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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

Thomas W. Hazlett

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Thomas W. Hazlett is a Resident Scholar at the American Enterprise Institute. He received his Ph.D. in Economics from UCLA (1984), and served as Chief Economist of the Federal Communications Commission (1991-92). Earlier versions of this research paper received helpful comments from seminar participants at the UCLA Department of Economics, the Claremont Graduate School, the Columbia University Graduate School of Business, and the Kennedy School of Government, Harvard University. Coleman Bazelon, Bob Hahn, Giancarlo Ibarguen Charles Jackson and Evan Kwerel, Greg Rosston and Doug Webbink offered numerous suggestions, while Bruno Viani and James Hinckley supplied research support. The author is indebted to each, while absolving them of responsibility for the contents of this paper. Comments to the author are most welcome: AEI, 1150 17th St. NW, Washington, DC 20036; thazlett@aei.org.

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TABLE OF CONTENTS

Executive Summary

In 1959 the Federal Communications Commission invited economist Ronald Coase to testify about his proposal for market allocation of radio spectrum rights. The FCC's first question: "Is this all a big joke?" Today, however, leading policy makers—including the current FCC Chair—decry the "spectrum drought" produced by administrative allocation and call for the creation of private bandwidth markets. This essay examines marketplace trends driving regulators' change of humor, and considers the path of spectrum policy liberalization in light of emerging technologies, theories of unlimited bandwidth, reforms such as FCC license auctions, and recent progress in deregulating wireless markets in the U.S. and around the globe.

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I. RONALD COASE'S 'BIG JOKE'

An important speech by Federal Communications Commission (FCC) Chairman William Kennard on February 28, 2000 exposed the chasm between optimal policy and regulatory practice at the FCC.[1] Speaking at a wireless telecommunications trade show in New Orleans, Chairman Kennard issued an ironic challenge to the private sector. "Today in America there is a spot market for wireline bandwidth," Commissioner William Kennard lectured, "Why can't we do this for wireless?"[2]

An excellent idea—a Nobel Prize winning idea—as demonstrated decades ago by Professor Ronald Coase, winner of the 1991 Nobel Prize in Economics. In an important 1959 paper in the *Journal of Law & Economics*, Coase explained the failure of FCC radio spectrum policy.[3] In work that would lead directly to his Nobel-winning work on the "Coase Theorem" the following year,[4] Coase discovered the source of inefficiency to be rules pre-empting private ownership—and therefore market allocation—of frequencies.

Since December 1926 it has been illegal to assert a propertied interest in spectrum.[5] That makes Chairman Kennard's query somewhat of a trick question. Indeed, just days after his challenge was issued, Commission staff revealed that they were moving towards a "radical overhaul" of FCC policies to make wireless bandwidth markets possible. The story was big news, appearing as the front-page lead in the *New York Times*. Trading radio spectrum like a commodity is currently not quite legal.[6]

Bandwidth confined within fiber optic cables is privately owned, and exchanges for this capacity are spontaneously emerging. RateXchange, Arbinet, Enron, Pulver.com, and Bandwidth Market already operate domestically, with international trading active at Band-X (London), Cape

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[1] William E. Kennard, "Wire Less is More," Address to the Cellular Telecommunications Industry Association, New Orleans, Louisiana (Feb. 28, 2000), http:www.fcc.gov/Speeches/ Kennard/2000/spwek007.txt.
[2] Bill McConnell, *Kennard Makes Waves*, BROADCASTING & CABLE (March 27, 2000).
[3] Ronald Coase, *The Federal Communications Commission*, 2 J. L. & ECON. (1959), 1.
[4] Ronald Coase, *The Problem of Social Cost*, 3 J. L. & ECON. (1960), 1.
[5] See Thomas W. Hazlett, *Physical Scarcity, Rent Seeking, and the First Amendment*, 97 COL. L. REV. 905 (May 1997), 925.

Saffron (London), and Interxion (Amsterdam).[7] These markets materialize precisely because the airwaves are housed in wires—"spectrum in a tube." While technically identical to wireless, wired bandwidth is private property.

The FCC, in its mandate to regulate airwaves according to "public interest, convenience or necessity," determines what wireless services go where. The traditional approach has maintained strict separation of services, "block allocation." Interference between operators is maintained by slotting each type of wireless service into its own reserved slice of spectrum. There has been noteworthy progress in reducing micro-management in some bands, where FCC licensees have been granted flexibility. Yet a top-down regulatory structure continues to anchor spectrum management, blocking entry and innovation. Moreover, the services liberalized constitute just a small slice of available airspace. In the prime frequencies under 3 GHz, particularly important for mobile uses, only about 6% of frequencies are zoned for flexible use.[8] Above 3 GHz, the proportion is much less.[9]

Spectrum that could provide a wide range of valuable uses remains off-limits or severely under-utilized. This limits competition among existing wireless providers, and deters the introduction of innovative services.[10] This is curious in light of sentiments expressed by recent and current FCC officials. Reed Hundt, FCC Chair 1993-97, claimed that "for the first time ever the FCC truly follows a market-based approach to the allocation and use of spectrum."[11] William Kennard, Hundt's successor, has warned of a "spectrum drought" squeezing the emerging wireless Internet, and has pledged to improve spectrum management by greater reliance on market forces.[12] It may seem ironic that the current Commission Chair would aim to achieve what his predecessor had already taken credit for accomplishing. In fact, myriad FCC rules and

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[6] Stephen Labaton, *F.C.C. to Promote a Trading System to Sell Airwaves*, NEW YORK TIMES (March 13, 2000), A1. See also, Kathy Chen, *FCC May Let Firms Trade Licenses To Ease Congestion of Airwaves*, WALL STREET JOURNAL INTERACTIVE EDITION (March 14, 2000).

[7] Joanna Makris, *Not Exactly Nasdaq*, DATA COMM. (May 1999), www.data.com/issue/990507/ brokers.html.

[8] This defines cellular (50 MHz), personal communications services (120 MHz), and enhanced specialized mobile radio (about 10 MHz) as regulated in relatively permissive manner.

[9] As estimated by John Williams, Senior Engineer, FCC Office of Plans and Policies. Conversation with the author, May 31, 2000.

[10] Bruce M. Owen writes: "For three-quarters of a century, the federal government has specified in great detail the way in which the airwaves can be used, for what purpose, and by whom. These rules run 1,330 pages in the Code of Federal Regulations, and every one of them affects the ability of communications firms to compete and to adopt innovative methods of using the airwaves. And yet no change is possible without the elaborate and ponderous process of winning the government's approval." Owen, The Internet Challenge to Television (Cambridge, MA: Harvard Univ. Press, 1999), 82.

[11] Reed Hundt, "Spectrum Policy and Auctions: What's Right, What's Left," Speech to Citizens for a Sound Economy (June 18, 1997), http://www.fcc.gov/Speeches/Hundt/spreh734.html.

[12] Jennifer Jones, *FCC Chief Prods Internet Industry on Wireless Spectrum*, INFOWORLD.COM (May 31, 2000, 10:03 am PT), http://www2.infoworld.com/articles.

regulations are frozen into a daunting mass, and pronouncements by agency officials do not typically exert great impact on the glacier's size, shape, speed, or path.

Take the case of "wireless cable." MMDS, as the service is known at the FCC (for multi-channel, multi-point distribution service), was allocated some 198 MHz of microwave spectrum (at 2.1 and 2.5 GHz) beginning in 1963. The band is divvied into 33 channels for subscription or educational television service (6 MHz per TV signal). MMDS was recently seen as potential competition to cable TV monopolies (hence, the oxymoron, "wireless cable"). Yet, by issuing individual channel licenses in a crazy-quilt fashion (to for-profit operators, as well as churches, schools and other non-profits that leased them back to pay TV companies), and limiting capacity, the technology was severely hampered. As of December 1996, wireless cable served only about 1.18 million subscribers—less than 2 percent of U.S. households.[13] This would be the industry high water mark.

By 1997, wireless cable's stock was plummeting in financial markets. Major telephone companies that had bought into MMDS exited the market. Analysts downgraded industry debt issues, projecting that long run competition with just 33 analog video channels was not economically viable.[14] System values plunged and operators scrambled for alternative business models. A new plan quickly emerged: broadband wireless access (BWA). By using MMDS frequencies for high-speed Internet access instead of cable TV, licensees could profit by satisfying demands in the burgeoning telecommunications data market.

Glitch: MMDS licenses were one-way. Network communications are two-way. That MMDS operators could provide two-way traffic within the allocated frequency space did not matter: two-way violated license specifications. Some waivers for two-way MMDS service were granted, proving that there was no interference spillover. Yet, no general liberalization was enacted. In late 1996, CAI Wireless petitioned the FCC to "review the Mass Media Bureau decision that wireless cable systems can't automatically be used for upstream digital data transmission."[15] The policy, wrote CAI, caused firms to apply for "costly and time-consuming" rule waivers on a case-by-case basis, "hurting [the] ability of wireless cable to obtain

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[13] Federal Communications Commission, *Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming, Fifth Annual Report*, CS Docket No. 98-102, FCC 98-335 (Dec. 23, 1998), C1.
[14] Ibid., par. 84.
[15] WARREN'S CABLE REGULATION MONITOR, *Full FCC should review Mass Media Bureau decision that wireless cable systems can't automatically be used…*, Warren Publishing (Nov. 27, 1996), www.newspage.com/CSTORY/NEW…public/C.d1127027.2c0.dco00000.htm. In fact, the Wireless Cable Association, now known as the Wireless Communications Association, has been receiving two-way high-speed access to the Internet over MMDS licenses since 1995 due to an experimental permit initially granted by the FCC.

financing."[16] Ultimately, CAI Wireless, Heartland Wireless, Nucentrix, People's Choice TV and other firms filed for bankruptcy protection.[17] While the FCC promised quick turnaround, the rule was not approved until September 1998.[18]

MMDS, gasping for air, breathed rich oxygen when permitted to meet market demands. The industry's white cell blood count rose rapidly, particularly after announcements in March and April 2000 that long distance carriers MCI/WorldCom and Sprint would purchase nearly the entire U.S. wireless cable industry.[19] PCTV shares had dropped to just 15.625 cents in 1998; Sprint paid $10 a share for the company in April 2000.[20] Specialized equipment suppliers like California Amplifier,[21] Digital Microwave[22] and Hybrid Networks,[23] rebounded as sharply. Investment was diverted back into the sector, funding new waves of R&D for applications and infrastructure in wireless broadband.

The misallocation of MMDS frequencies cost society a fortune. For decades, a potentially productive swath—198 MHz of prime microwave spectrum—has produced little of value to consumers. Yet, these airwaves are anticipated to be extremely valuable in uses unforeseen by

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(Conversation with Andrew Kreig, President, Wireless Communications Association, July 2000.) Regulatory lag in generalizing this policy waiver dates at least from this date.

[16] Ibid.

[17] Ibid. See also, Michael Grebb, No Strings Attached, UPSIDETODAY (April 13, 2000), http://www.upside.com.

[18] Karen J. Bannan, *Wait's Over in FCC Wireless Ruling*, INTER@CTIVE WEEK (Sept. 22, 1998), wysiwyg://content.174/http://www.zdnet.com/intweek/dialing/9809221.html; Nancy Gohring, *The Miracle Cure*, TELEPHONY (July 5, 1999), http://www.internettelephony.com/ archive/7.5.99/cover/cover.htm.

[19] Seth Schiesel, *Wireless Cable Carriers Finally Cash In*, NEW YORK TIMES (July 19, 1999), www.nytimes.com/library/tech/99/07/biztech/articles/19band.html.

[20] Ibid.

[21] California Amplifier (CAMP) shares closed at $1.84 on March 29, 1999. As the wireless cable deals were announced, the stock soared to $3.06 on April 8 and a high of $5.50 on April 13. The stock peaked at $48.38 in March 2000. The company has benefited from rapidly rising sales of equipment for direct broadcast satellite in addition to the improved prospects for BWA. Source: YAHOO!FINANCE.

[22] Digital Microwave (DMIC) shares hit a low of $2.78 in October 1998, rebounding to an April 1999 high of $12.75. The stock continued its ascent, reaching $38.75 per share prior to the tech stock crash in mid March 2000. Source: YAHOO!FINANCE.

[23] Hybrid Networks (HYBR) raised $35 million in its Nov. 1997 IPO, but was suspended from NASDAQ trading in June 1998 prior to being delisted due to financial reporting irregularities. Its share value sank to $0.13 in late 1998. Despite the firm's continuing management difficulties (the shares are still not traded on NASDAQ or other exchanges), share prices rebounded to $2.88 in 1999-II, $9.03 in 1999-III, and as high as $20.00 in 1999-IV. The bounce-back was linked to the MCI/WorldCom and Sprint BWA play in early 1999: "the broadband wireless industry, which had historically been under-capitalized, has had a substantial capital infusion. During 1999, Sprint Corporation and MCI WorldCom acquired a majority of MMDS wireless frequency licenses in the United States." Hybrid Networks Annual Report, 10-K filing with the Securities and Exchange Commission (March 24, 2000). In fact, there was an explicit financial connection to Sprint's wireless plans: "In September 1999, Sprint invested $11 million in purchasing convertible debentures from us and acquired warrants to purchase additional convertible debentures. The warrants are in consideration for a commitment by Sprint to purchase $10 million of our products by the end of 2000." Hybrid Networks 10-Q filing, Securities and Exchange Commission (May 5, 2000). See also, *Hybrid Networks Reaches Settlement with SEC*, INTERNET WIRE (June 29, 2000, 3:42 pm EST), www.cbsmarketwatch.com.

the original spectrum allocation for MMDS. [24] Of course, who could have sensibly ranked multi-channel video against wireless Internet access in 1963? As a 1997 FCC staff paper conceded, "No government agency… can reliably predict public demand for specific services or the future direction of new technologies." The study urged the Commission to attempt "substantial replication in the spectrum context of the freedoms inherent in property rights [to] allow competition to function more effectively, much as it does in those sectors of the economy where basic inputs are privately owned."[25]

This call for spectrum reform was intensely controversial within the Commission. Wireless operators tried to kill the report altogether. Liberalizing spectrum access would invite competitors to steal market share from established firms. Moreover, if private markets were permitted to allocate radio spectrum, regulators' human capital would diminish.[26]

Ronald Coase learned about the intensity with which regulators and their constituents defend the status quo soon after proposing bandwidth markets in 1959. Called to testify at the FCC, Commissioner Philip S. Cross opened the questioning with, "Is this all a big joke?" Coase was in for even ruder treatment by the Rand Corporation, which had commissioned Coase (along with economists William Meckling and Jora Minasian) to write a report on "Problems of Radio Frequency Allocation." Rand funded the research but pointedly declined to publish the study when a draft, circulated for comment, received "highly critical" reviews. For instance, one anonymous referee wrote: "I know of no country on the face of the globe—except for a few corrupt Latin American dictatorships—where the 'sale' of the spectrum could even be seriously proposed." More ominously, perhaps, an internal memo warned of the trouble publication would

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[24] While MMDS licensees now face fewer restrictions than previously, liberalization is far from complete. An executive for MCI WorldCom explained in March 2000 that to deal with the regulatory delay the company was introducing a limited roll-out of its service with General Wireless Service licenses authorized to operate at 2.3 GHz, between the 2.1 GHz and 2.5 GHz allocations used for MMDS. "[T]he company is able to get a feel for operations while it awaits long-delayed two-way licenses. That process at the Federal Communications Commission is now expected to conclude this summer." Fred Dawson, *MCI Moves Ahead in Wireless Broadband*, MULTICHANNEL NEWS (March 20, 2000), 48. Moreover, a cloud continues to lurk overhead: the International Telecommunications Union is entertaining a proposal to establish MMDS frequencies as mobile bands. Because the FCC may go along with such an ITU policy, MMDS licensees, "fear they may get eviction notices in about a year or so." Curt Harler, *View from the Hill: 3G's Spectrum Victims*, TOTAL TELECOM (March 1, 2000), wysiwyg://161/htt:// ad.uk.doubleclick.ne…live.com; *MMDS, ITFS, MSS, Wireless Interests Argue Over Allocation of '3G' Spectrum*, TELECOMMUNICATIONS REPORTS (Sept. 4, 2000), 19.

[25] Gregory L. Rosston and Jeffrey S. Steinberg, *Using Market-Based Spectrum Policy to Promote the Public Interest* (Federal Communications Commission staff paper, January 1997), 7.

[26] [T]he Commission [is not] likely to support abolition of the public interest standard. Bureaucrats enjoy a highly developed instinct for self-promotion and self-preservation. The public interest standard gives the Commission a raison d'etre…. The Commission has absolutely no incentive to help facilitate the demise of its public interest watchdog duties…" Ronald Krotoszynski, Jr., *The Inevitable Wasteland: Why the Public Trustee Model of Broadcast Television Regulation Must Fail*, 95 MICH. L. REV. 2101 (May 1997).

prompt in "Rand's 'public relations' in Government quarters and in Congress," anticipating the "fire and counterfire of CBS, FCC, Justice, and most of all—Congress."[27]

Today, the Chairman of the FCC calls for bandwidth markets in wireless. Indeed, Kennard's speech led to a Commission hearing on May 31, 2000: Public Forum on Secondary Markets in Radio Spectrum.[28] Three panels of experts spoke on policy changes needed to enable market forces to allocate spectrum.[29] Kennard stated that the FCC "should establish as a goal that spectrum become like any other commodity that flows fluidly in the marketplace."[30]

The FCC's commitment to liberalization is perhaps more flirtatious than solemn. Political inertia, the interests of regulators and regulatees, and the structure of spectrum allocation mitigate against reform. Fundamental changes in the marketplace, however, are invigorating new options. Nearly 75 years after the initiation of spectrum allocation in the public interest, the FCC appears destined to provide its own answer to the question impudently posed to Professor Coase some 41 years ago. No joke—but a very long build-up to the punchline.

II. THE WIRELESS CRAZE

Financial markets are showering new capital on wireless services.[31] While booming valuations of Internet start-ups and *dot.com* IPOs dominated the financial press throughout 1999, the leading gainer among technology issues was a wireless technology supplier—Qualcomm.[32] Among the large capitalization stocks comprising the Standard & Poor's 500, all five top 1999 performers were substantially in wireless—Qualcomm, Sprint PCS (a nationwide wireless telephone network), Nextel (a nationwide wireless telephone network), LSI Logic (a chip maker

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[27] Ronald Coase, *Comment on Thomas W. Hazlett: Assigning Property Rights to Radio Spectrum Users: Why Did FCC License Auctions Take 67 Years?* 41 J. LAW & ECON. 577, 579-80 (Oct. 1998).

[28] Federal Communications Commission, *FCC Announces Agenda for Public Forum on Secondary Markets in Radio Spectrum,* Press Release, DA 00-1139 (May 23, 2000).

[29] The author was among those to speak at the hearing. Panel presentations are available at: http://www.fcc.gov/realaudio/presentations/2000/053100/welcome.html.

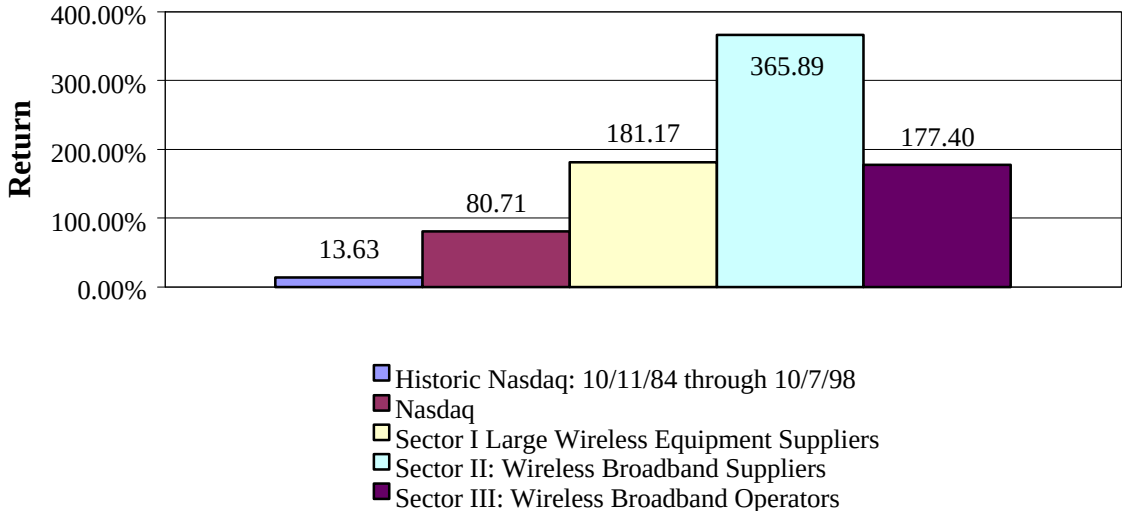
[30] Federal Communications Commission, *FCC Chairman Kennard Urges Three-Pronged Strategy to Promote Wireless Web*, Press Release (May 31, 2000).

[31] "This is the Wild West – wireless makes the Internet look tame," says Donna Oliva, CEO of W-Trade Technologies, a company that's putting banking transactions on cell phones and PDAs [personal digital assistants]." Robert McGarvey, *Wireless Craze*, UPSIDE TODAY (Jan. 31, 2000), www.upside.com. See also: Corey Price, *Investors See Riches in Wireless Realm*, CNET News.com (Mar. 6, 2000), www.news.com; Peter S. Goodman, *Tech Executives Launch Firm to Invest in Wireless Internet*, WASHINGTON POST (Mar. 9, 2000), E3; Craig Tolliver, *Guinness Flight's new wireless play: First fund to focus exclusively on the sector*, CBS MarketWatch (Mar. 10, 2000, 11:04 am ET), www.cbsmarketwatch.com. Tally Goldstein, *Despite Recent Stock Price Woes, Wireless Sector is Poised for Growth*, THESTREET.COM (April 24, 2000), www.thestreet.com/pt/markets/earnings/925014.html; Cisco Systems, *Cutting the Cord: Fixed Wireless Delivers Flexible, High-Bandwidth Solutions*, 12 PACKET MAG. (First Quarter, 2000), www.cisco.com/warp/public/784/packet/lastmile.html; Reshma Kapadia, *AOL Steps Into Wireless Fray with Sprint PCS Launch*, REUTERS (June 16, 2000).

heavily involved in wireless communications), and Nortel Networks (a major telecommunications equipment manufacturer substantially invested in wireless and fiber optic technologies).[33]

While the general increase in the NASDAQ stock index, dominated by high-technology firms, has been impressive in recent years, wireless stocks have done substantially better than average. From its low on October 8, 1998 to its close on June 28, 2000, the NASDAQ posted an absolute return of 177.7 percent, or 80.7 percent annualized. This was magnificent by historical standards. Between October 1984 (when Yahoo!Finance begins its Nasdaq index time series) and October 1998, the Nasdaq index registered per annum returns of 13.63%. The Nasdaq's recent runaway performance, however, has been easily exceeded by three wireless portfolios. Large wireless equipment providers[34] saw annualized returns of 181.2 percent, mid-cap broadband wireless operators[35] returned 177.4 percent for shareholders, and mid-cap wireless broadband suppliers[36] rose an incredible 365.9 percent. See Figure 1.

Figure 1. Annualized Wireless Sector Returns
10/8/98 through 6/28/00



[32] Larry Barnett, *The Year in Review: Qualcomm Top Tech Stock of 1999*, INTER@CTIVE INVESTOR, www.zdii.com (Dec. 23, 1999, 9:41am).
[33] STANDARD & POOR'S, reprinted from the GILDER TECHNOLOGY REPORT (Jan. 2000).
[34] Motorola, Alcatel, Qualcomm, Nokia, Ericsson, 3Com, Nortel Networks, and ADC Telecom. This sector had an average market capitalization of $101 billion per firm in June 2000.
[35] Metricom, Advanced Radio Telecom, Motient, General Motors-Hughes, EchoStar, Nextlink, Winstar, and Teligent. These firms had a mean market cap of 5.2 billion dollars in June 2000.
[36] Adaptive Broadband, Digital Lightwave, Digital Microwave, Andrew Corp., California Amplifier, Proxim, P-COM, Spectrian, Anaren Microwave, and SpectraLink. The average market cap was $3.9 billion in June 2000.

These financial shifts presage widespread tumult in operating markets. Both the boom in mobile telephone use and innovative approaches for high-speed Internet connectivity are driving pervasive structural realignment for consumers, businesses, and governments.[37] The rising importance of wireless telephony is most dramatic. See Table 1. Cellular systems were recently a minor footnote in telecommunications. At a press conference announcing the consent decree under which AT&T divested the Regional Bell Operating Companies (RBOCs) to settle a U.S. Department of Justice antitrust suit in 1984, AT&T CEO Charlie Brown was asked whether AT&T got to keep its cellular licenses. He did not know.[38] AT&T had good reason to underestimate cellular. In the early 1980s, it hired McKinsey & Co. to estimate U.S. cell-phone demand in year 2000. Their prediction: 900,000 subscribers—under 1% of the level obtained. [39]

Table 1. U.S. Mobile Telephone Subscribership (Cellular and PCS)

Year	*Subs*	*Cell Sites*	*Employees*
1985	91,600	346	1,404
1990	5,283,055	5,616	21,382
1995	33,785,661	22,663	68,165
2000 (E)	107,000,000		
2004 (E)	217,000,000		

Sources: 1985-1995, Federal Communications Commission, *Annual Report and Analysis of Competitive Market Conditions With Respect to Commercial Mobile Services, Fourth Report*, FCC 99-136 (June 24, 1999), B-2; 2000 and 2004 estimates, Merrill Lynch, *Wireless Internet*, (June 5, 2000), 8.

Sixteen years after the break-up of Ma Bell, many wireless carriers exceed the valuations of the largest wireline carriers. All-wireless Sprint PCS has a market cap of $58 billion. That tops the $42 billion valuation investors place on U.S. West, one of the seven RBOCs emerging from divestiture.[40] The difference in value would be greater if not for U.S. West's substantial cell-phone operations. Remarkably, of AT&T's market cap of about $107 billion, just over half is

[37] Henry Blodget, Wireless Internet, Merrill Lynch & Co. (June 5, 2000), 9.
[38] Peter Huber, Law & Disorder in Cyberspace (New York: Oxford Univ. Press, 1997), 106. Huber calls this a "$17 billion mistake," referring to the price AT&T was to pay to buy McCaw's cellular systems, re-entering the wireless world in 1994.
[39] *Cutting the Cord*, THE ECONOMIST (Oct. 9, 1999).
[40] Market capitalizations at close of trading, June 16, 2000 on YAHOO!FINANCE.

accounted for by its 84.6% ownership stake in AT&T Wireless, spun off in an April 2000 public offering.[41]

Explosive growth in wireless has produced a paradigm shift with a name, the Negroponte Switch. This is the observation of Nicolas Negroponte of the M.I.T. Media Lab that, while we were born into a world in which we made our phone calls on wires and watched our television over-the-air, we will die in a world featuring just the reverse.[42] The demands for mobility are typically associated with telephone use, while TV viewing is a stationary enterprise.[43] Moreover, ordinary phone calls consume a small fraction of the bandwidth used for full motion video. Common sense seems to suggest untethered technology to best satisfy mobile, low-bandwidth demands, while relying on high-capacity cables (coaxial copper and/or fiber) for fixed services.

Mobility is not the only factor driving demand for radio-based communications. As seen in the MMDS migration from video to BWA, the "race for bandwidth"[44] crosses technologies. Vast increases in the quantities of digital information jamming into communications networks are fueling further increases in demand for still more information.[45] All conduits are being pressed into action. This is partly due to the increasing power and functionality of the computerized devices attached to communications channels, and partly due to the "network effect." The per capita utility of the Internet—a network of networks—grows with the number of users.[46]

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[41] Market capitalizations at close of trading, June 16, 2000 on YAHOO!FINANCE; Steve Gelsi, *AT&T Wireless to Ring IPO Bell*, CBS MarketWatch (April 24, 2000, 1:30 PM ET), www.cbsmarketwatch.com.

[42] Nicolas Negroponte, Being Digital (NewYork: Vintage; 1996), __. The author credits George Gilder with popularizing his prediction, upgrading it to a paradigm shift in the process.

[43] Some scholars take the passive nature of TV viewing quite seriously. "Interactive entertainment on the Web or elsewhere can never substitute fully for conventional television because it cannot satisfy the need to be entertained passively… Part of the allure of television is freedom from choice. It is a respite from an active world." John P. Robinson and Geoffrey Godbey, Time for Life: The Surprising Ways Americans Use Their Time (University Park, PA: Penn. St. Univ. Press, 1997), 312. See also: Bruce M. Owen, The Internet Challenge to Television (Cambridge, MA: Harvard Univ. Press, 1999).

[44] Corey Grice, *Tricks of the Bandwidth Trade*, CNET NEWS.COM (Dec. 18, 1999), http://news.cnet.com/category/0-1004-200-336591.html; John Borland and Ben Heskett, *Is the Fiber-Optic Boom Nearing the End?*, CNBC.COM (Jan. 29, 2000), wysiwyg://12/http://www.cnbc.com/commenta…ntary_full_story_stocks.asp?StoryID=12306; Corey Grice, *Start-up Carrier Dives into Crowded Bandwidth Market*, CNET NEWS.COM (April 13, 2000), http://news.cnet.com/news/0-1004-200-1692223.html.

[45] Corey Grice, *Study: Fiber-optic Demand to Keep Pace with Supply*, CNET NEWS.COM (May 16, 2000), http://news.cnet.com/news/0-1004-200-1885771.html. Despite huge new investments in fiber infrastructure, the "glut" of communications capacity forecast by some has not materialized. One consulting firm, TeleGeography, estimates "demand for bandwidth could grow 25 times over the next five years," and that "for every 50 percent reduction in the cost of bandwidth, ISPs [Internet service providers] have purchased 100 percent more capacity." Ibid.

[46] See Carl Shapiro and Hal R.Varian, Information Rules (Boston, MA: Harvard Business School Press, 1999), 173-225; Stanley J. Liebowitz and Stephen E. Margolis, *Path Dependence, Lock-In, and History*, 11 J. LAW, ECON. & ORGAN. 205 (1995).

Massive investments in high capacity fiber optic transmission lines (radio spectrum in a tube) are the most visible manifestation of the bandwidth race. See Table 2. Wireless operators compete directly with landline systems in providing "last mile" connectivity for high speed Internet access.[47] The "wireless web" feeds both the demand for ubiquitous (mobile) connectivity and the general demand for high-speed last-mile network access. Virtually all major software and hardware suppliers now support wireless applications, anticipating new generations of wireless computers and devices.[48] Analysts project extremely rapid growth in wireless Internet usage in the U.S. and worldwide. Over $100 billion in global wireless e-commerce is anticipated annually by 2005, for instance. See Table 3. Spectrum is increasingly vital to productivity. As one analyst puts it: "Wireless Internet usage represents the convergence of two enormous communications trends—the Internet and mobile telephony."[49] This marked trend creates inevitable policy tension. Business and residential customers ravenous for high-speed access to computer networks are *taxed* by policies that inefficiently restrict spectrum use. As wireless applications become more valuable, the effective tax rate rises.[50]

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[47] Note that Nextlink, one of the major fiber capacity suppliers in Table 2, is the U.S.'s largest holder of wireless FCC licenses (licenses weighted by MHz per capita). The company uses fiber and wireless solutions interchangeably for local access, with fiber dominant in city-to-city links. (It should be noted that Nextlink changed its name to XO Communications in late 2000.)

[48] Microsoft, Cisco, Intel, Sun, Oracle, Dell, Compaq and IBM have all announced major wireless initiatives within the past two years. Corey Grice, *Microsoft Committed to Wireless, Gates Says*, CNET NEWS.COM (Feb. 28, 2000, 1:30 pm PT), http://news.cnet.com/category/0-1004-200-1559479.html. Company Press Release, *Cisco Extends Broadband Fixed Wireless Leadership Through Addition of New World Ecosystem Partners* (June 28, 2000), http://biz.yahoo.com/bw/000628/rpt_ca_cis.html; Joe Wilcox, *Dell Hustling Toward Wireless Internet Access*, CNET NEWS.COM (June 28, 2000, 8:20 am PT), http://news.cnet.com/news/0-1006-200-2165270.html. Wylie Wong, *IBM Jumps Into Wireless Pool*, CNET NEWS.COM (Feb. 29, 2000, 8:00 am PT), http://news.cnet.com/category/0-1003-200-1560139.html.
Stephen Shankland, *Sun Set to Announce Partnership With Palm*, CNET NEWS.COM (Feb. 28, 2000, 4:50 pm PT), http://news.cnet.com/category/0-1006-200-1559908.html. Small wireless companies are also switching gears, ramping up to provide broadband wireless access to the net. Corey Grice, Wireless Boom Leads Firms to Swap Strategies, CNET NEWS.COM (Feb. 29, 2000, 7:10 am PT), http://news.cnet.com/category/0-1004-200-1560128.html.

[49] Merrill Lynch, *Wireless Internet: Industry Overview* (June 5, 2000), 9.

[50] "Demand for spectrum, which is required to run all mobile communications devices, has increased and wireless companies are running out of space to offer new services. The wireless phone industry signs up a new customer every two seconds. And as the Internet moves from desktop computers to portable devices such as Palm's popular handheld unit, demand will intensify. 'Put these two things together and you've got this extreme pressure on this spectrum resource,' said Dale Hatfield, chief of the FCC Office of Engineering and Technology." *FCC to Consider New Market for Wireless Spectrum*, BLOOMBERG NEWS (May 30, 2000), http://news.cnet.com/news/0-1004-200-1983203.html.

Table 2. Fiber Optic Conduit Suppliers (April 13, 2000)

Supplier	*Miles Planned*	*Miles Installed*	*Estimated Cost*
Aerie	20,000	0	$3.5 billion
Williams	33,000	26,000	$4.7 billion
Qwest	25,500 (all No. America)	25,500	n.a.
Level 3	16,000	9,334	$13 billion (European, Asian, U.S. costs)
Broadwing	18,000	17,000	n.a.
Enron Broadband	15,000	14,600	n.a.
Nextlink	5,000 (metro areas only; links shared with Level 3)	4,235	n.a.
Global Crossing	16,000	14,000	n.a.
360Networks	24,100 (all No. America)	15,000	n.a.

Source: Corey Grice, *Start-up Carrier Dives into Crowded Bandwidth Market*, CNET News.com (April 13, 2000), http://news.cnet.com/news/0-1004-200-1692223.html.

Table 3. Worldwide Wireless Internet Market

	1999E	*2000E*	*2001E*	*2005E*
WW Wireless Subs (mm)	472	670	907	2,038
Proportion Internet-Enabled	0%	5%	15%	80%
No. Internet Enabled	1	34	136	1,631
WW B2C Commerce Spending			$99	$463
% Transacted through Wireless			5%	24%
Wireless e-Commerce Spending			$5	$111

Subscribers in millions, $ in billions, E = estimated
Source: Merrill Lynch, *Wireless Internet* (June 5, 2000), 6.

III. THE BROADCAST TV FADE

One wireless industry is a lonely bystander to the sector's upward economic spiral: traditional broadcast media. Off-air TV and radio, historically dominant in the business and politics of the wireless world, are increasingly pushed to the margins. New digital technology is being deployed by TV stations, but the transition is a costly defensive tactic designed to slow gains by cable and satellite TV video competitors. High-Definition Television (HDTV) policy, in

fact, underscores the decline of broadcasting's dominance among video and other wireless industry segments.[51]

In 1987 the FCC began a rule making for "Advanced Television" (ATV).[52] It was ostensibly undertaken to promote a transition to HDTV, a highly touted system delivering crisper pictures by transmitting signals of higher resolution. In fact, the proceeding was prompted by the political interests of TV station owners, who were not interested in HDTV, but were quite concerned that the FCC would re-allocate vacant UHF channel space to other uses. In particular, land mobile interests had, beginning in 1985, requested that the Commission make additional UHF frequencies available for mobile wireless services. The first re-allocation of UHF TV spectrum involved channels 70-83 (78 MHz @ 6 MHz per channel). This allowed the creation of two cellular licenses, with each allocated 25 MHz. As cellular telephone service was proving popular beyond expectation, pressure arose for the Commission to allow additional entry.

TV broadcasters blocked re-allocation. While not using the requested frequencies, they coveted "spectral *Lebensraum.*"[53] Leaving "TV spectrum" vacant provided an inventory of valuable inputs should expansion one day prove profitable. The enabling mechanism was the FCC rule making. Once begun, unoccupied UHF radio waves were frozen so that HDTV might use them in the future.[54]

While providing the pressure to initiate the Advanced Television proceeding and the momentum to keep it slowly rolling forward, the TV industry remarkably *opposed* actual creation of HDTV broadcasting at almost every turn. [55] Stations did not perceive consumer demand for higher resolution pictures that would justify the cost of providing them. The cost of HDTV included outlays for physical equipment (everything from cameras to transmitters to home receivers had to upgrade to new technological standards), investments in programming in the new format, and the opportunity cost of radio spectrum. Increasing picture resolution consumes more bandwidth, ceteris paribus. Broadcasters discovered that using digital technology to deliver standard definition (STV) signals[56] could be done in a fraction of the spectrum space

[51] HDTV spectrum allocation is separately discussed below.
[52] Federal Communications Commission, *Notice of Inquiry*, MM Docket No. 87-268, 2 FCC Rcd 5125.
[53] George C. Calhoun, Digital Cellular Radio (Norwood, MA: Artech House, 1988), 48.
[54] Thomas G. Donlan, Super-Tech (Homewood, IL.: Business One Irwin, 1991); Cynthia Beltz, High-tech Maneuvers: The Industrial Policy Lessons of HDTV (Wash. D.C.: AEI Press, 1991);. See also, Thomas W. Hazlett and Matthew L. Spitzer, *Digital Television and the Quid Pro Quo*, __ BUSINESS & POLITICS (forthcoming, 2000).
[55] Joel Brinkley, Defining Vision: How Cunning, Conceit, and Creative Genius Collided in the Race to Invent Digital, High-Definition TV (New York: Harcourt Brace & Co.; 1997).
[56] The analog format for standard definition is NTSC, an acronym for the National Television Standards Committee.

consumed by one HDTV signal. The compression ratio is somewhere between 4-1 and 10-1 depending on the programming.[57]

As the ATV rule making pushed into the mid-1990s, it was clear that it had performed its function: UHF spectrum not used by analog TV broadcasters remained untouched. But constituents of the HDTV idea—primarily technology suppliers and set makers—were pushing for deployment. The broadcast lobby was still dubious about the economic merits of the HDTV business model. It would not generate net revenues (i.e., additional advertising) unless it expanded audience size. Until viewers bought new HDTV-compatible equipment, that would not happen—and there was no evidence that either consumer enthusiasm for higher resolution, or efficiency gains to drive down very high set prices, would soon be observed.[58] The broadcast industry knew that its transition to new technology would cost billions of dollars, but the payoff was highly uncertain.

The industry deserted HDTV, and soon thereafter so did the FCC. In late 1996, just months before awarding licenses to stations, the Commission substituted a generic digital standard in place of one mandating high-resolution video.[59] Stations would each receive a (second) license, free of charge, on which to transmit. The new channel licenses mandated digital transmission; HDTV, in digital format, was an option but was not required. Indeed, the FCC allowed broadcasters to use some of the allocated 6 MHz for data or other services besides television, so long as at least one STV signal were broadcast digitally. Broadcasters, issued DTV licenses in April 1997, took advantage of the ruling by abandoning HDTV.[60]

The rule change eased the potential economic damage of an industrial policy forcing customers to pay for a particular resolution quality (1080 lines per inch) in a system devised in

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[57] For instance, talking head TV shows consume relatively little bandwidth; football games with lots of movements consume relatively large amounts. Live broadcasts consume more bandwidth than recorded programs, which can be compacted prior to being televised.

[58] Digital television sets cost between $5,000 and $10,000, and only 600,000 will have been sold in the U.S. by year-end 2000, according to TV manufacturers (with a vested interest in optimistic forecasting). Associated Press, *Bumpy Press Slows Digital TV Release*, CNET NEWS.COM (April 11, 2000, 10:40 am PT), http://news.cnet.com/news/0-1006-200-1681018.html. By contrast, there are about 220 million analog sets in use in approximately 100 million U.S. television households.

[59] *FCC Is Set to Adopt Standard for HDTV, Speeding Introduction*, WALL STREET JOURNAL (Dec. 26, 1996), 11.

