 49, at 340.

53. *See* 47 U.S.C. § 310(d).

54. *See* Reza Dibadj, *Regulatory Givings and the Anticommons*, 64 OHIO ST. L.J. 1041, 1053 (2003). Evan Kwerel and John Williams estimate that reallocating this wide swath of spectrum by public auction would result in an increase in public good of over $1 billion in Los Angeles over an eight-year period. Evan R. Kwerel & John R. Williams, *Changing Channels: Voluntary Reallocation of UHF Television Spectrum*, at vii (FCC, Office of Plans & Policy, Working Paper No. 27, 1992), *available at* http://www.fcc.gov/Bureaus/OPP/working_papers/oppwp27.pdf.

55. Werbach, *supra* note 30, at 958.

56. *See* 47 C.F.R. § 15.1 (2005).

57. *See* Werbach, *supra* note 30, at 958.

58. *See* SPECTRUM POLICY TASK FORCE, FCC, REPORT OF THE UNLICENSED DEVICES AND EXPERIMENTAL LICENSES WORKING GROUP 9–11 (2002), *available at* http://www.fcc.gov/sptf/files/E&UWGFinalReport.pdf.

59. *See* Red River Broad. Co. v. FCC, 98 F.2d 282, 285 (D.C. Cir. 1938); 47 C.F.R. § 1.701 (2005).

resolve and even then are subject to court challenge. A single notorious example makes the point: the NextWave Communications case,[60] in which NextWave bid on a very large swath of spectrum at auction and soon after declared bankruptcy.[61] The FCC reclaimed the spectrum and reauctioned it, only to have a bankruptcy court claw back the spectrum as a NextWave asset.[62] The FCC challenged this ruling, eventually resulting in a Supreme Court decision upholding the bankruptcy court's decision.[63] A complex negotiation then followed to sort out what would happen to this spectrum. The dispute lasted over five years, during which time this huge swath of spectrum was unavailable to cell phone firms and customers. While this case is particularly egregious (and well known), dozens of similar examples demonstrate the inefficiencies of regulatory dispute resolution.[64]

In the past, the huge inefficiencies in spectrum utilization that resulted from bureaucratic command and control were tolerable in that technology kept making new spectrum available, so the waste was not evident. As demand grew, advancing technology ensured that new frequency bands were available, and there was no need to deal with the wasted spectrum. More recently, demand has grown very rapidly and technology has delivered new services and devices to serve that demand.[65] Most of the usable frequency bands, however, are committed to licensees or unlicensed uses;[66] in an administrative sense, the United States is close to being "out" of spectrum. In an economic sense, there is plenty of spectrum, but it is not available under the current bureaucratic/political control mechanism. In light of this current and expected future surge in demand, the old bureaucratic model of spectrum management is breaking down quickly. The question is, How should we manage spectrum going forward, so that the nation uses this important resource as efficiently as possible?

60. FCC v. NextWave Pers. Commc'ns, Inc., 537 U.S. 293 (2003).

61. *Id*. at 297.

62. *Id*. at 298–99.

63. *Id*. at 308.

64. For a full explanation of several dispute resolutions at the FCC, see Ellen P. Goodman, *Spectrum Rights in the Telecosm to Come*, 41 SAN DIEGO L. REV. 269, 376 n.348 (2004).

65. Some of these new services include pagers, mobile phones, Wi-Fi, Bluetooth, cordless phones, XM and Sirius satellite radio, and DirecTV and similar satellite television services.

66. *See* 47 C.F.R. § 15.1 (2005).