[60] "Multichannel DTV is good…and HDTV is expensive." This was the bottom line at an industry seminar just four months after the FCC issued DTV licenses. Glen Dickson, *Low Blows Against High-Def*, BROADCASTING & CABLE (Aug. 18, 1997), 46. "High-definition TV is starting to get the short shrift as stations decide they'd rather use their newfound digital real estate to create multiple standard-definition channels." John M. Higgins, *HDTV Falling Out of Favor*, BROADCASTING & CABLE (Aug. 18, 1997), 4. Jim Davis, Broadcasters to Send Data Over Digital TV Airwaves, CNET NEWS.COM (March, 2000, 9:45 am PT), http://news.cnet.com/ category/0-1006-200-1581932.html.

Washington.[61] The shift to DTV by both policy makers and television stations, moreover, reveals the disintegration of the old broadcasting cartel. Broadcasters previously stood firmly against head-to-head competition, with the FCC in lock step. Here, HDTV is abandoned in favor of multiple STV channels—*increasing* rivalry among off-air TV stations. The (high-definition) signal is that broadcasters consider the threat posed by new media has flipped the old regulatory equilibrium. In the past, broadcast TV's dominance led it to *restrict* competition between licensees. Now the cartel is anemic. Cable, satellite, and Internet-distributed video stand as greater threats to broadcaster profits than station rivals. As an ABC executive commented, the network is foregoing HDTV to "occupy more shelf space in the television marketplace."[62] That indicates a sea change in sector economics that is rippling throughout the spectrum allocation system.

The eclipse of traditional broadcasting is seen in the maturation of cable television and the explosive growth of direct broadcast satellite. Combined, the two technologies were subscribed to by 81.4% of U.S. households as of June 1999.[63] Viewing audiences are deserting broadcast TV in favor of basic cable networks. See Table 4. And while radio and television broadcasters have maintained strong revenue growth over the past twenty years, the rate of increase pales in comparison to subscription services. See Figure 2. These trends are firmly established, and there is no evidence that they will reverse. As Bruce Owen writes: "[T]wo things are clear: the government-created artificial scarcity of spectrum will cease to be a defining factor in the television industry, and the days when most viewers do not pay for most programs are numbered."[64] The new competition from fee-based entertainment services is shifting the old advertising-supported media to a multi-channel video delivery market. This undercuts the easy profitability associated with control of the conduit to customers, forcing renewed emphasis on content.

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[61] The Grand Alliance technical standard, eventually adopted by the FCC, was itself a creation of scientific work in laboratories around the world. It is important that the Commission, when looking for complex solutions, is often best served by sponsoring private competitions rather than attempting to manufacture systems in-house. In fact, most FCC rule making relies heavily on the adversarial process generated by allowing private Comments and Replies to be filed in response to Commission notices. The FCC nonetheless acts as the ultimate decision maker, using public interest criteria to set the rules of the competition and to determine when, and how, proffered solutions are implemented.

[62] Dickson, *Low Blows*, supra note __, 46.

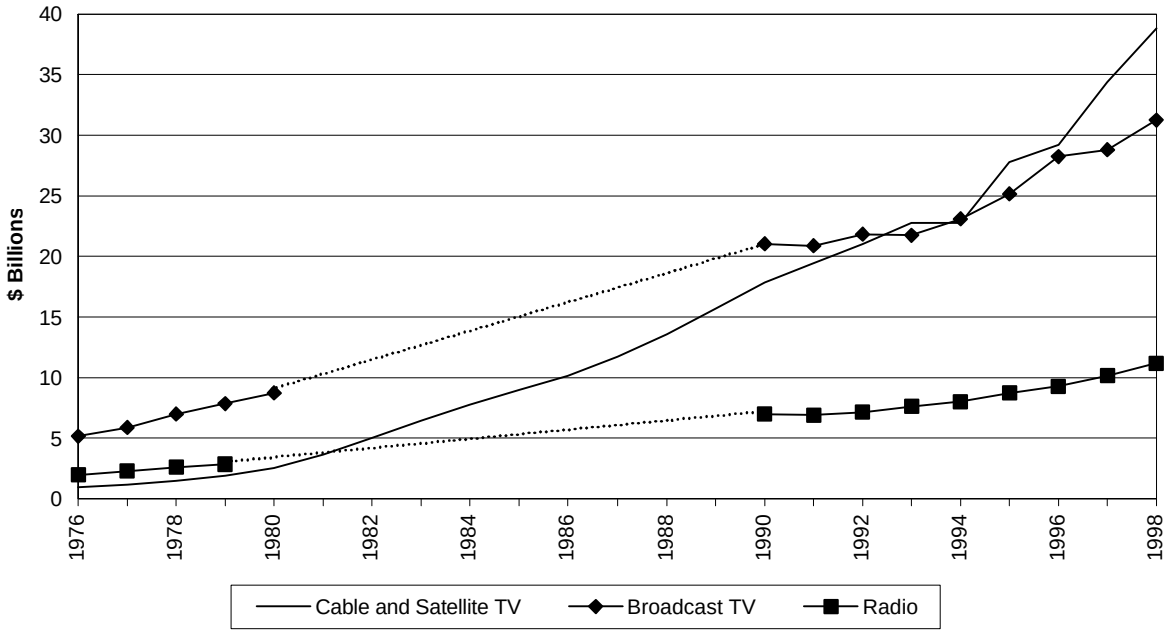
[63] Multi-channel video subscribership grew 5.5% between 1998 and 1999. Federal Communications Commission, *Annual Assessment of the Status of Competition in Markets for the Delivery of Video Programming*, CS Docket No. 99-230 (Jan. 14, 2000), par. 6.

[64] Bruce Owen, The Internet Challenge to Television (Cambridge, MA: Harvard University Press, 1999), 37.

Table 4. Viewing Shares for Broadcast TV and Cable-only Channels				
		1988	*1993*	*1998*
Commercial Broadcast TV Network Affiliates and Independents		78	73	57
Public TV		3	4	3
Basic Cable Channels		17	26	41
Pay Cable Channels		7	5	6

Source: National Cable Television Association, Cable Television Developments, www.ncta.com.
Note: Shares may sum to more than 100% due to multiple television sets per household.

Figure 2. Annual Radio and Television Revenues, 1976-98



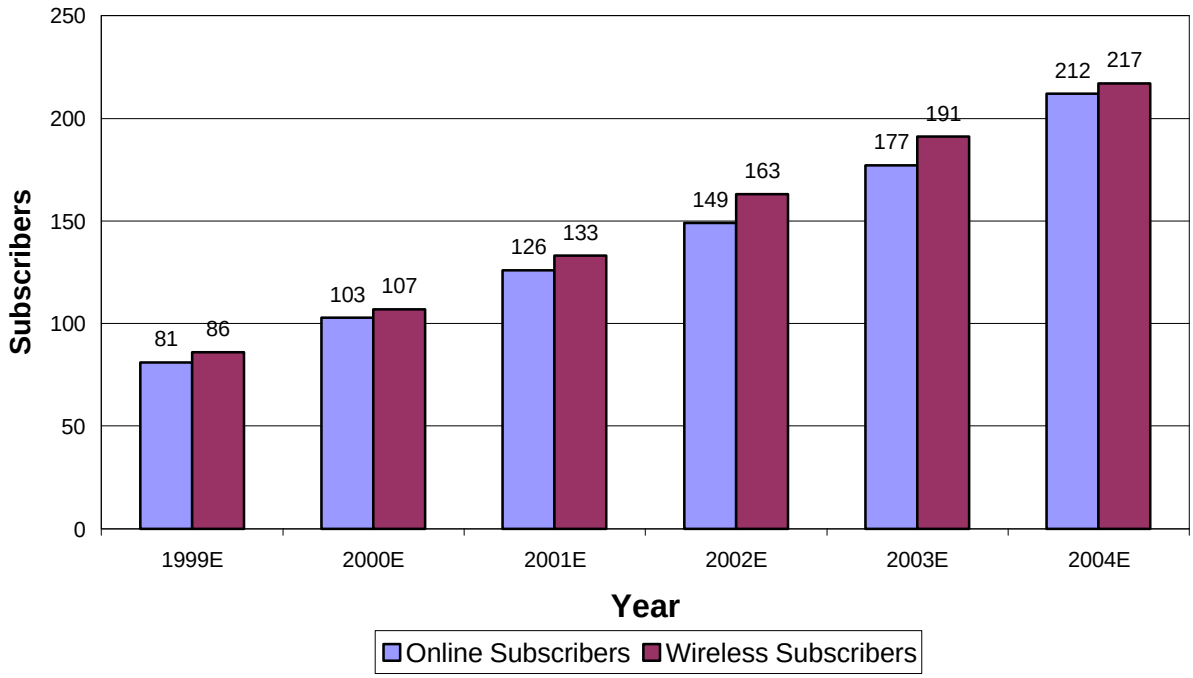
Sources: www.census.gov/statab/www/part2.html
Statistical Abstract of the United States, 1997, pp. 565, 569
Statistical Abstract of the United States, 1994, pp. 568, 571
Statistical Abstract of the United States, 1995, pp. 572, 575
Statistical Abstract of the United States, 1981, p. 563
No Broadcast TV data, 1981 through 1989
No Radio data, 1980 through 1989

Broadcasting's one-time dominance is rapidly fading in the market for *news & information*, as well. According to a 2000 survey by the Pew Research Center for the People and the Press, only 30 percent of U.S. adults regularly watch TV broadcast network evening news shows—a 50% decline since just 1993. Fifty-six percent report regular viewership of local TV news, down from 77 percent in 1993. Conversely, Internet and cable network news sources are

luring vast new audiences. One third of U.S. adults regularly use computer networks for online news, while 33 percent regularly watch CNBC, MSNBC, or the Fox News Channel. (Two of the three were not yet created in 1993.[65]) And 37% regularly tune into either Discovery or the History Channel. The exodus from broadcasting has been triggered by competition simply yielding preferred consumer choices, coupled with the fact that, as Pew finds, only one-third of U.S. "adults say they believe most of what they see on ABC, CBS, and NBC."[66]

Among wireless communication services, the relative decline of television is even sharper. Cellular and PCS growth is explosive in comparison with the comparatively stable revenue picture in broadcasting. Current projections are for the torrid pace of wireless telephone subscribership to continue, with a doubling of U.S. users between 2000 and 2004. See Figure 3. In the broader market yet, the information technology sector, the race for bandwidth is furious. Demand for communications conduits intensifies as networks expand, technologies upgrade, applications mount, software improves, and customer acceptance of e-commerce grows. All these trends point in the same direction: broadcasting, which so long reigned supreme in spectrum policy making, is fast becoming just another industry.

Figure 3. U.S. Online and Wireless Subscribers (millions)



Source: Merrill Lynch, *Wireless Internet* (June 5, 2000), 8.

[65] Paul Kagan Associates, The Economics of Basic Cable Networks (July 1993).

This changes policy. The licensing bargain struck between broadcasters and regulators was a political accommodation that drove the 1927 Radio Act and has determined essential aspects of spectrum allocation ever since. The bargain relied on spectrum regulation to create gains for both parties.[67] Allocation and "technical" rules protected broadcasters from competition as well as from fees or competitive bidding (for licenses), and gave political incumbents (both in congress and the executive branch) the opportunity to leverage "public interest" discretion for some measure of control over content. Given the ban on regulation of free speech in the U.S. Constitution, this was a formidable regulatory achievement.[68] As the rents accruing from parsimonious spectrum allocation policies (licensing many fewer broadcast competitors than could utilize the airwaves) were substantial in the golden eras of radio and television broadcasting, the incentives for radio and TV interests to play the quid pro quo game were high. Likewise for policy makers, who consider the publicity generated by mass media outlets as key inputs into the "political support functions" which ultimately determine career success.

Prior to the advent of cellular telephone service, licensed 1984-1989, the FCC's spectrum allocation policies were almost solely focused on broadcasting. No other wireless service assumed sufficient economic or political importance to rival broadcasting's hegemony over spectrum policy. While AT&T wielded considerable regulatory clout over telecommunications, AT&T-backed initiatives to re-allocate UHF spectrum for mobile services were rebuffed, due largely to broadcaster opposition, for decades.[69] It is also noteworthy that, within markets not directly involving broadcasters, spectrum allocation policies thawed.[70]

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[66] Michael Kelly, *Network Snooze*, WASH. POST (June 14, 2000), A39.

[67] See Thomas W. Hazlett, *The Rationality of U.S. Regulation of the Broadcast Spectrum* 33 J. LAW & ECON. 133 (April 1990).

[68] See Thomas W. Hazlett, *Assigning Property Rights to Radio Spectrum Users: Why Did FCC License Auctions Take 67 Years?*, 41 J. L. & ECON. (Oct. 1998) 529.

[69] When mobile phone service debuted in 1946, it proved popular and AT&T petitioned the Commission for additional air channels. Yet, "the Commission's decision on the 1949 docket was a total victory for the broadcast interests. They rejected Bell's ideas and refused to allocate any portion of this valuable spectrum to mobile telephony." Not until 1968 did the FCC begin to allocate UHF spectrum for telecommunications, and not until the 1980s were licenses finally issued to cellular operators. See Calhoun, Digital Cellular Radio, supra note __, 46-49, 63.

[70] In point-to-point microwave for long distance service, important liberalization was instituted in the 1970s. The 1988 FCC decision to allow cellular operators to voluntarily adopt digital standards was another key precedent (if too late to avoid inefficient deployment of analog cellular). The relatively liberal rules used in the PCS allocation demonstrate the most far-reaching deregulation of a major service category – in common carrier telecommunications, not broadcasting. Indeed, broadcasters continue to block flexible use of 700 MHz spectrum in the ongoing battle over relocation of TV channels 60-69. See discussions below.

The broadcast sector fade undermines regulatory micro-management.[71] Increasingly, telecommunications equipment manufacturers, computer software and hardware companies, networking firms, application service providers and silicon chip makers are drawn to wireless. These interests are generically progressive where broadcasters are generically conservative; they promote enhanced availability of spectrum where radio and television broadcasters seek to sequester it. The New Economy companies typically profit from expanding bandwidth, driving access costs down, increasing functionality and expanding the size (and therefore utility) of networks. The FCC's professed interest in liberalization is not a mystery in the rising shadow of Intel, Dell, Nortel, Apple, Microsoft, Cisco, RealNetworks, Akamai, InfoSpace, Critical Path, Wind River Systems, Broadvision, and Research in Motion,[72] or the diminishing presence of ABC, CBS and NBC. The newcomers naturally seek access to unoccupied radio waves, attempt to tap "spectrum reserves," and challenge inflexible rules protecting the status quo.

The shifting economics have yet to overturn history, however. The basic structure for allocating radio waves is still that crafted in the Radio Act of 1927.[73] FCC airwave regulation operates on two broad levels. First, basic resource utilization is determined in the *spectrum allocation* process. This zones bands of frequencies for particular uses—e.g., AM radio, broadcast TV, cellular telephone, point-to-point private communications, satellite messaging, etc. The FCC, however, has much broader power than determining type-of-service. Within the allocation process it sets rules on how many rivals will compete, what services they are permitted to offer, what technologies they will use, and a host of fundamental business decisions—e.g., if they are to operate as a common or private carrier.

Once the allocation decision is made, regulators carry out the *license assignment* process.[74] From 1927 until 1981, the sole method used was comparative hearings, political

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[71] The policy to relax the HDTV requirement in December 1996 was itself largely the result of pressure from computer software and hardware interests. Alex Lash, *Digital TV Standards Off to Market*, CNET NEWS.COM (Dec. 26, 1996, 1:30 pm PT), http://news.cnet.com/category/0-1003-200-315409.html.

[72] Intel, Dell, Nortel, Apple, Microsoft, Cisco, RealNetworks, and Akamai, are important New Economy firms building pieces of communications networks, and each benefits from lower priced network inputs (including spectrum). InfoSpace, Critical Path, Wind River Systems, Palm, Broadvision, and Research in Motion depend on wireless 'conduits' for service delivery.

[73] The Radio Act of 1927 created the Federal Radio Commission. The Radio Act was then inserted, virtually verbatim, into the Communications Act of 1934, which replaced the Radio Commission with the Federal Communications Commission. The latter assumed responsibility for wireless communications from the FRC, as well as authority over long-distance telephony, which it acquired from the Interstate Commerce Commission. This regulatory apparatus has remained largely untouched by legislation in the decades since. The 1996 Telecommunications Act, a major reform effort in wireline communications, did not alter the spectrum allocation process in any substantial way.

[74] Some spectrum is allocated on an unlicensed basis. Here the FCC sets rules for spectrum usage, and allows open entry under those rules. This requires FCC approval of the equipment used for transmitting in the band. Other bands

selection of competing applicants. Then Congress voted to allow the FCC to employ lotteries for non-broadcast licenses. In 1993, Congress finally granted the FCC authority to conduct auctions for non-broadcast licenses.[75] In 1997, this authority was extended to include broadcast licenses.[76]

Federal regulators allocate airwaves under the statutory standard of "public interest, convenience, or necessity." Firms wishing to utilize airwaves for new, competitive purposes must make an affirmative public interest showing before the Federal Communications Commission. This burden cannot be met by simply offering to invest private capital in an attempt to deliver better and/or lower-priced services to customers, the hurdle for entry into an unregulated market. Other public interest considerations can, and will, be raised by interests opposed to competition. These objections may be raised without penalty, even if allegations made prove false and self-serving. The rule making process is open (with all interested parties free to file Comments or Replies) to the various notices issued, and open ended, taking years or decades to complete. Of course, incumbents benefit from delay, while potential entrants are deterred (leading some potential entrants not to try at all). Given this conservative bias, the basic spectrum allocation system is structurally hostile to new competitors.

IV. SPECTRUM ECONOMICS: TRAGEDIES COMMON AND UN

Unregulated access to radio waves may result in a "tragedy of the commons,"* destroying a valuable resource due to over-use. The standard tools of property law address such issues more directly than does public interest spectrum allocation, however. Private owners spontaneously assess consumer benefits in nuanced profit calculations (trading costs against revenues), while regulators tend to categorical decisions. The block allocation system is the sine qua non of FCC spectrum regulation. It uses an economically crude, and technically obsolete, framework to separate various services in frequency space. The system is administratively manageable, and it affords great opportunities for incumbent service providers to truncate entry (automatically limited by the blocks and channels allocated). But the system is clearly inept at maximizing consumer welfare, as vast portions of spectrum space is left vacant and virtually all the remaining portions are under-utilized. This is seen in great detail in examples discussed throughout this paper.

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are allocated for federal or military use. Wireless users in these blocks are not licensed by the FCC, but are coordinated by the U.S. Department of Commerce's National Telecommunications and Information Administration (NTIA).

[75] Numerous calls for a system of fees or auctions had been made during virtually the entire life of the present regulatory system. See Hazlett, *Assigning Property Rights*, supra note __.

[76] Ibid.

The interference rationale for public interest allocation has historically been based on the claim that radio spectrum is a "unique" resource that cannot be regulated by standard means such as property rights. Not only is this proposition theoretically false, as demonstrated by Coase,[77] it is operationally incorrect, as radio spectrum users under public interest regulation rely on de facto private property rights to limit interference. Wireless licensees, not the FCC, police "their" airspace,[78] reporting interference from unauthorized transmissions ("piracy") to law enforcement authorities.[79] Rarely is trespass reported because incursions are rare and substantial damage rarer still. In practice, investors are unwilling to underwrite transmitting facilities without secure spectrum access. Market forces constrain private parties to respect lines drawn by regulators.

Interference is a cost of doing business in wireless. Like some other byproducts (e.g., pollution) it is a cost that can spill over to third parties, short-circuiting rational mitigation by interference producers *if* the rules allow it. Of course, avoiding spillovers is itself a delicate process. It is not efficient, for example, to *minimize* interference. All wireless communications (indeed, all radiation-emitting activities) imply some positive level of potential deterioration of valuable signals. Some interference is valuable input into services providing consumer gains that far outweigh the costs (including those emanating from interference damage). Hence, the quest is for an *optimal level of interference*.

A simple example illustrates. Consider a given band of frequencies that has been divided into twenty channels.[80] These channels may carry audio broadcasts at low cost to consumers with receivers. There are six different plans considered for implementation. See Figure 4.

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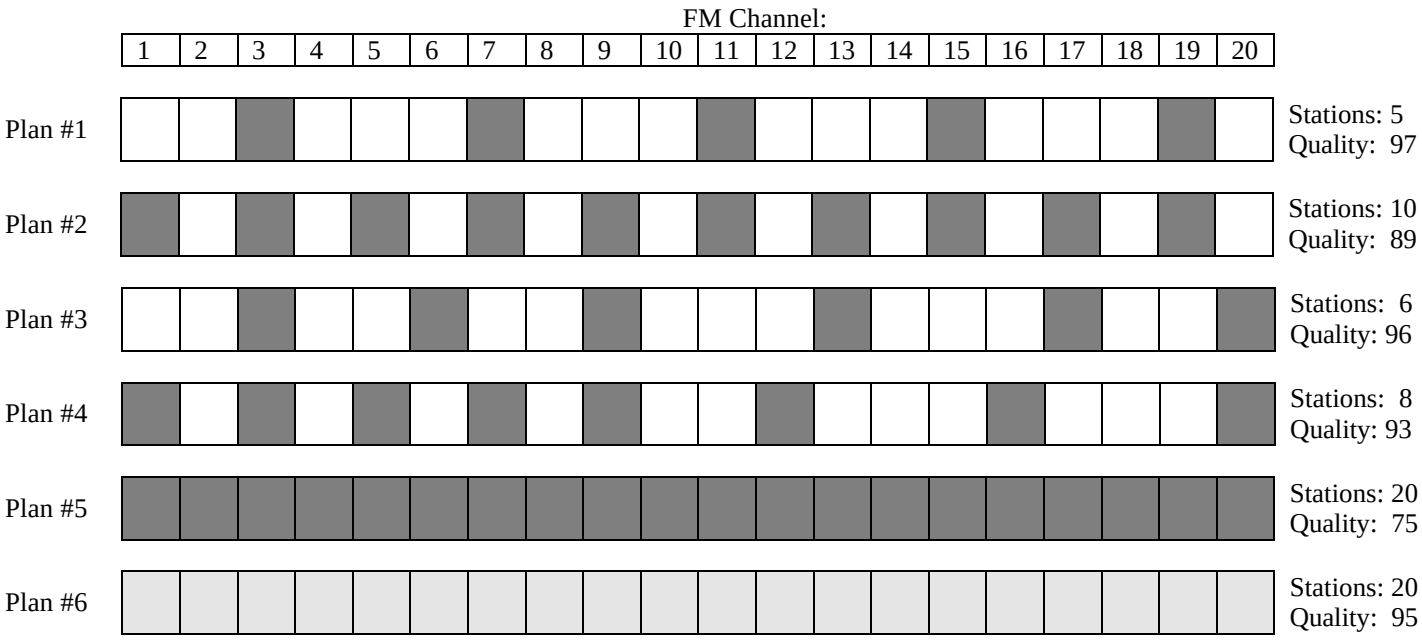
[77] Ronald Coase, *The Federal Communications Commission*, 2 J. L. & ECON. (1959), 1.

[78] The airspace does not formally belong to the wireless service provider, but is allocated to the license under which they operate. This is sometimes argued to be de facto private property, but the limitations on use due to non-ownership are typically substantial. Hence, an important distinction remains between the de facto and de jure notions of spectrum ownership.

[79] When it is asserted that the FCC polices the airwaves, the picture of radio scanning equipment in a high tech government facility comes to mind. In fact, the FCC engages in minimal monitoring of frequency use. The practical FCC contribution to law and order in frequency space is enforcement of licensing rules in response to complaints. Licensees are very efficient monitors of their transmissions and are quick to report interference to the agency. The limited arena in which FCC detection of illegal emissions is important is "pirate radio." Precisely because unlicensed low power FM stations typically do not materially interfere with existing broadcasts, their whereabouts may be undetected by locally licensed stations. These latter broadcasters are vigilant in communicating suspected incidents of unlicensed broadcasting to the Commission, however, as such broadcasts compete for audience share. FCC officials then track down and prosecute the illegal broadcasters. See discussion of low power FM, below.
*see discussion on infra at note __.

[80] Choices over channelization plans are themselves subject to efficiency trade-offs, but we abstract from them in this example.

Figure 4. Alternative Band Plans



This hypothetical array of alternative band plans—six out of an infinite population—poses standard trade-offs in spectrum use. In Plan 1, channels are spaced widely and interference relatively low. This yields just five listening choices for customers, but an excellent signal quality rating of 97.[81] Plan 2 packs in more stations with less separation. This results in a many more station choices (11), with reduced signal quality (89). Plans 3 and 4 represent compromises in the choice-signal trade-off bounded by 1 and 2. Plan 5 packs in emissions very densely, using all twenty channels for communication. The loss in signal quality is pronounced. Plan 6 is identical to Plan 5, except a change in a second variable (in addition to spacing) is introduced—power. At lower power assignments the 20 channels of transmissions create much less interference. Of course, this changes other aspects of reception, including a narrowing of their geographic reach.

Countless plans are possible when channel slots, bandwidth, power, technology, and transmitter location are varied. Changing the quality of listeners' receiving equipment also alters the value of broadcasting. Which plan yields the greatest value? All plans encompass trade-offs between more broadcasting and less static. Rational spectrum use does prevent a "tragedy of the commons," but it must simultaneously guard against the reverse problem—"tragedy of the

[81] These numbers and ratings are arbitrarily constructed in the example. They demonstrate the general nature of the allocation problem. When allocating spectrum further complexity is introduced by the disagreement over the actual magnitudes. The trade-offs shown in the example expand to new dimensions concerning the reliability of differing estimates for reception, station viability (determining the final allocation of stations in the marketplace), the value to consumers of additional choices, and the value to consumers of improved reception.

uncommons." If the incremental value gained by additional radio emissions exceeds the value of communications lost due to increased interference, it would be tragic to "protect" spectrum by blocking socially valuable use.

The Static Case [82]

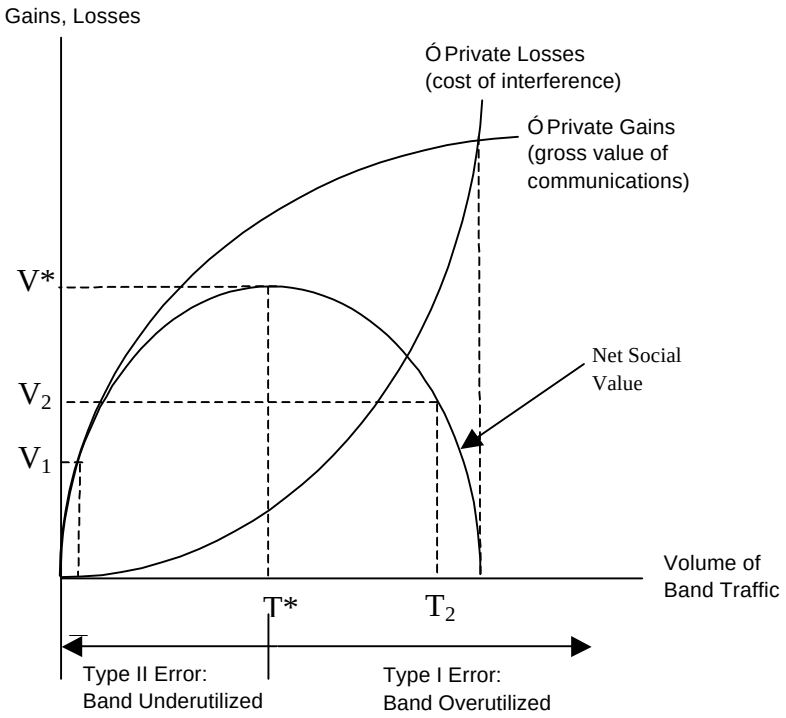
Radio transmissions generate benefits but also cause potential interference. In the standard situation, pictured generically in Figure 5, gross benefits are depicted as the aggregate Sum of Private Gains from wireless communications in the band (Ó Private Gains). These rise with the quantity of transmissions, but at a decelerating rate. That is because of two reinforcing effects: (a) the most valuable communications are conducted first, and (b) increasing traffic compacts the bandwidth available for new service. The costs of radio interference are also displayed in Figure 5 (Ó Private Losses). Losses result when transmissions disrupt other wireless communications, degrading signals.[83] In the absence of compensation, this results in external costs—pollution—imposed on third parties. Initially, the low volume of transmissions causes little interference, resulting in little economic damage. As more intensive use is made of the band, however, increasingly valuable communications are lost. Indeed, the losses are anticipated to rise at an accelerating rate.[84]

[82] No pun intended. "The Static Case" refers to optimal band allocation at a point in time, freezing technology and service innovation. "The Dynamic Case" follows. Static interference is part of the static case analysis by semantic coincidence.

[83] Proponents of "spread spectrum" or "ultra-wide band" technologies sometimes claim that these modes of transmission do not fit this pattern. In essence, they argue that unlimited communications are possible via computer algorithms or low-power devices, yielding additional communications in a band without congestion – forever. This is false, as discussed below. In fact, dynamic considerations do change the shape of the Gains and Losses curves and are an important consideration in determining the optimal level of communications, but the basic access rule framework is impervious to such technical arguments.

[84] While non-linearity in band degradation is the likely functional form, the basic economics are unaffected if a linear degradation pattern obtains.

Figure 5: Social Costs and Benefits from Spectrum Use (Static)



Net Social Value, the difference between Private Gains and Private Losses, is at a maximum where the marginal cost of band use equals marginal benefit. This point will be the optimum utilization level (*T** in Figure 5). The practical challenge is in deriving the underlying cost and benefit functions. Both are defined by consumer valuations, and how customers value alternative possibilities is not easily discovered. Indeed, the information is not likely to be known ex ante by consumers themselves. Only in actual markets are choices made that reveal such data.

This reality will properly influence the tools chosen – and their effectiveness – in regulating radio spectrum usage. But it does not change the basic implication of Figure 5, which is that utilization close to *T** is the optimal level of communications. Strictly speaking, public policy should not seek to eliminate all sources of interference, only those whose costs exceed their value. Figure 5 also suggests that spectrum access rules may avert "tragedy of the commons," a resource allocation problem most famously described by biologist Garrett Hardin:

> The tragedy of the commons develops in this way. Picture a pasture open to all…
> As a rational being, each herdsman seeks to maximize his gain. Explicitly or

implicitly, more or less consciously, he asks, 'What is the utility to *me* of adding one more animal to my herd?' This utility has one negative component and one positive component.

1. The positive component is a function of the increment of one animal. Since the herdsman receives all the proceeds from the sale of the additional animal, the positive utility is nearly +1.

2. The negative component is a function of the additional overgrazing created by one more animal. Since, however, the effects of overgrazing are shared by all the herdsmen, the negative utility for any particular decisionmaking herdsman is only a fraction of –1.

Adding together the component partial utilities, the rational herdsman concludes that the only sensible course for him to pursue is to add another animal to the herd. And another… But this is the conclusion reached by each and every rational herdsman sharing a commons. Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit—in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all.[85]

Overuse similarly dissipates value in the spectrum "pasture." While individual users reap gains from wireless transmissions, potentially destructive interference lands on third parties. Service providers are able to realize Gains even when usage exceeds T^*—a situation where the marginal Losses from congestion are higher than the incremental Gains. The system's defect stems from the fact that Losses (from interference) are incurred *generally* whereas Gains are captured *specifically*. It is not a technical problem, but an economic coordination problem, as shown by both Hardin and the seminal paper by Ronald Coase.[86] The commons leads to market failure in that the marginal costs faced by resource users exclude damage absorbed by others.

[85] Garrett Hardin, *The Tragedy of the Commons* 162 SCIENCE (1968), 1243 (emphasis in original).

[86] Ronald Coase, *The Problem of Social Cost*, 3 J. L. & ECON. 1 (1960). This article notes that the tragedy of the commons can be solved by enforcement of property rights to the resource, leading to optimal dissipation. This was later dubbed the "Coase Theorem" by George Stigler, winner of the Nobel Prize in Economics. Stigler, Memoirs of an Unregulated Economist (New York: Basic Books, 1988) 73-79. The Theorem was actually discovered as Coase

The "tragedy of the commons" has a corollary—the "tragedy of the *un*commons." This results from use limitations that prevent over-exploitation by being too restrictive, leaving socially valuable uses unrealized. Were band use capped at T_1 (< T*), for example, very little damage would result from interference. In fact, *too* little. Services that could be efficiently provided consumers are prevented, lowering social welfare.

Optimal policy involves a balancing of the respective forms of social loss. Call *Type I Error* over-utilization (or the airwave "chaos" problem, featuring "destructive interference"). Call *Type II Error* under-utilization (where "productive interference" is inefficiently blocked). Rules that minimize social losses from the sum of these errors maximize social welfare.

The Dynamic Case

T* is a static optimum. In a dynamic world, however, changing customer preferences and new opportunities perceived by entrepreneurs affect optimal spectrum use. Net Social Value is maximized only if the "best" T* obtains. This means that rules should not simply police bandwidth to limit destructive interference, they should encourage innovative services and technology to develop and compete in the marketplace. As seen in Figure 6, the optimum at T_A^* (identical to T_A^* in Figure 5) loses its luster when services offering greater benefits (Gains_B) and superior technology with lower congestion costs (Losses_B) are available.

It is even more difficult to determine values associated with future technologies, however, than existing services. While some operating data, including revenues and accounting flows, exist for the latter, similar information for new systems or applications can only be projected. Even for existing firms with established operating histories, projections by market experts can vary widely. For innovations, the projections are extremely volatile. One indicator of the uncertainty associated with technology adoption is the high cost of capital facing start-up firms. Venture capitalists require returns far higher than those associated with standard equity investments to back innovative ideas, for the simple reason that even scientific certification of the technical aspects of a new service or product yields only limited clues as to its ultimate success with consumers. Picking winners on the frontier of creative enterprise is very risky, even given due diligence.

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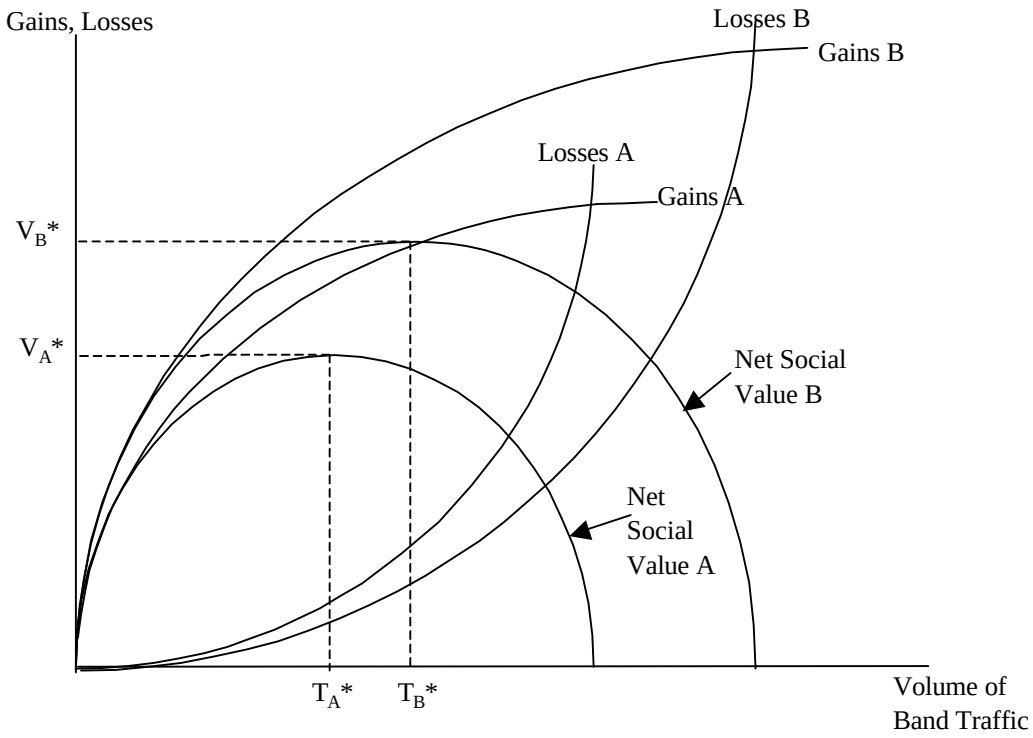
pondered the very issue at hand – regulation of radio spectrum. Hence, the analysis of radio waves has achieved "a special, almost holy, place in the economic analysis of law and the economics of property rights." Dean Lueck, *The Rule of First Possession and the Design of the Law*, 38 J. L. & ECON. 393, 419 (Oct. 1995).

Figure 6: Social Costs and Benefits from Spectrum Use (Dynamic)



There are many more ways to miss a optimum than in the static case. For instance, assume that policy makers succeed in establishing rules leading to optimal spectrum use at T_A^* in Period A. Economic conditions change in Period B. A new set of innovative wireless services becomes available, offering a new (static) optimum at T_B^*. Because $T_B^* > T_A^*$, it is clear that consumer welfare would improve (more wireless service, lower prices) were the radio spectrum reallocated to the new service in Period B.[87] Public policy that performs flawlessly under one set of conditions can, in failing to accurately forecast coming marketplace opportunities, become instantly obsolete.

The Conservative Bias of Spectrum Regulation

Identifying *T** is a complex practical matter. It requires an intensity of wireless traffic, and efficient systems, taking the market right up to the "edge of chaos."[88] Band managers must

[87] This also assumes that the costs of transition are less than the gains realized by the new technology.

[88] S. Kaufman, At Home in the Universe (New York: Wiley, 1995). Sophisticated technologies aim to produce just such a result, using every possible bandwidth available before significantly diminishing communications quality. Joseph Mitola III, *Software Radio Architecture: A Mathematical Perspective*, IEEE J. OF SELECTED AREAS IN COMMUNICATIONS (May 1999).

account for consumer demands over a wide array of competing services, including demands by business users (input markets). These include services not yet provided or even invented. Optimal deployment entails comparing countless alternative delivery platforms (including non-wireless services that substitute for or complement wireless). As the standard discovery of such platforms is via the "gale of creative destruction,"[89] projections are fraught with difficulty. Investments in technology and telecommunications infrastructure are long-lived, meaning that spectrum allocation plans necessarily impact—and are impacted by—future innovation. No central authority enjoys knowledge of the information relevant to such complex economic issues.

Regulators do not attempt to blindly assert control over radio spectrum. While the public interest allocation process is formally top-down, with rule makings initiated and then imposed by Commission fiat, essential information inputs are gathered from decentralized sources. The FCC methodically invites public comment at every stage of its deliberations, drawing extensive information from interested parties.[90]

Each FCC spectrum allocation requires a rule making, usually triggered by a petition filed by a private party. (The agency may initiate a proceeding on its own, and it need not initiate a rule making just because one is requested.) Petitions received are published and public comment is invited. If the Commission decides to act, it issues one of three general documents: a *Notice of Inquiry* (NOI), a *Notice of Proposed Rulemaking* (NPRM), or a *Memorandum Report and Order* (R&O). Unless the Commission chooses to deny a petition without further evaluation, the standard sequence is to issue (if the agency wishes to proceed) an NOI, followed (if it wishes to proceed further) by an NPRM, followed (if proceeding still further) by a R&O. Multiple notices can be issued at every level, as the FCC considers, reconsiders, and amends its rules.[91]

The process elicits information for policy makers. The NOI says, in effect: *This is what we're thinking about doing. Tell us what you think*. There is a Comment period and then a Reply Comment period. The NPRM is the FCC's tentative proposal—again, comments are invited. Licensees, wireless equipment manufacturers, potential entrants, industry trade associations, and government agencies with a material interest in the matter dutifully respond with documents

[89] Joseph Schumpeter's memorable phrase describing the dynamic process of capitalism, much used in today's communications markets. Schumpeter, Capitalism, Socialism and Democracy (New York: Harper & Sons, 1942),
[90] The rule making process is formally governed by the Administrative Practices Act, U.S.C. § 706. For an informative overview of its actual operation, see Glen O. Robinson, *The Federal Communications Commission: An Essay on Regulatory Watchdogs*, 64 VA. L. REV. 169 (1978).
[91] Robert L. Hilliard, The Federal Communications Commission: A Primer (Stoneham, MA: Focal Press, 1991), 72-3.

offering legal arguments and empirical evidence supporting their preferred policy.[92] Law firms specializing in communications are retained to draft these statements, and expert statements by industry experts, economists, engineers, or scientists are often attached as exhibits. That the filings from vested interests are self-serving does not destroy their credibility. Indeed, because comments and supporting data submitted to the Commission are crafted on behalf of shareholders, the Commission views such information as reliable representations of economic interest. In the adversarial process contrasting positions are presented and argued, allowing regulators to glean useful knowledge about the marketplace.[93]

The rule making process is iterative, open-ended and highly discretionary, limited only by "public interest, convenience, or necessity." The Commission may elect to pause, to stop, or to move forward at essentially any point. There is no time limit, and costs or benefits accruing to consumers are external to policy makers, who are directly influenced by political costs and benefits specific to Commission members.[94] Congress and the Executive Branch also provide essential information conduits to FCC policy makers, communicating the positions of important constituencies through legislators.[95] This is often a preferred medium for influential interest groups, who can gain input into rule makings without public disclosure, thereby improving their advantage over rival interests; for legislators, who may extract compensation (of various forms) for the access provided interested parties; and commissioners, who have more regulatory latitude the slimmer the formal record, and who use such channels to nurture ongoing relationships with

[92] Other parties, including individual consumers, activist lobbying organizations, academics, or independent industry experts, also participate. As a practical matter, these filings typically produce limited market data for Commission decision makers. They may offer valuable political information to the agency, however.