V. CAN WE DO BETTER?

A. THE COASIAN ANSWER

Ronald Coase answered this question in his famous 1959 paper[67] before anyone really asked it: place all licenses into private hands and let the market allocate licenses for specific frequency bands/ location/ power to ensure that licenses are put to their highest valued use.[68] He noted that the extant system of bureaucratic allocation was exactly the wrong way to do it, and this was a task for which markets would yield a far superior outcome.[69] As with most visionaries, he was thought to be a crackpot at the time, even by his colleagues at the University of Chicago: Professor Harry Kalven called his work "an insight more fundamental than we can use."[70] FCC commissioners were more blunt and less kind.[71] But the logic of Coase's suggestion was unassailable: a fundamental tenet of modern economics is the efficiency of market allocations (absent market failure) relative to the gross inefficiency of government allocation mechanisms.[72] After years of tiresome preaching by economists, policymakers in some countries were willing to give markets a try. In 1989, New Zealand auctioned off its spectrum,[73] and in 1993 the U.S. Congress gave permission to the FCC for limited licensing via auctions, specifically for digital cellular telephony.[74] The rights granted to licensees at auction, however, are quite limited and do not constitute ownership in any sense of the word. Licensees do not own their license, nor are they permitted to trade or sell it without FCC permission.[75] They are not permitted to use the license for anything other than cellular communications. While auctions are an interesting first step, there is a long way to go before spectrum licenses can be freely traded in the market for whatever use the licensee wishes within the technical parameters of the license.

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67. *See* Coase, *supra* note 4, at 1.
68. *Id*. at 35–40.
69. *Id*. at 36.
70. Harry Kalven, Jr., *Broadcasting, Public Policy and the First Amendment*, 10 J.L. & ECON. 15, 30 (1967).
71. *See* Hazlett, *supra* note 49, at 343.
72. Coase, *supra* note 4, at 14.
73. Ruth W. Pritchard-Kelly, Comment, *A Comparison Between Spectrum Auctions in the United States and New Zealand*, 20 MD. J. INT'L L. & TRADE 155, 163 (1996).
74. Omnibus Budget Reconciliation Act of 1993, Pub. L. No. 103-66, 107 Stat. 312, 379–86 (codified as amended in scattered sections of 47 U.S.C.).
75. 47 U.S.C. § 310(d) (2000).

As we survey the wreckage of the great government-controlled economies of the twentieth century, the logic of markets is even more evident than it was in Coase's time. The fall of the Soviet Union in 1989 began a somewhat bumpy transition period for the countries of Central and Eastern Europe toward market economies. Some have been so successful that they are now member states of the European Union.[76] Similarly, the explosion of demand for wireless devices and services could be the start of a transition in the United States (perhaps not as bumpy) toward a market economy for spectrum.

B. THE TECHNO-UTOPIA OF THE COMMONS

In the past five years, however, a different model of "fixing" the command and control system has developed, primarily by technologists and legal scholars. This model critically depends on new technology that enables "smart" radios to control interference themselves.[77] The advocates of this position argue that if the hardware built into the devices, such as handsets, can control interference,[78] than there is no need to establish licensed frequency bands to do so. Rather, we can permit all (or perhaps most) spectrum to be a "commons," in which anyone can use any device, provided it is equipped with the hardware that controls interference. One view is that this takes present day unlicensed bands to their logical conclusion; we control interference in the unlicensed bands simply by limiting power (built into the hardware).[79] With the new technology, we have an even better means of controlling interference via hardware, so everything (or nearly so) can be unlicensed; a commons is created.

There are several stratagems for accomplishing this. The FCC has traditionally created low power spectrum rights that create minimal interference with the primary licensee.[80] Such rights have traditionally been a locus of dispute and regulatory lobbying.[81] A newer version of this

76. Examples include the former German Democratic Republic (East Germany), Poland, the Czech Republic, and Slovakia.

77. *See* Benjamin, *supra* note 12, at 2026 (describing spread-spectrum technology).

78. *Id.*

79. Power limits are in place in the unlicensed spectrum as it exists today. 47 C.F.R. § 15.407 (2005). But some commons advocates would abandon this restriction entirely and substitute a regime of mandatory protocols to prevent interference. Still another approach is espoused by Kevin Werbach: he would "optimize" interference through a tort-based dispute resolution mechanism. Werbach, *supra* note 30, at 892–93, 942.

80. *In re* Additional Spectrum for Unlicensed Devices Below 900 MHz & in the 3 GHz Band, 17 F.C.C.R. 25,632, 25,632 (2002); 47 C.F.R. § 15.205 (2005).

81. *See* Free Press: Issues: Low Power FM, http://www.freepress.net/issues/lpfm (last visited Mar. 26, 2006).

is ultra-wideband ("UWB"), in which power levels are so low that transmissions throughout a wide swath of spectrum are virtually undetectable by standard receivers.[82] Encoding of the signal, however, permits UWB receivers to detect and decode the signal; in essence, the communication is interference-free.[83] The FCC has recently permitted UWB to operate in the United States, although not without controversy.[84] Advocates of UWB desired to transmit at a higher power, while licensees who might suffer interference insisted on lower power. Establishing the "noise floor" below which UWB can transmit is a disputatious regulatory issue.

Another new approach is cognitive, or agile, radio. With this technology, the transmitter detects which frequency bands are currently unused, and chooses one such band.[85] Should another user, such as the primary licensee for this band, start to use the band, the cognitive radio would immediately vacate the band and switch seamlessly to the next unused band, much as a cellular telephone user is seamlessly switched from one cell tower to another as the user moves about during a call.[86] This technology would permit high power transmission but would control interference by instantly vacating a band when the primary user demanded use. Cognitive radio promises to improve spectrum utilization through dynamic allocation of frequencies, compared to the static allocation of frequencies implicit in licensing.[87] As the name implies, the new technology permits real-time spectrum allocation in response to demand, rather than ex ante static allocation.[88]

Cognitive radio, however, poses serious interference threats, both in design and in use. As it turns out, the ability of any radio to detect when a primary licensee begins transmission—and thus forces the opportunistic users off the airwaves—is limited by topography[89] and other features that

82. *In re* Revision of Part 15 of the Commission's Rules Regarding Ultra-wideband Transmission Sys., 17 F.C.C.R. 7435, 7436 (2002) [hereinafter Revision of Part 15].

83. *See* UWB Forum, About Ultra-wideband, http://www.uwbforum.org/index.php?option=com_content&task=view&id=20&Itemid=48 (last visited Mar. 26, 2006).

84. *See* Revision of Part 15, *supra* note 82.

85. *See* Benjamin, *supra* note 12, at 2026–28. *See also* SPECTRUM TASK FORCE, *supra* note 6, at 29–30.

86. Yochai Benkler, *Some Economics of Wireless Communications*, 16 HARV. J.L. & TECH. 25, 62 (2002).

87. *See* SPECTRUM TASK FORCE, *supra* note 6, at 29.

88. Benkler, *supra* note 86, at 62–63.

89. This can occur, for example, if the primary licensee and the opportunistic radio are on opposite sides of a mountain or other radio-opaque obstruction; they would not be able to "hear" each other, even though a common listener could hear both and be subject to interference if both

could result in interference fairly often, even if the hardware works perfectly.[90]

VI. TWO RADICALLY DIFFERENT SOLUTIONS TO THE "SAME" PROBLEM

Both advocates of property rights for spectrum licenses and advocates of the commons completely agree on the huge inefficiencies of the traditional command and control system.[91] How is it that the two camps arrive at two radically different reform strategies? It appears there are two interrelated drives for this surprising difference in view. The first relates to *why* the command and control regime has failed so miserably. For Coasian property rights advocates, the problem is simple: *government regulation*, the core of the command and control system, is the problem.[92] Licensing itself is not a problem; in fact, it fits well into a property rights model.[93] The problem is the management and control of spectrum by a political bureaucracy that has led, and will continue to lead, to productivity and allocation inefficiencies.[94] The analogy to the bureaucratic allocation

(unknowingly) transmitted at the same time. *See In re* Wireless Operations in the 3650–3700 MHz Band, 20 F.C.C.R. 6502 (2005). Therefore, "listen before talk" protocols would not avoid interference. One suggested solution is to require all transmitters to communicate with a central database (perhaps government-managed) that would act as the "traffic cop," granting and retracting permission to transmit in real time, rapidly enough to ensure that handoffs are seamless. *See* D. RAYCHAUDHURI, WINLAB, RESEARCH ON SPECTRUM TECHNOLOGY AND POLICY: AN INTERIM REPORT (2004), *available at* http://www7.nationalacademies.org/cstb/wireless_ppt_raychaudhuri.pdf. Of course, this centralized solution is a far cry from letting the hardware solve the interference problem.

90. The deployment of cognitive radio promises to be a nightmare for enforcement against interference in either a property regime or a commons regime. In most cases, a licensee will have but a few neighbors in frequency or geographic space and will have no difficulty determining the cause of interference and whether the interferer is violating license restrictions. With cognitive radio, the interferer can show up in any frequency band, briefly (but significantly) interfere, and then disappear undetectably. Enforcing restrictions on such fast-moving, opportunistic interferers is virtually impossible; widespread abuse is likely to be the result, earning this technology the sobriquet "hit and run radio."