[93] The analogy to the adversarial process in jurisprudence is clear. Yet, the structure of justice in equitable courts is distinct from what develops under the public interest standard. See below.

[94] Members of the Federal Communications Commission are appointed to five-year terms by the President, subject to confirmation by the Senate. Three members are of the president's political party. Congressional leaders (usually ranking members of the Senate Commerce Committee, overseeing FCC operations) and the White House use FCC appointments to reward important campaign contributors or outstanding staff members for services rendered. Members are predictably loyal to their political champions. Chairman Reed Hundt (1993-1997), for example, claims to have regularly consulted Vice President Al Gore, known to be the source of Hundt's selection, in making Commission decisions. Hundt, You Say You Want a Revolution (New Haven, CT: Yale Univ. Press, 2000).

[95] "[T]he most powerful and persistent 'political' influence over the Commission clearly originates with the congressional appropriations and oversight committees and with other important members of the legislature." Richard E. Wiley, *"Political" Influence at the FCC*, 1988 DUKE L. J. 280. 282 (1988). Wiley chaired the FCC under Pres. Nixon. He went on to quote a predecessor's experience: Newton Minow's "courtesy visit" to House Speaker Sam Rayburn after his nomination: "'Mr. Sam' put his arm around the new FCC Chairman and said, 'Just remember one thing, son. Your agency is an arm of the Congress; you belong to us. Remember that and you'll be all right.'" In Erwin Krasnow, Lawrence Longley & Herbert Terry, The Politics of Broadcast Regulation (New York: St. Martin's Press, 1982), 89.

political patrons. With the formal and informal information collected on industry economics, alternative technologies, and interest group pressures, regulators then supply spectrum rules.[96]

Three sources of *non-market failure* are evident in FCC spectrum allocation.[97] The first is the FCC's lack of information relative to competitive markets. Despite the elaborate and partially successful attempt to draw information from private sector sources, the resulting allocations must rely on relatively crude estimates. For instance, a recent Department of Commerce report reviewed wireless services being provided in the 24 GHz, 28-31 GHz, 39 GHz, and 59–64 GHz bands. The study was specifically designed to determine "spectrum requirements for the fixed [i.e., non-mobile or satellite] services." Despite abundant input from non-government sources, the study's author is unable to even hazard a guess as to future market developments:

> It is difficult to know whether all (or any) of these applications will be commercially successful… Not only are these totally new applications, but they are still changing. MMDS [multi-channel, multipoint distribution service, or "wireless cable"] and LMDS [local, multipoint distribution service], for example, started out as alternative ways to distribute analog TV. They are now becoming super-CLECs [competitive local exchange carriers], offering telephone, high-speed Internet access, and video entertainment. Who knows what they will be ten years from now? Industry is making its predictions backed with billions of dollars of capital investment. The author hesitates to even venture a guess, but it will be very interesting to see how things work out.[98]

The second source of non-market failure is that the information gleaned from interested parties will systematically exclude the interests of the general public. Individual consumers have small interests at stake, and the investment required to become both knowledgeable and influential are insufficiently compensated. While consumers would generally benefit from policies allowing optimal spectrum use, each consumer rationally attempts to free ride on

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[96] Some economists model regulation as a supply and demand problem, with (monopoly) policy makers maximizing political support (ultimately, votes) by supplying rules sought by political constituencies. See Sam Peltzman, *Toward A General Theory of Regulation*, 19 J. LAW & ECON. 211 (Aug. 1976); Gary Becker, *A Theory of Competition Among Pressure Groups for Political Influence* 98 Q. J. ECON. 371 (Aug. 1983).

[97] Charles Wolf, Jr., Markets or Governments: Choosing Between Imperfect Alternatives (Cambridge, MA: MIT Press, 1989).

[98] Robert J. Matheson, *Spectrum Usage for the Fixed Services*, NTIA Report 00-378 (Washington, D.C.: U.S. Dept. of Commerce, National Telecommunications and Information Admin., March 2000), 92-3. The NTIA regulates federal spectrum use.

investments of others. That strategy is rational even when little investment in pro-consumer lobbying results. Public policy is a non-excludable public good.[99]

The third non-market failure stems from the incentives of incumbent licensees and regulators. Material self-interest of these primary participants in the regulatory process strongly favor under-utilization of radio spectrum. Incumbent licensees benefit from policies that keep interfering transmissions (costly to their emissions) at a minimum, and also from rules that exclude competitive entry into their markets. The block allocation system has historically served spectrum-based industries (AM radio, TV broadcasting, cellular radio, e.g.) as a cartel enforcement device, limiting service competition by denying licenses to newcomers and policing technical operations so as to lower industry output.[100] In addition to this anti-competitive motive, however, incumbent licensees will predictably serve as aggressive monitoring agents of radio spectrum, such that any interference (actual or potential) will be reported to the FCC with elaborate documentation. Wireless firms will not sit idly by while new entrants invade their operating space, degrading quality of service. Indeed, the problems of radio interference are unlikely to be over-estimated, as incumbents use the system to strategically deter entry.[101]

On the contrary, losses from deterring entry will be under-reported. First, the major beneficiaries of entry, consumers, will not invest in rent seeking to unleash new competition due to the public good problem.[102] Consumer interests will not generally be represented at all except insofar as equipment manufacturers, large users, or technology suppliers—better organized constituencies with interests parallel to consumers—enter the policy fray. Second, potential

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[99] This problem is not easily remedied by organizations purporting to represent consumer interests. Such groups do not prosper by how well they advance policies lowering prices, but by how well they appeal to targeted audiences such as the press, ideologically driven contributors, and ideologically driven executives (who enjoy "consumer activism"). Such organizations are highly motivated to appeal to such constituencies, as can be seen from the sharp philosophical divergence of such groups. Naderite groups such as the Consumer Federation of America or Consumers' Union rarely agree or collaborate with market-oriented groups such as Citizens for a Sound Economy or the Competitive Enterprise Institute, despite rival declarations promoting consumer interests. Each group prospers by appealing to a core constituency defined by philosophical motivations rather than consumer interests. An example illustrating the difference is the endorsement of trade barriers (or opposition to trade liberalization) by some "consumer" groups.

[100] Existing communications firms will be vigilant – and relatively effective -- in bringing the alleged problems of entry to the attention of regulators, Congress, the Administration and the press. They will motivate regulators' sympathy by offering compensation in multiple dimensions, offering to subsidize popular programs (universal service, educational programming for children, etc.), hiring ex-FCC officials at attractive pay levels, contributing generously to political benefactors, or making other commitments to the public weal. This inducement to regulate is summarized by Richard A. Posner, *Taxation by Regulation*, 2 BELL J. OF ECON. & MGT. SCI. 22 (1971).

[101] Bruce Owen and Ronald Braeutigam, The Regulation Game: Strategic Use of the Administrative Process (Cambridge, MA**:** Ballinger, 1978).

[102] This reflects the bias inherent in economic regulation. Concentrated gains for special interests are pursued more diligently than equal dollar values diffused among the general public. Mancur Olsen, The Logic of Collective Action (Cambridge, MA: Harvard Univ. Press, 1965).

competitors have less incentive to lobby for pro-entry policies than incumbents have to lobby against them. Incumbent rents predictably exceed those available to entrants in what would be a more competitive marketplace.[103]

Potential entrants may not even be identified prior to opening a market. Entry is discouraged by the requirement to invest in a rule making to open spectrum access; it is a tax (paid in lawyers' fees, consulting contracts, and the capital-draining byproducts of delay and uncertainty) lowering expected returns. Incumbents are more motivated players in the lobbying process, as they seek to protect profits in a less competitive field. Incumbents also enjoy advantages in challenging arguments concerning social gains from new entry. Such gains are always speculative. In an open-ended public interest determination, intense debate can focus on the benefits asserted to materialize in the future. Innovative technology, inherently risky, is relatively uncompetitive in the administrative process, where the status quo creates a comfort level for agency bureaucrats armed with ample documentation from vested interests.

Since the losses associated with over-utilization of spectrum will be closely monitored and carefully reported, while losses from under-utilization will generally not be, the allocation system will be especially prone to *Type II* error.[104] Equivalently, it will be overly sensitive to *Type I* error, the "cacophony of competing voices" forming the fundamental legal rationale for a central allocation system.[105] There is relatively little negative feedback to the FCC from the costs of restricting spectrum access, compared to the pressure resulting from potential losses from output expansion (including both pro-competitive effects and radio interference). This parallels the skewed incentives of Food and Drug Administration regulators, who tend to weigh the potential costs of new drug approvals (per injury or death) more heavily than costs resulting from the suppression of live-saving medicines.[106] Potential victims of deterred entry are not well identified, and are under-valued. Competition is inefficiently truncated, and consumers lose.

Not all arguments by incumbents opposing entry are anti-competitive. Existing operators offer informed and useful testimony as to the probability that new spectrum users will create interference, imposing real costs. Such information is valuable for optimal band utilization. What is problematic in spectrum allocation policy, however, is that the incumbent has incentives to

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[103] The exception to this rule would be where a new entrant anticipates overwhelming advantages due to the use of innovative technology. In such instances, regulatory resistance may, in fact, be overcome.

[104] Political pressure will accompany reporting, assuring regulatory responsiveness, particularly when interests notify congressional and executive branch policy makers about FCC policy concerns.

[105] *Red Lion Broadcasting Co. v. F.C.C.* 395 U.S. 367 (1969).

combine the interference problem with the (incumbent's) market structure problem. Indeed, the opportunity to deter competition by leveraging interference concerns is the primary manner in which technical spectrum issues will enter the incumbent's calculus.

For instance, suppose that an incumbent wireless operator discovers, through internal research and testing, that adjacent bandwidth could accommodate a competitive entrant were a slight, inexpensive modification made by the incumbent (perhaps aiming antennae and transceivers at different angles). This private information is not likely to be proffered in a rule making considering allocation of the adjacent band for competitive services. Instead, wishing to avoid a loss of profits due to entry, the incumbent will argue that interference will degrade existing transmissions, and elaborately document the costs. The arguments will be true, but not economically accurate. More efficient rules would reward incumbents that volunteer their best information, including proprietary knowledge about economical ways to intensify utilization of the spectrum resource.[107] Instead, incumbents maximize profit by withholding information, advancing narrow arguments against entry. The limits imposed by inefficient spectrum use can serve to protect incumbents' market share,[108] and spectrum regulation—largely dependent on regulatees for information about alternative system designs—often lock-in obsolete standards. A rather striking example of technology fossilization is provided by analog television broadcasting.

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[106] Sam Peltzman, Regulation of Pharmaceutical Innovation (Washington, D.C.: American Enterprise Institute, 1974); Paul J. Quirk, *Food and Drug Administration*, Chapter 6 in James Q. Wilson, The Politics of Regulation (New York: Basic Books, 1980), 191.

[107] Virtually all relevant technical data are held by private firms. These "owners" of information are scattered throughout the economy, and each harbors its "knowledge capital" as a productive asset. FCC rule makings solicit this information, and the Commission relies on that which is revealed. The agency staff is tiny in comparison to the size and complexity of the industry it regulates. In 1997, the Commission employed 2,255 full-time equivalent workers, of which only a small fraction are professionally trained in engineering, economics, communications, or law. Robert Corn-Revere, *Mass Media Regulation and the FCC: An Agenda for Reform*, Citizens for a Sound Economy Issue Analysis No. 65 (Oct. 20, 1997). No technology development is attempted. The FCC may supervise system testing, but this is traditionally contracted to private sector or university laboratories. The in-house expertise available to the government pales in comparison to the human resources commanded by even *one* major firm in the broadcasting, cable, cellular, satellite, telecommunications, or network infrastructure industries. Bell Labs, owned by Lucent Technologies, has over *30,000 full-time researchers* who file four patents per day. Six Nobel Prizes, awarded to 11 different scientists, have been won for work performed at Bell Labs. http://www.bell-labs.com/employment/; http://www.bell-labs.com/blpeople.html. At the other end of the spectrum is CableLabs, founded by cable TV operators to pursue joint research projects and coordinate industry standards in 1988. It has over 80 full-time employees and hosts over 30 engineers and scientists from other organizations. http://www.cablelabs.org/about_cl/factSheet.html. Literally scores of research centers and thousands of private telecommunications firms invest to explore new technologies, standards, and applications. One such firm, Qualcomm, spent over $381 million in 1999 on research and development. Qualcomm Inc. 10-K Annual Report (filed with the Securities and Exchange Commission Nov. 17, 1999), 34. By contrast the entire budget of the FCC in fiscal 1997 totaled about $190 million. Robert Corn-Revere, *Mass Media*…

[108] A great example of incumbent interests pushing technical standards designed to impose inefficiency is seen in the HDTV proceeding. As one advocate of HDTV told an industry group concerned about possible FCC auctions to assign licenses, "The beautiful thing about high-definition is that it takes up the whole 20 megabits [the transmission

The current NTSC standard for off-air TV was adopted in 1941.[109] Meanwhile, the unregulated computer industry has been upgrading. While personal computer monitors in the early 1980s had decidedly lower resolution than TV screens, the cheapest PC monitors sold today feature pictures far sharper than analog television.[110]

Optimal spectrum management moves the radio resource into promising new applications, closing down low-valued operations. Technology adoption is simply another transition: using spectrum inputs more effectively, satisfying more intensely-valued consumer demands. The key to efficiency lies in (a) identifying the gains from new deployment, (b) identifying the losses from discontinuing, or uprooting, existing services, and (c) the ability to execute winning trades in a timely fashion. At all three levels, regulatory bias appears: (a) new opportunities are speculative and under-weighted, without existing constituencies; (b) costs to existing users are more immediate, easier to document, and over-weighted, with relatively powerful allies vested in the status quo; (c) the adjudication process is itself a public good, and regulators do not suffer material loss when consumer benefits are delayed or destroyed.

The structural nature of rule making favors inaction. Entrants petitioning for the use of under-utilized frequencies must shoulder a burden of proof, showing that new competition is in the public interest. This vague standard gives wide latitude to regulators to block entry, even in instances in which consumers would clearly benefit. As is typically the case in bureaucratic or even legislative processes, it is much easier to stop an initiative than to enact one, ceteris paribus. Of course, incumbents may be coaxed into accepting new spectrum allotments, but the price is typically high. Incumbents will not settle for mere compensation, but will seek to extract up to the entire social gain that their cooperation (moving, and thereby allowing spectrum to be reallocated) enables. These negotiations—arduous given the level of uncertainty prior to technology adoption, and further complicated by lack of clear ownership rights—are costly and time-consuming. [111]

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rate of the 6 MHz allocated to each license].” As explained by Joel Brinkley, “If TV stations broadcast high-definition programs… there would be no space left to auction off.” Brinkley, Defining Vision, supra note __, 324.

[109] Brinkley, Defining Vision, supra note __, 12.

[110] David W. Sosa, *Market Failure in Standard Setting: The Case of AM Stereo*, University of California, Davis, Dept. of Ag. & Resource Econ. Ph.D. thesis (1999), 49.

[111] Between 1989 and at least 1992, the 1850-1990 band was blocked from reallocation to PCS by incumbent microwave users despite full compensation to move to higher frequencies. Similar hold-ups currently delay reallocation of TV channels 60-69 to public safety and mobile communications. See, Peter Cramton, Evan Kwerel, and John Williams, *Efficient Relocation of Spectrum Incumbents*, 41 J. L. ECON. 647 (Oct. 1998); Peter Cramton, *Auctioning Encumbered Spectrum*, presentation at FCC-Stanford Conference on Combinatorial Bidding (Wye River, MD; May 5, 2000). See also discussion below.

This is precisely the argument for market allocation of radio spectrum. Coase advanced it in 1959, noting the basic nature of the issue:

> This "novel theory" (novel with Adam Smith) is, of course, that the allocation of resources should be determined by the forces of the market rather than a s a result of government decisions. Quite apart from the misallocations which are the result of political pressures, an administrative agency which attempts to perform the function normally carried out by the pricing mechanism operates under two handicaps. First of all, it lacks the precise monetary measure of benefit and cost provided by the market. Second, it cannot, by the nature of things, be in possession of all the relevant information possessed by the managers of every business which uses or might use radio frequencies, to say nothing of the preferences of consumers for the various goods and services in the production of which radio frequencies could be used. In fact, lengthy investigations are required to uncover part of this information, and decisions of the Federal Communications Commission emerge only after long delays, often extending to years. To simplify the task, the Federal Communications Commission adopts arbitrary rules. For example, it allocates certain ranges of frequencies (and only these) for certain specified uses.[112]

The case for property rights is simply the case for markets, the argument against central planning. Private band owners compete to discover the information that eludes policy makers allocating spectrum owned by others. True owners have incentives to maximize value, and escape the distractions of rent seeking. Of course, this assumes the absence of regulatory institutions offering to supply favored market positions for the market-clearing political price—the "attractive nuisance" of public policy.[113] When limited to a general regime of property rights, spectrum users would ironically have less ability to control spectrum. Consumer demand, and competitive rivalry, would constrain firms to act in socially useful ways in the pursuit of profit. Spectrum owners race to develop new applications, compete to increase traffic, and rationally

[112] Coase, *Federal Communications Commission*, supra note __, 18.
[113] I am indebted to Ken Robinson, author of the weekly publication, TELECOMMUNICATIONS POLICY REVIEW, for this apt phrase.

trade off the gains from serving consumers in one wireless market versus the costs of lost opportunities elsewhere.

In sum, the private owner–more specifically, rivalry among *competing* owners—will most reliably find the delicate balance defined by *T**. Airwaves may fall victim to a tragedy of the commons (*Type I* error) or over-regulation (*Type II* error). The tragedy of the commons can be solved by ownership of frequency space. Markets can efficiently allocate spectrum given property rights to spectrum. Over-regulation, on the other hand, is endemic to the public interest allocation system.[114]

V. SCARCE, ELASTIC SPECTRUM

Intensive and Extensive Margins[115]

> On April 13, the FCC handed out the last remaining substantial portion of prime radio waves, setting aside six megahertz of spectrum for companies that want to sell U.S. air-to-ground telephone service to airplane passengers… With the radio-wave spectrum booked solid, innovating telecommunications firms are pressing the government to redivide it to help the industry's international competitiveness.[116]
>
> Now, with virtually all usable frequencies actually being used….[117]

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[114] Curiously, the traditional view of FCC spectrum allocation as deux ex machina survives. Economist Gerald W. Brock's Telecommunication Policy for the Information Age (Cambridge, MA: Harvard Univ. Press, 1994), while devoted to exploring the regulation of wireline telephone service, ventures into spectrum policy when describing the FCC's 1959 decision to allow limited long-distance service over (non-AT&T) microwave links. Prof. Brock writes: "Any reasonable proposed use of the radio spectrum that did not interfere with other existing or proposed uses was generally approved." Ibid., 107. Not only is this at odds with FCC history, as shown below, it contradicts the facts relayed on the previous page of Brock's text. There it is explained that, while experimental licenses to operate microwave facilities were granted liberally after World War II, "the FCC's permanent licensing policy was more restrictive and favored AT&T provision of microwave service for both voice and video signals." Ibid., 106. Private licenses were granted only when AT&T declined to provide similar service. Not until microwave manufacturers (desiring more competition to sell more equipment) presented a comprehensive study (6,000 person-hours) showing that a twenty-fold increase in microwave use would not result in material interference even in the most crowded areas, did the FCC permit non-AT&T entry. Of course, this took many years, as the 1959 decision unlocked the use of World War II technology. The delay favored the incumbent telecommunications monopolist, AT&T, and was not necessary to police airwave interference.

[115] Harvey J. Levin uses this delineation in defining the supply curve for wireless bandwidth. Levin, *The Radio Spectrum Resource*, 11 J. L. & Econ. 433 (Oct. 1968). See also Arthur S. DeVany, Ross D. Eckert, Charles J. Meyers, Donald J. O'Hara and Richard C. Scott, *A Property System for Market Allocation of the Electromagnetic Spectrum: A Legal-Economic-Engineering Study*, 21 STAN. L. REV. (June 1969), 1499; Douglas W. Webbink, *Radio Licenses and Frequency Spectrum Use Property Rights*, 9 COMMUNICATIONS AND THE LAW (June 1987), 3.

[116] Margaret Kriz, *Supervising Scarcity*, NAT'L J. (July 7, 1990), 1660.

[117] Keith Bradsher, *The Elbowing is Becoming Fierce for Space on the Radio Spectrum*, N. Y. TIMES (June 24, 1990), A1, 20.

The airwaves always look crowded. In fact, looks are deceiving. While press reports in 1990 lamented "the last remaining substantial portion of prime radio waves," a 6 MHz band allocated by to telephone access for airline passengers (see above quotation), vast tracts of "new" spectrum were apparently discovered over that last decade when the FCC allocated and licensed:

- 14 MHz for Specialized Mobile Radio
- 120 MHz for personal communications services
- 25 MHz for General Wireless Services
- 30 MHz for Wireless Communications Services
- 25 MHz for Digital Audio Radio Services
- 400 MHz for Digital Electronic Messaging Services
- 1.3 GHz for Local Multi-point Distribution Services
- 1.4 GHz for 39 GHz Services

Hundreds of companies now provide service in these bands, while hundreds of millions of customers use them.[118] Some of these allocations have produced gales of economic activity; the infusion of competition into the cellular telephone sector by the advent of PCS rivalry has slashed prices for consumers and brought new efficiencies throughout the business sector.[119] Today it is clear that bandwidth was available for new services in 1990.

Yet, reliable sources backed up what the NATIONAL JOURNAL and NEW YORK TIMES reported in 1990. Underutilized or even unused radio spectrum is formally "allocated" within the regulatory system. What is impossible to infer from FCC designations is the productivity of wireless services versus alternative opportunities. A band providing miniscule public benefit while blocking potential 'killer apps' is fully occupied only in the jargon of bureaucratese.

Frequencies composing the electromagnetic radio spectrum are defined by science. The communications capacity of given frequencies, however, is defined by economics. This capacity changes with cost, demand, technology and market structure. The relevant question for band managers is: At what cost is communications capacity available? Each band carries a range of possibilities. More communications can be squeezed out of a given frequency with more sophisticated transmitters and receivers. Investment in technology permits increased traffic and

[118] This is only a partial listing of allocations coming "online" in the 1990s. It excludes unlicensed bands and other licensed services, including the additional 6 MHz allocated for each of the digital TV licenses issued to all 1,600 television stations in April 1997. Federal Communications Commission, *In the Matter of Advanced Television Systems and Their Impact Upon the Existing Television Broadcast Service*, Docket No. 87-268, 12 FCC Rcd 12809 (1997).

[119] Goldman Sachs, *Telecom Wireless* (Oct. 20, 1998); Federal Communications Commission, *Annual Report and Analysis of Competitive Market Conditions With Respect to Commercial Mobile Services*, FCC 99-136 (June 24, 1999).

higher quality over time; at each moment there are countless combinations trading volume for quality (e.g., reliability) to consider as well.

A century of progress exhibits profound improvements in the economical use of airwaves. When Guglielmo Marconi began developing wireless communications in the last years of the 19th Century, he believed that only one radio transmitter could operate in any geographical area.[120] He soon discovered that multiple signals could peacefully co-exist – and promptly applied for Patent No. 7777, awarded in 1900. Marconi's "tuned circuit" was instrumental in creating both Frequency Division Multiplexing (FDM) and Frequency Division Multiple Access.[121] This began a rolling history of leap-frogging advances to make productive use of higher and higher frequencies. This is seen vividly in spectrum taxonomy:

- Medium Frequency (300 KHz – 3 MHz)
- High Frequency (3 MHz – 30 MHz)
- Very High Frequency (30 MHz – 300 MHz)
- Ultra High Frequency (300 MHz – 3 GHz)
- Super High Frequency (3 GHz – 30 GHz)
- Extremely High Frequency (30 GHz – 300 GHz)[122]

In the 1920s, engineers dubbed the frequencies used by radio broadcasters "medium waves," defined as 3W KHz to 3,000 KHz.[123] By the 1930s, short waves (high frequencies) were utilized in long-distance communications. They had different properties than long waves, clinging to the curvature of the earth. Short waves tended to shoot straight out, and were first thought only useful for short point-to-point communications. They could cover long distances, but only by use of relay stations. It was then discovered that short waves were reflected off the ionosphere and back to earth, eliminating relay expense. The supply of wireless communications capacity shifted out.

Also in the 1930s radio engineers found they could economically utilize the spectrum above 3 MHz. In fact, they learned it was possible to send FM signals long distances at 30 to 300

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[120] Paul Baran, *Is the UHF Frequency Shortage a Self Made Problem?* Paper delivered to the Marconi Centennial Symposium, Bologna, Italy (June 23, 1995), 1.

[121] Andrew J. Viterbi, *The History of Multiple Access and the Future of Multiple Services through Wireless Communications*, http://www.gte.com/Showcase/Cdma/Feature/editorial.html. Viterbi is Vice Chairman of the Board of Qualcomm, developer of Code Division Multiple Access (CDMA).

[122] Website of the National Telecommunications and Information Administration, U.S. Department of Commerce, http://its.bldrdoc.gov/fs-1037/dir-022/_3268.htm.

[123] A Hertz, the standard unit of measurement of radio waves, denotes one cycle per second. A kilohertz (KHz) is 1,000 cycles per second, a megahertz (MHz) is 1,000,000 cycles per second, and so on. A frequency's wavelength is inversely related to its measurement in cycles; shorter waves have more cycles per second, and are said to have higher frequencies.

MHz (Very High Frequency). FCC engineers had flatly rejected such transmissions as useful. A January 1936 report by Chief Engineer Charles B. Jolliffe stated that very high frequencies were of little value, being limited to "only a few miles, probably on the order of two to ten miles."[124] In fact, FM radio signals had already traveled 80 miles in the band. Both FM radio and television were to live in the very high frequency band, transmitting far beyond ten miles. Research during World War II led to the use of Ultra High Frequencies, 300 MHz to 3 GHz. Microwave transmissions in this band are now widely utilized for point-to-point communications, relay services, mobile telephony, paging, dispatch, and "wireless cable." By 1990, transmissions were routine up to about 16 GHz.[125] In 1998, LMDS licenses to offer point-to-multipoint data, voice and video services over 1.15 GHz between 27 and 29 GHz were auctioned by the FCC. Winning bids totaled $597 million.[126] As one prominent analyst wrote, "The conventional wisdom was that these microwaves (above about 12 gigahertz) are useless for anything but point-to-point transmissions and are doubtful even for these."[127] Today, several publicly listed firms compete directly with local telephone companies using LMDS licenses or those allocated similar frequencies. Nextlink, the largest LMDS licensee, has a market capitalization of $10.8 billion. Teligent, valued at $1.6 billion, offers wireless service at 24 GHz. Winstar, with a market cap of $2.97 billion, and Advanced Radio Telecom, at $432 million, operate on licenses allocated 38 and 39 GHz frequencies.[128]

John O. Robinson, in an interesting history of federal spectrum regulation, notes that the regulated band keeps growing. The government was aware of only 1500 KHz of utilizable "ether" at the time of the first federal Radio Act (1912). By 1930 the Federal Radio Commission defined its jurisdiction (in sync with international organizations) to cover 60 MHz. This grew to 300 MHz in 1936, and to 30 GHz in 1944.[129] Today, the regulated band stretches to 300 GHz.[130]

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[124] As quoted in Lawrence Lessing, Man of High Fidelity: Edwin Howard Armstrong (New York: Bantam, 1969), 184 ["High Fidelity"].

[125] Ithiel de Sola Pool, Technologies Without Borders (Cambridge: Harvard Univ. Press, 1990), 28-9.

[126] The technology was developed long before the FCC's allocation and licensing processes were complete. By 1990, in fact, LMDS technology developers had begun lobbying the Commission for an allocation, and did obtain an experimental license to provide service in part of New York City. Edmund L. Andrews, *A New Microwave System Poses Threat to Cable TV*, N. Y. TIMES (Dec. 11, 1992), Al, D2. The FCC opened a formal rule making for LMDS in 1992. See Federal Communications Commission, *In the Matter of Rulemaking to Amend Part 1 and Part 21 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band and to Establish Rules and Policies for Local Multipoint Distribution Service*, CC Docket 92-297.

[127] George Gilder, *The New Rules of Wireless*, FORBES ASAP (Mar. 29, 1993), wysiwyg://50/://www.forbes.com/asap/gilder/telecosm2a.htm.

[128] YAHOO!FINANCE company profiles as of June 8, 2000.

[129] Robinson, *Spectrum Management Policy in the United States: An Historical Account*, OPP Working Paper No. 15 (Washington, D.C.: Federal Communications Commission, April 1985), 10, B-5, B-8, B-12.

[130] Ithiel de Sola Pool, Technologies of Freedom (Cambridge, MA: Harvare Univ. Press, 1983), 29.

The milliwave frequencies, 18 GHz to 100 GHz, are today's hot battleground in technology labs and, increasingly, the marketplace. The Federal Communications Commission is currently in the process of allocating 59-64 GHz for unlicensed use, and is in the preliminary stages of a rule making to allocate 95 GHz spectrum, due to intense private sector interest in the airwaves for wireless broadband applications.[131]

Innovation enabling communications in progressively higher bands expands the *extensive margin*. Methods to intensify traffic within a given band push the *intensive margin*. Gains have perhaps been even more impressive in the latter. For instance, the original mobile telephone[132] transmissions consumed 120 KHz of bandwidth per phone "line", but by 1950 were using only 60 KHz per line, 50 KHz in the mid-1950s, and 25 KHz by the mid-1960s. This was achieved by improvements in transmitting and receiving equipment.[133] Each decrease in channel size makes room for more channels, increasing service capacity. Variations on this theme provided huge increases in mobile telephone system capacities via cellular architecture, which lowers the power of emissions and splits bandwidth into re-usable cells. Adding cells creates capacity, at a cost.[134]

All interesting capacity questions are economic.[135] At a higher price, more wireless communications will be supplied to customers. In the jargon of economists, the supply curve of effective bandwidth capacity is upward sloping.[136] The location and slope of this functional relationship between cost and capacity will change with technology, but the quantity of

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[131] *Antenna Technologies for New Millimeterwave Communications Systems*, Endwave Corporation, http://www.endwave.com/papers/mill.html.

[132] This service began in 1946 and was subject to severe capacity constraints. High-capacity wireless phone systems originated with cellular configurations, beginning in 1983. George Calhoun, Digital Cellular Radio (Norwood, MA: Artech House, 1988).

[133] Ibid., 32

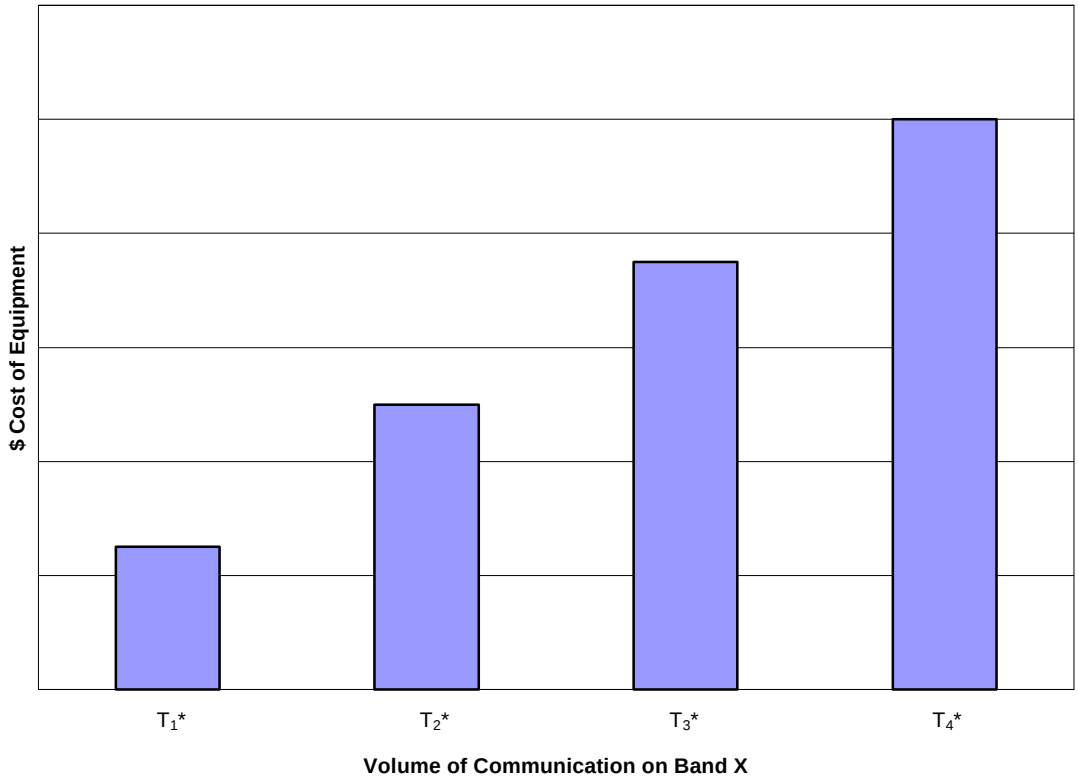
[134] Cellular was actually delayed by regulators for decades. "In the 1940s researchers at Bell Labs proposed… radio telephones [to] be low-power, short-range devices. The same frequencies could then be reused again and again, just as they are today with cordless home telephones. A city would be divided into many separate 'cells,' each one served by its own small transmitter. The capacity of a cellular system could then be increased almost indefinitely, by shrinking cells and increasing their number." Huber, Law & Disorder in Cyberspace, supra note __, 67-8.

[135] Not even scientists can escape the constraints of financial incentives. Pure technical research aims to look beyond immediate applications, but practical trade-offs determine which direction such inquiry takes and how it develops. While spillovers are often unplanned, costly yet valuable processes inspire greater research investment than inexpensive or low-valued ones.

[136] The term "wireless bandwidth" is often employed to similarly denote communications capacity. This differs from its strictly definitional sense. A "band" is simply a range of frequencies, while "bandwidth," in common parlance, is the throughput offered by a given communications technology. For instance, the term "broadband" refers to the speed at which information is communicated (over 200 kilobits per second each way, according to the FCC). This performance can be delivered using various technologies, including digital subscriber lines. DSL is delivered over "narrowband" frequencies (just 1 MHz) on a standard telephone line. Investments have been made, and will be needed, to "technologically enhance the *effective* bandwidth capacity of their spectrum-poor 1 MHz copper plant…" Scott C. Cleland, *Residential Broadband Outlook: Investment Implications of a Duopoly?* PRECURSOR GROUP INDEPENDENT RESEARCH (Aug. 11, 2000) (emphasis in original). Cleland's term "effective bandwidth capacity" is used here to avoid ambiguity.

communications delivered to the market will always tend to increase with the price paid. With greater compensation, more service is possible. See Figure 7. While the relationship holds at a moment in time, it looks similar to the increase in communications capacity of a band (at a constant price) *over* time. That is because knowledge of radio frequency engineering increases with the progress of science, acting as a multiplier in wireless technologies.

Figure 7. Supply of Effective Bandwidth Capacity



Bringing "New" Spectrum to Market

The process of spectrum regulation is conducted under the public interest standard in two connected, but conceptually discrete, phases. First, the agency conducts a rule making to consider the allocation of frequencies, a zoning function. The rule making will determine more than simply the category of band use, however. It defines the service allowed, what business model that business will be conducted under (common carrier, private carrier, broadcaster, etc.), technical standards, the number of competitors in the marketplace, geographic size of licenses, terms of license renewal and license transfer, and myriad business details.

Once a band is allocated the Commission issues licenses to users. (Where unlicensed use is mandated, rules are adopted mandating that prospective users receive FCC certification of transmitting equipment.) Until 1981, the assignment of licenses was exclusively by comparative hearing, an administratively-judged 'beauty contest.'[137] In 1981, the U.S. Congress authorized the use of lotteries, and the FCC assigned over 1,400 cellular telephone licenses using this method between 1986 and 1989. Hundreds of thousands of license applications poured into the Commission, and billions of dollars in cell-phone permits were awarded to speculators who quickly flipped the licenses to actual operators. Because the Commission maintained the fiction that lottery applicants certify themselves as capable of constructing and running mobile phone systems, "application mills" sprang up that generated huge fees—and up to $1 billion is social losses—helping prepare complex paperwork for each applicant.[138] Despite the embarrassment of lotteries, including an FCC facility that partly collapsed under the weight of the voluminous if meaningless applicant documentations,[139] the system successfully shortened the regulatory delay of comparative hearings.[140]

In 1993 Congress finally allowed the FCC to issue licenses via competitive bidding.[141] Auctions began the following year and proved so popular that auction authority was extended by Congress in 1997 to include virtually all licenses issued by the FCC, even previously excluded broadcast licenses.[142] License auctions raised over $20 billion by May 1996, although some winning bids have proven uncollectable.[143]

The central feature of the spectrum allocation system is that the underlying resource cannot be owned by any party (including the government), but is held in common by the people of United States. The federal government regulates access to the airwaves on behalf of the

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[137] Thomas W. Hazlett, *Assigning Property Rights to Radio Spectrum Users*…, supra note __.

[138] Thomas W. Hazlett and Robert J. Michaels, *The Cost of Rent Seeking: Evidence from the Cellular Telephone License Lotteries*, SO. ECON. J. (Jan. 1993), 425.

[139] Ibid.

[140] The FCC later estimated the average time to issue a license under comparative hearings in the cellular market as 720 days (the first 30 cellphone licenses issued under the old rules), while lotteries speeded up the average license lag to 412 days. Federal Communications Commission, *The FCC Report to Congress on Spectrum Auctions*, FCC 97-353 (Oct. 9, 1997).

[141] Requests to sell FCC licenses had been issued regularly by executive agencies, the FCC, appropriations committees in Congress, academics, policy analysts and others almost continuously for the previous half-century. See Hazlett, *Assigning Property Rights*, supra note __, 533-35.

[142] This was more a symbolic than a substantive gesture, in that the only economically important broadcasting licenses issued by the FCC in recent years were those for digital television. These were awarded, without charge, in April 1997 under a mandate contained in the Telecommunications Act of 1996 that such licenses be awarded to existing TV stations *without* competitive bidding. Only when these licenses were safely in the hands of TV broadcasters did Congress permit the FCC to auction remaining radio and TV licenses. The few that remained in inventory were of trivial market value.

public. (See discussion below for more detail on the nature of the rights issued.) The predictable result of such radically diffused ownership is tragedy of the spectrum commons. Members of the general public are the nominal spectrum owners, but they are individually uninterested in management of "their" property. Much of the value of the resource is squandered, one graphic example being the 67 year period during which Congress refused to authorize competitive bidding for wireless licenses. Taxpayers literally squandered billions of dollars. Losses from inefficient spectrum use are much larger—and ongoing. Effective control over spectrum allocation belongs to the political coalition victorious in a rent-seeking competition. This tilts decision making away from consumer welfare maximization and towards influential pressure groups.

The key operational result is inversion of pro-consumer spectrum management: instead of rules being crafted to encourage innovation and competitive entry, rules are designed to subject new wireless competition to administrative scrutiny. The burden of proof is on the potential entrant. No incumbent must show that less competition serves the public in order to preserve the status quo, it must only rebut proponents of competition. The default position is that entry does not occur, as new service may be offered only after the Commission affirmatively determines the service to be in the public interest, an Order is adopted and released, equipment is certified, and licenses are issued.

Regulators can block allocations for a variety of reasons, or simply by administrative delay. Requests to use radio waves may be opposed by claims that new services will interfere with existing services. Evidence demonstrating interference-free operations must *outweigh* pro-interference documentation for the entrant to meet its burden. Given the ability and incentives of incumbents to pile on the paperwork, this is a daunting task. No clear standards resolve such conflicts; the Commission reviews technical disputes, under the public interest, on a case-by-case basis. More significantly, allocations may be challenged for reasons unrelated to interference. If new services lessen the profitability of incumbents, these firms can assert that obligations imposed on them in the public interest will be terminated, thus threatening the public interest itself. This opens up an unlimited number of cross-subsidy plans for consideration, and gives regulators a range of public interest rationales for promoting incumbents' interests over consumers.'