91. *See* SPECTRUM TASK FORCE, *supra* note 6, at 2. The FCC itself has been a leader in seeking alternatives to the traditional command and control system. Indeed, it was early work at the FCC in the 1980s that established the framework for auctions eventually approved by Congress in 1993. *See generally* Evan Kwerel & Alex Felker, *Using Auctions to Select FCC Licensees* (FCC, Office of Plans & Policy, Working Paper No. 16, 1985), *available at* http://www.fcc.gov/Bureaus/OPP/working_papers/oppwp16.pdf. More recently, the FCC's *Report of the Spectrum Policy Task Force* urged migration to alternative spectrum management regimes. *See* SPECTRUM TASK FORCE, *supra* note 6, at 30–31.

92. Coase, *supra* note 4, at 18.

93. *Id*. at 14–16, 18.

94. *Id*. at 18.

mechanisms of centrally planned economies is strong. In previous work, I have referred to the FCC as the "GOSPLAN"[95] of U.S. spectrum.[96]

Commons advocates, on the other hand, view the primary problem of the traditional command and control regime as the *static allocation of spectrum via licensing*.[97] Licensing, in this view, not only introduces a rigid and static system into what should be a highly dynamic means of spectrum management, but also leads to private and exclusive control of licensed spectrum, where spectrum is a public asset that should be managed for the public good.[98] From this perspective, licensing is about the exclusive use and denial of access to this public asset; the commons is about ensuring that all have access to it.[99] And now, technology promises to enable this happy state of affairs.[100]

The second reason motivating two divergent solutions to the spectrum management problem relates to the intellectual tradition of the two advocate groups. As Coase's article suggests, economists observe and analyze the power of the market to reveal customers' needs, to adapt to new technology, and to ensure that resources move to their highest valued uses.[101] Taking the concept of licenses as a given, Coase recommended unleashing this power by establishing property rights in licenses, constrained only by technical parameters (power, frequency, location) and not (as today) by use constraints.[102] Let licenses be bought, sold, traded, subdivided, and aggregated, just as is all property in markets.

Some technologists and legal scholars have a tradition that springs from the early days of the Internet, exemplified by the words of John Perry

95. GOSPLAN was the supreme economic planning agency in the former Soviet Union, responsible for the detailed production and distribution plans for all Soviet economic activity. Russell Carlberg, *The Persistence of the Dirigiste Model: Wireless Spectrum Allocation in Europe,* à la *Francaise*, 54 FED. COMM. L.J. 129, 133 n.14 (2001). Of course, it was the very antithesis of a decentralized market system, and after the economic collapse of the Soviet Union, GOSPLAN became a symbol for all that was wrong with central planning by a government agency. *See* Cait Murphy, *The Makers of Europe Inc.*, FORTUNE, Nov. 22, 1999, at 201.

96. Gerald Faulhaber & David Farber, *Spectrum Management: Property Rights, Markets, and the Commons* 5 (Telecomm. Policy Research Conference Program, Working Paper No. 24, 2002), *available at* http://tprc.org/papers/2002/24/SPECTRUM_MANAGEMENTv51.pdf.

97. *See* SPECTRUM TASK FORCE, *supra* note 6, at 8; Werbach, *supra* note 30, at 874.

98. *See* Benkler, *supra* note 86, at 64–65.

99. *Id.*

100. Werbach, *supra* note 30, at 874.

101. Coase, *supra* note 4, at 18–19. Of course, market failures can significantly interfere with this process, as economists are the first to point out. *Id.* But even if markets do not operate with perfect efficiency, the power of private incentives to achieve superior outcomes is impressive. For a comparison of market and nonmarket systems generally, see *supra* note 95.

102. Coase, *supra* note 4, at 14, 25.

Barlow: "We will create a civilization of the Mind in Cyberspace. May it be more humane and fair than the world your governments have made before."[103] This is a view of the Internet—and by extension, spectrum—in which users interact creatively without the need of governments or corporations; a common space in which we are all producers and consumers, creators and innovators, without need of lawmakers and private property. For at least some legal scholars, this view meshes nicely with a distrust of private enterprise, suspicions about markets, and a faith that the Internet will save us from both.[104]

VII. OVERARCHING LEGAL REGIME: WHAT IS THE BEST WAY FORWARD?

The issues contested by the advocates of the two reforms are fundamental: which regime is best suited to the enormous growth in demand and evolving technology of the future? Each represents not simply a tweak on existing systems, nor small differences in spectrum management, but rather entirely different organizing principles for spectrum. Which solution results in greater benefits to the U.S. public?