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[143] Congressional Budget Office, *Impending Defaults by Winning Bidders in the FCC's C Block Auction: Issues and Opinions* (visited March 15, 1999), <http://www.cbo.gov/showdoc. cfm?index=37&sequence=0&from=1>.

At a minimum, substantial delays are imposed on innovative applications and competitive services. Once the Commission considers an application to allocate spectrum for a particular service, questions can be raised by private parties or public agencies, including incumbent licensees whose conflict of interest in deterring new entry is palpable. Objections to new entry may be made without cost. Countering questions and dispensing with controversies raised in a spectrum allocation rule making is costly, taxing new competitors. This lowers the gains from pursuing new services and may deter entry altogether.

VI. CONSUMER WELFARE V. PUBLIC INTEREST

"Public interest, convenience or necessity" is a legal standard for regulatory action. Yet, not even the government's own experts can define what it means, or what action it rules out. Former FCC Chairman Reed Hundt (1993-97) dubbed it, "a vague, general, amorphous standard that can be all things to all people."[144] Dean Burch, FCC Chairman under President Richard Nixon, once commented: "If I were to pose the question, what are the FCC's [public interest] renewal policies and what are the controlling guidelines, everyone in this room would be on equal footing. You couldn't tell me, I couldn't tell you—and no one else at the Commission could do any better (least of all the long-suffering renewals staff)."[145] Henry Geller, a noted telecommunications policy expert who served as General Counsel of the FCC during the Kennedy-Johnson Administration observed, "[A]ll the 'public interest' means is, 'We give up. Congress doesn't know.'"[146] Others have noted that, "[The 'public interest'] is ill-defined to the point of being meaningless,"[147] and "The phrase... lacks any definitive meaning."[148] Alas, the author of the public interest, Sen. C.C. Dill, conceded, "It covers just about everything."[149]

Which, as the last source might suggest, was largely by design. The phrase provided the least constraining constitutional standard for regulation. (Only when charged to act on mandated criteria could a regulatory authority outside Congress be created). Putting spectrum regulation under "a vague and meaningless standard" allowed a creature of Congress to exercise influence

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[144] Former FCC Chairman Reed Hundt, describing the "public interest" standard in: *Longest Running Show on TV: Station Licenses*, WASH. POST (Oct. 13, 1995), A1.

[145] Former FCC Chairman Dean Burch, in a speech to the International Radio and Television Society (Sept. 14, 1973), quoted in Barry Cole and Mal Oettinger, The Reluctant Regulators 133 (Reading, MA: Addison-Wesley Publishing Co., 1978).

[146] Former FCC General Counsel Henry Geller, as quoted in: Erwin Krasnow, Lawrence Longley & Herbert Terry, The Politics of Broadcast Regulation 251 (New York: St. Martin's Press, 1982) ["Krasnow *et al.*, 1982"].

[147] Neal Devins, *Congress, the FCC, and the Search for the Public Trustee*, 56 LAW & CONTEMPORARY PROBLEMS 145, 147 (1993).

[148] Coase, *Federal Communications Commission*, 8.

over an industry with intense political significance. The standard's malleability offered policy makers maximum degrees of freedom while shielding Congress from the First Amendment, a potential constraint to intervening in the editorial content of the broadcast press.[150]

What does not satisfy the public interest? William Mayton observed that whatever government rules is, by definition, in the public interest.[151] Only procedural violations are barred by the public interest standard. In substance, virtually any well-documented policy flies.

This pliability yields political advantage to policy makers and influential interest groups. Because a public interest explanation can easily be manufactured,[152] regulators are legally free to promote economic transfers to members of a prevailing coalition. Regulation justified as safeguarding resources yields to pork barrel politics. The process naturally leads agency officials to maximize support. Indeed, if FCC leaders do not, competition in the market for political influence will replace them with those who do.[153]

The Case for Property Rights

The public interest standard gives rise to a regulatory architecture that is genetically hostile to efficiency.[154] Consumer interests are dependably eclipsed by special interests. Public interest rule makings are open-ended. The merits of entry are considered in the broadest possible context, forcing regulators to gauge the social benefits of competition ex ante. That requirement

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[149] Senator Clarence C. Dill, *A Traffic Cop for the Air*, 75 REVIEW OF REVIEWS 181 (1927).

[150] The technical mechanisms used to regulate radio spectrum have had an important place in First Amendment jurisprudence. See David Bazelon, *FCC Regulation and the Telecommunications Press*, 1975 DUKE L. J. 213; Pool, Technologies of Freedom, supra note __; Lucas A. Powe, Jr., American Broadcasting and the First Amendment (Berkeley, CA: Univ. of Calif. Press, 1987); Thomas G. Krattenmaker and Lucas A. Powe, Jr., Regulating Broadcast Programming (Cambridge, MA: MIT Press, 1994); Hazlett, *Physical Scarcity…*, supra note __; Hazlett, *Assigning Property Rights*, supra note __.

[151] William Mayton, *The Illegitimacy of the Public Interest Standard at the FCC*, 38 EMORY L. J. 715 (1989).

[152] Long-time FCC attorney William B. Ray describes this process in vivid detail in his fascinating memoir. In one instance, he notes that the FCC staff was told to write up a public interest justification explaining why a particular applicant had been awarded an FCC license in a closed meeting. The Commissioner told the attorney heading the FCC's Office of Opinions and Review to write up the official report. When the lawyer inquired what the public interest arguments were, the Commissioner responded, "you'll think of some." In another, FCC staff was instructed to create a public interest rationale for awarding a TV license. Their report ran to over 100 pages. But the FCC then re-voted, reversing its previous decision. The staff went back and wrote an equally long and involved explanation for why the new winner was in the public interest. See William B. Ray, The Ups and Downs of Radio-TV Regulation 44-5 (Ames, IA: Iowa State Univ. Press, 1990).

[153] Of course, FCC members are selected for service based largely on their understanding the requirements of the job. Loyalty to the interests nominating and/or confirming such members is a prime qualification. Moreover, the incentives for continuing loyalty are strong even if a commissioner serves just one term. Being called to testify at hostile congressional hearings, facing budgetary penalties or Congressionally-mandated restrictions, and losing access to key policy makers in post-agency employment comprise serious sanctions for aberrant behavior.

[154] Consumer welfare is defined as the sum of consumers' surplus plus producers' surplus. It is at a maximum in markets where consumer prices are as low as possible given the constraint that producers (efficiently) cover their costs. Monopoly and other inefficiencies are inconsistent with maximizing consumer welfare.

front-loads the regulatory process, substantially raising the cost of entry. Allocations are then made on a case-by-case basis, and rules adopted in one proceeding may be rejected in another. This further swells the pre-entry certification process, again deterring market competition. The sum procedural total is that the public interest allocation system is booby-trapped against new rivals, an irresistible "attractive nuisance" to anti-competitive constituencies.[155]

Consider the logic of replacing the public interest standard with a policy to maximize consumer welfare. Profiting from the lesson that antitrust law runs amuck when it serves many masters,[156] the uniform promotion of consumer welfare would eliminate the distractions leading to perverse outcomes. The resulting economic efficiency would create greater resources for society. Richard Posner argues that this is a powerful motive force driving law: "The efficiency theory of the common law is not that *every* common law doctrine is efficient… The theory is that the common law is best (not perfectly) explained as a system for maximizing the wealth of society."[157]

A consumer welfare goal in spectrum allocation would logically establish a framework to promote competitive wireless markets.[158] Potential wireless competitors would be afforded ready access to unoccupied radio spectrum. Rather than delay entry until essentially unanswerable questions are resolved to the satisfaction of regulators, rules would encourage private parties to *discover* how to best satisfy consumer demands through trial and error in the marketplace. Risks would shift from public administrators asserting knowledge of the public interest, to private investors. Financial markets would regulate which products or innovations were worth offering customers, as capitalists would assume liability for unprofitable ventures.[159] Profit calculations would include the opportunity cost of spectrum. Investors would likewise assume liability for

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[155] Indeed, if managers of firms holding FCC licenses failed to strategically use the regulatory system to deter competitive entry, they would be violating fiduciary obligations to shareholders.

[156] The basic theme of Robert Bork's Antitrust Paradox (New York: Basic Books, 1978) is that antitrust law subverts consumer interests by pursuing conflicting objectives. He argues that focusing on maximization of consumer welfare is the correct policy both historically (in terms of the intent of Senator William Sherman and the framers of the Sherman Antitrust Act of 1890) and as a matter of public policy. While I have been critical of Bork's historical analysis (Thomas W. Hazlett, *The Political and Economic Motivation for Antitrust Legislation: The Sherman Act Re-examined*, 30 ECON. INQUIRY 263 [April 1992]), the advantages of consumer welfare as an exclusive regulatory standard are compelling.

[157] Richard A. Posner, Economic Analysis of Law, 21 (Boston: Little, Brown; 3rd Edition 1986).

[158] The standard micro-economic analysis concludes that consumer welfare (or efficiency) is maximized where markets are highly competitive. This excludes externalities or monopoly. Joseph E. Stiglitz, Economics (New York: Norton, 1993), 386.

[159] As costs are opportunities sacrificed, and consumer demand establishes the value for these alternative resource employments, consumers determine both demand and supply.

airwave interference.[160] Third party certification services would allow entrants to contract for interference protection. Agents, including insurance companies, would test systems for harmful emissions, indemnifying users and operators against damage. Efficient mitigation by wireless technologists and entrepreneurs would lower the cost of such coverage.

Spectrum would be competitively allocated, the bandwidth market Ronald Coase long ago advocated and which FCC regulators now profess to champion. The enabling policy is simply private property in radio spectrum. Such a regime would allow for the efficient definition of rights, adjudication of disputes (including interference), and easy entry into unoccupied property. Monopoly problems would continue to be the domain of antitrust law. Dispute resolution would be the province of courts, including, perhaps, an expert court to expedite the resolution of technical issues specific to spectrum use.[161] Remedial market failures are not available to justify creation of a specialized regulatory agency.

VII. SILENCE OF THE ENTRANTS

In fact, spectrum regulation is not mandated to advance consumer welfare, and the structure yielded by the public interest standard protects incumbent licensees. To gain the right to compete, entrants must affirmatively establish a public interest rationale supporting additional allocation of bandwidth, scaling a procedural gauntlet to produce an actual rule making. Given the relatively weak constituency for consumer interests, the open-ended and long-winded nature of rule makings, and the relatively modest gains available to entrants versus those realized by incumbents opposing new licenses,[162] wireless competitors have strong incentives to respect the regulatory wall. This system has the attributes, in fact, of a cartel-enforcement device, an appearance that the historical creation of the Federal Radio Commission does nothing to

[160] In general, liability should be placed on the "least-cost avoider," the party having the best information and ability to mitigate damage with minimum effort. See Harold Demsetz, *When Does the Rule of Liability Matter?* 1 J. LEGAL STUD. 13 (1972).

[161] Courts of special jurisdiction include the U.S. Tax Court, U.S. Bankruptcy Courts, U.S. Court of Appeals for Armed Forces, U.S. Court of Appeals for Veterans Claims, U.S. Court of International Trade, and the U.S. Court of Federal Claims, which "has been given new equitable jurisdiction in the area of bid protests, as well as jurisdiction in vaccine compensation, civil liberties, product liability, oil spills, and various other areas of the law…" U.S. Court of Federal Claims website, http://www.law.gwu.edu/fedcl/ (Oct. 3, 2000).

[162] Suppose there are two firms currently serving a wireless market. An entrant – equally efficient to the two incumbents – files an FCC petition requesting an additional allocation of spectrum to enable the entrant to obtain a competing license in this market. The entrant stands to gain less from FCC approval than the incumbents collectively stand to lose, for at least two reasons. (1) Duopoly profits are greater (in aggregate or per firm) than triopoly profits, all else equal. (2) The entrant does not enjoy a secure right to being the third – and only – entrant should the FCC and issue more licenses. A third license may be issued to another firm, or multiple new licenses may be issued. A free rider problem emerges as the applicant may succeed in gaining a spectrum allocation yet emerge

diminish (see discussion below). A recent FCC Chairman conceded that his agency had long been known as, "Forever Captured by Corporations."[163] This section summarizes illustrative episodes in FCC spectrum allocation history, including some ongoing, to demonstrate how this reputation has been earned.

AM Radio Chases the Non-profits

When the Radio Act was signed into law on February 23, 1927, about 750 radio stations dotted the AM dial. This included about 200 new stations that began broadcasting during the "break-down of the law," initiated July 9, 1926. On that day Secretary of Commerce Herbert C. Hoover announced that his Department would no longer enforce the priority-in-use rights regulating airwave traffic since the advent of broadcasting in 1920. During this anarchistic period there was some confusion as to how property rights were being determined and enforced. "Pirates," "trespassers," and "interlopers" were decried by radio listeners and the press for interfering with established broadcasts.

There were several ways to remedy the situation, the most straightforward being to increase the number of available frequencies. Indeed, European regulators had already expanded the AM band in international agreements, and two proposals to increase broadcast slots were quickly brought to the new Federal Radio Commission. One would have extended the top of the AM band from 1500 kc to 2000 kc, upping available broadcast frequencies by 50%. (The band stretched from 500 to 1500 kc). The other proposal would have increased the number of frequencies by dropping channel separation from 10 kc to 7 kc. This would have increased the number of stations permitted to broadcast by nearly 50%. But accommodating the demand for stations was not considered to be in the "public interest." Both proposals were firmly rejected by the FRC to the applause of major commercial broadcasters.[164]

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without a license. The incumbents are secure in knowing that if they successfully resist competition they will reap the benefits by enjoying higher capital values.

[163] Reed Hundt and Gregory Rosston, *Spectrum Flexibility Will Promote Competition and the Public Interest*, IEEE COMM. 40 (Dec. 1995). There is some irony in the "FCC" acronym, which would be more accurately be formulated as FCIL: Forever Captured by Incumbent Licensees. If any corporation could capture the FCC, spectrum access for new competitors would not be blocked. Indeed, incumbent licensees often promote non-corporate (say, amateur or non-profit) use of bands precisely because the competitive pressure applied by such organizations is demonstrably less than what more business-oriented licensees would bring. For instance, the FCC policy to issue most MMDS licenses to churches, schools and colleges instead of wireless cable suppliers stifled development of that fledgling rival to cable for years.

[164] Hazlett, *The Rationality of U.S. Regulation…*, supra note __. The political dynamics, and even some particulars, have remained remarkably stable. "In 1980 the FCC considered increasing the number of radio stations by reducing the bandwidth of each from 10 KHz to 9. The broadcasters objected; they did not want more competitors. The FCC dropped the idea." Pool, Technologies of Freedom, supra note __, 152.

Rejecting the opportunity to expand radio station slots, the Commission winnowed the market. It instituted a number of technically arcane requirements that had the effect of eliminating small stations, particularly non-profits. As many as 200 stations were then owned by universities, schools, churches, labor unions, municipalities, and various amateur associations. The seven years of the FRC (it was folded into the Federal Communications Commission in the Communications Act of 1934) were not kind to this sector. Non-profit stations were driven off the air by the cost of complying with FRC rules. Much more often than commercial broadcasters, non-profits forfeited their licenses.[165]

Two hundred stations fell silent even as the strongest stations, particularly those with network affiliations, prospered. The loss in competition, and particularly in community-oriented niche programming, did not conflict with the Commission's public interest mandate. It actually characterized many of the non-profit stations as "propaganda" outlets devoted to serving narrow audiences, unworthy of receiving a license to broadcast in the "public interest." While important and controversial stations like WCFL, the voice of the Chicago Federation of Labor, floundered and failed, major commercial interests surfed Depression-era economic conditions to new prosperity.[166] NBC and CBS, the dominant networks, saw their affiliates rise from 6.4 percent of stations in 1927 to 30 percent by 1931.[167] By then, the two networks accounted for 70 percent of U.S. broadcasting factoring in hours on-air and power levels. By the mid-1930s, they would be responsible for an astounding 97 percent of night-time broadcasting.[168] To this day, non-profit broadcasting has not recovered.

AM Blocks FM

One of the most heroic stories in the annals of American communications is the tale of Major Edwin Howard Armstrong.[169] Armstrong, a professor of electrical engineering at Columbia University, was an inventor whose contributions to radio broadcasting technology

[165] This was a classic instance of 'raising rivals' costs,' with the FRC instituting rules at the behest of commercial radio interests to drive competitors from the market. See Thomas G. Krattenmaker and Steven C. Salop, *Anticompetitive Exclusion: Raising Rivals' Costs to Achieve Power over Price*, *Raising Rivals' Costs*, 96 YALE L.J. 209 (1986); Chapter 18, "Predation via Governmental Processes," in Bork, The Antitrust Paradox, supra note __, 347-64.
[166] Robert W. McChesney, Telecommunications, Mass Media, and Democracy (New York: Oxford Univ. Press, 1994), 66-7.
[167] Ibid. 29.
[168] Ibid.
[169] This story is eloquently detailed in Lawrence Lessing, Man of High Fidelity: Edwin Howard Armstrong (New York: Bantam, 1954).

were seminal.[170] His greatest achievement, however, was inventing frequency modulation, FM, a transmitting technique using wider bands than amplitude modulation (AM).

The key FM innovations were patented by Armstrong in 1933. He then asked regulators to allocate radio spectrum for FM broadcasting. After some difficulty, Armstrong was issued experimental licenses. But the FCC did not believe FM radio would work. In January 1936, for instance, a Commission engineering report stated that the VHF band (where Armstrong had devised his FM equipment to operate) was virtually worthless for communications stretching beyond 10 miles. This was despite the fact that Armstrong had reported, in a November 1935 paper, test results indicating that FM signals were clearly received over 80 miles away.[171] He set about building more formidable testing facilities, aiming to amass evidence rebutting the FCC's technical arguments.

In 1937 Armstrong paid General Electric to construct twenty-five proto-type FM receivers. These were used to gauge reception from a 50,000 watt FM station Armstrong built with a personal investment of $60,000 in Alpine, New Jersey. Further experiments were conducted by John Shepard III of the Yankee Network, a New England chain. Shepard constructed a 50,000-watt FM transmitter on a mountain near Worcester, Massachusetts. Test results stirred great excitement in Armstrong and his collaborators. The signals traveled much further, and with much greater clarity and far less sensitivity to sources of interference than existing methods. Stations operating on almost identical bands still did not drown one another out; receivers picked up whichever signal was clearest.

Armed with impressive field data, Armstrong returned to the Commission. He was surprised to find great hostility to his request for an allocation to use unoccupied VHF frequencies for FM radio broadcasting. Specifically, the Radio Corporation of America (RCA), the Columbia Broadcasting System (CBS), and American Telephone and Telegraph (AT&T) all advanced arguments that would hinder or thwart FM. RCA, owner of the National Broadcasting Company (NBC), was the largest AM broadcaster. CBS was a close second. These established incumbents did not see a public interest in increased competition. AT&T was concerned about the new technology because the Yankee Network had shown that FM was ideally suited to provide wireless relay service, successfully linking several New England stations with point-to-

[170] "Modern radio… is built on seven basic inventions – the four-circuit-tuning invention of Marconi, the heterodyne of Fessenden, Lee and Hogan, the audio amplifier of Lowenstein, the regenerative and superheterodyne circuits of Armstrong and the high vacuum tube of Langmuir…" Ibid., 256.
[171] Ibid. 184.

point transmissions. FM networking bypassed long distance lines, where AT&T enjoyed a good business transporting network programs via coaxial cable connections. [172]

In 1940 these interests and their allies attempted to dissuade the Federal Communications Commission from moving forward with an FM spectrum allocation. They were right—or, at least, rational—to be worried. FM posed a grave threat to AM:

> Armstrong saw in the development of FM the opportunity to free the U.S. radio system of oppressive restriction and regulation. An almost unlimited number of FM stations was [sic] possible in the shortwaves, thus ending the unnatural restrictions imposed on radio in the crowded longwaves. If FM were freely developed, the number of stations would be limited only by economics and competition rather than by technological restrictions. Small stations and new networks would have a chance to grow, reducing the need for FCC regulation and lessening the domination of the industry by a few corporations. Armstrong likened the situation that had grown up in radio to that following the invention of the printing press, when governments and ruling interests attempted to control this new instrument of mass communications to imposing restrictive licenses on it. This tyranny was broken only when it became possible for men freely to acquire printing presses and freely to run them. FM in this sense was as great an invention as the printing press, for it gave radio the opportunity to strike off its shackles.[173]

Armstrong was naïve. The possibility of new competition did not prompt FCC regulation to wither away, but *instigated* regulatory action to resist entry.[174] This anti-competitive response delayed FM's introduction in the years following its invention in 1933. But, interestingly, Armstrong won a major victor 1940. Despite contentious hearings and proposals by CBS to derail FM, the Commission chose to re-allocate 6 MHz of radio spectrum, previously one channel of the thirteen assigned to VHF television, for the use of FM radio broadcasters. This would allow 40 channels, on which as many as 2,000 FM stations could be located

[172] Ibid., 196.
[173] Ibid., 196-97.
[174] Armstrong's technological determinism is also quite instructive. Liberalizing spectrum access wouldn't have thrown off "technological restrictions" but political restrictions. Technology would continue to shape the economic trade-offs faced by market participants. This is a precursor to contemporary arguments that the regulatory system is rendered obsolete by scientific breakthroughs in digital computing, spread spectrum, or software-defined radio.

nationwide.[175] The ruling paved the way for development of FM. By late 1941, 40 stations were on the air or under construction, and some 500,000 households had purchased receivers.

U.S. entry into World War II froze technology adoption. Station construction halted, and set manufacturers switched from civilian to military production. Armstrong was himself diverted to lead 'round-the-clock Army Signal Corps research on mobile communications via FM. The technology again proved robust, and FM relay units developed by Armstrong were soon in use by U.S. forces (including Gen. George S. Patton's Third Army on its furious march through France in 1944—too speedy for wired communications).[176] As the war came to a close, Armstrong assumed that peacetime would usher FM radio into a golden age. The public had gotten a taste of FM—the few stations on air had continued to broadcast to the few receivers spread around the country—and listeners liked what they heard. "Yankee's FM broadcasting system had blanketed the New England area with a service that AM stations and big AM network affiliates could not match in quality or coverage."[177] But this very success, coupled with the pause in industry development caused by wartime mobilization, pushed competitors of FM broadcasting to regroup.

NBC and CBS petitioned the FCC in 1944 with a bold proposal: toss every FM station off its assigned frequency. The plan was to relocate the industry to a band higher up the dial, but all existing equipment—transmitters owned by stations, receivers by ordinary listeners—would be rendered obsolete. The claim was that the move would help FM stations by allowing them to avoid "ionospheric interference," a threat alleged to emanate from sunspots. This technical problem was said to uniquely degrade transmissions in the frequencies of the current FM band. FM broadcasters and equipment makers were united their opposition to this view. Armstrong, who again conducted extensive tests on the matter, submitted voluminous data to the FCC dismissing the interference threat.

Such testimony is persuasive and should be dispositive. Atmospheric damage to FM broadcasts would inflict economic damage on FM licensees and their suppliers. By forcing the alleged victims to move, the FCC substitutes its administrative powers for the expert opinion of self-interested parties. This is not the ostensible aim of regulation, which is to limit spillover damage suffered by third parties. Here the only third party effects concern listeners who purchased radio sets, assets complementary to the broadcasts provided by licensed FM stations—

[175] Ibid., 200.
[176] Ibid., 207.
[177] Ibid., 211.

and the Commission decided to *appropriate* these investments.[178] The federal government enthusiastically joined forces with the incumbent broadcasters hostile to FM, going so far as to produce testimony from a Army Signal Corps engineer, formerly with the FCC, that "secret military data" showed FM should move.[179] Other public testimony, and technical experts who met with the Commission privately, revealed the conclusion to be in error. The FCC ordered staff to omit corrections to the record, later congressional hearings found.

In 1945 the Commission uprooted FM. A higher band (88 to 108 MHz) was mandated for relocation. The migration rendered existing transmitters inoperative and receiver sets worthless. Armstrong spent the next two years frantically developing new FM technology for use in the higher band. The blow was devastating to consumers and radio entrepreneurs who had been early adopters of FM technology, creating negative momentum for efforts to establish FM on the new band. A study later found the public extremely reluctant to buy redesigned FM sets. The industry now had a reputation as a speculative technology.[180]

Gratuitously, the FCC also decided to reduce FM station power. Armstrong's Alpine, New Jersey station (operated commercial-free, subsidized by Armstrong to promote FM) was cut back from 50,000 watts, for instance, to just 1,200. The stated rationale was to promote local broadcasting, a recurring theme in FCC public interest regulation. To squeeze in more local assignments, each station's coverage area had to be reduced (else interference between stations in adjacent communities would threaten local broadcasting). The practical effect of the so-called Single Market Plan was to lower the economic viability of the new FM stations. With smaller audiences, it would be more difficult to compete with established AM stations for advertising revenues.

These policies stopped FM dead in its tracks in 1945.[181] In 1948 Senate hearings, Armstrong would testify: "[T]he effort has been to mold the allocation of FM into a form where it will become a network subsidiary, unable to take the leading role which its technical merits

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[178] Lessing has no difficulty in finding the interference issue a sham. "The plain dishonesty of this order was promptly demonstrated when the FCC turned about and assigned the band it had just ordered FM to vacate to television, a service about twenty-five times more sensitive to any kind of interference than FM and which, moreover, was still required to use FM on its sound channel. Later the same band of frequencies was assigned to government safety and emergency radio services, in which interference of any kind could be tolerated even less than in commercial broadcasting or television. The fact is that none of the 'ionospheric interference' predicted for this band ever materialized." Ibid., 213.

[179] Ibid., 212.

[180] See Stanley Besen, *AM versus FM: The Battle of the Bands*, 1 INDUSTRIAL AND CORPORATE CHANGE 375 (1992).

[181] "The series of body blows that FM radio received right after the war, in a series of rulings manipulated through the FCC by the big radio interests, were almost incredible in their force and deviousness." Lessing, Man of High Fidelity, supra note __, 211.

would give it if left unhampered by regulation."[182] Soon listeners were lost and stations went silent, relinquishing broadcasting licenses. The threat to AM radio was over. It was a financially painful loss for Armstrong, as his key patents expired in 1950. Due to the delays of the FCC and the diversions of war, his impressive scientific breakthroughs went largely uncompensated.

Not until the FCC approved stereo broadcasting for FM in 1960—some *26 years* after Armstrong had initially developed multiplexing—did FM rise from the dead. Audiophiles flocked to FM "high fidelity" in the years that followed, and the mass market soon thereafter. FM stations multiplied in number and audience share. By 1979, FM surpassed AM in listeners.[183] By 1985 there were as many FM stations broadcasting as AM, and by 1995 there were substantially more (nearly 7,000 FM to under 5,000 AM).[184] Armstrong's boasts about the superiority of FM were not idle.

Armstrong was not alive to see vindication. On January 31, 1954, broken by the successful campaign to deter his invention and locked in an acrimonious lawsuit over royalty payments owed him for FM manufacturing,[185] he penned a letter to his wife, dressed neatly, and walked straight out the window of his 13th floor New York City apartment. "[I]t seemed incredible to [Armstrong] that in this country, by means of restrictive regulations and slippery measures, a superior scientific advancement could be overwhelmed by the shoddy and the expedient."[186]

The Death of Du Mont

The average American household can receive 13 signals of off-air TV programming. Yet, the official FCC Allocation Table blocks off spectrum space for 67 channels. Why are so many channels "allocated," yet so little product delivered? The technical limits of (analog or digital) television receivers do not restrict viewers to just a few channels of off-the-air television. Rather, deliberate policies of the FCC do. Indeed, the dominance of just three national TV networks was an entirely predictable consequence of the FCC's regulatory plan:

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[182] Ibid., 223.
[183] Vincent Ditingo, The Remaking of Radio (Boston: Focal Press, 1995), 18, 60.
[184] Thomas W. Hazlett and David W. Sosa, *Was the Fairness Doctrine a 'Chilling Effect'? Lessons from the Post-Deregulation Radio Market*, 26 J. LEGAL STUD. (Jan. 1997) 279, 291.
[185] Armstrong's widow was to finally receive over $10 million in judgments and settlements from RCA, Emerson, Motorola and nearly twenty other firms. The litigation ended in 1967.
[186] Lessing, Man of High Fidelity, supra note __, 225-6. The story of FM landed its inventor in an unenviable pantheon. Armstrong is one of 22 people chronicled in Ken Smith, Raw Deal: Horrible and Ironic Stories of Forgotten Americans (New York: Blast Books, 1998), 255-68.

> Perhaps the most significant event in the history of television regulation was the creation of an artificial scarcity of VHF-TV licenses. The effect of this policy has been to create a system of powerful vested interests, which continue to stand in the path of reform and change…[187]

The Federal Communications Commission began allocating VHF radio spectrum for television in 1940, and in 1945 an allocation plan for channels in the top 140 markets was established.[188] In 1948, however, a rush of post-war applications prompted the FCC to freeze assignments after 108 TV licenses had been issued. The thaw came when the Sixth Report and Order was released in 1952.[189] The TV Allocation Table issued in the Order determined how both VHF and UHF TV channels were to be distributed, although a fierce debate over the rule making continued for many years.

Two basic positions evolved. The first proposed to emphasize viewer choice. Du Mont, the weakest of the four TV networks, aggressively pushed this position. Its fortunes depended on the FCC issuing licenses such that large numbers of Americans could tune into four (or more) stations. Without a number of competing broadcast outlets, Du Mont would not be able to establish nationwide coverage. With its potential audience dwarfed by rivals, the network would then be handicapped in the race to produce quality programs, having a smaller base over which to amortize fixed costs of production. Quality erosion would reduce audience share, further diminishing the network's viewer base. A downward spiral into financial futility would result.

The alternative position emphasized localism, seeking to "provide each community with at least one television broadcast service."[190] Enhancing the number of TV markets would produce many cities with one or two viewing choices, but relatively few with four or more. Spectrum would be "consumed" by small markets crowding in to get their "own" TV stations, blocking (through airwave interference) the use of channels in adjacent markets.

If it were not for the FCC's TV allocation plan, which created low-power, local stations, we could all have access to a great many more channels. The same spectrum could be used for powerful regional stations, no one of which could serve a small community. This is called the "Du Mont Plan"…. The essence of the Du Mont Plan was to have fewer cities with TV stations,

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[187] Bruce M. Owen, Jack H. Beebe, and Willard G. Manning, Television Economics (Lexington, MA: Lexington Books, 1974), 12.
[188] Note, *The Darkened Channels: UHF Television and the FCC*, 75 HARV. L. REV. 1578, 79 (1962).
[189] 1 RADIO REG. 91:602 (FCC 1952).
[190] *Darkened Channels*, 1579, citing 1 RADIO REG. 91:602, par. 63.

but to have each station cover a large geographical area, spanning a number of cities. Such a plan would permit the creation of new networks and increase the number of choices available to each viewer… [S]uch an increase in the number of channels may increase diversity of programming, and certainly increases competition… [C]onsideration of the Du Mont plan does point up the choice that was before the FCC in the early years of television—a greater range of diversity of programming and competition versus localism in decision-making.[191]

The FCC adjudged localism to be in the public interest in 1952. By September 1955, Du Mont went dark. U.S. television viewers were limited to just three commercial networks until 1986 (when Fox finally recreated a fourth off-air network). The regulatory rationale was clear:

The FCC could have allocated the total volume of spectrum to [television] broadcasting in such way as to produce fewer, higher-powered outlets. This would have resulted in six or seven national television networks. Such a system, however, would have contained many fewer "local" broadcasting outlets than we have today. Instead, he FCC chose to allocate the spectrum so as to create a larger number of much lower-powered stations. In fact, the FCC's primary goal appears to have been to place at least one over-the-air service in every large community. This corresponds neatly to placing broadcasting station in as many congressional districts as possible.[192]

VHF-TV Blocks CATV

The network triopoly that formed under the FCC's restrictive VHF-TV licensing plan could have been ameliorated had the FCC permitted a competitive UHF-TV sector to emerge. Instead, the Commission took actions to guarantee that VHF-TV incumbents would be virtually unchallenged for years to come. While allocating a huge swath of bandwidth to UHF, ostensibly to provide increased choice for American viewers, the spectrum was regulated in such a way as to make competition with VHF untenable. UHF assignments were inferior in their reach and signal quality, and were unable to gain audience shares sufficient to compete with VHF stations. This problem could have mitigated by a proposal for "de-intermixture," moving markets into all-VHF or all-UHF status. The FCC extensively considered the plan, but it was resisted by the networks and was never implemented. For decades, UHF TV spectrum went largely unused.[193]

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[191] Owen, et al., Television Economics, 124.

[192] Matthew L. Spitzer, *The Constitutionality of Licensing Broadcasters*, 64 NEW YORK UNIV. LAW. REV. (Nov. 1989), 990, 1053 (footnotes omitted).

[193] This is all the more interesting because the FCC has touted its policies as being favorable to UHF. This was true in the case of cable television rules, as discussed in the text, but also with respect to the All-Channel Television Receiver Law of 1962. FCC Chairman Newton Minow lobbied Congress for the legislation, predicting it would

Which gave an opening to cable television operators. If airwaves were set off limits by airwave regulation, then wires—"spectrum in a tube"—would provide the competition to satisfy customer demand. Yet regulators did not sit idly by. The Commission launched a dramatic and now notorious campaign to suppress this potential competitor to broadcast TV. This effort offers a fascinating illustration of the dynamics of spectrum regulation.

The episode eerily coincided with the most famous attack on television programming ever launched: the "vast wasteland" speech delivered by FCC Chairman Newton Minow to the National Association of Broadcasters, May 9, 1961.[194] Minow surprised industry officials by blasting broadcasting's product quality, a rude gesture for FCC policy makers:

> [W]hen television is bad, nothing is worse. I invite you to sit down in front of your television set… I can assure you that you will observe a vast wasteland.
>
> You will see a procession of game shows, violence, audience participation shows, formula comedies about totally unbelievable families, blood and thunder, mayhem, violence, sadism, murder, Western badmen, Western good men, private eyes, gangsters, more violence and cartoons. And, endlessly, commercials—many screaming, cajoling and offending. And most of all, boredom. True, you will see a few things you will enjoy. But they will be very, very few. And if you think I exaggerate, try it.[195]

Excluded from this analysis was the most salient policy fact: Spectrum allocation rules produced the "vast wasteland." As then noted by Peter Steiner,[196] Ronald Coase,[197] and Allen Du Mont, FCC regulation pre-empted product diversity. Given the importance of scale in TV programming (where fixed costs are substantial but marginal costs are zero), issuing sufficient

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have a dramatic impact on UHF-TV growth. Newton N. Minow, Equal Time (New York: Atheneum, 1964), 132-45. In fact, a study later found the act so unsuccessful in stimulating UHF development that the law was not likely worth the incremental TV set costs it imposed on consumers. See Douglas W. Webbink, *The Impact of UHF Promotion: The All-Channel Television Receiver Law*, LAW & CONT. PROBLEMS 535 (Summer 1969).

[194] Newton N. Minow, Equal Time, 47. The speech is important enough to be included as subject matter for law school admissions tests, and to have been the subject of a 30-year anniversary conference at the Freedom Forum Media Studies Center at Columbia University. It is reprinted in Newton N. Minow & Craig L. LaMay, Abandoned in the Wasteland (New York: Hill & Wang, 1995), 185-96.

[195] Minow, Equal Time, supra note __, 52.

[196] Peter O. Steiner, *Program Patterns and Preferences, the Workability of Competition in Radio Broadcasting*, 66 Q. J. ECON. 194 (May 1952).

[197] Ronald Coase, *Evaluation of Public Policy Relating to Radio and Television Programming: Social and Economic Issues*, 41 LAND ECONOMICS 161 (1965).

TV licenses for just three networks to amass national scope ordained that each network would target mass audiences with least-common-denominator programming.

The very same producers and networks would exhibit more sophisticated tastes were the opportunity costs of airtime not so high. Once cable TV was permitted to develop, it demonstrated the economics perfectly. Cable networks provide an array of specialized programming, serving a diversity of tastes high, medium and low.[198] While attracting many fewer viewers than major broadcast networks, they are nonetheless profitable—precisely because they are abundant and the *opportunity cost of bandwidth* is low.

Given that TV regulation produced a "vast wasteland," Newton Minow might have greeted emerging cable competition warmly. Tellingly, just the reverse: Minow's FCC moved decisively to quash cable. [199] The policy offensive began with a 1962 ruling, *Carter Mountain v. FCC*.[200] Cable TV had been unregulated by the Commission; two staff requests to apply common carrier rules were rejected by the FCC in the 1950s.[201] But this was in cable's earliest days, when broadcasters did not object to "community antenna television" (CATV) extending broadcasts to more eyeballs. Once cable began to "import" competitive signals into local markets, however, the mood changed. Broadcasters protested cable TV expansion at the FCC.

But the FCC lacked jurisdiction. Cable systems were local, not interstate, and did not utilize radio spectrum. The FCC had not been awarded authority in this market by the FCC's authorizing statute, the 1934 Communications Act. There was a backdoor into cable, however. The Commission had jurisdiction over microwave operators in the transport business. The operators were used by CATV systems to import TV signals to a local head-end, where they were then distributed via coaxial cable to subscribers. CATV systems were customers of these common carriers, who served customers without discrimination. Turning common carriage on its head, the FCC stepped forward to mandate discrimination against one type of customer—CATV

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[198] The enhanced diversity of cable, as opposed to broadcast, TV has long been noted. See Eli Noam, Television in Europe (New York: Oxford Univ. Press, 1991), 39-41. "According to one frequently made assertion, multi-channel television (i.e., cable television) is essentially the same as traditional commercial broadcast television, except that there is more of it. But this view is not empirically based. The diversity of programs available on American cable TV, for example, is much greater than that under the earlier restricted systems, particularly in smaller towns and cities, because additional and specialized program channels provide more variety."

[199] See Stanley Besen & Robert Crandall, *The Deregulation of Cable Television*, 44 LAW & CONTEMPORARY PROBLEMS (Winter 1981), 77-124; Roger Noll, Merton Peck, and John McGowan, Economic Aspects of Television Regulation (Wash. D.C.: Brookings Institution, 1973); Pool 1983; Powe 1987; and Thomas W. Hazlett, *Station Brakes: The Government's Campaign Against Cable Television*, REASON (February 1995), 41-47.

[200] *Carter Mountain Transmission Corp.*, 32 FCC 459 (14 February, 1962). This decision is reprinted in: Frank J. Kahn, editor, Documents of American Broadcasting, Third Edition (Englewood Cliffs, N.J.: Prentice Hall, 1978), 298-305.

companies.[202] The Commission's rationale was the "ancillarity doctrine." In order to successfully regulate broadcasters, the Commission argued that it needed to also control those forces that threatened the public interest obligations of licensees. Loss of consumer choice was simply collateral damage in a larger war.

The FCC formally established its anti-cable policy on February 14, 1962—the Valentine's Day CATV massacre. A broadcaster, KWRB-TV, filed a petition to deny a common carrier, Carter Mountain Transmission Corp., a permit to construct microwave transmission facilities for the purpose of sending TV programming to existing cable TV systems in Riverton, Lander and Thermopolis, Wyoming. KWRB-TV broadcast on channel 10 in Riverton, and considered itself a competitor of CATV systems in all three towns. The rationale for its FCC petition, according to the FCC, was that "the microwave facilities would enhance their [the cable systems'] competitive standing to the economic detriment of KWRB-TV."[203]

The FCC found that "economic harm" to the broadcaster was proper grounds upon which to act, and proceeded to examine the record of "competitive standing." The Commission wrote that if allowing competition via the microwave relay, "enables this customer potential to destroy a basic Commission policy, then… the ability to create such a situation in this particular instance is sufficient to warrant an examination into the entire problem. We will not shut our eyes to the impact upon the public service which is our ultimate concern..."[204] The rationale for licensing, that it was necessary to maintain order over the airwaves by restricting access to some, was precisely reversed. Now the FCC was stating that the government's licensing structure was sacrosanct, and that competitive access should be blocked to protect it.

The FCC denied Carter Mountain's microwave application. "Reason and logic cause us to agree with the conclusion that should the CATV system be permitted to expand its services and furnish better technical facilities, KWRB-TV will be placed in the economically disadvantageous position of finding it more difficult to sell its advertising..." This, the Commission augured, might lead to the destruction of the station altogether, and the loss of TV service to those who couldn't afford, or weren't passed by, cable TV. "True, a grant of the instant

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[201] Lucas A. Powe, Jr., American Broadcasting and the First Amendment (Berkeley: Univ. of California Press, 1987), Ch. 12.