While early commons advocates espoused complete communization of the spectrum,[105] it soon became clear this was beyond the pale. Many applications such as airport radars, broadcast radio, and television, continuously transmitted high power with no need for sharing.[106] For these applications, commons and the new technologies were, at best, unnecessarily costly to achieve what exclusive licenses already gave them, and at worst, disabling.[107] Many of these legacy applications (and perhaps new ones, as well) required dedicated spectrum and could not easily exist in a fully commons world.[108] Commons advocates suggested that spectrum be partitioned into licensed spectrum and unlicensed—or commons—spectrum with perhaps the latter predominating.[109] There were suggestions

103. John Perry Barlow, A Declaration of the Independence of Cyberspace (Feb. 8, 1996), http://homes.eff.org/~barlow/Declaration-Final.html.

104. *See* LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD 265–68 (2001); Benkler, *supra* note 8, at 388–94.

105. *See, e.g.*, Benkler, *supra* note 86, at 28 n.7; Eli Noam, *Taking the Next Step Beyond Spectrum Auctions: Open Spectrum Access*, IEEE COMM. MAG., Dec. 1995, at 66.

106. *See* Werbach, *supra* note 30, at 942.

107. *Id.*

108. *Id.*

109. Benkler, *supra* note 86, at 32–36, 82–83; Werbach, *supra* note 30, at 942–43.

that this dual system could be run as a social and economic experiment for perhaps ten years, after which the FCC would decide who had won.[110]

Two conclusions come from this debate: (1) a pure commons regime is not a feasible alternative, as such a regime cannot accommodate exclusive use at all; and (2) the resulting regime would be influenced heavily by regulation, which would decide how much spectrum to allocate to licensed and unlicensed commons and how that allocation would change over time. In other words, spectrum would continue to be regulated. The original vision that hardware control of interference would substitute for regulatory control was lost; regulators would still rule the roost.

But we need to ask the question in reverse: would a property rights regime preclude the development of commons in some parts of the spectrum? Even more, would a property rights regime result in purely exclusive use and denial of access? In both cases, the answer is in the negative. In fact, a property rights model easily encompasses commons use. Government can own swaths of spectrum which it then devotes to commons use, much as it does today with unlicensed frequency bands.[111] This is quite similar to real estate, in which governments own land and may use the land either for government purposes, (such as a military base or a post office) or for public access (such as a national park or Central Park, the latter property owned by the city of New York). In a property regime, governments can act like any other property owner, and commit their assets to whatever purpose voters wish to support. Thus, while a property regime can easily accommodate commons, a commons regime cannot accommodate exclusive-use property. This suggests that a property regime may be substantially more robust than a commons regime—even a commons regime supported by regulation.

Is the Internet model of open access to all appropriate for spectrum? At the most basic level, the answer must be no. A server connected to the Internet whose owner decides to shun the use of the TCP/IP protocol[112] for her own protocol would (1) be ignored by everyone else, (2) generate no

110. Benkler, *supra* note 86, at 81–83.

111. *But see id.* at 64–65 (doubting the federal government's ability to restrain itself by either forgoing potential revenue and refraining from auctioning the spectrum or setting aside treasury funds for purchasing spectrum at market price for unlicensed use). By setting up a "dual system" as previously suggested by the Spectrum Policy Task Force, however, the government has created a de facto wireless park already, having forgone the revenue that an auction might bring. *See* SPECTRUM TASK FORCE, *supra* note 6, at 30–31.