[202] This was pointed out in a dissent to the *Carter Mountain* decision by Commissioner Cross, who cited the Commission's own policy that: "[I]t is neither proper, pertinent, nor necessary for us to consider the specific lawful use which the common carrier subscriber may make of the facilities of the carrier." He noted that, "[I]t is my view that we should not try to correct one isolated situation in the instant case by departing from our previously well-considered and soundly bottomed actions on the subject..." Ibid.

[203] Quoted in Kahn, Documents, supra note __, 298.

[204] Ibid.

application would permit the rendition of better service by the CATV, but at the expense of destroying the local station and its rural coverage."

Carter Mountain laid the foundation for a series of Commission rule makings checking cable television growth to protect broadcasters from audience "siphoning." The financial health of struggling UHF TV stations played a central role in the rule makings, as the limits place on cable were crafted to counter the "grave danger to UHF broadcasting."[205] Events were soon to lead to a natural experiment testing this proposition.

The deregulation wave of the mid- to late-1970s led the FCC to relax anti-cable rules.[206] Permitted to compete for audience share, cable systems grew rapidly in a "gold rush" that saw U.S. cable subscribership rocket from 11.8 million households in 1976 to 45.7 million in 1988—the year in which national penetration surpassed 50%. Interestingly, UHF TV did not collapse. UHF's signal transmission inferiority relative to VHF faded due to a rising tide of cable subscribership—the "community antenna" improved reception for all stations, and the fuzziest signals benefited most. Audiences grew and UHF stations prospered. One indicator of this robust new health was that the number of UHF outlets[207] rose *pari passu* with the climb in cable penetration, 1970 to 1991. See Figure 8. Indeed, by the time that half of U.S. homes subscribed to cable, the U.S. finally saw the creation of its fourth broadcast network.

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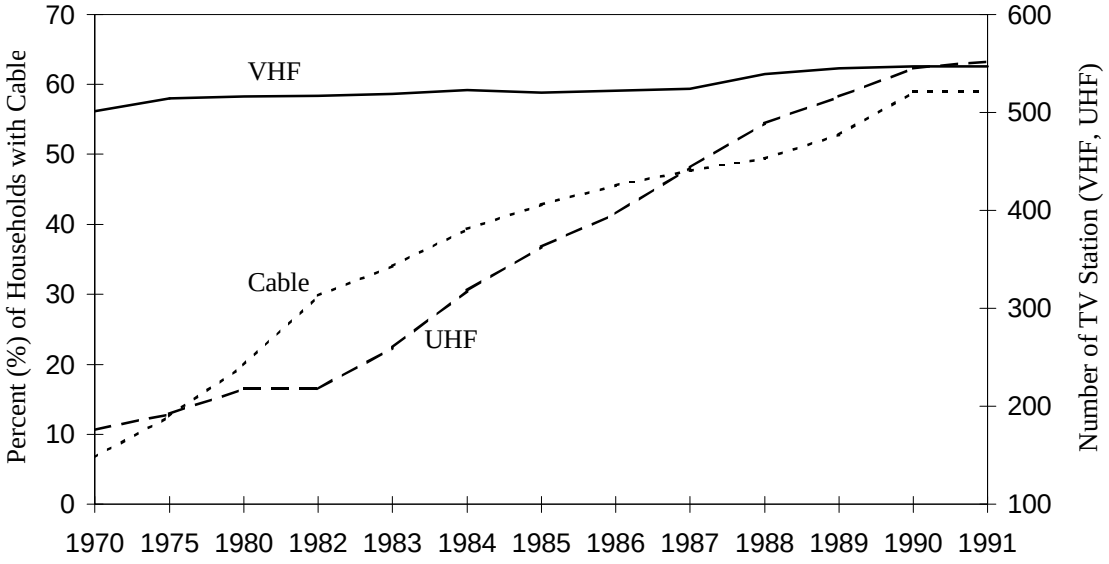
[205] Federal Communications Commission, *Amendment of Subpart L, Part 91, To Adopt Rules and Regulations To Govern the Grant of Authorizations in the Business Radio Service for Microwave Stations To Relay Television Signals to Community Antenna Systems: Second Report and Order*, FCC 66-220, Docket No. 14895 (March 4, 1966), 1775.

[206] Stanley Besen & Robert Crandall, *The Deregulation of Cable Television*, 44 LAW & CONTEMPORARY PROBLEMS (Winter 1981), Lucas A. Powe, American Broadcasting and the First Amendment (Berkeley: Univ. of Calif. Press, 1987), Ch. 12.

[207] The number of UHF television stations broadcasting is a proxy for the financial fitness of the industry. Allocated licenses had gone unused, as audience limitations reduced profitability.

Figure 8. Cable and Broadcast TV Growth: 1970-1991



Sources: Statistical Abstract of the United States, 1990, p. 550;
Statistical abstract of the United States, 1992, p. 551

The factual basis for the FCC's *Carter Mountain* decision proved false.[208] The episode now serves as a textbook example of anti-competitive regulation:

> Cable television made possible an unlimited transmission of stations to any given point, unlike broadcasting through the air. The whole structure of the industry—networks, affiliates, advertising patterns—could have been undermined or destroyed by the new technological possibilities. So too would have been the existing regulatory apparatus… so in communications the response to the elimination of the initial rationale for regulation was to extend the regulation to encumber and contain the new threatening technology.[209]

[208] The FCC reviewed conflicting economic testimony on the specific issue as to whether cable TV development would help or hurt UHF survivorship. It elected to agree with the negative correlation asserted by MIT economist Franklin Fisher. By 1972, however, the dominant scholarly view was that UHF was assisted by CATV. Rolla E. Park, *Cable Television, UHF Broadcasting, and FCC Regulatory Policy*, 15 J. Law & Econ. 207 (April 1972). As early as 1974 the UHF argument for cable suppression seemed transparent: "It is difficult to avoid the conclusion that the FCC acted to protect the wealthiest and most powerful stations [i.e., VHF] against increased competition, and in doing so denied millions of viewers in larger markets a greater range of choice among broadcast signals." Owen, et al., Television Economics, supra note __, 143.

[209] Thomas Sowell, Knowledge and Decisions (New York: Basic Books, 1980), 188.

This has not stopped regulators from audaciously stealing credit for the eventual progress the FCC's broadcast protectionism so long delayed. In his 1995 book, Newton Minow boasts that his "Commission worked to promote cable and other technologies."[210] A more accurate assessment of the Commission's cable policies is available. Former FCC member (now University of Virginia law professor) Glen Robinson described them this way, some 16 years after *Carter Mountain*:

> When cable television emerged as a marketable service in the early 1960s, the FCC faced a unique opportunity to overcome the mistakes it had made in the regulation of broadcast television. Cable television, with its multiple channel capability, solved the problem of spectrum scarcity—the rationale and rationalization for nearly all the FCC's basic regulatory policies and indeed for the Communications Act [of 1934] itself...
>
> Since the advent of cable, the Commission's first concern has been the impact of cable, not on the public, but on the broadcast industry. To be sure, the Commission has always couched its concern in terms of the public interest: the possible adverse impact on the growth of UHF, the threat to local television service, and the possible loss of service to rural areas and to the poor. However, the Commission simply presumes there is a one-to-one correspondence between the interests of the broadcast industry and those of the public...
>
> Proceeding from that premise, the Commission's regulation of cable has been concerned only with estimating the degree of harm and selecting the measures necessary to prevent it from becoming too serious. Even in assessing the degree of harm, however, the Commission has proceeded more from assumptions of faith than from findings of fact. In 1959, it could find no significant threat. In 1962 and again in 1965, a changed membership saw things differently...
>
> Ostensibly, the Commission's premier concern always has been UHF stations, those sickly siblings of the broadcast industry over which the FCC has fussed and fretted for twenty years, trying to shelter them as much as possible from the cold competitive environment. What was the evidence of the impact of cable on UHF? An early econometric study *predicted* that duplicative

> programming over cable would cause substantial harm particularly to UHF stations... Later studies, however, suggest that cable has been more beneficial than harmful to UHF insofar as it has brought UHF signals into par with VHF. What is particularly notable is that every time the occasion arises for contracting some rule designed to protect broadcasters, the cry of dire harm is heard. But when as a Commissioner I asked for credible evidence to substantiate the claim, all I ever heard from the industry and the probroadcast faction at the FCC was: "We are not going to wait for the corpses of dead broadcast stations."[211]

AM & FM Block DARS

In 1990, a firm called CD Radio petitioned the Federal Communications Commission to allocate spectrum to provide CD-quality satellite audio service to the U.S. market. The service was dubbed Digital Audio Radio Satellite service, or DARS, and the FCC soon opened a formal rulemaking to decide the issue of spectrum allocation.[212] Three additional firms soon joined CD Radio in applying for DARS licenses.

The four applicants outlined their business plans. They were to use satellite distribution for national dissemination of packages of commercial radio broadcasts. Each planned to deliver approximately 30 channels of CD-quality programming. Two firms anticipated advertiser support, with zero charge to listeners, while the other two planned subscription fees.

The FCC proceeding moved forward slowly. NASA and other U.S. organizations argued that DARS would interfere with vital national communications links. These objections were finally overcome, and in 1995 the Commission allocated 50 MHz of radio spectrum (2310—2360) for DARS, four blocks of 12.5 MHz each.[213] Intense opposition came from radio broadcasters, who filed documents challenging the introduction of satellite radio. The primary justification to deny the spectrum allocation request was “localism.” Under the public interest standard, the importance of service to local communities is long established. Broadcasters argued that national satellite competitors would siphon audiences and, therefore, advertising revenues

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[210] Minow & LaMay, Abandoned, supra note __, 95-6.
[211] Glen O. Robinson, *The Federal Communications Commission: An Essay on Regulatory Watchdogs*, 64 VA. L. REV. 169 (1978), 246-7 (footnotes omitted, emphasis in original).
[212] *Notice of Inquiry in the Matter of the Commission’s Rules with Regard to the Establishment and Regulation of New Digital Audio Radio Satellite Service,* 5 F.C.C. REC. 5237 (Aug. 1, 1990).
[213] *Notice of Proposed Rulemaking, In the Matter of Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band*, IB Docket No. 95-91; GEN Docket No. 90-357 (June 15, 1995).

from radio broadcasters licensed by the FCC to serve local communities, thus undermining the public interest in localism.

The question appeared weighty in the context of the FCC's public interest determination. The arguments for and against DARS were both substantial, the Commission wrote in its 1995 proposed rulemaking:

> [S]atellite DARS… could expand and complement the audio programming choices now available to listeners. By offering a national based service, satellite DARS providers could target niche audiences that have not been served by traditional local radio but now could be served as an aggregate national audience. Such specialized program offerings could include foreign language programming, music formats not usually carried by radio broadcasts, and programming geared to children or senior citizens…
>
> It is also apparent that satellite DARS, to some extent, will compete with terrestrial radio. Proposed satellite DARS systems will provide 30 or more channels of national digital audio programming to fixed and mobile receivers…. throughout the country…. Some of these DARS channels may provide programming that is similar to what is available on local stations… We request comment on whether consumers would alter their listening patterns by abandoning local stations to any significant degree…
>
> We also seek comment regarding advertising revenues that may be lost due to competition from satellite DARS.[214]

The FCC sought to weigh the benefits of new technology against economic losses on existing suppliers. The consideration afforded market incumbents is generous when compared to the competitive market's adjudication of such questions. This example demonstrates the ease with which public interest (here, localism) melds into incumbent protection.

Interested parties introduced sharply conflicting evidence as to the public interest associated with DARS.[215] Even after the initial spectrum allocation decision, deliberations over how to set rules stretched another two years. What is interesting is that the case is easy and

[214] DARS NPRM, supra note __, Pars. 2, 3, 4, 17.

[215] As a telecommunications economist, I was approached by one of the DARS applicants to produce a consulting report showing that satellite radio would not hurt radio station profits. Speaking with the firm's counsel on the telephone, I responded that, if this were correct, the firm ought be careful to fully disclose the information to investors. Only if the DARS entrant's competitive strategy were to flop would radio audience share *not* flow from terrestrial broadcasters. The organization continued searching for a consulting economist.

overwhelming that DARS will not threaten local radio content but promote it. The strong trend within the radio broadcasting market has been for "local" radio stations to distribute (i.e., rebroadcast) national programs. Syndicated talk shows, national news services, satellite and fiber-optic cable feeds, and turn-key music programs have allowed stations to dramatically reduce locally-generated radio productions. Satellite broadcasting direct to consumers would both create efficiency in distributing national services (cutting out the middle layer) and free radio stations to provide *more* local programs. Only by nurturing and promoting local talent and community-oriented content, in fact, will radio stations be able to offer unique programming alternatives to DARS. Hence, the threat to radio station financial viability offers to *stimulate local program production*.[216]

The effect of nationally distributed audio programming on localism has already been observed in two historical transitions—the introduction of television and radio-over-the-Internet. The first of these explains how national programming competition *created* radio localism.

> In radio's early years, local stations relied heavily on nationally delivered network programming… Television, however, became the primary purveyor of (national) block programming in the 1950s when its executives persuaded many then-popular radio personalities such as Jack Benny, Bob Hope, and Abbott and Costello to move to TV…
>
> [R]adio executives turned to specifically targeted or specialized local programming… to effectively compete against television for audience share and against each other for advertising dollars. Radio networks redefined their role by offering mostly news and special event programming. Thus, radio broadcasting staked its claim as "the local medium."[217]

Similarly, the advent of streaming audio over global telecommunications networks naturally moves off-air radio stations to focus on content uniquely interesting to community audiences. As reported by Inter@ctive Week:

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[216] In addition to perverse application of the localism doctrine, the public interest argument for DARS is much stronger than hinted at in the FCC's NPRM. With its wide expansion of programming channels, various national public interest programming niches will be filled due to the low opportunity cost of bandwidth. For instance, C-SPAN, the cable network broadcasting Congressional proceedings and other news and public affairs without commercial interruption, signed an agreement to distribute its audio version over CD Radio (now Sirius) in 1998. Alan Breznick, *C-SPAN Cuts Radio Deal*, CABLE WORLD (April 6, 1998), 16. C-SPAN programming is currently available only to radio listeners in the Washington, D.C. area, broadcast by an FM station owned by C-SPAN.

[217] Vincent Ditingo, The Remaking of Radio, supra note __, 5-6.

> Not too long ago, progressive radio stations were streaming music on the Web. Today, thousands of radio stations replay their content on the Web. But already, the idea of listening to the same broadcast that's available on a nearby radio is getting stale, particularly because music networks such as Spinner Networks and Yahoo! Broadcast offer continuous streams of various genres, according to a new report by market research Nielsen/NetRatings. "Every single site that's offering some kind of entertainment stream becomes a local station," says T.S. Kelly, director of Internet media strategies at NetRatings. That means stations that really are local "need to expand to offer specialty programming catered to the local market, where their strength is," Kelly says.[218]

Lack of substance did not render the localism argument impotent in the FCC's public interest rule making. Broadcasters delayed and partially deterred DARS. Not until 1997 was the rulemaking completed, and by then the spectrum allocation had been cut in half. In April 1997, just two DARS licenses were auctioned. One license was won by Sirius Satellite Radio, while the other went to XM Satellite Radio. Even as firms ready their systems for roll-out in 2000, and before the first subscriber fee is collected, either firm sported a market capitalization in excess of $1 billion—strong evidence the service is likely to deliver valued services to customers. See Table 5. Part of the investor appeal may lie in the fact that either firm, through technical advances in compression, now plans to deliver 100 channels of programming. One decade after they petitioned the FCC for the right to do so, it appears two surviving DARS applicants will.

Table 5. DARS Service Providers in the United States

Company	*Market Capitalization*	*Sales*	*Channels*
Sirius Satellite Radio	$1.28 billion	$0.00	100
XM Satellite Radio	$1.42 billion	$0.00	100

Source: Yahoo!Finance, January 26, 2000.

SMR's End Run

> [A] recent deal in New York valued a band of cellular telephone frequencies 25 megahertz wide at $4 billion, or $160 million a megahertz. But a band of adjacent

[218] Mindy Charski, INTER@CTIVE WEEK (June 27, 2000, 8:32 am PT), http://www.zdnet.com/intweek/stories/news/0.4164,2595029,00.html.

> radio frequencies 1.5 megahertz wide in New York recently sold for about $12 million, or $8 million a megahertz, because the F.C.C. had allocated those frequencies for use by long-range car radios like those used in taxis.[219]

Some people see newspaper reports and yawn. Others arbitrage FCC regulation. The extraordinary success of entrepreneur Morgan O'Brien, founder of Fleet Call (now Nextel), brilliantly illustrates the dynamics of FCC regulation as the exception proving the rule. O'Brien did what should be easy and unremarkable: He moved radio spectrum from a low-valued use to where it did far more for customers. Yet his path was strewn with regulatory obstacles. This paradoxically raised the gains realized by O'Brien, who emerged a wealthy man. But it demonstrates the social costs of a system where visionary and audacious strategies are required to achieve simple and obvious efficiencies.

O'Brien, a nine-year FCC lawyer, left government service to work with a Washington, D.C. communications firm. After a some years of representing wireless clients, contrasting market phenomena struck him as interesting: While cellular telephone license sales prices were soaring in 1987, specialized mobile radio (SMR) licenses were not. SMR licenses authorized wireless dispatch for taxis, construction crews, pizza delivery vehicles, and other service vehicles. The business was not particularly lucrative and an SMR license was cheap. Far cheaper than, for instance, FCC licenses to deliver cellular telephone service.

Given existing rules, this was perfectly natural: the right to engage in a highly profitable business is worth much more than a permit to operate a barely profitable one. But O'Brien recognized a deeper incongruence. If the spectrum allocated to the respective licenses were equally *regulated*, values should be similar. Cellular licenses were allocated 25 MHz each; SMR licenses up to 14 MHz. The bands were nearly identical in technical characteristics, both in the 800 MHz band. "[T]he only difference between the two industries was artificial – an FCC decree limiting SMR's use. Yet the same amount of spectrum sold for just $100,000 with a dispatch license and $2 million with a cellular license."[220]

The strategy was simple: O'Brien would buy cheap SMR licenses, and then petition the FCC for permission to use the bandwidth for mobile telephony. But that would be a long, drawn-out, lawyer-intensive process. Moreover, incumbent licensees would fiercely oppose such efforts. The increased competition would lower the value of their FCC licenses. That is where

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[219] Keith Bradsher, *The Elbowing is Becoming Fierce for Space in the Radio Spectrum*, N. Y. TIMES (June 24, 1990), A1, 20.
[220] O. Casey Corr, Money From Thin Air (New York: Crown Business, 2000), 235.

O'Brien's "arcane knowledge of FCC rules—and how to get around the— was crucial to the Nextel effort." [221]

O'Brien knew he could not succeed in a straight-up rule making to re-allocate SMR bands to cellular. The FCC's administrative process would block that. So he figured out a below-the-radar-screen approach to accomplish the same thing. After tying up the rights to scores of local SMR licenses, he met with Motorola's wireless technology experts. They had developed devices to make more efficient use of the bandwidth allocated to SMR by digitizing existing analog systems. Of course, use of the new technology required an FCC waiver, but when O'Brien made the application he petitioned to *upgrade* dispatch service, not *compete* with cellular. Since digitization would economize on bandwidth, new capacity would be available. Fleet Call requested permission to utilize it for increased business-to-business communications. While this was similar to dispatch service, the request adroitly positioned the company to extend mobile phone service to the general public.[222] "When Nextel lobbied at the FCC in 1990 for waivers to rules that limited how rapidly Nextel could assemble its systems, the filing didn't play up the cellular angle, emphasizing instead how to improve dispatch service. By early 1991 Nextel had won FCC approval."[223]

The achievement was not insignificant. According to a Nextel vice-president, the company spent approximately $2 million on its application (filed in 1989), while opponents (including cellular operators) invested $25 million attempting to defeat it.[224] Once having survived the regulatory process, however, Nextel became enormously valuable in promoting competition with established cellular and (now) PCS carriers, innovating in wireless telephony products, and creating shareholder value. As of June 29, 2000, the firm was capitalized at about $42 billion.

Nextel is the exception that proves the rule. Bringing radio spectrum out of an unproductive employment should not be such tricky business. Regulators should not have to be fooled, competitors blindsided, and businesses pursued as though delivering better service to millions of customers were an illegal activity. Entrepreneurs should have to make their mark innovating in the marketplace, inventing technologies or marketing "killer apps," not out-foxing

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[221] Gautam Naik and Dennis Kneale, *Old Dispatch Systems Are Ticket to Riches for Former FCC Man*, WALL STREET JOURNAL (Aug. 31, 1994), A1.

[222] Note that "Fleet Call" was the name of the firm that applied for the FCC waiver. After the waiver was granted, the company was renamed "Nextel." The branding was strategic.

[223] Gautam Naik and Dennis Kneale, *Old Dispatch Systems*, supra note __, A4.

[224] Jack Markell, Nextel vice president, conversation with the author, Women in Communications Forum, American Bar Association, San Francisco (Oct. 22, 1993).

competing sets of lawyers. The countless other businesses that have flunked this test—most of them unknown and deterred from the start—constitute economic carnage without offsetting social advantage.

NAB & NPR Block Low-power FM

In January 2000 the FCC designated a new class of low-power broadcasting outlets and set a timetable for accepting applications for licenses. The stations will radiate extremely limited power, with broadcast coverage between one to 3.5 miles in radius. Commission staff estimated that "as many as 1,000 stations or perhaps even more" would potentially be licensed under the rules.[225] The policy was hailed as a "stunning reversal,"[226] a "clear victory" for low power enthusiasts.[227] In fact, the episode reveals the protectionist bias of the regulatory system.

The FM band is divvied into 100 channels by the FCC, with 200 KHz allocated to each.[228] According to the technology available to the market in 1962, regulators channelized this band.[229] In general, each FM station was awarded a slot with three vacant channels on either side. These buffer zones reduced potential interference at the cost of audience program choice. Adopted prior to digitization, the scheme ignores tuners that lock onto FM frequencies.

Low-power stations were once tolerated in the FM band. But twenty years ago the Commission reversed its policy, refusing to issue low-power licenses anywhere in the continental United States.[230] Low power is defined as 1,000 watts or less, in contrast to emissions of full-power FM stations of 6,000 to 100,000 watts or more.[231] By 1999 the Commission was receiving over 13,000 inquiries annually about starting such stations,[232] and hundreds, perhaps thousands, of stations were operating illegally without licenses.[233] Several well publicized cases, and a campaign in the early Clinton Administration to crack down on "pirates," raised visibility

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[225] Kathy Chen, *FCC Is Set to Open Airwaves to Low-Power Radio*, WALL STREET JOURNAL (Jan. 17, 2000), B12.
[226] Fiona Morgan, *Pirate Radio Goes Legit*, SALON.COM (Jan. 19, 2000), http://www.salon.com/news/feature/2000/01/20/radio.
[227] Alex Markels, *Radio Active*, WIRED (June 2000), 326.
[228] Federal Communications Commission, *Notice of Proposed Rulemaking*, MM Docket No. 99-25, FCC 99-6 (Jan. 28, 1999), par. 18.
[229] Alex Markels, *Radio Active*, supra note __, 371-2.
[230] Jeannine Aversa, *Low-Power Radio Idea Criticized*, ASSOCIATED PRESS (Feb. 11, 1999, 12:10 EST); Jesse Walker, *Upstart's in Radio's Land of the Bland*, N.Y. TIMES (Jan. 29, 2000).
[231] Federal Communications Commission, www.fcc.gov/mmb/asd/fmclasses.html.
[232] Federal Communications Commission, *Notice of Proposed Rulemaking*, MM Docket No. 99-25, FCC 99-6 (Jan. 28, 1999), par. 11.
[233] "FCC agents have busted about 150 [pirate broadcasters] per year…" Alex Markels, *Radio Active*, WIRED (June 2000), 320.

of the issue.[234] The FCC changed course, however, when it issued a *Notice of Inquiry* in 1998. It followed up with a *Notice of Proposed Rule Making* in January 1999, and a *Report & Order* in January 2000.

The existing FM allocation inefficiently devours spectrum by keeping multiple channels vacant between broadcasting stations in the same market. These guard bands give a station assigned 94.5 MHz the implicit right to silence six adjacent channels: 94.7, 94.9 and 95.1 to the north, 94.3, 94.1, and 93.9 to the south.[235] FM "pirates" discovered many years ago that they could transmit in these stretches of dead air. Such broadcasts did not disrupt existing communications; indeed, they long went undetected. Commercial and National Public Radio-affiliated broadcasters, keenly concerned about loss of audience, informed the FCC about unlicensed operators.

Pirate radio stations attempt to make productive use out of idle airspace. Not only is it economically efficient to extract additional value from a given resource, new broadcasting activity promotes public goods as defined by the Federal Communications Commission. It enriches democratic debate to bring diverse information and entertainment to listeners. Given the FCC's long-standing policy that "localism" is in the public interest, tiny neighborhood competitors might have been embraced by regulators. Instead, the FCC reflex was to suppress such broadcasting. The crackdown, however, mainly worked to inspire additional illegal entry.

Finally, the Commission chose to suppress low-power FM in a more effective manner: by embracing it. By extending an extremely limited, highly regulated opportunity to a small handful of community radio stations, vast opportunities for low-power FM broadcasting will continue to be left unexploited. Incumbent broadcasters, both public and private, will be protected from effective competition. But the cause of the anti-consumer result will be invisible to the public, as the generic policy against LPFM will have ended. The Commission will ironically appear to champion the interests of LPFM listeners.

Indeed, thanks to harsh opposition to the FCC's LPFM proposal by the National Associations of Broadcasters (NAB) and National Public Radio (NPR),[236] this has already

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[234] Loring Wirbel, *Too Much Noisy Static*, ELECTRONIC ENGINEERING TIMES (Feb. 14, 2000), http://www.techweb.com/se/directlink.cgi?EET20000214S0056.

[235] Federal Communications Commission, *Report and Order*, MM Docket No. 99-25, FC 00-19 (Jan. 27, 2000), par. 2.

[236] "The firestorm of opposition from broadcasters to a U.S. proposal to set aside spectrum for low-power FM radio stations resurfaced again last Monday at the National Association of Broadcasters convention." The NAB appealed to Congress and filed suit in federal court to stop the FCC's low-power FM license assignments. George Leopold, *Debate Over Low-power FM Flares Again at NAB Confab*, EETIMES (April 17, 2000), www.techweb.com/se/directlink.cgi?EET2000041720027. The NAB was joined in its fight by National Public Radio. Stephen Labaton,

occurred. The conflict demonstrates the conservative bias of spectrum allocation, including the huge over-weighting of *Type I* error. Three things are notable about industry opposition to low-power FM. First, the broadcasters boldly assert factual mis-statements, prompting the FCC to issue almost humorous rejoinders.[237] In particular, the NAB distributed a compact disk to members of Congress in January 2000 that featured sounds of static interference. The screechy noises purported to simulate the marketplace effect of allowing new low-power stations to crowd in on the FM dial. The special effects, however, had no technical connection to the alleged market failure. As the NEW YORK TIMES reported, "Although government engineers say the stimulation [sic] is downright fraudulent and cannot be replicated at the F.C.C.'s radio lab, the compact disk has had a substantial impact on the debate in Congress and has repeatedly been cited by lawmakers as evidence of the need to block the low-power radio program."[238]

Second, the brash tactics are productive. H.R. 3439, a bill "To prohibit the Federal Communications Commission from establishing rules authorizing the operation of new, low power FM radio stations," passed the House of Representatives, 274-110, on April 13, 2000.[239] The bill guts low power FM by protecting three vacant co-channels around FM assignments, and requires the FCC to consider the effect of low-power FM stations "on incumbent FM radio broadcasters… including an analysis of the economic impact on such broadcasters" prior to issuing any new licenses.[240] Its sponsor, Rep. Billy Tauzin (R-LA), Chair of the House Telecommunications Subcommittee, has openly defended such interests. "Rep. Billy Tauzin of Louisiana said the Federal Communications Commission plan for so-called microradio would reduce the audience and advertising revenue of current stations and possibly create severe interference."[241] (The admission that economic damage is certain, while signal degradation is speculative, is a clue into regulatory dynamics.)

F.C.C. Heads for Showdown With Congress Over Radio Plan, N.Y.TIMES (March 27, 2000); Marc Fisher, *Low-power to the People*, AMER. J. REV. (Oct. 2000), http://ajr.newslink.org/ajrfishoct00.html.

[237] Federal Communications Commission, *Low Power FM Radio Service: Allegations and Facts*, FCC web page, July 4, 2000; Federal Communications Commission, *Statement of Dale Hatfield, Chief, Office of Engineering and Technology, and Roy Stewart, Chief, Mass Media Bureau, Concerning Low Power FM Engineering Issues* (March 24, 2000), FCC web page.

[238] Stephen Labaton, *F.C.C. Heads for Showdown with Congress Over Radio Plan*, N.Y. TIMES (March 27, 2000).

[239] Marc Fisher, *Lobbying Against Low-power Radio*, AMER. J. REV. (Oct. 2000), http://ajr.newslink.org/ajrfishoct00a.html.

[240] H.R. 3439, 106th Congress, 2nd Session, 7.

[241] *Top Legislator Blasts U.S. FCC Microradio Proposal*, REUTERS (Feb. 11, 1999, 3:39 pm PST). Tauzin has attacked the content that would emanate from low power stations, fearing "microradio would be filled by the rhetoric of 'skinheads' and other fringe groups. 'Suppose we have a bad message,' Tauzin said. 'Do we create a special spectrum for those kind of voices? I don't think we should.'" Elizabeth A. Rathbun, *Tauzin Hits FCC Over Microradio*, BROADCASTING & CABLE (Feb. 15, 1999), 18.

Congressional sentiment was clearly an incentive for the FCC to abandon more ambitious FM low-power policies, including that originally proposed by the Commission in 1999.[242] (See discussion related to Table 7, below.) On Dec. 15, 2000, anti-LPFM legislation did indeed become law, meaning "that at most a handful of stations in the least populated parts of the country may be started, although even that now is uncertain."[243]

Finally, broadcasters argue interference in a categorical way. Instead of debating the pluses and minuses of low-power FM, or comparing the cost of new signal degradation with the benefit provided by new stations, they present an all-or-nothing defense of the status quo. If *any* new transmissions interfere with *any* stations now on the air to *any* degree, the conclusion is that *no* new broadcasting should be allowed.[244] An NAB vice president declares: "Interference is obnoxious." No quantification necessary, nor consideration of the rival obnoxiousness—reduced listener choice.[245]

An illuminating expert report by Virginia Polytechnic Institute engineering professor Theodore Rappaport documents the polar position taken by regulators and broadcasters.[246] It notes that the FCC adopts worst-case assumptions in creating station separation rules. These rules err hugely on the side of too few stations (rather than too much interference) when adopted, and become increasingly obsolete over time (as new technology improves radios). Of course, with such rules in place, radio sets need not upgrade performance, as there is no demand for equipment to receive additional signals (which fail to be licensed by the FCC). Broadcasters then seize on the least discriminating radios to test the effect of new transmissions.[247] Interference becomes a self-fulfilling regulatory reality.

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[242] Powerful members of Congress have repeatedly attacked the FCC, and FCC Chairman William Kennard, on the issue of low-power FM. "The FCC 'is an agency out of control that demands congressional action to straighten it out,'" claimed House Telecommunications Subcommittee Chair Billy Tauzin (R-LA). *Top Legislator Blasts U.S. FCC Microradio Proposal*, REUTERS (Feb. 11, 1999, 3:39 pm PST). See also, Elizabeth A. Rathbun, *Tauzin Hits FCC Over Microradio*, BROADCASTING & CABLE (Feb. 15, 1999), 18. "Saying 'I have never been so offended by an agency of government' except perhaps the IRS…, Tauzin blasted the FCC's new microradio proposal."

[243] Stephen Labaton, *Congress Severely Curtails Plan for Low-Power Radio Stations*, N.Y. TIMES (Dec. 19, 2000).

[244] Or, equivalently, that numerous studies and safeguards should be imposed that effectively kill LPFM for years into the future.

[245] George Leopold, *Debate Over Low-power FM Flares Again at NAB Confab*, EETIMES (April 17, 2000), www.techweb.com/se/directlinnk.cgi?EET 2000041720027.

[246] Theodore S. Rappaport, Kirk Carter and Roger Skidmore, "Technical Analysis of the Low Power FM Service," report submitted to the Media Access Project (Aug. 26, 1999) (MAP). The MAP attached the report to Comments it filed at the FCC, and posts it at: www.mediaaccess.org.

[247] "FCC protection ratios do not reflect the actual FM interference environment. In fact, the interference environment is much more forgiving than the FCC ratios would indicate, which is why modern receivers are designed less stringently than the ratios indicate. The FC ratios are the basis for a conservative calculation of the required separation distances for FM stations. Thus, the ratios tell us how close FM stations can be to each other, but very little about the actual resulting interference." Rappaport et al., supra note __, 44. The "protection ratios" are the coverage areas allotted to stations as defined by signal/noise levels.

Ignoring dynamic improvements, information revealing whether new broadcasts improve or lessen listener enjoyment would be interesting. These experiments are not performed. Instead, broadcast industry engineers show that low-power broadcasts could exceed FCC interference parameters. To achieve even this modest result, broadcasters use receivers of such poor quality that existing full-power FM transmissions can also be shown to violate FCC interference rules. "The NAB invents a 'worst radio,'" writes Rappaport, "in order to show much greater potential LPFM interference than would be experienced by any real receiver."[248]

The categorical plea for interference-free operations, while theoretically rendering all FM broadcasting in violation of the public interest, is applied asymmetrically. Old FM stations already have licenses; only new stations must apply. The administrative process invites interests to oppose "reduc[ing] the audience and advertising revenue of current stations," by raising the possibility that entry will "create severe interference."

If existing broadcasters were given the right to sub-divide assigned frequencies (including first, second and third adjacent channels), they would race to establish thousands of new stations in a quest for new revenues. Broadcasters oppose privatization, however, because radio license values would decline as competition for listeners intensified. Incumbents would be forced to provide additional programming were the 100 FM channels owned fully by private parties.

Instead, license restrictions police a cartel and block new entry. As of September 30, 1999, the FCC listed 7,832 full power FM stations (of which 2,066 were non-commercial), and 4,783 AM outlets.[249] Since November 1964 some 400 full power FM stations have been "short spaced," operating with just one or two channels of separation. According to the Commission, "These full-power stations… have consistently met the Commission's criteria for distortion-free signals."[250] Radio stations operating at a small fraction of the power could transmit "distortion-free signals" with similar buffers.

The FCC's January 2000 LPFM allocation provided for about 1,000 stations emitting 10 or 100 watts—less than four new stations per each of the 269 U.S. radio markets.[251] (Under the truncated allocation consistent with the Dec. 2000 legislation, less than one new low-power station will be permitted per market.) How many stations *could* be inserted into the FM dial

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[248] Ibid., 48.
[249] FCC website, www.fcc.gov/mmb/asd/totals/bt990930.html.
[250] FCC Fact Sheet, *Low Power FM Radio Service: Allegations and Facts*, FCC web site.
[251] While 276 radio markets are defined by Arbitron, seven are subsumed by adjacent markets. See Table 6.

subject to the constraint that interference does not exceed current levels?[252] If full-power stations peacefully co-exist with one or two channel separation, it is reasonable to assume that they will offer acceptable signal clarity when 100-watt stations are in similar proximity. Let us calculate the capacity of the FM band to support new 100-watt stations by supposing that each existing full-power station occupies a 20 kHz channel and is protected by two adjacent channels (one on either side) kept vacant. Because other full-power stations also enjoy such protections, and buffer channels are not shared in this model, each existing licensee is given two adjacent channels of protection (i.e., more than that afforded some full-power stations operating for decades) against other full-power stations. The spacing would result, however, in some full-power stations sharing just one buffer channel with low-power stations.

On each channel unused by high-power FM (including buffers), drop in 100-watt stations. Because a 100-watt station has a broadcast contour radius of 3.5 miles, assume that each station "consumes" 64 square miles. (This is an 8X8 square, slightly larger than the coverage area.)[253] This implies that $100 - 3X$ channels are available for LPFM stations in each market, where X = no. of local full-power FM stations. As each station is allocated 64 square miles, potential LPFM drop-ins = $[100 - 3X]\ [SQM/64]$, where SQM = square miles in the radio market.

Some of these potential low-power stations could be damaged by "blanketing interference" from full-power stations. This is the effect that an FM transmitter has in blocking all other FM stations' reception in the immediate area. With the most powerful FM stations the area "blanketed" is up to 2.5 miles in radius.[254] If we assume that one entire 64 square mile LPFM slot will be unavailable on any local frequency in the area used by every local full-power FM station, we account for this interference posed by subtracting $X(100 - 3X)$ slots from possible LPFM insert capacity.

Finally, to avoid having small markets with small potential audiences skew results, an optional constraint limits the available slots in a market to just one station per 1,000 of population (12 years and older). This is not recommended as a normative policy, as demand for licenses should be satisfied without regard for economic viability.

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[252] The appropriate constraint accounts for the additional consumer benefits provided by increased broadcasts, so the "current level of interference" must be measured as a ratio.

[253] While low-power stations may suffer non-trivial interference by being packed in tightly, these stations could coordinate (through spacing, aggregation, time-sharing, etc.) or use technology to control signal degradation (assuming flexible FCC rules). The key is that the one-channel separation barrier limits degradation of full-power station signals.

[254] Rappaport, Technical Analysis, supra note __, 21-22.

By this estimation, there exists sufficient space in allocated FM frequencies for about 5,500 new 100-watt station—in the top ten U.S. radio markets alone. Medium markets like Peoria, Illinois and small markets such as Casper, Wyoming have ample room to accommodate new stations up to the artificially imposed 1/1000 person cap. See Table 6.[255] In total, the 269 U.S. Radio Markets.[256] (Under the truncated allocation consistent with the Dec. 2000 legislation, less than one new low-power station will be permitted per market.) How many stations *could* be inserted into the FM dial subject to the constraint that interference does not exceed current levels?[257] If full-power stations peacefully co-exist with one or two channel separation, it is reasonable to assume that they will offer acceptable signal clarity when 100-watt stations are in similar proximity. Let us calculate the capacity of the FM band to support new 100-watt stations by supposing that each existing full-power station occupies a 20 kHz channel and is protected by two adjacent channels (one on either side) kept vacant. Because other full-power stations also enjoy such protections, and buffer channels are not shared in this model, each existing licensee is given two adjacent channels of protection (i.e., more than that afforded some full-power stations operating for decades) against other full-power stations. The spacing would result, however, in some full-power stations sharing just one buffer channel with low-power stations.

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[255] These station assignment availabilities are not the result of an engineering study, but of a review of FCC records using the described rules. Because FCC data do not precisely define radio markets, they are subject to judgments regarding how stations are locally aggregated. To deduce a more precise estimation of the low-power station insertion capacity of the FM band, a full-fledged engineering study should be undertaken. Such a study should use market-oriented interference standards rather than the overly conservative FCC parameters.

[256] While 276 radio markets are defined by Arbitron, seven are subsumed by adjacent markets. See Table 6.

[257] The appropriate constraint accounts for the additional consumer benefits provided by increased broadcasts, so the "current level of interference" must be measured as a ratio.

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By this estimation, there exists sufficient space in allocated FM frequencies for about 5,500 new 100-watt stations—in the top ten U.S. radio markets alone. Medium markets like Peoria, Illinois and small markets such as Casper, Wyoming have ample room to accommodate new stations up to the artificially imposed 1/1000 person cap. See Table 6.[260] In total, the 269 U.S. radio markets defined by Arbitron yield 97,701 opportunities for 100-watt stations. Without imposing the population-based cap, slots for over 306,000 LPFM stations are estimated to be available.

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[259] Rappaport, Technical Analysis, supra note __, 21-22.

[260] These station assignment availabilities are not the result of an engineering study, but of a review of FCC records using the described rules. Because FCC data do not precisely define radio markets, they are subject to judgments regarding how stations are locally aggregated. To deduce a more precise estimation of the low-power station insertion capacity of the FM band, a full-fledged engineering study should be undertaken. Such a study should use market-oriented interference standards rather than the overly conservative FCC parameters.

Table 6. Capacity of U.S. Radio Markets to Absorb LPFM Stations

Rank	Radio Market [a]	Pop (12+) [a]	Area (sq mi)[b]	No. FM stations[d]	LPFM slots[e]	Blanketing effect[f]	Net slots after blanketing effect	Cap (Max = 1/1000 pop)	Final result: No. of LPFM stations
1	New York, NY	14,449,700	7,796	69	0	0	0	14,450	0
2	Los Angeles, CA	10,347,700	4,850	38	0	0	0	10,348	0
3	Chicago, IL	7,147,300	5,619	46	0	0	0	7,147	0
4	San Francisco, CA	5,812,200	7,369	62	0	0	0	5,812	0
5	Philadelphia, PA	4,063,000	3,518	19	2,364	817	1,547	4,063	1,547
6	Dallas-Ft. Worth, TX	3,928,600	6,968	32	435	128	307	3,929	307
7	Detroit, MI	3,826,600	4,466	23	2,163	713	1,450	3,827	1,450
8	Boston, MA	3,724,100	3,105	24	1,359	672	687	3,724	687
9	Washington, DC	3,664,600	3,967	29	806	377	429	3,665	429
10	Houston-Galveston, TX	3,613,700	7,107	29	1,444	377	1,067	3,614	1,067
1-10	Large Market Totals				8,571	3181	5,487	60,579	5,487
134	Appleton-Oshkosh, WI	289,700	1,399	13	1,333	793	540	290	290
135	Peoria, IL	289,200	1,797	13	1,712	793	919	289	289
136	Biloxi-Gulfport-Pascagoula, MS	286,700	1,785	13	1,701	793	908	287	287
137	Atlantic City-Cape May, NJ	286,600	816	18	587	828	0	287	0
138	Trenton, NJ	284,800	226	5	300	425	0	285	0
139	Stamford-Norwalk, CT	283,300	210	4	289	352	0	283	0
140	Tyler-Longview, TX	272,500	2,101	15	1,806	825	981	273	273

141	Newburgh-Middletown (Mid-Hudson Valley), NY	270,900	816	9	931	657	274	271	271
142	Montgomery, AL	266,400	2,008	10	2,196	700	1,496	266	266
143	Eugene-Springfield, OR	265,200	4,554	9	5,195	657	4,538	265	265
134-143	Mid-size Market Totals				16,050	6823	9,656	2796	1941
267	Jackson, TN	72,000	557	11	583	737	0	72	0
268	Bangor, ME	71,400	352	12	352	768	0	71	0
269	Beckley, WV	67,800	1,271	6	1,628	492	1,136	68	68
270	Mason City, IA	67,800	1,469	8	1,744	608	1,136	68	68
271	Jonesboro, AR	66,100	711	8	844	608	236	66	66
272	Cheyenne, WY	64,300	2,686	9	3,064	657	2,407	64	64
273	Great Falls, MT	63,300	2,698	5	3,583	425	3,158	63	63
274	Meridian, MS	61,200	1,380	10	1,509	700	809	61	61
275	Brunswick, GA	56,500	1,052	7	1,299	553	746	57	57
276	Casper, WY	50,600	5,340	8	6,341	608	5,733	51	51
267-277	Smallest Market Totals				20,947	6156	15,361	641	498
1-276	**ALL-MARKET TOTALS**	**183,127,200**	**606,292**	**3,736**	**488,179**		**306,805**		**97,701**

Notes

New York market includes Markets 47 and 99; San Francisco metro includes 27 and 113; Providence-Warwick-Pawtucket includes 164; Washington DC includes 200.

a. Based on Arbitron radio markets, Fall 1999.

b. Based on Arbitron definition of market areas (follows US Census Bureau Metropolitan Statistical Areas).

c. CMSA=Consolidated Metro Statistical Area. MSA=Metro Statistical Area. PMSA=Primary Metro Statistical Area

d. Data from BIA Research Inc, Radio Yearbook 2000.

e. Gross LPFM slots = [100 – 3X] [SQM/64], where X = no. of full-power FM stations. Assumes LPFM 100-watt station coverage area 8 miles square.

f. Slots lost to blanketing = X(100 – 3X), where X = no. of full-power FM stations. Assumes a blanketing area of 64 square miles.

Sources:

Arbitron radio market rankings, www.arbitron.com/radiosurvey/mm001025.htm

US Census Bureau, www.census.gov/population/censusdata/90den_ma.txt

FCC, Mass Media Bureau, Audio Service Division, www.fcc.gov/mmb/asd/fmq.htm#sprung3

BIA Research Inc., Radio Yearbook 2000. Invest In Series.

This approximation is rough but exceedingly conservative. Blocking off three channels for each full power FM assignment wastes usable bandwidth, as does the use of separate buffer channels between stations. These rules are so stringent they soak up all low-power insert capacity in the top four markets, despite the fact that airspace for low-power broadcasting has been found there by both radio pirates and FCC regulators. Indeed, that the four largest radio markets each feature in excess of 34 FM stations under existing rules demonstrates that full-power stations do not effectively block three channels throughout each local market.

Small cities, towns, and even sparsely populated rural areas support both licensed and unlicensed stations,[261] but are entirely excluded from our estimation. About one-half the total number of FM radio stations in the United States are located outside defined radio markets. Were low-power assignments extended to these areas, available insert slots would swell. Of course, such areas are served by far fewer full-power stations, so spectrum space is relatively abundant for LPFM.

The estimation also assumes that only 100-watt stations are desired. Including a mix of 10-watt stations could dramatically increase available slots. The estimate also excludes low-power opportunities in AM, a band less populated than FM.[262] The assumption that a band used once for FM high-power stations (even if only as a buffer) is available nowhere within a given radio market is also extremely conservative.

This lower-bound approximation reveals that the FCC's controversial plan to create a low-power radio service contemplates allocating barely a flash of available airspace to community broadcasters. Low-power radio *could* be a ubiquitous communications medium for churches, schools, local businesses, farms, and public safety organizations. Given permissive regulation, supply would flood the market, triggering experiments with newly abundant wireless communications. In many markets licenses might be available to all who applied, without charge.

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[261] A pirate radio case still in the federal courts, for example, involves a North Dakota farmer providing classical music to his and neighboring farms. Roy Neset v. United States of America, Case No. 98-3539, U.S. 8th Cir.

[262] Citing the filings of Aaron Reed, Chuckie Broadcasting Co., and Oklahoma Dept. of Transportation, the FCC eliminated AM low-power thusly: "Many commenters agreed that existing interference within the AM band and the relative complexity of AM facilities should preclude consideration of a low power AM service." This is hardly compelling, least of all because the "relative complexity of AM facilities" would be a problem for the private applicants to deal with if given the opportunity to enter the market. Indeed, FM was thought to be relatively complex compared to AM for many decades (see AM Blocks FM discussion, above), and remained so until pirates used inexpensive broadcasting kits to invade the airwaves. *Report and Order*, supra note __, par. 57.

Would interference result? Yes, *some* would occur. It always does.[263] This is the unhelpful question posed by regulators and anti-competitive interests. Would the interference annoy listeners so substantially as to cancel the gains from enhanced choice? No—and a much more useful question. The FCC has run the one-channel separation experiment with full-power stations since 1964. Stations emitting 100-watts do not create more interference than those operating at 6,000 to over 100,000, ceteris paribus.[264]

Even prior to its 80% congressional haircut,[265] the plan approved by the FCC was a textbook example of how to effectively curtail new entry while nominally supporting it. Over-regulation of entrants is a victory for incumbents by raising rivals' costs.[266] The structural biases of public interest spectrum allocation facilitate this anti-competitive outcome. As FCC Chair William Kennard conceded, "We knew the firestorm of criticism we would get from broadcasters trying to protect their markets. That's why we proceeded so cautiously in the rule-making process."[267]

In 1999, the FCC sought to license 100 watt and 1,000 watt stations,[268] but the *Order* limited new licensees to a maximum of 100 watts. This yields a standard coverage area just one-

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[263] Interference among full-power stations can be found where signals using the same frequency are of approximately equal strength. Hence, signal degradation can be documented in existing services. The Virginia Center for the Public Press (VCPP) has done this, recording actual interference between full-power FM stations in Washington, D.C.: http://hometown.aol.com/Wrfr/COM.htm. "Some interference from existing FM stations is already acceptable under FCC rules. For example, blanketing interference… The FCC considers blanketing interference to be acceptable from existing FM stations." Rappaport, Technical Analysis, supra note __, 21.

[264] The VCPP notes five pairs of "short spaced" stations in Washington, including WTOP (107.7) and WRQX (107.3), separated by just one channel. The stations' transmitters are 43 miles apart, and broadcast at 29,000 watts and 34,000 watts, respectively. "Grandfathered 'Short Spaced' stations… are close on the dial and are very near each other. Do they interfere significantly with each other? A drive through test has shown that they do not. Compare their signal wattage with a 100 watt LPFM station. Would you expect any interference in that case? Under these circumstances, it's obvious you would not." Testimony of Christopher Maxwell, Secretary/Treasurer, The Virginia Center for the Public Press, Before the U.S. House of Representatives Subcommittee on Telecommunications, Trade and Consumer Protection, Hearings on THE FCC'S RADIO SPECTRUM MANAGEMENT, INCLUDING H.R. 3439, March 17th, 2000, Washington, D.C., 6.

[265] The new law, "Reverses the FCC's decision with respect to interference protection by putting back 'third adjacent protection.' This means that about 75-80% of the low power stations will no longer be available. The loss of stations will be concentrated in the most populated markets." "Summary of the Anti-LPFM Legislation," Media Access Project web site (visited Jan. 3, 2001), www.mediaaccess.org/programs/lpfm/rpa2000.html.

[266] Thomas G. Krattenmaker and Steven C. Salop, *Anticompetitive Exclusion: Raising Rivals' Costs to Achieve Power over Price*, *Raising Rivals' Costs*, 96 YALE L.J. 209 (1986).

[267] Alex Markels, *Radio Active*, supra note __, 372. The article goes on to report: "He [Kennard] says this led to the FCC's decision against earlier plans to allow narrower channel spacing and higher-wattage LPFM signals." This illuminates the conservative bias of spectrum allocation. It is the primarily the structure of the administrative process – not the ideology of regulators – responsible for anti-competitive outcomes.

[268] Federal Communications Commission, *Report and Order*, MM Docket No. 99-25 (Jan. 27, 2000), par. 4.

eighth of that provided by 1,000 watt transmitters, which broadcast a 10 mile radius.[269] The severe power limits undermine economies of scale in marketing and promotion, as well as other productive dimensions.[270]

For-profit entities were ruled ineligible for low-power radio licenses. This protects incumbents from new competition in local advertising markets.[271] It also eliminates organizations perfectly suited to provide community radio programming, including some Indian tribes.[272] Further, only one license will initially be granted per non-profit licensee. After two years, as many as five stations may be owned in different areas, and after three years the national limit is relaxed to ten stations—where it stays. Additionally, LPFM licensees may not have any ownership interest in other media properties (including a newspaper).[273] These rules, designed to favor amateur operators, virtually guarantee inexperience, and block efficient combinations of operations. They are far stricter than rules applied to full-power stations, an asymmetry impossible to justify on consumer protection grounds. Such constraints will severely hamper entrants in producing popular programming and, therefore, attracting capital from either investors or donors.

Third, low-power licensee are assigned by comparative hearings, the traditional FCC method wherein the Commission determines who deserves to broadcast according to public interest criteria. The three key items evaluated in the process are (a) local community presence of group applying for a permit; (b) commitment to on-air operation; (c) commitment to original program content. The last two criteria are specified: applicants pledging to provide at least 12 hours of daily programming, and *eight hours* of original daily programming, receive bonus points.[274] Stations making such pledges will be first to receive licenses, but the obligations

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[269] Aaron Pressman, *Now You Can Create A Radio Station*, REUTERS (Jan. 20, 2000, 10:37 am PT), http://www.zdnet.com/filters/printerfriendly/0,6061,2424651-2,00.html. The average 100 watt station will reach only about 12% the area covered by the average 1000 watt station.

[270] The FCC was strongly urged to allow 1,000 watt emissions, because "restricting LPFM stations to lower power operation will adversely affect their economic viability." Even where 1,000 watt stations could broadcast without serious interference problems, the Commission rejected the plea. Federal Communications Commission, *In the Matter of Creation of Low Power Radio Service: Memorandum Opinion and Order on Reconsideration*, MM Docket No. 99-25 (Sept. 28, 2000), par. 70.

[271] The FCC received public comment that "restricting the service to noncommercial service reduces LPFM stations' economic viability and eliminates a potential advertising medium for small business." *Order on Reconsideration*, supra note __, par. 72.

[272] Tribes are allowed to apply for LPFM permits, but must meet noncommercial enterprise criteria. Those that operate profitably are presumably ineligible. *Order on Reconsideration*, supra note __, par. 75.

[273] *Order on Reconsideration*, supra note __, pars. 76, 78.

[274] *Order on Reconsideration*, supra note __, par. 97.

incurred will prove crushing. They will also deprive low-power listeners of desirable programming produced elsewhere—say, home country news and entertainment in an immigrant enclave. This content is heavily discriminated against by FCC rules.

As bold and innovative as local content sounds in theory, it is extremely difficult to achieve and typically counter-productive to mandate. The failure of public access cable television channels to attract even trivial audiences, despite receiving literally hundreds of millions of dollars in cross-subsidies courtesy of local franchise regulators, is testimony to the consumer hostility embedded within the scheme.[275] That low-power FM advocates strongly agree with such entry-killing mandates is powerful evidence of the structural infirmities of FCC spectrum regulation.[276]

Table 7. Limitations of FCC's Jan. 2000 Low Power FM Broadcasting Policy

Policy	*What Obtained*	*What was Possible*	*Reason/Comment*
Power	10 watt and 100 watts	1000 watts (in NPRM)	Reduced service areas from 10 mi. radius to between 1 and 3.5 mi.
No. of stations	Up to 1,000	97,701 (capped) 306,805 (uncapped)	Using second adjacent channels for local stations yields abundant insert opportunities
Which Band	Only FM	AM, FM, UHF, others	
Programming	Stations promising 12 hours per day total, 8 hours original programming, first to receive licenses	Market determination	Heavy financial burden is imposed, one that eliminates popular programming, hinders network formation for content
Eligibility	Only non-commercial educational, "pirates" ineligible	Open entry	Limits lessen the ability of LP stations to operate efficiently, attract audiences or capital
Cross-ownership	One station per applicant, no cross-ownership of any media property (including newspapers)	Open entry	Raises costs, guarantees entrants are relatively inexperienced
Speed of enactment	LPFM licenses in 2001 barring further delays	Same policy decades previous	

[275] Thomas W. Hazlett, *Private Monopoly and the Public Interest: An Economic Analysis of the Cable Television Franchise*, 134 U. PENN. L.R. (July 1986), 1335, 1400-01; Mark Zupan, *The Efficacy of Bidding Schemes in the Case of Cable Television: Some Systematic Evidence*, 32 J. LAW & ECON. 401 (OCT. 1989).

[276] The Media Access Project actively promotes LPFM, but sabotages its success by arguing, for instance, "The Commission May Place Stricter Ownership Limits on Low Power FM Stations than on Full Power Stations." Reply Comments of United Church of Christ, et al., Federal Communications Commission, *In the Matter of Creation of a Low Power Radio Service*, MM Docket 99-25 (Nov. 15, 1999), 36.

Fourth, in what has to be considered almost gratuitous violence, the FCC barred operators of pirate radio stations from being granted new low-power station licenses. Because the FCC long determined that low-power radio would be illegal, the only experienced community radio operators are those who engaged in underground broadcasting. Prohibiting these lawbreakers from operating lawfully eliminates even the modest supply of human capital available to fledgling radio entrants.[277] Curiously, past non-compliance with various rules and regulations does not bar a corporation from being licensed to operate a full-power radio station.

Finally, licensing is likely to stretch several years. The experience with pirate FM broadcasting, the low-power rule making, the legislative fight, and the current assignment of licenses by the FCC has already stretched beyond a decade. It may go much longer. Even if licensed immediately, however, the spectrum allocation process would have prevented useful exploitation of FM frequencies for a generation. As the president of the NAB says with perhaps unintended candor: "If this could be done, it would have been done 20 years ago."[278]

UWB and SDR: The Queue Starts Here

Among the most promising wireless technologies are those known as software-defined radio (SDR). These systems intelligently sort communications across many bands, reading coded information detailing traffic conditions over alternative frequencies. These codes allow for protocols that prioritize messages. Emergency fire or police communications might take precedence over cell-phone calls, e.g., and interactive cell-phone calls over one-way data downloads (where a 0.5-second delay is not disruptive).[279] SDR intelligence can be embedded in decentralized devices to avoid interference by frequency-hopping. Congestion is managed by protocols directing traffic in order of the most time-sensitive communications. Improved traffic management increases communications capacity. [280]

A related family of communications systems is based on ultra-wideband (UWB) transmissions.[281] By utilizing very low power, UWB systems can operate underneath existing

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[277] Alex Markels, *Radio Active*, supra note __, 324.
[278] Stephen Labaton, *F.C.C. Heads for Showdown with Congress Over Radio Plan*, N.Y. TIMES (March 27, 2000).
[279] The SDR Forum provides useful information at, www.sdrforum.org. The FCC's Technical Advisory Council posts discussion papers at, www.fcc.gov/oet/tac/focusgroups.html.
[280] Joseph Mitola III, *Cognitive Radio for Flexible Mobile Multimedia Communications*, 6th International Workshop on Mobile Multimedia Communications (Nov. 1999), and Appendix D in Joseph Mitola III, *Software Radio: Wireless Architecture for the 21st Century*, Ph.D. dissertation (1999).
[281] *Bandwidth from Thin Air*, THE ECONOMIST (Nov. 6, 1999), online edition.

radio emissions without causing noticeable degradation of signals. Yet, by utilizing frequencies spanning a wide range of the radio spectrum, greater communications capacity is achievable. Much like SDR, this capacity is unleashed through intense, simultaneous use of radio bands. Receivers decipher coded information, constructing messages from what would appear a "cacophony of competing voices" to less sophisticated systems. The ability to detect low power transmissions, combined with intelligence to separate data sent over a given frequency, again increases communications capacity.

Despite years long development,[282] neither technology has gained FCC authorization. A *Notice of Inquiry* was issued for SDR in March, 2000, and the Commission is now determining what policy is warranted.[283] A rule making for UWB was initiated in September, 1998,[284] and in May, 2000 the Commission tentatively proposed to allow UWB on an unlicensed basis.[285]

The wait is on. Every week of delay in the deployment of these promising communications systems represents a loss of utility to customers and an unrecoverable reduction in wealth. While there are legitimate issues regarding the effect of new SDR and UWB devices the transmissions of existing wireless infrastructure, the process by which the FCC will resolve those issues fails to properly account for the costs of delay.

This is vividly seen here, because both SDR and UWB economize on spectrum use by *reducing* the problems of interference. Rather than pose a threat to existing communications, the technologies represent an opportunity to squeeze far more out of given bandwidth. This means that a technology-neutral regulatory structure designed to maximize the value of the public's airwaves would embrace and expedite adoption. Instead, the new applications are confronted by

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[282] Both trace their origins to military research. SDR was first demonstrated in 1995. Federal Communications Commission, *In the Matter of Inquiry Regarding Software Defined Radios*, ET Docket No. 00-47, FCC 00-103 (March 21, 2000), par. 4. UWB, an offshoot of a larger family of wireless applications called "spread spectrum," traces its roots back at least four decades. "During the period 1960-1999, over 200 papers were published in accredited IEEE journals and more than 100 patents were issued on topics related to ultra wideband technology." Gerald F. Ross, *Early Motivations and History of Ultra Wideband Technology* (Lexington, MA: Anro Engineering, Inc.), www.jacksons.net/tac/A_Brief_History_of_UWB_Communications.pdf. A leading UWB technology supplier, Time Domain, notes that it "has been meeting with members of the FCC's staff since 1991 to describe its novel time-modulated ultra-wideband (TM-UWB) RF technology." *Part 15 Emissions Measurement Technique for TM-UWB Signals*, Prepared by Members of the Technical Staff of Time Domain, attachment to Comments filed with FCC, ET Docket No. 98-153 (May 22, 1997).

[283] Federal Communications Commission, *In the Matter of Inquiry Regarding Software Defined Radios*, ET Docket No. 00-47, FCC 00-103 (March 21, 2000).

[284] Federal Communications Commission, *In the Matter of Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, FCC 98-208 (Sept. 1, 1998).

[285] Federal Communications Commission, *In the Matter of Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, ET Docket 98-153, FCC 00-163 (May 11, 2000).

tall administrative barriers, and must shoulder heavy burdens in demonstrating the public interest in new technology adoption.

SDR. Software-defined radio poses a fundamental challenge to the block allocation system. Instead of reserving entire frequencies for particular, pre-defined transmissions, SDR allows more sophisticated use of spectrum. "The technology enables devices to seek out pockets of the airwaves that are not being used locally and adapt to those frequencies."[286] Under block allocation—and the spectrum-hogging technologies mandated by block allocation—these voids are substantial. SDR introduces a more efficient traffic cop. Smart systems are programmed to automatically sidestep interfering signals, freeing unused guard bands to be used productively.

SDR poses a direct threat to traditional spectrum management by frequency hopping.[287] This jeopardizes existing interference control mechanisms, centrally planned allocations that limit traffic to neatly separated, pre-designated slots. The decentralized, agile, real-time bandwidth optimization of SDR is the antithesis of this regime, distributing "pooled spectrum" efficiently among competing licensees *and* services. FCC equipment approval rules effectively bar software-defined radio, as devices are restricted to assigned frequencies. Changing frequencies or communications protocols is forbidden without an FCC rule making.[288] As Joe Mitola writes: "Software radios provide a vast untapped potential to personalize services. But the contemporary process of spectrum allocations takes years to decades and lacks flexibility."[289]

Ultra-wideband. This family of technologies has excited interest in the press and before the FCC.[290] They "'could be the silver bullet' that resolves spectrum congestion."[291] Yet, rule

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[286] Associated Press, *Cell Phones May Upgrade Automatically*, CNET NEWS.COM (March 17, 2000, 11:00 am PT), http://news.cnet.com/category/0-1004-200-1575643.html.

[287] "Regulators in the United States and worldwide have scarcely begun to grasp what software-defined radio could mean… In fact, Dale Hatfield, chief of the FCC's office of engineering and technology, warned that it may be next to impossible to employ frequency planning in an environment where handsets could be programmed for different frequency bands and different digital air interfaces at the push of a button." Loring Wirbel, *Software Radio's Move to Handset Jolts Regulators*, ELECTRONIC ENGINEERING TIMES (Aug. 16, 1999), 67.

[288] Federal Communications Commission, *In the Matter of Inquiry Regarding Software Defined Radios*, ET Docket No. 00-47, FCC 00-103 (March 21, 2000), par. 19.

[289] Mitola, supra note __, 293. Mitola also notes that the *Type I/Type II* error trade-off extends to SDR protocols: "If the etiquette is too strict, very little additional benefit will come from spectrum pooling because the control overhead will be too high to be workable. If, on the other hand, the etiquette is too liberal, there will be much interference and universally poor quality of service. Such complex adaptive systems operate best at the 'edge of chaos.' This is not a particularly comfortable place for regulators to be." Ibid. (The quoted material is credited to Nicolas Negroponte.) Again, the conservative bias of spectrum allocation is material.

[290] See: Kevin Maney, *Pulsing With Promise: New Digital Technology Likely to Revolutionize How We Live*, USA TODAY (April 9, 1999); Speech by Commissioner Susan Ness, "Meeting the Challenge of Innovation at Internet Speed," (Sept. 29, 1999), http://www.fcc.gov/commissioners /ness/spmain.htm; Dale N. Hatfield, "Software Defined

changes are needed to allow UWB transmissions. Principally, UWB needs permission to access a wide range of frequencies (several GHz) at very low power levels. The FCC must decide if the devices generally emit an acceptable level of interference to other communications, and whether the incursion of such (low level) interference in restricted bands, including broadcast television, is in the public interest.

Both questions stir controversy. The first invites questions from wireless operators, most particularly amateur operators and users of unlicensed spectrum.[292] These firms would directly compete with the new users, and be most vulnerable to possible interference. The Federal Aviation Administration and Global Positioning System (GPS) users also fear interference, and cite dangerous consequences if UWB operations are permitted.[293] Opposition in the restricted bands is stiff. TV set makers and the National Association of Broadcasters voice concerns about UWB.[294] The FCC rule making again focuses on concern over *Type I* errors despite presumably much larger social costs associated with *Type II* errors.

The basic UWB story is even, perhaps, more compelling than that of SDR. By using low-power transmissions spread very widely, additional communications can be achieved even where spectrum looks extremely crowded. As THE ECONOMIST writes, UWB creates "bandwidth from thin air."[295] It also has extraordinary ability to go through physical structures, alleviating problems plaguing other wireless systems depending on line of sight connections.[296] Existing

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Radio: A Regulator's Perspective," SDR Forum 19th General Meeting, Seattle, Washington (June 20, 2000), www.fcc.gov/oet/speeches/ sdrforumsph.html.

[291] *Quick Rulemaking Predicted on Ultra Wideband Communications*, COMM. DAILY (Sept. 30, 1999). The passage quotes from Ralph Petroff, CEO of Time Domain.

[292] See Comments of the Wireless Information Networks Forum, FCC, ET Docket No. 98-153 (Dec. 7, 1998), and Comments of the American Radio Relay League, Inc., FCC, ET Docket No. 98-153 (Dec. 7, 1998).

[293] See Comments of the Federal Aviation Administration, FCC, ET Docket No. 98-153 (Oct. 20, 1998); Comments filed by GPS Industry Council, Federal Communications Commission, ET Docket No. 98-153 (Dec. 7, 1998), and Reply Comments of the U.S. GPS Industry Council, American Airlines, the General Aviation Manufacturer's Association, Stanford University (the GPS Research Program) and United Airlines, FCC, ET Docket No. 98-153 (Feb. 3, 1999).

[294] See Comments of the Consumer Electronics Manufacturers Association and the National Association of Broadcasters, FCC, ET Docket No. 98-153 (Dec. 7, 1998). "Clearly, it would be inconsistent with the fundamental tenets of the Commission's… policies… if the Commission were to amend its rules to accommodate the provision of unlicensed UWB radio systems, knowing that such systems can cause harmful interference within restricted bands and the TV broadcast bands." Id., 2.

[295] *Bandwidth from Thin Air*, THE ECONOMIST (Nov. 6, 1999), online edition. See also, *How to Look Through Walls*, THE ECONOMIST (Nov. 6, 1999), online edition

[296] This aspect of UWB actually has quite dynamic possibilities apart from mass communications. Time Domain, for instance, received an FCC waiver in June 1999 allowing it to sell up to 2500 devices capable of "seeing" through walls to fire and police departments. Federal Communications Commission, *In the Matter of Revision of Part 15 of*

transmissions are undisturbed due to the ability of UWB to use extremely low-power transmissions that do not rise above the "noise floor."[297]

The primary request by the UWB users is for FCC approval of devices that emit no more radiation than existing non-communications devices such as microprocessors used in personal computers. As the UWB Working Group filing submitted to the FCC argues: "The principal regulatory issue confronting UWB technologies under Part 15 involves the fact that the rules distinguish between *intentional* and *unintentional* radiators."[298] The UWB users request parity with digital devices that accidentally pollute the airwave. The request does not appear ambitious, given that the spillover emission standard adopted for microprocessors in 1979 has not proven dangerous despite vast expansion in the use of desktop and laptop computers,[299] and that the FCC agrees that "only spurious emissions" are allowed in restricted bands.[300]

Nonetheless, the UWB proposal is highly controversial. First, it is opposed by interests alleging UWB would, in fact, cause deleterious interference.[301] Any new application faces such concerns, particularly one using novel technical standards, aiming for broad deployment, and utilizing many bands. Interference is a possibility, as proponents admit, and it would be extraordinary if existing spectrum users did not call for a thorough pre-entry investigation.

Second, such interests have strong incentives to oppose entry. Objections to the applicants' ambitious new plans can be filed free of charge (by the FCC), and there is no reward offered incumbents to resist temptation. At worst, potential interference may be mitigated. At best, potential competition will be delayed. Given the spectrum allocation framework incumbents oppose entry unless they have material stakes in the innovations of the entrants.

Third, the adjudication process at the Commission allows opposition considerable leverage not afforded applicants. Opposing interests need only raise questions about possible

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the Commission's Rules Regarding Ultra-Wideband Transmission Systems: Notice of Proposed Rule Making, ET Docket 98-153 (May 11, 2000), footnote 16.

[297] The "noise floor" is background static present in all bands. Wireless communications are typically designed to ignore such signals, focusing higher power emissions. UWB uses directional microphones, metaphorically speaking, to decipher conversations in this buzz.

[298] Comments of the Ultra-Wideband Working Group to the Federal Communications Commission, ET Docket No. 98-153 (Dec. 8, 1998), footnote 6 (emphasis in original).

[299] Ibid.

[300] The FCC specifically asked for comment "on whether the Commission should eliminate the requirement that only spurious emissions be permitted to fall within the restricted bands…" FCC, *Notice of Inquiry In the Matter of Revision of Part 15 of the Commission's Rules Regarding Ultra-wideband Transmission Systems*, ET Docket No. 98-153, FCC 98-208 (Aug. 20, 1999), par. 11.

interference. That is because the entrant has an affirmative obligation to make a public interest showing, and because there is no cost (beyond lawyers' and experts' fees) to raising questions that extend rule makings. Entrants bear considerable costs, denied the ability to compete in the marketplace, often for years.[302] But these are external to incumbents.

Scientist David Hughes filed Comments and Reply Comments in the UWB proceeding, arguing "that the fears of interference by UWB devices on existing services is simply overrated."[303] Hughes appeared frustrated by the low price of admission charged opponents:

> The objections by the FAA, WinForum…, Broadcasters, and the AARL… simply provided no technical analyses—only assertions—that UWB will interfere to unacceptable degrees with their current spectrum-using devices. It appears to us that they should be called upon… to offer objective proof of the interference they fear. But simply objecting on the grounds their exclusive use of the bands assigned is the way it's always been, not be allowed to stop this important and progressive step to much more beneficial use of the spectrum.[304]

But the delays imposed on UWB are FCC pro forma. Despite the enormous spectrum efficiencies of UWB, the tsunami of demand from business and residential customers for faster,

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[301] See, for instance, the Comments filed by GPS Industry Council, Federal Communications Commission, ET Docket No. 98-153 (Dec. 7, 1998). The Council includes Boeing, Honeywell, and Rockwell International.

[302] Krohne Technology offers one excellent example. It developed an UWB method for measuring petroleum and chemicals in large tanks and requested permission to market their "novel technology" in 1992. The FCC was unwilling to classify the system as a low-power device able to access unlicensed bands, but did allow it Krohne to apply for a private radio license on every site at which the measurement device was operated. This cumbersome method allowed Krohne's Tank Level Radar Gauge BM70 to be used at "hundreds of sites" since 1992, and "there has not been a single reported case of interference *in or out of the restricted bands*." Yet, Krohne's efforts at commercial roll-out have been severely hampered "by licensing cost and inconvenience to Krohne and its customers." Krohne supports approval of UWB equipment as it is "now ripe for the Commission to discard the cumbersome and costly regulatory 'red tape' that accompanies its BM70 sales." Reply Comments of Krohne, Inc., FCC, ET Docket No. 98-153 (Feb. 4, 1999), 2-3 (emphasis in original).

[303] Reply Comments by David Hughes, FCC, ET 98-153 (Feb. 3, 1999). Hughes is Principal Investigator of the National Science Foundation's Wireless Project. He has championed the use of spread spectrum for high-speed Internet access. See David R. Hughes and DeWayne Hendricks, *Spread-Spectrum Radio,* SCIENTIFIC AMERICAN (April 1998) 94.

[304] Reply Comments by David Hughes, FCC, ET 98-153 (Feb. 3, 1999), 2. The FCC appeared unmoved, examining the record to express "a number of concerns about generally permitting the operation of UWB devices in the region of the spectrum below approximately 2 GHz." This is where the largest number of restricted bands exist, and where television is located. To solve Commission concerns, the *Notice of Proposed Rule Making* suggested consideration of even stricter power limits in the region below 2 GHz, conceding that notch filters (restricting such frequency use altogether) are exorbitantly costly (as argued by many UWB proponents commenting in the proceeding). The FCC invited further comment, stretching out deliberations. Federal Communications Commission, *In the Matter of*

more economically broadband access, and recent FCC policy directives pledging streamlined regulation to usher new services to market, UWB is going nowhere fast.[305] A news account of the September 1999 meeting of the UWB Coalition gave a glowing assessment of the technology: "UWB is to today's cell phone and radar what the microprocessor was to yesterday's mainframes. It could launch another revolution."[306] But legal problems dominated:

> [T]he UWB market is stalled… the regulations and the process for changing them has grown so many layers and so much bureaucracy, it's stultifying. So the panelists fretted over potential problems with UWB interfering with other radio signals—problems that don't seem to exist. They laid out timetables that would unfold slower than a soap opera plot. Julius Knapp of the FCC said the next steps are to analyze information, do more testing and then make a proposed rulemaking, which is not to be confused with an actual rulemaking. It's about like saying to your wife, "I'm going to make a proposed lawnmowing"—then going in the garage and gazing at the lawnmower before going inside and turning on the football game….
>
> To her credit, FCC Commissioner Susan Ness got up and criticized government sluggishness saying it has to learn to move at "Internet speed." But then, when she specifically addressed UWB, she said she'd push for "an initiative within the next few months with the hope of completing a study next year." Next year? For just a study? That's Internet speed? By next year, any Silicon Valley venture capitalist worth his salt will have found, funded and taken public four companies.

Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems: Notice of Proposed Rule Making, ET Docket 98-153 (May 11, 2000), par. 28.

[305] See, for example, *FCC Unveils 'Guiding Principles' for Spectrum Management*, Mobile Communications Report (Nov. 29, 1999). "Principles outlined in policy statement: (1) Allow flexibility in allocations, including harmonized rules, to enable licensees to respond to market. (2) *Encourage new technologies such as ultra-wideband and spread spectrum*. (3) Reserve spectrum for 'important communications needs' such as public safety. (4) Increase efficiency of assigning spectrum through 'streamlining and innovative techniques.' (5) Promote development of secondary markets for spectrum. (6) *Find ways to increase availability of spectrum*." (Quotations are to FCC. Emphasis added.)

[306] Kevin Maney, *Ultra-wideband Technology Gets Stuck in Feds' Red Tape*, USA TODAY (Oct. 6, 1999), 3B.

> Fact is, we don't really know what UWB can do or whether it could mess up existing wireless communications because regulations have prevented much testing and development. [307]

Summary

This litany of spectrum regulation horror stories is not a scientific sample. Yet it illuminates the manner in which new entry is deterred despite the absence of compelling—or even plausible—evidence that consumer welfare will be harmed. Combined with studies revealing that FCC spectrum regulation has not advanced public interests specifically identified as justification for FCC rulings, the pattern is clear.[308] Indeed, the pattern is admittedly evident to federal policy makers themselves, as seen in detailed critiques of spectrum allocation procedures[309] as well as in the call by the current FCC Chairman for market reforms to remedy the "spectrum drought"[310] The regulatory system is seen to systematically suppress competitive entry, block efficient spectrum use, and protect obsolete technologies from innovate challenge. These outcomes prevail due to structural attributes of the spectrum allocation system:

- The FCC determines bandwidth use top-down.
- Entrants wishing to compete or innovators attempting to develop new wireless technologies must apply for permission, and assume the burden of making a public interest showing.
- The public interest standard relegates consumer welfare to one interest competing among many.
- Incumbent licensees and their allies, including interest groups benefiting from cross subsidies, have incentive and opportunity to obstruct competitive forces through FCC rule makings.

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[307] Ibid.

[308] Harvey J. Levin**,** *The Radio Spectrum Resource*, 11 J. LAW & ECON. 433 (Oct. 1968); Noll, et al., Economic Aspects of Television, supra note __; Owen, et al., Television Economics, supra note __.

[309] Douglas Webbink, *A Working Paper on Frequency Spectrum Deregulation Alternatives*, Federal Communications Commission (1979); Alex Felker and Kenneth Gordon, *A Framework for a Decentralized Radio Service*, Federal Communications Commission: OPP Staff Report (Sept. 1983); U.S. Department of Commerce, U.S. Spectrum Management Policy: Agenda for the Future (NTIA Special Publication 91-23, Feb. 1991); U.S. Congressional Budget Office, *Auctioning Radio Spectrum Licenses* (March 1992); Evan Kwerel and John Williams, *Changing Channels: Voluntary Re-allocation of UHF TV Spectrum*, Federal Communications Commission: OPP Working Paper No. 27 (November 1992); Reed E. Hundt and Gregory L. Rosston, *Spectrum Flexibility Will Promote Competition and the Public Interest*, IEEE COMMUNICATIONS MAG. 40 (Dec. 1995); Rosston & Steinberg, *Using Market-Based Spectrum Policy…* supra note __.

[310] "'All of the new technologies – mobile phones, faxes, wireless computers – are consuming spectrum faster than we can make it available, and we are in danger of a spectrum drought,' Kennard say today at a meeting intended to lay the groundwork for wireless policy in the future. 'The demand for spectrum is simply outstripping supply.'" John Borland, *FCC Prepares to Ease Wireless Spectrum "Drought,"* CNET NEWS.COM (May 31, 2000).

- Protected interests enjoy substantial advantages in influencing Commissioners and their over-seers in Congress and the Executive Branch.
- The costs of excessive entry are very well represented in FCC decision making.
- The costs of insufficient entry—including the costs of delaying entry eventually deemed to be in the public interest—are dramatically under-represented in FCC decision making.

Many analyses of spectrum regulation note similar results, but attribute such outcomes to the innocent, confused origins of broadcast regulation. Despite their sharply divergent normative prescriptions, Ronald Coase and Newton Minow both believe that errors by policy makers in the earliest days of radio law led to unanticipated anti-social consequences. I believe this to be an incorrect reading of history, one that leads to a basic misunderstanding of the structure of regulation. The overly conservative legal framework in spectrum has achieved precisely what was sought by the political coalition instrumental in enacting the 1927 Radio Act. Understanding the linkage between system design and system performance leads to clearer diagnosis of spectrum policy ills, and to more effective reform.

VIII. THE GENESIS OF RADIO REGULATION[311]

Conventional wisdom regarding the origins of spectrum allocation has two essential elements. The first is that prior to the public interest standard instituted by the 1927 Radio Act the radio market was victimized by a tragedy of the commons. Dramatic measures were needed to rescue the public from a "cacophony of competing voices." The second part is that Congress' decision to regulate reflected a passive interest in legislation, motivated by radio's market failure. This led to vague rules that, out of neglect, resulted in perverse outcomes. As described by former FCC Chair Newton Minow:

> The law governing radio and television broadcasting, the Federal Communications Act of 1934, gives broadcasters free and exclusive use of broadcast channels on condition that they serve the "public interest, convenience and necessity." When I arrived at the FCC, I sought out the man who had drafted the law twenty-seven years earlier, Washington's former senator Clarence C. Dill, long retired by then. I asked him what he had meant by the "public interest."