112. TCP/IP (Transmission Control Protocol/ Internet Protocol) is part of the Internet Protocol Suite. The Internet Protocol Suite is the set of communications protocols that implements the protocol stack on which the Internet and most commercial networks run.

interference, and (3) make the user of the server worse off. In spectrum, however, an operator that chooses to exceed power limits would (1) annoy all other users, (2) generate lots of interference, and (3) make the operator better off because the operator could reach more receivers with higher-than-legal power. In other words, in spectrum there are incentives to break the protocols that help the offender and make others worse off. On the Internet, there are no incentives to cheat and no possibility of interference.[113]

The conclusion is obvious: there must be rules and the rules must be enforced in all frequency bands. The only issues left are: who sets the rules, and who enforces them. In the case of private property, the owner sets the rules and those who use the property must abide by them. The owner must enforce the rules, as well. For example, the owner of a hotel invites guests to stay but sets the price, establishes rules, and enforces those rules on guests. In a public commons context, the city of New York sets the price of using Central Park (at zero), establishes rules, and enforces them on all visitors. In the spectrum context, Verizon Wireless controls licenses for frequencies used in wireless telecommunications, sets the rules for use, and polices those rules. In contrast, the FCC sets the rules for use of unlicensed spectrum by cordless telephones and Wi-Fi access points, and may also enforce them.[114] The main rule for such devices is a rather severe power limit[115] that ensures that interference with devices at some distance is unlikely.

113. In fact, there are ways to generate significant amounts of annoying (even disabling) interference using the Internet: spam, spyware, worms, and viruses abound on the Internet and constitute a major problem for users. Curiously, the very properties of the Internet most beloved by enthusiasts permit this—openness and anonymity, without which such bad behavior could be easily policed and minimized. Compare, for example, the effectiveness of the Federal Trade Commission's "Do Not Call" list in drastically reducing unwanted telemarketing calls, where the network used is the proprietary telephone system, with the complete ineffectiveness of the CAN-SPAM Act, which has had no apparent effect on spam, where the network used is the public open and anonymous Internet. *See* CAN-SPAM Act of 2003, Pub. L. No. 108-187, § 877, 117 Stat. 2699 (codified as amended at 15 U.S.C.A. §§ 7701–7707 (West Supp. 2004); 18 U.S.C.A. § 1037 (West Supp. 2004)); CAN-SPAM Act of 2003, http://en.wikipedia.org/wiki/CAN-SPAM (last visited Mar. 26, 2006); Federal Trade Commission—The Do Not Call Registry, Consumer Information, http://www.ftc.gov/bcp/conline/edcams/donotcall/coninfo.html (last visited Mar. 26, 2006).

114. 47 C.F.R. § 15.1 (2005) (prohibiting all transmissions not in accordance with FCC regulations); 47 C.F.R. § 15.401 (2005) (setting technical requirements for unlicensed national information infrastructure ("U-NII") devices).

115. The difficulty of enforcing such limits was manifest at the time of the citizens' band ("CB") radio boom in the 1970s, when the FCC was receiving 100,000 complaints a year about power-boosted CBs that enabled the user to communicate over greater distances but interfered with other users and broadcast television reception. *See* Faulhaber & Farber, *supra* note 96, at 191.

Provided that there is plenty of both licensed and unlicensed spectrum, we need not be concerned; users will figure out which rules they like best and migrate to those services. In a property regime, a high demand for commons/ unlicensed spectrum will result in governments providing more of it in response to voter demand evidenced by voters buying it on the market. In a regime where the regulator controls everything, including the overall allocation of spectrum between the market and commons, then meeting the needs of users requires political mediation through the regulator to ensure that this demand is met. The track record of the FCC in this regard is quite poor.[116] There are two levels here: setting and enforcing the operating rules, and setting the overall allocation rules. The latter constitutes the overarching regime. Property advocates argue that the overall allocation rules for spectrum should be established via property rights and markets, as they are throughout the rest of the economy. Government should only have control over frequency licenses that it actually owns, and then only to the extent of control possessed by any owner.

Commons advocates argue that the overall rules for spectrum should be controlled by the government—presumably the FCC—with a "thumb on the scale" in favor of commons/unlicensed spectrum.[117] Thus, the bureaucrats decide, not the market. Commons advocates claim the new technology favors a commons regime.[118] But this simply is not true. Technology is neutral regarding the overarching legal regime; UWB and cognitive radio, as well as mesh networks, function either in a commons regime or a property regime. The new technology, however, is necessary for a commons regime to work at all. Were it not for the new technology, there would be little discussion of a commons regime—the technology enables the regime. The converse is not true, however; a commons regime is not at all necessary for the deployment of these new technologies.[119]

A key determinant in the performance of any overarching legal regime is dispute resolution. Inevitably, any system with the potential for

116. *See, e.g.*, Coase, *supra* note 4, at 18. *See also* Goodman, *supra* note 64, at 376 n.348.