> Senator Dill told me that he and his colleagues had been of two minds: on the one hand, it was the middle of the Great Depression and they wanted to encourage people to risk their money in the new medium; on the other hand, they knew they had to have some legal standard with which to award licenses to some people while rejecting others, because there were not enough channels to go around. "A young man on the committee staff had worked at the Interstate Commerce Commission for several years," Dill recalled, "and he said, 'Well, how about "public interest, convenience and necessity"? That's what we used there.' That sounded pretty good so we decided we would use it, too." [312]

Minow criticizes the casually crafted standard as ill-defined, resulting in a pro-industry tilt to policy. In this commonly held view, lackadaisical legislators unintentionally enacted a regulatory standard too weak to effectively constrain FCC licensees:

> The plan backfired. No one in Congress defined what the public-interest clause was supposed to mean in broadcasting. It had been developed to regulate the railroads and later the telegraph and telephone services, industries that the law deemed public utilities subject to detailed rate and public-service regulation. But the Federal Communications Act specifically exempted broadcasters from obligations as public utilities, which meant that they had the best of both world–all the benefits of a utility monopoly but none of the rate and public-service obligations.[313]

Minow is correct in positing Senator Dill, author of the 1927 Radio Act and the 1934 Communications Act, as an authority on the origins of regulation.[314] However, the history actually written by Dill is sharply at odds with what Minow claims to have been told a quarter century later.[315] According to Clarence C. Dill's 1938 volume, Radio Law,[316] the public interest

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[311] This section is based on Thomas W. Hazlett, *The Rationality of U.S. Regulation of the Broadcast Spectrum* 33 J. LAW & ECON. 133 (April 1990), and Thomas W. Hazlett, *Physical Scarcity, Rent Seeking, and the First Amendment*, 97 COL. L. REV. 905 (May 1997), 925.
[312] Newton N. Minow & Craig L. LaMay, Abandoned in the Wasteland (New York: Hill & Wang, 1995), 4.
[313] Ibid., 4.
[314] It is not clear why he focuses solely on the 1934 Communications Act, however, as the radio spectrum allocation system was created in the 1927 Radio Act and folded into the 1934 Act almost verbatim.
[315] This history, originally offered in Newton Minow, Equal Time (New York: Atheneum, 1964), was viewed skeptically in Krattenmaker & Powe 1994, 8. Dill's contradictory testimony, which follows, was not utilized in their analysis, however.

standard was not concocted by the Senate Commerce Committee. The book details what any serious student of the 1920s broadcasting marketplace would have independently discovered. Namely, that the public interest standard was anything but an ad hoc policy gambit:

> **How Broadcasters Suggested "Public Interest" Test**
>
> An interesting fact in this connection is that the broadcasters themselves suggested the inclusion of the words "public interest" in the law as a basis for granting licenses. They did this by a resolution which the National Association of Broadcasters passed in 1925.
>
> A resolution submitted to the Fourth National Radio Conference declared: "That in any Congressional legislation *** the test of the broadcasting privilege be based upon the needs of the public served by the proposed station. The basis should be convenience and necessity, combined with fitness and ability to serve."
>
> One of the provisions which the Fourth National Radio Conference adopted, read: "That public interest as represented by service to the listener shall be the basis for the broadcasting privilege."[317]

According to its legislative author, the broadcasting industry originated and promoted the public interest standard—not an innocent young congressional staffer. It is apparent that the industry acted rationally. Major commercial broadcasters were 'grandfathered' on existing frequencies, yet were not subject to fees, common carrier obligations, rate regulation, or universal service mandates. Instead, broadcasters were given licenses as *de facto* private property.[318] These licenses were enhanced in value by a regulatory structure designed to slow competitive entry. This was an innovative regulatory device, and was not borrowed from existing law as stated in Minow's version of his 1961 conversation with Dill. As Dill had written years earlier:

> **Newness of the "Public Interest" Requirement**

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[316] Clarence C. Dill, Radio Law (Washington, D.C.: National Law Book Co., 1938). In the introduction Dill writes: "With pardonable pride, I may mention that while a member of the United States Senate, I was in active charge of the writing and passage of the basic Radio Act of 1927 and of the Communications Act of 1934." Ibid., VII.

[317] Ibid., 89 (boldface and ellipses in original). As noted, this account was not unique to Dill: "As a matter of history it should be stated that at each of the four National Radio Conferences called, and presided over, by President Hoover when Secretary of Commerce, emphasized the interest of the listening public as the paramount consideration in the regulation of broadcasting." Louis G. Caldwell, *The Standard of Public Interest, Convenience or Necessity as Used in the Radio Act of 1927*, 1 AIR LAW REVIEW 295, 324 (July 1930).

[318] While the *licenses* were de facto private property, the *spectrum* allocated to licenses was not. See discussion below.

> The requirement that before granting a license to operate a radio transmitting apparatus, the federal regulatory body must find that "the public convenience, interest and necessity will be served thereby", was entirely new in radio law. In fact, it had no direct precedent in any federal regulatory law.
>
> **Previous Uses of "Convenience and Necessity"**
>
> In the Transportation Act of 1920, Congress provided the Interstate Commerce Commission must find that "the present or future public convenience or necessity require or will require" the construction or abandonment of a railroad line before granting a certificate to a railroad; but it made no mention of "public interest." Anyhow, a railroad is a public utility, but a broadcasting station is not...[319]

The regulatory standard was not casually chosen, but carefully crafted to facilitate cartelization of the broadcasting market.[320] Legislators implemented the regime pushed by major commercial radio interests, thereby gaining entrée to regulate an emerging medium of great social influence. As Dill noted:

> Congress has good reason for this jealousy as to the control of radio. Nobody can even imagine what the use of radio may some day mean to the human family. When Marconi first sent radio signals across the English channel and even after he sent them across the Atlantic, the most fantastic imagination could not foresee the marvelous programs of music encircling the earth or literally all of the peoples of the world being able to listen to the speech of a king or president. Nor can any one even now dream of the possibilities of television or what the results of the transmission of electricity by radio may some day be.[321]

The story would later develop that policy makers were dragged into regulation by airwave chaos, a tale that has helped facilitate government regulation of the broadcast press. The Supreme Court reasoned that since the state essentially created the opportunity for wireless “speech,” it could regulate what it had enabled:

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[319] Dill, Radio Law, supra note __, 86-7 (footnote omitted, boldface in original).
[320] Thomas W. Hazlett, *The Dual Role of Property Rights in Protecting Broadcast Speech*, 15 SOC. PHIL’Y & POL. 176 (Summer 1998).
[321] Dill, Radio Law, supra note __, 127.

> Before 1927, the allocation of frequencies was left entirely to the private sector, and the result was chaos. It quickly became apparent that broadcast frequencies constituted a scarce resource whose use could be regulated and rationalized only by the Government. Without government control, the medium would be of little use because of the cacophony of competing voices, none of which could be clearly and predictably heard. Consequently, the Federal Radio Commission was established to allocate frequencies in a manner responsive to the public "convenience, interest, or necessity."[322]

This rationale has been widely used to defend spectrum policies. For instance, when former FCC Chairmen Charles Ferris (1977-81) and Newton Minow (1961-63) testified in support of the Fairness Doctrine to Congress in 1987,[323] "chaos" formed the core of their analysis. Despite the evidence that maintenance of order can be achieved without program regulation (simply observe TV station sales or FCC license auctions), Charles Ferris tied content and chaos:

> The public interest standard and the concept of broadcasters as public trustees date back to the origins of broadcasting. Back then, anyone who could put up a transmitter could broadcast, and the result was chaos. Broadcasters universally demanded federal government licensing of broadcasting. Congress provided for such licensing, and in return mandated that licenses be awarded on the basis of public interest.[324]

Newton Minow joined Ferris in stressing the critical nature of airwave chaos:

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[322] Red Lion Broadcasting Co. v. F.C.C., 395 US 367, 380-1 (1969).

[323] The Fairness Doctrine was the FCC's two-pronged obligation on radio and television licensees. Adopted in 1949, it mandated first that broadcasters cover controversial issues of importance to their communities, and second, that they do so from balanced perspectives. The Doctrine was intensely controversial, although its constitutionality was upheld by the Supreme Court in Red Lion (1969). It was eventually abolished by the Commission in 1987, and congressional efforts to enact it by statute failed in 1993. The 2000 Democratic Party Platform calls for a revival of the Fairness Doctrine, and FCC Chairman William Kennard may endorse this effort. Bill McConnell, *It's Alive!* BROADCASTING & CABLE (Sept. 4, 2000), 5. On the empirical impact of the Doctrine, see Thomas W. Hazlett and David W. Sosa, *Was the Fairness Doctrine a "Chilling Effect"? Evidence from the Postderegulation Radio Market*, 26 J. LEG. STUD. 279 (Jan. 1997).

[324] Testimony of Charles Ferris, *Hearing Before the Subcommittee on Telecommunications and Finance of the Committee on Energy and Commerce, U.S. House of Representatives, One Hundredth Congress, on H.R. 1934* (April 7, 1987), 62.

> Charlie Ferris said something very important and I want to amplify it. We all forget history. Why is broadcasting regulated in the first place? It started out unregulated, and then when broadcasters realized that they had to have the exclusive right to a channel because all the public was getting was static, then broadcasters came to Washington, and they went to the then secretary of Commerce, Herbert Hoover, and they said: Mr. Hoover, you have got to do something to regulate us, you have got to do something so the public can hear the radio.
>
> That is what led to the licensing system. As Charlie said, an equation was struck. On the one hand they said to a broadcaster, here, you have the exclusive use to the microphone, just as I have it right now. In exchange for that, you will assume the responsibilities of a public trustee. You will serve the public, and as a part of that obligation it became amplified as the Fairness Doctrine.[325]

Minow ironically demonstrates his own admonition, "we all forget history," offering an account that is entirely fanciful. Policy makers in the 1920s were not driven to public interest allocation of radio spectrum by airwave chaos. Just the opposite: chaos was strategically used to procure public interest allocation.

Radio broadcasting began in the United States in November 1920,[326] and quickly became popular. By the end of 1922, over 500 radio stations were on the air. Stations held licenses from the Department of Commerce determining where and when they could broadcast; unlicensed transmissions were illegal. The Department was mandated to award licenses under the 1912 Radio Act so as to "minimize interference." [327] This it did by following two procedures. The first was to allocate bands for radio broadcasting. Initially (1920-23), broadcasters were limited to but two frequencies, with time-sharing and power limits controlling interference. In 1923, the Commerce Department expanded the number of frequencies to 70; in 1924, it further expanded the band to 89 channels (between 500 Kc and 1500 Kc, very close to the AM band used today).

Radio stations adhered to the rules, and interference did not deter industry development. Millions of Americans purchased radio receiver sets, and retailers promoted a "Radio Christmas"

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[325] Testimony of Newton Minow, ibid., 64.

[326] Most histories date radio broadcasting as beginning Nov. 2, 1920, when KDKA began broadcast daily in Pittsburgh. Many stations had transmitted programs prior to this, but the term "broadcasting" is typically not applied because few households had receivers and programming was irregular. The U.S. government officially dates the beginning in September 1921, when the Department of Commerce created a license category for radio broadcasting.

in 1924. One colorful episode illustrates the existence of airwave policing during the period of alleged chaos. It involved the Rev. Aimee Semple McPherson, "a flamboyant female evangelist who preached what she called the Four Square Gospel Church" in Los Angeles. Her church owned and operated KFSG ("Kall Four Square Gospel"), but the station strayed from its assigned frequency. "After many warnings, Hoover ordered it off the air and promptly received" the following telegram:

> TO SECRETARY OF COMMERCE HERBERT HOOVER:
>
> PLEASE ORDER YOUR MINIONS OF SATAN TO LEAVE MY STATION ALONE. STOP. YOU CANNOT EXPECT THE ALMIGHTY TO ABIDE BY YOUR WAVE LENGTH NONSENSE. STOP. WHEN I OFFER MY PRAYERS TO HIM I MUST FIT INTO HIS RECEPTION. STOP. OPEN THE STATION AT ONCE. STOP.
>
> AIMEE SEMPLE McPHERSON

The station was eventually allowed to resume broadcasting on its assigned frequency. [328]

The second important Department policy was utilization of priority-in-use rules for license assignments. Because no discretion was granted the Commerce Department under the 1912 Act beyond "minimizing interference," it could only discriminate against stations only on the basis of priority-in-time. This reflected an old principle of common law, that when a resource is effectively utilized in a socially useful way, a right is acquired against late-comers who might attempt to appropriate the resource.[329] This system worked well to control interference in the 1920-26 period. Its weakness was not in effective traffic control, but in failing to distribute benefits to key rent seeking constituencies. Hence, a primary goal of the 1927 Radio Act was to overturn the emerging property rights regime. In the words of Senator Dill:

> It is interesting to note that some of the long established principles of law were not applied to radio. In fact, the ratio statute specifically denies the application of a number of such principles. The most important of these which the radio statute sets aside is the principle of acquiring a certain property right by user.
>
> It is a long and established principle of law that if a citizen openly and adversely possesses and uses property for a long period of time without opposition, or without contest, he adcquires title by adverse possession. This is

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[327] U.S. Comp. St., 1916, Sect. 10100-10110.
[328] William B. Ray, The Ups and Downs of Radio-TV Regulation (Iowa State Univ. Press, 1990), 126-27.
[329] The principle encompasses the right of first appropriation; first-come, first served; squatter's sovereignty; pioneering rights; homesteading; adverse possession; vested rights; right of user.

> known as property by right of user. Congress wrote into the radio law the provision that user should no effect upon the right of the Commission to provide for the use of any wave length by a new and different person if the public interest would thereby be served.[330]

Priority-in-use rules policed the early radio market. Yet, major commercial broadcasting interests and key policy makers, including Senator C.C. Dill and Secretary of Commerce Herbert Hoover, were critical. Commercial broadcasters, seeing the market as overly competitive, formed the National Association of Broadcasters to lobby for public interest licensing. The motive was to secure the rights of vested incumbents and to pre-empt the entry of rivals. Under a priority-in-use regime, with rights established under common law, only the former could be achieved. The door was open for new competition to use unoccupied frequencies (including higher bands with improved technology). Policy makers also feared a property regime would limit their jurisdiction. The emerging mass medium was inherently attractive as a regulatory target. Moreover, alliances between big business and government planners were then popular tools for rationalizing economic development. Hoover, as the leading "technocrat" of his day, sought administrative federal guidance for this important new industry.[331]

In short, both Hoover and his opponents in Congress pushed for legislation. The debate concerned jurisdiction. Hoover pushed for an agency in Commerce, which he ran. This legislation was popular in the House of Representatives, where it was advanced by Rep. William White (R-ME), a Hoover ally. The Senate, however, favored an independent regulatory

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[330] Dill, Radio Law, supra note __, 78.

[331] Hoover's later service as President of the United States has tended to obscure his politics. In defending modern FCC regulation, broadcasting industry lawyer Ellen Goodman writes: "Critics [of spectrum regulation] argue that virtually all spectrum should be auctioned to the highest bidders who will use it for its 'best' purpose—the use that yields the its owner the highest financial return. As for interference, blocks of spectrum would operate much like unzoned land, with courts adjudicating disputes. Some immediate problems come to mind that even Calvin Coolidge and Herbert Hoover (not noted as champions of big government) foresaw when they launched government spectrum management." Ellen P. Goodman, *Superhighway Patrol: Why the FCC Must Police the Airwaves*, WASH. POST (Aug. 5, 1995), op-ed page. This succinct passage suggests several features of spectrum policy folklore, including the implication that public interest regulation was begun due to technical problems policing the airwaves. The interesting assertion in the immediate context, however, is that Hoover and President Coolidge (in whose administration Hoover served, and who ultimately signed the 1927 Radio Act into law) were opposed to "big government." Indeed, 1920s Republicans were very much in favor of high tariffs, substantial federal programs, and administrative controls on industries so long as such controls were worked out in partnership with business leaders. Democrats were generally anti-tariff and pro-states' rights. Franklin Roosevelt, for instance, campaigned against President Hoover's "big government" in the watershed election of 1932, promising to reduce federal spending by one-quarter.

commission yielding perks to Senators who confirm—or reject—presidential nominees. The resulting legislative standoff lasted years.

Then, Hoover acted—or, rather, strategically *failed* to act. The Secretary of Commerce openly invited broadcasters to challenge his power to regulate radio. He lost the resulting case.[332] The Secretary of Commerce then refused to appeal the decision, on advice of a public opinion offered by the Acting Attorney General of the United States, William Donovan, despite its conflict with a previous case decided by a higher court.[333] Hoover's Department of Commerce then issued a press release July 9, 1926 announcing that the Commerce Department would no longer enforce airwave assignments.[334]

Secretary Hoover coordinated industry standards though consensus, sponsoring annual Radio Conferences each year from 1922 through 1925. Curiously, no Radio Conference was called in 1926, as the Secretary "refused to regulate radio transmissions by common consent, although nearly all the broadcasters urged it. This, as one United States Senator observed, 'seemed almost like an invitation to the broadcasters to do their worst.'"[335] In the following seven months, some 200 new stations entered the marketplace, and many existing stations changed wavelengths. This excited popular discontent over airwave "pirates," "intruders," and "wave-jumpers."[336] The period from July 1926 to February 1927 quickly became known as the period of the "breakdown of the law."[337]

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[332] U.S. v. Zenith Radio Corp., 12 Fed. (2) 614 (1926).

[333] Hoover v. Intercity Radio Co., 286 F. 1003 (D.C. Cir. 1923).

[334] It is often reported that Hoover lost his regulatory authority in Zenith. That is a curious interpretation. First, the 1912 Radio Act, the statute under which the Secretary of Commerce was involved in radio licensing, explicitly granted Hoover the right to issue licenses so as to "minimize interference." Second, the 1923 Intercity decision by the D.C. Circuit Court of Appeals held that the Commerce Secretary had discretion in "selecting a wave length, within the limitations prescribed in the statute, which, in his judgment, will result in the least possible interference." The 1912 Act clearly included regulation of "wavelengths authorized…. and the hours for which the station is licensed for work." Comp. St. § 10101. Hence, the government retained control over interference through time and frequency restrictions, as well as time-sharing agreements (Commerce Department licenses were sometimes conditioned to broadcast subject to the availability of free airspace, allowing a licensee to enjoy primary or subordinate rights). Third, it is standard for federal agencies to appeal limitations on their power rather than issue statements siding with the least deferential legal interpretation. Fourth, if a cabinet official formally requests that the Attorney General issue a legal opinion, it is unlikely that the opinion was unwanted. Back channels vet internal administration information, suggesting that Hoover wanted the "adverse" opinion of the Attorney General to be publicly released.

[335] Silas Bent, *Radio Squatters*, INDEPENDENT 389 (Oct. 2, 1926).

[336] *The Survival of the Loudest*, INDEPENDENT 623 (Dec. 11, 1926).

[337] "[I]n 1926, after a second adverse decision to the effect that the Secretary of Commerce had no power under the Act of 1912 to restrict the time of operation or frequency of any station, there came a period of unregulated confusion generally known as 'the breakdown of the law.'" *Federal Control of Radio Broadcasting*, 29 YALE L. J. 247 (1926) (footnote omitted).

Two events help break the legislative impasse over the Radio Act. The first was Hoover's orchestrated chaos, which raised demand for new law. Importantly, it gave proponents of public interest licensing an answer to the question Hoover claimed was plaguing his legislative efforts: "if nothing is wrong, why fix it?"[338] The second was the development of enforceable property rights during the "breakdown" period. In a widely discussed opinion reached by an Illinois state court (which Senator Dill took care to insert into the CONGRESSIONAL RECORD[339]), radio station WGN (owned by the Chicago Tribune) obtained an injunction against a station that relocated within 40 Kc of WGN's signal in September 1926. The court found that the incumbent broadcaster enjoyed a property right under common law, and issued an injunction against the interloper. Within weeks Congress passed a resolution mandating broadcasters relinquish all claims to vested rights as a condition for continued operations. Soon after, the radio legislation stalemate lifted when Senator Dill's measure was redrawn as a compromise. The resulting Radio Act passed both houses and was signed by President Coolidge Feb. 23, 1927. In Dill's view, Congress legislated principally to pre-empt property rights:

> **Why Congress Became Aroused on Subject [of radio legislation]**
>
> The development of these claims of vested rights in radio frequencies has caused many members of Congress to fear that this one and only remaining public domain in the form of free radio communication might soon be lost unless Congress protected it by legislation. It caused renewed demand for the assertion of full sovereignty over radio by Congress...
>
> [T]he purpose of Congress from the beginning of consideration of legislation concerning broadcasting was to prevent private ownership of wave lengths or vested rights of any kind in the use of radio transmitting apparatus.[340]

Later analysts would characterize the 1920s radio market as an audio maelstrom rescued only via public interest regulation, yet the U.S. government's official history of the era—

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[338] Hoover wrote about his frustration in failing to procure a licensing law between 1923 and 1926. "One of our troubles in getting legislation was the very success of the voluntary system we had created. Members of the Congressional committees kept saying, 'it is working well, so why bother?' A long period of delay ensued." Herbert C. Hoover, The Memoirs of Herbert Hoover: The Cabinet and the Presidency 1920-1933 (1952), 142.

[339] Tribune Co. v. Oak Leaves Broadcasting Station (Nov. 1926), reprinted in the CONG. REC. – SENATE 215 (Dec. 10, 1926).

[340] Dill, Radio Law, supra note __, 80-81 (boldface in original).

contained in the first Annual Report of the Federal Radio Commission—calibrated the chaos more precisely:

> We have had about six years of radio broadcasting. It was in 1921 that the first station (KDKA) started operating, and soon grew in popularity, sales mounted, and a great new industry was in the making. Then something happened.
>
> In July, 1926, just 10 months ago, the Attorney General of the United States rendered his famous opinion that the Secretary of Commerce, under the radio law of 1912, was without power to control the broadcasting situation or to assign wave lengths. Thus, *after five years of orderly development*, control was off. Beginning with August, 1926, anarchy reigned in the ether.[341]

Radio developed in "orderly" fashion under priority-in-use rules. These rules did not depend on public interest regulation; the rules were enforceable via common law principles adjudicated by federal regulators lacking public interest discretion (as demonstrated by the U.S. Department of Commerce up until July 9, 1926), or by state courts (as Oak Leaves demonstrated in November 1926[342]). A public interest standard was clearly unnecessary to bring order to airwaves, as those dealing with the "break-down of the law" well understood.

Rather than remedying market failure, the Radio Act transferred wealth to two key interests: broadcasters and policy makers. Major commercial stations received preferential frequency assignments from the FRC, while smaller stations were eliminated via costly technical requirements.[343] Robert W. McChesney identifies the Radio Commission's General Order 40, issued in August 1928, as particularly brutal.[344] The rule reassigned 94% of U.S. broadcast stations in some dimension (frequency, time, power, or location), but carefully exempted the 6%

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[341] Federal Radio Commission, Annual Report (1927), 10-11 (emphasis added). While dated "1927," the report was published in April 1928. This passage was from a speech given by Commissioner O.H. Caldwell.

[342] Interestingly, the Cook County court ruling in Chicago Tribune v. Oak Leaves ordered the defendant not to broadcast within 50 kc of WGN within one hundred miles of downtown Chicago. This was the same separation rule adopted by the Federal Radio Commission the following year. Hence, by the standards of the federal regulatory commission, the state court got the interference question exactly right.

[343] Firms strategically impose costs on rivals, thereby reducing competitive pressures and realizing higher prices. It is a particularly profitable strategy when government regulators absorb the expense of the cost-raising activity. Thomas G. Krattenmaker and Steven C. Salop, *Anticompetitive Exclusion: Raising Rivals' Costs to Achieve Power over Price*, *Raising Rivals' Costs*, 96 YALE L.J. 209 (1986); see also Chapter 18, "Predation via Governmental Processes," in Bork, The Antitrust Paradox, supra note __, 347-64.

[344] Robert W. McChesney, Telecommunications, Mass Media, and Democracy (New York: Oxford Univ. Press, 1994), 12-37.

of stations affiliated with the two national networks (NBC and CBS). While commercial broadcasting continued to experience robust growth following 1927, the reign of the Federal Radio Commission was devastating for non-commercial broadcasting.

Policy makers also achieved their goal—jurisdiction over an important new industry. Lawmakers were empowered as licensing agents, a position yielding negotiable political currency. Lobbying activity became intense, as a 1932 study by the Brookings Institution noted: "Probably no quasi-judicial body was ever subject to so much Congressional pressure as the Federal Radio Commission."[345] Applicants seeking licenses or waivers were eager to offer political support. So were radio broadcasters, who disseminate information at wholesale prices. The news produced by broadcasters constitutes *publicity*—a key input into the support-maximizing functions of officeholders. Trading some degree of content control for protection from competition is attractive to broadcasters and policy makers alike.

In sum, public interest regulation was neither necessary nor sufficient to remedy market failure in spectrum. The lack of enforcement of frequency rights was understood as the cause of the "breakdown of the law," and priority-in-use rules were already an established and proven legal paradigm. On the other hand, public interest regulation actually introduced "non-market failure."[346] That is because the rules have been systematically biased to underutilize radio waves, producing *Type II* misallocation.

IX. THE "SPECTRUM AUCTIONS" FAUX PAS

> No station can operate without a license. Every station must operate within the terms of a license. A licensee must renew his license at regular intervals. A license may be revoked for violation of its terms, or of the regulations or of the law. In short, all the machinery of radio regulation operates through the radio station license.[347]

[345] Laurence F. Schmeckebier, The Federal Radio Commission 35 (Wash., DC: Brookings, 1932).
[346] Charles Wolf, Jr. has noted the symmetry between market and non-market failure. In this instance, public interest spectrum allocation has resulted in decisions that systematically exclude important costs or benefits. Such considerations are external to policy makers. This exhibits a "tragedy of the commons." Wolf, A Theory of Non-Market Failure (Cambridge, MA: MIT Press, 1989).
[347] Clarence C. Dill, Radio Law (1938), p. 128.

There are common references, even in official FCC documents, to "spectrum auctions."[348] This is an unfortunate phrase, because the FCC does not issue property rights to radio spectrum by auction or other assignment method.[349] What the Commission awards are licenses to use FCC-approved devices to emit signals via radio waves. It is the transmitter, and the enterprise operating that equipment, which a licensee is authorized to operate (under FCC rules). Wave lengths are allocated to licenses, not *licensees*, meaning that spectrum can only be used as authorized by regulation. Hence, FCC licenses are analogous to operating permits, not title to real property.

Indeed, to be issued an FCC license, an applicant must first certify that it will not assert any propertied interests in radio spectrum. This is so fundamental to U.S. communications law that it predates the 1927 Radio Act, being enacted in Senate Joint Resolution 125, signed into law by President Calvin Coolidge on Dec. 8, 1926.[350] This stipulation became part of the Radio Act and then, in 1934, the Communications Act, governing spectrum law to the present. The congressional motive for this provision was quite clear: "Throughout the consideration of radio legislation by both Houses, members of both the Senate and House feared the establishment of property rights in frequencies by licensees. They were of the opinion that the assertion of any proprietary rights in frequencies would fetter the regulatory authority."[351]

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[348] See, for instance, Federal Communications Commission, *The FCC Report to Congress on Spectrum Auctions*, Wireless Telecommunications Bureau, WT Docket No. 97-150 (Released Oct. 9, 1997).

[349] "Spectrum auctions" may constitute a convenient reference to the sale of licenses allowing use of radio frequencies. (In the spirit of full disclosure, the author confesses to having used the term in the title of a working paper written in 1993. Thomas W. Hazlett, "The Political Economy of Radio Spectrum Auctions," Program on Telecommunications Policy, University of California, Davis [June 1993]. The author is able to, and does, blame a headline-writing editor for the transgression committed in 1994: Thomas W. Hazlett, *Spectrum Auctions -- Only a First Step*, WALL STREET JOURNAL [Dec. 20, 1994].) The term is nonetheless misleading in its implication that spectrum is being auctioned or licensed. The regulatory system rests crucially on the distinction between wireless licenses, on the one hand, and radio spectrum rights, on the other. In creating reforms to enable market allocation of radio spectrum, the chief objective, in fact, is to turn wireless licenses *into* spectrum ownership rights.

[350] "That until otherwise provided by law, no original license for the operation of any radio broadcasting station and no renewal of a license of an existing broadcasting station, shall be granted… unless the applicant therefore shall execute in writing a waiver of any right or of any claim to any right, as against the United States, to any wave length or to the use of the ether in radio transmission because of previous license to use the same or because of use thereof." S.J. Res. 125 (69th Cong. 1st Sess.) introduced by Sen. Clarence C. Dill.

[351] Harry P. Warner, Radio and Television Law: 1952 Cumulative Supplement (New York: Matthew Bender & Co., 1953), 775. "[T]he proposed radio legislation in the nineteen twenties required a licensee to sign a waiver indicating that "there shall be no vested property right in the license issued for such station or in the frequencies or wave lengths authorized to be used thereon." ... The Commission, fearful that licensees would assert property interests in their coverage to the listening public, has inserted elaborate provisions in application forms precluding the assertion of any such right." Paul M. Segal and Harry P. Warner, *Ownership of Broadcasting Frequencies: A Review*, 19 ROCKY MT. L. REV. 111 (1947), 113, 121.

Hence, spectrum ownership rights are expressly denied FCC licensees. A cellular telephone operator, for instance, receives a series of "Radio Station Authorizations" granting the right to establish base stations. See Figure 9. (Note: an entire license can be hundreds of pages long. A 'cover sheet' is pictured in Figure 9.) These permit the licensee to utilize FCC-approved equipment, at particular geographic locations, to transmit at regulated power levels on given frequencies. The license specifies the physical equipment authorized, listing the location of each transmitter or base station. Other aspects of the business are regulated by *Orders* governing (in this example) "mobile radio authorizations." Market structure, technology, geographical service areas, rules of operation (including, for instance, the "receiver pays" rule differing from the European "calling party pays" rule), license eligibility, carrier status (common carrier vs. private carrier v. broadcaster, etc.), are among the dimensions specified in rule makings. Through the government's interest in protecting the public's airwaves from interference, a host of related, tangentially related, and completely unrelated mandates are imposed. FCC auctions do not alter this structure, despite the insistence of some commentators:

> Since the Radio Act of 1927, the radio spectrum in the United States has been allocated to broadcasters on the theory that the only way broadcasting could function was through such allocation. At first this allocation was through licensing, and recently, after many years of criticism by economists such as Ronald Coase, it has been allocated through spectrum auctions.[352]

[352] Yochai Benkler, "Topic 5: Spread Spectrum Architectures," class outline (Fall 1998), http://www-swiss.ai.mit.edu/6805/fall98-topics/topic5-spread.html.

Figure 9: An FCC License

UNITED STATES OF AMERICA
FEDERAL COMMUNICATIONS COMMISSION

RADIO STATION AUTHORIZATION

MOBILE RADIO AUTHORIZATION
FCC FORM 463

LOS ANGELES CELLULAR TELEPHONE COMPANY
6045 EAST SLAUSON AVENUE
COMMERCE, CALIFORNIA 90040

COMMON CARRIER
DOMESTIC PUBLIC CELLULAR RADIO
TELECOMMUNICATIONS SERVICE

CALL SIGN: KNKA351
SYSTEM IDENTIFICATION NUMBER 0027
FILE NO: 05602-CL-L-90
MARKET: 0002 LOS ANGELES, CALIFORNIA

PAGE 01 OF 25

OPERATOR: DC

ORIGINAL GRANT DATE: OCTOBER 13, 1989
DATE OF ISSUE: JULY 9, 1990
EXPIRATION DATE: OCTOBER 1, 1996

ALL PREVIOUSLY ISSUED AUTHORIZATIONS ARE VOID

MOBILE UNITS PRESENTLY AUTHORIZED: 250000
AUTHORIZATION IS GRANTED FOR BLOCK A –

BASE: 869.040 THROUGH 879.990 MHZ AND 890.010 THROUGH 891.480 MHZ
MOBILE: 824.040 THROUGH 834.990 MHZ AND 845.010 THROUGH 846.480 MHZ

CONTROL POINT NO. 001	6045 EAST SLAUSON AVENUE COMMERCE	CALIFORNIA
CONTROL POINT NO. 002	301 CRESCENT WAY ANAHEIM	CALIFORNIA
LOCATION NO. 001:	LATITUDE: 34 06 28 N 3024 GILROY STREET CITY: LOS ANGELES STATE: CALIFORNIA ANTENNA MARKINGS: NONE	LONGITUDE: l18 14 58 W COUNTY: LOS ANGELES
LOCATION NO. 002:	LATITUDE: 34 06 24 N 5320 FIGUEROA STREET CITY: HIGHLAND PARK STATE: CALIFORNIA ANTENNA MARKINGS: NONE	L0NGITUDE: 118 11 48 W COUNTY: LOS ANGELES

FEDERAL COMMUNICATIONS COMMISSION

In fact, spectrum is still allocated by the FCC to licenses. The method for *assigning licenses* is what has changed with the advent of auctions. Until 1981, comparative hearings were exclusively used to distinguish applicants according to "public interest, convenience, and necessity." In the budget bill passed that year, Congress approved lotteries for non-broadcast license assignments. In 1993, Congress again used an amendment to the budget to authorize competitive bidding for non-broadcast licenses. In 1997, Congress extended auctions to the few remaining broadcast licenses following the (zero-priced) award of digital TV licenses.[353]

A 1992 FCC study by economist Evan Kwerel and engineer John Williams is instructive. The paper considered the efficiency of "voluntary reallocation" of UHF radio spectrum from TV broadcasting to cellular telephone service in the City of Los Angeles. The gains were found to be substantial—around $1 billion given conservative assumptions. Yet, in recommending policies to allow spectrum to flow to more valuable uses with "pre-approval," the paper noted how far even a closely monitored deregulation of spectrum would move Commission rules:

> By relying on private initiative and market forces to implement a pre-approved reallocation objective, the recommended policy would represent a measured departure from past Commission practice. In the past, the Commission has generally accommodated new services or expansions of existing services by newly allocating or reallocating unoccupied spectrum. In rare cases the Commission has reallocated occupied spectrum and moved existing users to other bands after a period sufficiently long to amortize their investments. *But the Commission has never permitted an existing licensee to voluntarily discontinue providing the service for which it was licensed and provide a completely different service with the spectrum that was occupied by the old service.*[354]

An FCC license does not yield the right to deploy spectrum in alternative uses; market demand does not move spectrum into new services, the FCC does (or does not). Licensees seeking to use spectrum in new ways apply for a spectrum re-allocation; the default rule is that what is not permitted is disallowed. Non-licensees seeking to use unoccupied frequencies are

[353] See Hazlett, *Assigning Licenses*, supra note __, 534.
[354] Kwerel & Williams, *Changing Channels*, supra note __, 2 (emphasis added).

subject to the most stringent inflexibility, no access use whatever. Public interest determinations, not purchases of spectrum, govern their market access.

The economic result is that the "price of spectrum" is not evident in the sales price of a wireless license. Because the FCC has fixed the use of the spectrum, the opportunity cost of spectrum to the licensee is *nil*. What is valuable in the FCC license is the right to do business within the market designated by the FCC. Radio spectrum, as allocated to the license, is used at a price of zero.[355] If this opportunity is expected to earn positive profits on a discounted basis, the present value of such flows constitutes a pure rent (to the license).[356]

This accounts for the widely varying prices paid for "similar spectrum"—the spectrum is not similar if it cannot be used the same way. According to Kwerel & Williams, prices paid for UHF TV licenses were a small fraction of those for cellular telephones, adjusting for bandwidth, despite being in the same local market and being allocated adjacent frequencies. The vast differential in SMR and cellular telephone licenses that inspired the creation of Nextel is another illustration. Winning bids at FCC auctions vary considerably when allocated spectrum blocks are "priced."[357] For instance, a 1997 Congressional Budget Office analysis showed that 10 MHz PCS licenses (D, E, and F) were auctioned between August 1995 and January 1997 for prices averaging 33 cents per MHz per capita (counting every person in the licensed areas). In 1994, however, national and regional narrowband PCS licenses brought between $3.12 and $3.46 per

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[355] To the degree that a licensee is permitted flexible use (over technology or services), the cost of bandwidth becomes a factor in optimizing the value of the license. As policy imposes fewer restrictions, licensee rights approach ownership rights. Hence, the logic of liberalization to promote efficient spectrum resource use.

[356] Surprisingly, even prominent economists have confused license rents with spectrum rents. For instance, MIT professor of economics Jerry Hausman sought to explain cellular telephone license values as explained "totally [by] the scarcity of spectrum for cellular telephony… auction values reflect expected future rents to scarce spectrum." Affidavit of Professor Jerry A. Hausman, attached to "Reply Comments of the Bell Atlantic Companies," Federal Communications Commission, *Implementation of Sections 3(n) and 332 of the Communications Act: Regulatory Treatment of Mobile Services*, GN Docket No. 93-252 (Nov. 23, 1993), 7. To see that this analysis is incorrect, note that rents are payments in excess of opportunity cost. Opportunity costs are determined by the price commanded by the marginal not bid away from alternative uses. Since federal regulation does not permit markets to engage in such bidding for spectrum, that price is not observed and the *licensee's* opportunity cost of spectrum is zero. The spectrum allocated to the license may have a shadow price (social opportunity cost) substantially greater than zero. Indeed, the opportunity cost of spectrum may exceed the rents earned by the licensee – demonstrating that they accrue to the license, not the spectrum. The author submitted papers in the FCC proceedings in which Prof. Hausman wrote his analysis: Hazlett, *Market Power in the Cellular Telephone Duopoly*, Report for Time Warner Telecommunications (Aug. 1993); Hazlett, *Errors in the Haring & Jackson Analysis of Cellular Rents*, Report for the National Cellular Resellers Association (Jan. 1994).

[357] Market volatility is always a factor in auctions, as two items auctioned at different times will face distinct demands due to macro-economic changes external to the demand for wireless services or their inputs (i.e., FCC licenses). Yet, it is safe to say that price differences observed between various FCC auctions are not wholly accounted for such volatility in capital markets.

MHz per capita.[358] PCS licenses sold in the A and B blocks (allocated 30 MHz each) between December 1994 and March 1995, in contrast, were sold for $0.51 per MHz per capita. This 50% premium over D-F may be accounted for by a premium for sooner-to-market, non-linear scale advantages (30 MHz v. 10 MHz), and PCS capital market fluctuations.[359]

The law of one price implies that close substitutes sell for similar terms. Directly competitive licenses do tend to fetch equivalent prices, a result observed in auctions.[360] But spectrum allocated to different licenses are not equally functional or profitable to licensees.[361] As summarized by the Congressional Budget Office:

> The current U.S. system of spectrum management relies on wise planning decisions to promote an economically efficient distribution of the radio spectrum. An alternative is to allow spectrum license rights holders more flexibility, essentially broader rights of use, in bringing more desirable consumer services to the market. Inflexible and strict definitions of allocations may not allow an efficient distribution of frequencies among uses even when licenses for new uses are auctioned and private markets allow trading in existing licenses.[362]

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[358] Congressional Budget Office, *Where Do We Go From Here? The FCC Auctions and the Future of Radio Spectrum Management*, Congress of the United States (April 1997).

[359] The D, E, and F auctions occurred after severe financial distress followed opportunistic over-bidding in the C block auction. This may well have poisoned the financial well for firms seeking financing in PCS. Because the C block winning bids – which averaged $1.35 per MHz per capita – were largely uncollected, they are not relevant to the analysis. See Thomas W. Hazlett & Babette E.L. Boliek, *Use of Designated Entity Preferences in Assigning Wireless Licenses*, 51 FED. COMM. L. J. 639 (May 1999).

[360] Lawrence M. Ausubel, Peter C. Cramton, R. Preston MacAfee, and John R. McMillan, *Synergies in Wireless Telephony: Evidence from the MTA Auction*, 6 J. ECON. & MGMT. STRATEGY 497 (1997); Patrick S. Moreton and Pablo T. Spiller, *What's in the Air: Interlicense Synergies in the Federal Communications Commission's Broadband Personal Communications Service Spectrum Auctions*, 41 J. L. & ECON. 647 (Oct. 1998).

[361] The difference between license rents and spectrum value can be illustrated thusly. Suppose one was informed by the FCC that they had been approved for a license, License 1, allocated 400 MHz of prime spectrum (800 MHz to 1.2 GHz), perfectly suited for mobile wireless service. They were given a choice, however, of a second license instead. License 2 was allocated just 200 MHz in the UHF band, 900 MHz – 1.1 GHz. To maximize the value of your assets, which would you choose? The answer is: It depends. Specifically, it depends on the terms of either license. Most importantly, what services are licensees permitted to offer, and how? The number of competitors licensed now and in the future is also a key consideration. In short, the value question only considers the value of spectrum to the extent that the license rules explicitly yield the right to reallocate spectrum use across markets. Except in notable exceptions (discussed below), this is not the opportunity afforded by an FCC license.

[362] Congressional Budget Office, *Auctioning Radio Spectrum Licenses* (March 1992), 3.

That licenses do not reflect the value of radio spectrum creates social losses provoking current calls for bandwidth markets. Rational allocation is subverted for precisely the same reason socialist economies cannot achieve efficiency in the capital goods sector. Private owners are dogged in seeking to discover more valuable applications for resources so as to maximize wealth, yet this beneficial activity is blocked by law. Attempts to duplicate competitive profit-seeking by administrative mechanisms produce inferior information regarding conditions of demand and supply, and yield incentives for vested interests to excel by manipulating rules rather than by investing to discover and efficiently satisfy consumer demands.[363]

Who Owns the Airwaves?

The federal government does not assert ownership of spectrum. Indeed, Senator Dill thought the issue quite irrelevant: "[I]t makes no difference who owns the air or who claims to own channels in the air. The thing that is really controlling is the right to use apparatus which sends the radio impulses into the air."[364] The Federal Radio Commission held that the government could not define the spectrum resource, much less assert ownership: "The ether is an hypothetical medium. There is no satisfactory definition of it. It is not even known to exist."[365]

The official government position is that radio waves belong to the people of the United States, and the predicate for regulation is the furtherance of interstate commerce. The government regulates access to the "public's airwaves" to protect against the destruction which would result from interference. Senator C.C. Dill framed the issue thusly:

> The Government does not own the frequencies, as we call them, or the use of frequencies. It only possesses the right to regulate the apparatus, and that right is obtained from the provision of the Constitution which gives Congress the power to regulate interstate commerce.[366]

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[363] In general see, Thomas Gilligan W., William J. Marshall, and Barry R. Weingast, *Regulation and the Theory of Legislative Choice: The Interstate Commerce Act of 1887*, 32 J. LAW & ECON. 35 (April 1989).
[364] 68 CONG. REC. (Feb. 3, 1927), 2871.
[365] Federal Radio Commission brief in *General Electric Co. v. Federal Radio Commission*, 58 Appeals DC 386 (1929), 148; cited in General Electric's brief to the U.S. Supreme Court in response to request for writ of certiorari filed by the Federal Radio Commission (Dec. 1929), 47.
[366] 68 CONG. REC. (Feb. 3, 1927), 2870.