117. Benkler, *supra* note 86, at 32–36; Werbach, *supra* note 30, at 972–73.

118. Benkler, *supra* note 86, at 32.

119. Benjamin, *supra* note 12, at 2016. Often discussions of new wireless technologies assume that UWB, cognitive radios, and mesh networks are either commercially deployed or about to be deployed in the coming months. *See* Werbach, *supra* note 30, at 900–01. The fact is that such technologies are not available at your local Radio Shack and have little prospect of being available for a number of years, if ever. *See* Benjamin, *supra* note 12, at 2029–32. My experience at Bell Telephone Laboratories taught me that technologists must dream, but must also be humble in getting their dreams to market. Many are called but few are chosen.

interference will involve disputes, which are tedious and costly to resolve, even in the best of circumstances. Under the current regulatory regime, dispute resolution lies with the FCC.[120] As noted before, the FCC's track record on dispute resolution is appalling.[121] Disputes drag on for many years as the FCC attempts to reach consensus, third parties intervene in hopes of disadvantaging competitors, and in the end, parties may seek redress in the courts, which, if successful, may result in a remand of the issue back to the FCC, where the process starts all over again. In a property regime, the locus of dispute resolution would be the courts. If I am a licensee and I experience interference that I can prove occurred as a result of your having violated a condition of your license, then I take you to court to seek injunctive relief.[122] While courts may have their own inefficiencies, the rest of the economy seems to work quite well against the backdrop of the courts. If the property rights are written clearly and carefully,[123] then the courts likely will be able to interpret them successfully, and furthermore, most cases would be settled by negotiations if the rules are clear.

VIII. CONCLUSION

The history of wireless teaches us a number of things: (1) bureaucratic regulation is hugely inefficient; (2) markets indeed work, as evidenced by cellular; (3) there is a role for both licensed and unlicensed spectrum; and (4) the market is best positioned to determine the appropriate mix and the uses to which each is put. These lessons point the way forward, to an overarching legal regime of property rights, eliminating the role of government as the overseer of the spectrum economy.

While the FCC can, and has, gone some way to accommodate flexible spectrum use, it can only go so far without a specific congressional mandate to establish a property rights system in spectrum and develop a transition plan to this new regime. As Congress is currently contemplating

120. *See, e.g.*, Red River Broad. Co. v. FCC, 98 F.2d 282, 285 (D.C. Cir. 1938); 47 C.F.R. § 1.701 (2005).

121. *See* Goodman, *supra* note 64, at 376 n.348.

122. For a discussion of the superiority of trespass law and injunctive relief over a liability rule, see Gerald R. Faulhaber, *The Question of Spectrum: Technology, Management, and Regime Change*, 4 J. ON TELECOMM. & HIGH TECH. L. 111, 141–42 (2005). For an excellent critique of nuisance law in this instance, see Goodman, *supra* note 64, at 326–59.

123. This is a big "if." Establishing clear, easy-to-verify-and-measure property rights is a very substantial task that must be undertaken before a property regime is put into place. Current technical license limitations are a starting point, but only that. Great care must be taken when casting rules that are easy to interpret, measure, and enforce.

new telecommunications legislation,[124] this issue should be at the top of its agenda.

Of all areas of telecommunications, wireless is the mode poised for enormous growth, not only promising, but also delivering, value to customers and citizens in the United States and around the globe. The traditional wireline voice business is shrinking and wireless is growing by leaps and bounds, without government subsidies. The value proposition of wireless telecommunications improves daily; the only limits are those imposed by our archaic bureaucratic means of allocating and assigning spectrum. It is time to unlock the spectrum from the government vault and let the combined power of technology and the market show what it can do.

124. *See, e.g.*, Internet and Universal Service Act of 2006, S. 2256, 109th Cong. (2006); Community Broadband Act of 2005, S. 1294, 109th Cong. (2005); H.R. 1661, 109th Cong. (2005); Telecommunications Ownership Diversification Act of 2005, H.R. 1473, 109th Cong. (2005); Native American Connectivity Act, S. 535, 109th Cong. (2005).