Concern over vested rights in radio frequencies was intense. In noting that Congress rejected an amendment requiring monetary compensation to radio broadcasters forced to accept new frequency assignments by the new Federal Radio Commission, Dill writes that the measure (and its rejection) "shows that the purpose of Congress from the beginning of consideration concerning broadcasting was to prevent private ownership of wave lengths or vested rights of any kind in the use of radio transmitting apparatus."[367]

The law enlisted private capital as an expedient while maintaining federal authority over airwaves. Dill's book summarizes, "The Alpha and Omega of Radio Law":

> Instead of establishing government owned and government operated radio stations as most other great nations have done, Congress has adopted a policy of permitting private individuals to own and operate radio stations. But Congress provided that these privately owned and privately operated radio stations should be subject to a system of government regulation.
>
> Congress desired to secure the use of private funds and, most of all, the benefit of individual initiative for the more rapid development of the radio art, but all of this development has to be kept under government control.
>
> The means and method of administering and enforcing this system of government control is the radio license.[368]

The regulatory story comes full circle. Rather than airwave chaos dictating regulation, with content controls an incidental byproduct, a desire to control broadcasters was (according to Dill) Congress' primary motivation in establishing regulation. The utilitarian approach adopted was to license transmitting equipment. In discussing the "right to use radio apparatus," Dill differentiates spectrum ownership (which Congress determined can only belong to the people of the United States as a whole) and a license to operate wireless equipment:

> The right to use radio apparatus is often popularly termed "the use of the ether." In this sense "the ether" has been called the last public domain belonging to the people of the United States. Congress has been extremely desirous of retaining control of that

[367] Dill, Radio Law, supra note __, 81.
[368] Dill, Radio Law, supra note __, 127.

public domain, but the only way to do that has been to control the use of radio apparatus.[369]

Contemporary debate is confused by "spectrum auctions."[370] What prevents the emergence of a market in wireless bandwidth is the fact that spectrum is *not* being auctioned. Competitive bidding for operating licenses are not resource sales—oil leases, water and other tangible goods "can not be considered as analogous to the use of radio apparatus."[371] When frequencies are property, wireless users and operators will naturally buy, sell, and creatively reconfigure rights in complex ways. The demand for organized spectrum exchanges will be matched by the existence of a tradable commodity.

X. RADIO LICENSE AUCTIONS WORK WELL

In 1993 the U.S. Congress finally allowed the FCC to auction radio licenses. [372] The policy has created important efficiencies in license assignments in several dimensions:

- Reduced rent seeking in FCC assignments.
- Reduced delays in issuing licenses.
- Greater efficiency in license distribution.
- Easier license aggregation, enabling economies of scale.
- Rents extracted are an efficient means of tax collection.
- Competitive bidding for licenses helps the intellectual case for allocation liberalization.

Reduced rent seeking. In the absence of auctions, competition between potential licensees incurs socially wasteful rent-seeking.[373] When prices are excluded as rationing devices, other criteria fill the void. “Bidders” expend real resources to gain valuable licenses by influencing FCC policymakers. Such expenditures do not create valuable goods or services, but simply

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[369] Dill, Radio Law, supra note __, 126-7.

[370] A recent book on spectrum policy demonstrates how confused. Thomas Streeter’s, Selling the Air (Chicago: Univ. of Chicago Press, 1996), features a mistaken *title*; the book presents a Marxian critique of existing commercial broadcasting, a system created by public interest spectrum allocation and not by “selling the air.” Moreover, the radio and television cartels conceived and nurtured by regulation exist due to the pre-emption of private rights to airwaves. An important corollary is that incumbent licensees would generally be economically worse off under reforms moving existing law toward a property system, precisely the reverse of what is implied by Streeter. See Thomas W. Hazlett, *Review of Thomas Streeter's* Selling the Air, 35 J. ECON. LIT. (Sept. 1997), 1411.

[371] 68 CONG. REC. (Feb. 5, 1927), 3027.

[372] Auctions for non-broadcast licenses were authorized in the Omnibus Budget Reconciliation Act enacted in August 1993. See Nicholas W. Allard, *The New Spectrum Auction Law*, 18 SETION HALL LEGISLATIVE J. 13 (1993).

[373] See Evan Kwerel and Alex Felker, *Using Auctions to Select FCC Licensees*, Federal Communications Commission, OPP Working Paper No. 16 (1985).

influence the division of spoils. This inefficiency plagued even the FCC's lottery system, because expensive applications (with detailed financial and engineering data) had to be submitted by prospective winners. This was to maintain the fiction that licenses were being awarded to real telecommunications providers. (In the event, lottery winners rapidly sold their interests to actual mobile phone companies.) Between 1986 and 1989, some 400,00 applications costing between $500 million and $1 billion were entered in the cellular telephone license lotteries.[374]

By eliminating excess demand, auctions end rent seeking. Bidders invest in research to estimate values, but such investments are productive insofar as they generate useful information as to technology, costs, and market demand. Efforts to curry favor with public officials or prepare worthless paperwork do not produce information of comparable social value.

Competitive bidding is also a political cleanser, as arms length transactions reduce opportunities for corruption. Whether those opportunities are exploited or not, they diminish democratic institutions. FCC license assignments have historically suffered from the taint of insider dealing. Even one U.S. president, Lyndon Johnson, was involved in a series of ugly episodes involving personal enrichment though favoritism in FCC awards.[375] More recently, presidential hopeful John McCain (R-AZ), chairman of the Senate Commerce Committee (which oversees the FCC), was found to have aided contributors with broadcast license renewals. (Broadcast license renewals continue under the old comparative hearing method.) McCain faxed the FCC to complain of delays, with the assisted party hosting a McCain for President fundraiser days later. The appearance of campaign-cash-for-favors was apparent—as the candidate conceded.[376]

Faster licensing. Auctions are relatively expedient, allowing services to be provided more quickly. According to a study by the Congressional Budget Office, the FCC significantly reduced licensing duration by using auctions to issue PCS licenses compared to that experienced in broadcasting (comparative hearings) and cellular (lotteries). See Figure 10.[377]

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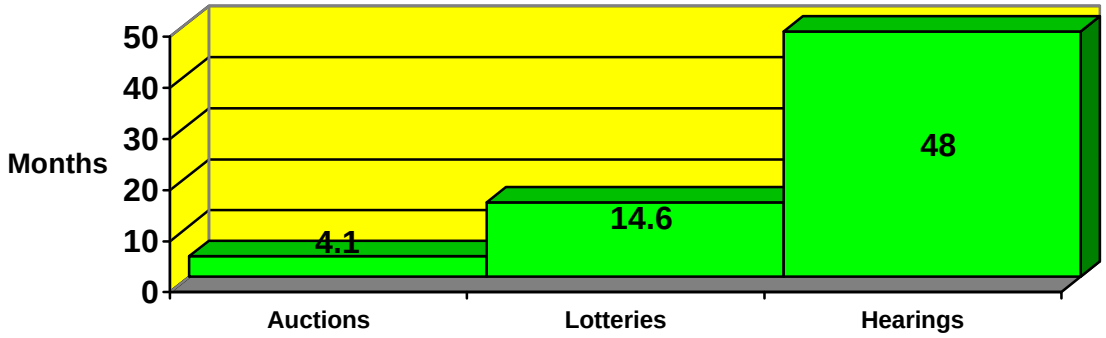
[374] Thomas W. Hazlett and Robert J. Michaels, *The Cost of Rent-Seeking: Evidence from the Cellular Telephone License Lotteries*, 59 SO. ECON. J. (Jan. 1993), 425.
[375] See Robert A. Caro, The Years of Lyndon Johnson: Means of Ascent (New York: Random House, 1990), 89-105.
[376] Tim Noah, *The McCain Mutiny*, SLATE (Jan. 6, 2000).
[377] Data in Figure 10 are from the Federal Communications Commission, *The FCC Report to Congress on Spectrum Auctions*, FCC 97-353 (Oct. 9, 1997), E1.

Figure 10. FCC Licensing Duration
Under 3 Regimes



Efficient distribution. License auctions result in superior initial assignments. Parties bidding the most to tend to value licenses them most highly. These, in turn, tend to be the most efficient providers of service. Given transferability of licenses, such firms would likely be the eventual licensees even without FCC auctions. Transition to an efficient equilibrium, however, would not be costless. The FCC estimated that secondary market license trades following cell-phone license lotteries cost about $190 million annually in brokers' fees, while imposing substantial additional costs on businesses and consumers.[378] Secondary market transactions also incur costs associated with strategic bargaining. Some licensees, even if not the most efficient long-term operators of a given service, may holdout for higher prices for some period.[379] The resulting inefficiency is fairly categorized as rent seeking waste.

Evidence indicates that license auctions are relatively efficient. Studies find that similar licenses tend to sell for similar prices, and are systematically influenced by economic and regulatory factors relevant to future profitability. This has led to an "emerging consensus regarding the efficacy of the PCS spectrum auctions."[380] This consensus has survived events in the PCS C Block auction, where below-market financing extended "small business" bidders

[378] Ibid., 8.
[379] Peter Cramton, *Strategic Delay in Bargaining with Two-Sided Uncertainty*, 59 REV. ECON. STUD. (1992), 205.
[380] Lawrence Ausubel, Peter C. Cramton, R. Preston MacAfee, and John R. McMillan, *Synergies in Wireless Telephony: Evidence from the MTA Auction*, 6 J. ECON. & MGT. STRATEGY 497 (1997); Patrick S. Moreton and Pablo T. Spiller, *What's in the Air: Interlicense Synergies in the Federal Communications Commission Broadband Personal Communication Service Spectrum Auctions*, 41 J. LAW & ECON. 677 (Oct. 1998);

encouraged strategic overbidding and ended in a string of defaults and bankruptcies, [381] as well as a string of wireless mergers reshuffling ownership of large numbers of licenses.[382]

Efficient aggregation. Simultaneous auctions allowed markets to determine PCS service area size. License aggregation instantly created regional and national coverage footprints. Sprint PCS, for example, entered the market with coast-to-coast operations. This facilitated relatively quick roll-out and achieved efficiencies in roaming, an integral aspect of mobility. The atomization of cellular service areas—734 U.S. franchise areas, with two licenses issued per market—seriously hampered network formation. Only after several years were a series of mergers and roaming agreements in place to facilitate low-cost national cell-phone use. The FCC is now considering combinatorial bidding to enable more sophisticated packaging of licenses by bidders in future FCC auctions. [383]

Efficient taxation. Lump sum payments to the Treasury resulting from auctions constitute a welfare improvement over income taxes because such transfers do not distort economic behavior. The evidence is that a dollar of taxes costs about $1.20 to $1.50 in foregone economic value, owing to the disincentives associated with taxing productive enterprise.[384] Since auctions simply transfer rents from the licensee to the government, no marginal taxes are levied and no labor or investment activities are deterred.

While the $23 billion bid for FCC licenses[385] was likely raised more economically than an equivalent sum collected via income or excise taxes, fiscal benefits are sometimes exaggerated. Even under alternative assignment methods the government receives a substantial portion of

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[381] Hazlett & Boliek, *Use of Designated Entity*, supra note __.

[382] The largest PCS network, owned by Sprint, agreed to WorldCom's take-over terms, but the merger was blocked by antitrust authorities. Corey Grice, *Sprint Struggles With Growth After Merger Collapse*, CNET NEWS.COM (Aug. 22, 2000), http://news.cnet.com/news/0-1004-202-2585624.html. Another large PCS network, VoiceStream, has agreed to sell to Deutsche Telekom, and the merger is pending. Associated Press, *Deutsche Telekom to Buy Voice Stream for $50.7 Billion*, CNET NEWS.COM (July 24, 2000), http://news.cnet.com/news/0-1004-200-2329078.html.

[383] These would allow bidders to submit offers for particular combinations of assets. Under simultaneous, multi-round auctions licenses can be aggregated, but bidders may fail to end up with an optimal array of licenses. See Federal Communications Commission, *Auction of Licenses in the 747-762 and 777-792 MHZ Bands Scheduled for September 6, 2000: Comment Sought on Modifying the Simultaneous Multiple Round Auction Design to Allow Combinatorial (Package) Bidding, Public Notice DA00-1075* (May 18, 2000).

[384] Julian A. Alston & Brian H. Hurd, *Some Neglected Social Costs of Government Spending in Farm Programs***,** 72 AM. J. AG. ECON. 149 (Feb. 1990). The theoretical issues underlying these estimates are still unresolved, however. See Charles L. Ballard & Don Fullerton, *Distortionary Taxes and the Provision of Public Goods*, 6 J. ECON. PERSPEC. (Summer 1992), 117 ("no general conclusion can be drawn about the marginal costs of taxation..." [129]).

[385] This is the total listed on the FCC web site, July 7, 2000. It includes the high bids for all auctions, even those in which the FCC has not been able to enforce payment.

license rents in taxes.[386] More importantly, if new licenses are reduced or delayed in order to drive up auction revenues, consumer welfare losses result. It is true that measures restricting competition can increase rents and, therefore, license bids. This is a losing proposition for the public as it introduces economic distortions to offset gains from lump sum taxation. Monopoly creation intentionally inflicts inefficiency, the reverse of optimal taxation strategy, which is to minimize dead weight losses from revenue collection.

A superficial advantage of auctions is that they raise revenue more quickly than alternative fiscal mechanisms. Auction bids include the discounted present value of future period profits, speeding up tax collections. Yet, the gain is illusory. The federal government has excellent access to capital markets, borrowing at the risk-free rate. Since the discount rate used to estimate license values is the risk-adjusted private discount rate,[387] which presumably exceeds the federal government's rate, the temporal compression implicit in lump sum auction bids actually increases revenue collection costs.

Builds momentum for liberalization. Perhaps the most important aspect of auctions is that they have given market mechanisms a test drive at the FCC. Despite warnings of public interest apocalypse, they have worked. This may be leading policymakers to the next step. "A few years ago the idea of selling frequency rights was considered radical; now it is mainstream."[388] This shift in orthodoxy puts additional measures on the table. This momentum can be important. Deregulation tends to come in "waves," with economic forces and elite opinion interacting to produce policy breaks.[389]

Auctions also present new challenges for public policy. Downside risks include increased risk for investments in wireless, the temptation for policy makers to enhance auction revenues by restricting license supply, and the possibility that FCC license auctions lower demand for additional spectrum allocations.

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[386] This does not obviate the non-distorting effect of auction revenues vs. income or excise taxes. It merely notes that auction receipts are not pure gains to the Treasury.

[387] A private bidder finances license costs in capital markets, raising either debt or equity at the rate commensurate with the firm's beta. This was conservatively estimated to be 14%, more than double the contemporaneous 30-year Treasury interest rate, by financial experts retained by the Department of Justice in 1997 bankruptcy litigation involved PCS C Block licenses. See Hazlett & Boliek, *Use of Designated Entity*, supra note __.

[388] Glen O. Robinson, *The "New" Communications Act: A Second Opinion*, 29 Conn. L. Rev. 289, 294. Robinson notes the "seminal argument" for FCC auctions in Coase's 1959 article.

[389] See Sam Peltzman, *The Economic Theory of Regulation After a Decade of Deregulation*, BROOKINGS PAPERS ON ECONOMIC ACTIVITY: MICROECONOMICS 1 (1989).

High Prices, Low Prices, and the "Quantity Theory" of Spectrum Management

High auction prices are reported to be the sign of a successful auction. While this is clearly true for a private asset owner, the sale of government-created licenses is another story. Wireless licenses are inputs into businesses providing services to the public. Where economic scarcity limits spectrum access, rents result from demand for the resource, and are efficiently transferred via competitive bidding. But where spectrum allocation artificially limits access, increased auction revenues accrue from the anticipation of monopolistic output restrictions.[390] This deprives consumers and business users of efficient use of the spectrum resource.

Nonetheless, it is often asserted that the government should maximize auction revenues.[391] While bids should not be suppressed by limiting the size or scope of rights, pro-consumer allocation rules will reliably fail to maximize auction receipts by authorizing such liberal use of frequencies that competition is robust.[392] No license is so valuable when other licenses are excellent substitutes. In the recent 3G license auctions in Europe, unexpectedly high prices are attributed to the unique opportunity to establish new standards, seizing first mover advantages in the coming battle among global wireless networks.[393] The implication could also be that the U.K. spectrum regulator has been overly restrictive; hungry wireless markets are being fed scraps.[394] As Reed Hundt appropriately noted:

> "At least I'm not the only one who really screwed up an auction." The government should make as much spectrum available as possible, at the lowest

[390] In short, this is the difference between *license* rents and *spectrum* rents.
[391] William Safire, *The Greatest Auction Ever*, N.Y. TIMES (March 16, 1995), 25.
[392] This assumes that spectrum rents -- observed in market prices following extensive liberalization of private rights – would fall below the level of license rents observed in today's market. It is likely, but not certain, that this is the case. The enhanced flexibility afforded wireless operators under deregulation increases their options for providing valuable services to customers, a gain to incumbents that is offset by the fact that license rents unambiguously decline with greater competition. It is possible that some licenses would gain in market value, but it is not plausible that this would be the general outcome. If it were, liberalization would have garnered the support of incumbent licensees, and become instituted, long before now.
[393] "3G" refers to third generation wireless telephone service (following analog cellular, and digital PCS). An April 2000 auction of five licenses in the United Kingdom resulted in total winning bids of $34 billion, while a July 2000 auction of six licenses in Germany generated $46 billion.
[394] High prices for 3G licenses have alarmed equipment manufacturers. "He [Jardine Fleming Research analyst Jake Lynch] believes that Ericsson, Nokia and other cellular equipment providers are very concerned about the high bids that European cellular operators are submitting for 3G spectrum." Karen Chan, *Merger in Mobile Sector Tipped*, HONG KONG IMAIL (July 1, 2000). See also: Bill Mann, *Threats to Third Generation Wireless*, THE MOTLEY FOOL (June 29, 2000).

possible prices, Mr. Hundt says now. It "should not be like a seller on eBay.com" trying to get the highest prices.[395]

There are political incentives, however, to promote high prices. First, governments receive favorable publicity, claiming taxpayer savings. The press routinely reports that dollars measure auction success.[396] Hundt, as FCC Chair, boasted about FCC auction revenues, making front-page headlines around the country.[397] The FCC grabbed national attention when President Clinton, accompanied by Vice President Gore, publicly accepted a check to the U.S. Treasury for $7.7 billion from Chairman Hundt following the PCS A and B block auction. "I'm glad to be here," said the President. "I'd go anywhere for a check this size."[398] The Vice President claimed credit for "reinventing government at work." Referring to the check, he said: "Ed McMahon, eat your heart out."[399]

Second, old license winners lobby against new license creation, employing arguments about equity and competitive dynamics not available prior to auctions.[400] Such interests may effectively mask protectionist goals while lobbying to limit spectrum access. The sale was mandated by Congress, which had budgeted projected revenues in its deficit reduction effort. While the hurried auction schedule was widely blamed for reducing license demand (firms having insufficient time to study the situation and prepare business plans), the licenses seriously restricted users in terms of power limitations and applications. In particular, most mobile uses were forbidden, ruling out the most lucrative applications. FCC Chair Hundt defended the auction, including McLeod USA's bargain—$4 for four rural Midwest licenses: "McLeod's

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[395] TELECOMMUNICATIONS REPORTS (May 15, 2000), 10.

[396] "The FCC's first-ever auctions of radio spectrum resulted in a bonanza for the U.S. Treasury, raising more than $800 million in a week of high-stakes bidding." Christopher Stern, *FCC Spectrum Auctions Hit Pay Dirt*, BROADCASTING & CABLE (Aug. 1, 1994), 8.

[397] John M. Broder, *Clinton Aims to Cut 4,805 Federal Jobs*, SACRAMENTO BEE (Mar. 28, 1995), A1. The story garnered the front-page headline, and reported that Pres. Clinton was presented "a mock-up of a check for $7.7 billion." It also erroneously noted, "The Clinton Administration was the first to propose that airwaves for wireless communications be auctioned…" Presidents Nixon, Carter, Reagan and Bush had previously made such requests, with Carter putting the request in his 1979 State of the Union message. See Hazlett, *Assigning Property Rights…* , supra note __, 534.

[398] "This money goes straight to reducing the deficit," President Clinton continued. "Chairman Hundt, on behalf of the American taxpayer, I thank you." *Clinton Praises FCC Auction Process as 'Reinventing Govt.' Model*, COMMON CARRIER WEEK (April 3, 1995).

[399] Ibid.

[400] "Cellular-phone-service companies that won in prior auctions complain that falling [auction license] prices have devalued their licenses. This makes it harder for them to raise capital for their wireless systems, which in turn delays competition, they say. They want Congress to have the FCC allot spectrum more slowly." Bryan Gruley, *Sale of FCC Licenses in Several States Nets Budget Pocket Change*, WALL ST. J. (June 3, 1997), A1.

license is a cheap way to ride the information superhighway… He'll hire people, he'll pay taxes, he'll create an entrepreneurial venture. What's not to like?"

Plenty, according to incumbent licensees. Broadcasters, still fearing auctions or fees for new digital TV licenses, seized on the low bids. The president of the National Association of Broadcasters wrote congressional leaders, "Clearly, spectrum auctions have reached the point of diminishing returns.[401] Firms in cellular or satellite telephone markets, were more emphatic.

> At a recent Washington soiree, Mimi Dawson, a lobbyist for Motorola Inc., the big wireless-communications company, flashed her diamond ring and said, "You see this? It wouldn't be worth a dime if DeBeers (the South African cartel) put their diamonds on the market that same way we're putting spectrum on the market." In an interview, she adds: "If you want to create value, you've got to create scarcity."[402]

Two aspects of this analogy are stunning.[403] First, the world's pre-eminent example of a successful private monopoly is invoked as a model for public policy. The stated rationale for government intervention is to prevent exactly the sort of monopolistic output restriction allegedly engaged in by DeBeers. Yet, the strategic behavior of a price-gouging monopolist is here used as a template for FCC policy makers to artificially restrict access to radio spectrum.

Second, the analogy appears compelling to lawmakers and some independent analysts. No less than the Chairman of the Senate Commerce Committee, John McCain, picked up the DeBeers analogy.[404] Indeed, McCain's staff may have first developed this line of argument before handing it off to lobbyists for incumbent interests.[405] And George Gilder, a leading writer on technology in computers and communications, used the reasoning to attack the FCC as too *liberal*:

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[401] Bryan Gruley, *FCC Auctions of Airwaves Draws Weak Bidding*, WALL ST. J. (April 24, 1997), A2.
[402] Ibid., A10
[403] Three, counting the sparkler.
[404] "We've got to maximize the value of this public asset," Sen. McCain says. Ibid.
[405] "In the next two weeks, Senate Commerce Committee Chairman John McCain (R-Ariz) plans to introduce legislation to 'establish order, regularity and method' to the spectrum auction process. Lauren 'Pete' Belvin, Senior Counsel to the committee likened the current process to 'DeBeers putting all the diamonds in the world on the market at the same time.'" *McCain Preparing to Unveil Spectrum Auction Legislation*, TELECOMMUNICATIONS REPORTS DAILY (summary prepared by Benton Foundation's Communications-related Headlines, April 1, 1997). Bryan Gruley, *Sale of FCC Licenses in Several States Nets Budget Pocket Change*, WALL ST. J. (June 3, 1997), A10.

> Congress determined that spectrum auctions should be a panacea for the budget crunch. And so it mandated that the FCC dump huge new spans of spectrum on the market, through an array of at least eight previously unanticipated new auctions… the mere announcement crashed the market… The result was to devalue the licenses the PCS entrepreneurs had won only a year earlier, in some cases to less than one-third of what they had been worth.[406]

The FCC "dumps" no "spans of spectrum" into the market. Rather, it issues permits to provide particular wireless services. While WCS licenses defined those services in broad terms, other license terms (including severe power limitations), made them uneconomic for use in lucrative applications: "technical limitations on the use of the WCS spectrum sharply curtailed interest in this band."[407] Hence, WCS licenses were evaluated as fixed wireless service permits for "last mile" connections (voice and data), not entry rights into the mobile phone market. WCS licenses were priced as comparable to MMDS, a service then languishing under restrictions preventing two-way data service. Bankruptcies of "wireless cable" firms spooked investors, dampened demand for new licenses, and provided a market overhang of cheap new supply (from bankruptcy reorganization).[408]

The spectrum glut argument is a myth. Licenses to provide similar services are good substitutes and increasing the supply of licenses within bands will lower license values, ceteris paribus. But increasing the supply of non-competing licenses will not. Hence, issuing WCS licenses does not devalue PCS licenses.[409] During the period following the PCS C Block auction (which closed on May 6, 1996) and the WCS license auction (which closed on April 25, 1997), there were trends within the financial markets that affected all wireless stocks. In general, the sector lost favor among investors. As with all price movements in financial markets, new

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[406] George Gilder, *Don't Crush Wireless Innovation*, WALL ST. J. (Sept. 16, 1997).
[407] *FCC Report to Congress*, supra note __, 35. Broadcasting was excluded by license terms.
[408] While GWS permitted two-way data, operations were constrained by power limits and bandwidth of 25 MHz (MMDS spans 198 MHz). Even an investor bullish on the financial prospects of fixed wireless would naturally constrain bids for WCS licenses to reflect the opportunity to buy MMDS license rights as options against FCC approval of two-way.
[409] To the extent that WCS services are anticipated to overlap (compete with) the services provided by PCS licensees, there will be valuation effects. Those are assumed to be trivial as of April 1997. This is not an ambitious assumption.

information (including changes in opinion or sentiment) accounts for this. But no shift in FCC policy is plausibly responsible.

As seen in Table 8, FCC spectrum allocations continue to take years to complete. In particular, the mobile telephone market has been methodically licensed over a period spanning decades. The PCS proceeding formally began in 1989, and the number of licenses granted to compete with cellular has been known—and has remained fixed—since September 1993.[410] The resulting allocation is clearly too parsimonious: the U.S. market is starved for additional bandwidth. Not simply in comparison with a theoretically ideal regime of liberal bandwidth access, but even with respect to the highly-regulated European Community: "The total amount of spectrum available for commercial mobile uses in the U.S. is only 210 MHz compared to an average European allocation of 355 MHz."[411] Regulatory hording of radio spectrum is the policy dilemma, as former FCC official Rudy Baca notes:

> The lack of a coherent, efficient, forward-looking spectrum management policy and process could hinder U.S. wireless operators' ability to compete in providing global interconnected seamless advanced communications… The reality of spectrum management in the U.S. in 2000, and for the foreseeable future, is chronic spectrum shortages…. Investors need to be aware that U.S. companies are relatively disadvantaged in "New Economy" growth in wireless Internet and E-commerce. Spectrum management reform could ameliorate some of the competitive disadvantages caused by spectrum scarcity, legacy policies, and ad hoc multi-regulator spectrum management but comprehensive reform is highly unlikely in a reasonable timeframe (two years)…. U.S. leadership in innovation and growth of broadband digital voice, data, and video wireless services could be threatened by a lack of sufficient spectrum."[412]

[410] Federal Communications Commission, *In the Matter of Amendment of the Commission's Rules to Establish New Personal Communications Services, Second Report and Order*, 8 F.C.C.R. 7700 (1993). This ruling established that there would be six licenses in each market, three allocated 30 MHz each, three allocated 10 MHz each.
[411] Rudy Baca, *U.S. Disadvantaged by Spectrum Scarcity*, Precursor Group Independent Research (July 25, 2000).
[412] Ibid., (emphasis in original).

Table 8. FCC Allocation and Auction Duration

Service	*Docket #*	*MHz*	*Petition or Event Cited as Trigger*	*Proceedings Initiated*	*Auction over*	*Total time to license (years)*
IVDS	GEN 91-2	0.5	12/2/87	1/10/91 (NPRM)	7/29/94	6.7
Narrowband PCS	GEN 90-314	3	9/22/89	6/14/90 (NOI)	7/29/94	4.8
Broad. PCS A-B	GEN 90-314	60	9/22/89	6/14/90 (NOI)	3/13/95	5.5
Broad. PCS C- F	GEN 90-314	60	9/22/89	6/14/90 (NOI)	4/15/99	9.6
DBS	IB 95 168 GEN 80-603 [a]	500	12/17/80	6/1/81 (NPPRM)	1/26/96	15.1
DARS	GEN 90-357	25	5/18/90	(8/1/90) (NOI)	4/2/97	6.9
WCS	GEN 96-228	30	8/10/95 (NTIA Rep.)	11/8/96 (NPRM)	4/25/97	1.6
LMDS # 17	CC 92-297	1300	1/91	12/10/92 (NPRM)	3/25/98	7.2
LMDS # 23 (re-auctions)	CC 92-297	1300	1/91	12/10/92 (NPRM)	5/12/99	8.3
39 GHz	ET 95-183	1400	9/9/94	12/15/95 (NPRM)	5/8/00	5.7
GWCS	ET-94-32	25	8/10/93 (OBRA)	2/10/94 (NTIA Rep.)	Auction pending	≥7
UHF Channels 60-69 (3G)	WT 99-168	24	1986[413]	6/17/96[414]	Auction 3/6/01	≥ 15
12 GHz terrestrial DBS	ET – 98-206	500	1994	11/19/98	pending	≥ 6

In this light, the political response to low auction prices appears perverse. Following the GWS auction, legislation was enacted to slow spectrum allocations and mandating reservation prices: "Congress specifically requires the Commission to establish minimum opening bids and reasonable reserve prices in all future auctions… to ensure that the public receive compensation while not deterring participation in the auction."[415] Low bids can be symptomatic of over-regulation of spectrum, as inefficient restrictions lower profits. Low GWS prices may have

[413] "Now, in the mid-1980s, a new group was clamoring for space – the manufacturers and users of two-way radios. Police departments, ambulance services, commercial delivery companies. Motorola made most of these radios and led this lobby, which was known as Land Mobile… Why not give some of those [UHF] channels to us? Land Mobile asked. By 1986, the FCC had pretty much decided to do just that. Several vacant UHF channels in ten big cities were to be taken away from broadcasters and given to Land Mobile." Brinkley, Defining Vision, supra note __, 8.

[414] "Initiative briefly mentioned by FCC Chairman Reed Hundt at a Senate Commerce Committee oversight hearing last week…." Jeffrey Silva, *TV Spectrum Could Convert to Wireless*, 15 RCR 1 (June 24, 1996).

[415] *FCC Report to Congress*, supra note __, 37.

reflected a too-conservative ruling with respect to power limits. But the consumer damage is remedied by liberalizing license rights, not by further with-holding them. That exacerbates the losses suffered by the public, which fails to "receive compensation" from either auction revenues *or* wireless services offered. Like "spectrum inventories," reservation prices for licenses squander the spectrum resource by blocking productive exploitation of available frequencies.

An important principle suggests itself for public policy. It can be summarized as the Quantity Theory of Spectrum Management.[416] The regulatory approach maximizing consumer welfare is to leave pricing issues to the financial markets. Policy makers should focus on creating ever-expanding opportunities for use of radio spectrum. Making access to spectrum easier, making licenses more abundant and more flexible, achieves this. This pro-consumer policy elicits no unambiguous feedback signal in the simple statistic of license price. The value of a wireless license *increases* as its functionality (or flexibility) is enhanced, but *decreases* as competitiveness (in services) grows. Hence, liberalization produces offsetting effects on license values. Given these, as well as a vector of exogenous market valuation fluctuations, license pricing will not prove a reliable guide for policy makers. The conclusion is that valuation should be left to the market, while regulators focus on rules to intensify use of the radio spectrum.

Without an "abundant spectrum" policy, regulation can become very confused very quickly. Following the surprisingly high prices paid for 3G licenses in the UK and Germany, EC antitrust chief Mario Monti attacked the monopoly power such bids seemed to reveal—but blamed the *bidders*. "We shall not consider the huge investments made in acquiring the licenses as a justification for excessive consumer prices, unacceptable concentration levels or leniency on state aid," Monti warned.[417] That an antitrust regulator would react to high license prices in this manner is ironic—if prospective wireless operators constrained their bids, it could prompt an investigation for collusion. In fact, Monti's fire is misdirected. The *only* value of such licenses is to charge future fees, and high prices indicate expectations of high profits.[418] By bidding for the privilege to collect them, licensees disgorge themselves of "excessive" profits ex ante.

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[416] The quantity theory of money has been used by Monetarists such as Milton Friedman to recommend that the central bank focus on limiting the growth of the money supply to constrain inflation. The approach distinctly rejects the targeting of interest rates, which – under the Quantity Theory – are left to fluctuate according to market forces.

[417] Tracy Ford, *Free Markets and the Cost of Business*, RCR (Oct. 9, 2000), 12.

[418] That some profits are anticipated to flow from equipment sales, as 3G suppliers race to establish competing standards, does not change the analysis. "Excessive consumer prices" may be alleged to prevail there, as well as in charges for operating service.

The discretionary power to create, or collapse, monopoly pricing is held by the regulator. If license values indicate "excessive consumer prices" the remedy is a more liberal spectrum allocation, provoking competition. More spectrum should be available to 3G suppliers and rivals. This would directly attack the problem of "unacceptable concentration levels," determined by spectrum allocation rules. For the antitrust regulator to be confused by such straightforward policy realities simply reinforces the importance of promoting an unambiguous policy goal of greater spectrum availability.

The Mirage of DE Credit Stimulus

When authorizing auctions Congress included measures to extend some level of political control. Specifically, the FCC was ordered to promote bids from "designated entities" (DEs), including firms led by women and minorities, small business enterprises, and rural telephone companies. The Commission began offering special bidding credits to these entities, but due to a 1994 Supreme Court ruling[419] the DE categories were scaled back to include just small business and rural telcos.

There is an inherent contradiction between auctions and bidding preferences. Unless the DE preference is extremely targeted, any preference given DE bidders will simply result in higher prices being bid. Yet, the finer one targets DE benefits, the more unlikely it is that truly disadvantaged parties will be generally included. In the end, DE categories must be fairly broad, and auctions take back whatever largesse is extended to the "protected" category.

In fact, a theory developed that FCC auctions would actually generate higher receipts in markets where DE bidders were "subsidized."[420] This result flowed from the simple analytics of competition: Where additional participants are brought into the auction, rivalry intensifies and the higher bids (net of the credits) are squeezed out of the players. The perverse upshot is that government can increase transfers from telecommunications providers. Rather than aid disadvantaged groups, preferences help taxpayers.

DE preferences also introduced inefficiencies hurting consumers when extended to financing terms. In certain auctions, the FCC allowed DE bidders to pay winning bids over several years, whereas non-DE bidders were required to pay cash. This ultimately proved very

[419] Adarand Constructors v. Pena, 115 S. Ct. 2097 (1995).
[420] Ian Ayres and Peter Cramton, *Deficit Reduction Through Diversity: How Affirmative Action at the FCC Increased Auction Competition*, 48 STAN. L. REV. 761 (April 1996).

costly by introducing long delays in service provision, particularly in the PCS C Block. The C Block auction ended in May 1996; winning bids were, in aggregate, over $10 billion, exceeding all previous auctions including the PCS A and B Block auctions (where twice as many licenses, allocated equal bandwidth of 30 MHz per, brought in $7.7 billion). Yet, a series of defaults and bankruptcies by DEs delayed licensing, and C Block service has yet to commence is many areas.

In fact, the generous credit terms extended by the FCC invited opportunistic behavior. DEs systematically over-bid for licenses and then strategically lobbied and litigated to shed assumed liabilities. The result is that service to the public has been frozen while regulatory brinkmanship is resolved. Auction rules were key to this outcome. Winning DE bidders were not qualified for credit-worthiness, and were in fact disqualified for excessive asset ownership. They were obligated to pay just ten percent of their total bids (five percent within 30 days, and another five percent at license award, likely to be months away). They would then pay interest only on remaining balances (ninety percent of total bid) for four years. Then, for six years, bidders would pay off the balance in equal annual payments. The interest rate would be the 30-year U.S. Treasury bond rate. In 1996, this meant that winning bidders would pay about 6.5%, with generous credit terms (just 10% down, no principle due for five years), when private financing would cost a minimum of 14% (as the U.S. Department of Justice expert later testified).[421]

This payment plan encouraged DEs to bid aggressively. Once a license was won, the licensee would attempt to raise necessary capital. If credit sources in the market responded positively, that would result in financial success for the bidders. If the market responded negatively, seeing the auction price as too high, the bidder could default and challenge the FCC to take its license back. The FCC is not anxious to make a clear admission of failure. In the event, the FCC did halt license awards to firms defaulting on the first five percent (30-day) payments. These were re-auctioned in July 1996. But—with a much larger number of licensees––it blinked and relaxed the terms extended to C Block winners in spring 1997.

Finally, over-bidding licensees could file for bankruptcy protection, asking a federal court to limit liability. The two largest C Block license winners, NextWave and General Wireless, Inc., did this, and won bankruptcy court claims. GWI saw its liability for 14 licenses written down from over $1 billion to just $18 million, while NextWave's $4.7 billion aggregate

[421] See Hazlett & Boliek, *Use of Designated Entities*, supra note __, 645-47.

bid was reduced to about $1 billion.[422] GWI's case was confirmed on appeal, while NextWave's verdict was overturned. Despite continuing litigation, the FCC has scheduled an auction of reclaimed licenses to begin Dec. 12, 2000.[423] At minimum, service to the public via C Block spectrum will be delayed five years. Given that the implicit subsidy in DE preferences are bid away, this delay constitutes a large social cost (reduced competition in wireless telephone service) for which there is no arguable compensating offset.

The Spectrum Allocation Paradox of License Auctions

Auctions can efficiently transfer license rents to the Treasury. But that very success tends to undermine dynamic efficiency in spectrum allocation. Consider the practical structure of FCC regulation. Incumbent licensees reliably oppose the allocation of airwaves for new wireless service providers. Two identifiable types of firms attempt to counter incumbent licensees. The first is a potential competitor who seeks an FCC license. The second is the equipment manufacturer (or other supplier) who will benefit from increased sales in a more competitive market.

Incumbents' incentives are typically sharper.[424] Yet, historically, one important pay-off for the service entrant was provided by an implicit licensing queue. If a firm were to lobby the FCC for a particular spectrum allocation, then—if the allocation were made—the petitioner assumed a place at the head of the licensing line. That was an interpretation of the public interest standard, and provided a reward for applicants who created public benefits by enduring the allocation process.

This incentive structure did not fully offset the influence enjoyed by incumbent operators. But the reward of a zero-priced license mitigated it. Auctions (and the lotteries before them) erase this incentive. Once an allocation is made, licenses are sold to high bidders. (With pure lotteries, actual providers also must be high "bidders" to obtain licenses in secondary markets, as seen in the accumulation of cellular licenses post-lottery by McCaw and other firms.) This diminishes returns to lobbying for access to radio spectrum. It does not eliminate all returns to

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[422] Mark Wigfield, *New Orleans Court Ruling Could Spell Wireless Auction Delay*, WALL ST. JOURNAL INTERACTIVE (Oct. 20, 2000); Scott Ritter, *Supreme Court Rejects NextWave Bankruptcy Appeal*, WALL ST. JOURNAL INTERACTIVE (OCT. 10, 2000).

[423] Bloomberg News, *NextWave Asks Court to Stop Wireless Auctions* (Sept. 22, 2000), http://www.news.cnet.com/news/0-1004-200-2839696.html.

[424] See discussion above at __.

rent seeking, particularly those of equipment manufacturers or technology suppliers. But given a reduction in the incentives of a key constituency, allocations should become even more restrictive under auctions in the absence of countervailing effects.[425]

The FCC has expressed concern that firms instrumental in discovering and promoting new wireless applications should be rewarded with favorable consideration in the distribution of licenses. This led to implementation of the "pioneer's preference" (PP) program under which entrepreneurs creating novel services would apply to the Commission for special consideration in the licensing process.[426] The program managed to survive into the auctions era, and pioneer's preferences for contributions to the development of PCS were Cox Enterprises, American Personal Communications (partnering with the WASHINGTON POST), and Omnipoint Communications for their contributions to the development of PCS service.[427] The process by which the Commission selected just three winning PP applicants—56 were pending at the time of selection—was controversial, to say the least. Litigation erupted, and fees were imposed on winners by the FCC ex post. One losing FCC applicant—Qualcomm—was victorious in two federal appeals court decisions declaring that the FCC had erred in refusing to grant a PP license to the San Diego-based developer of Code Division Multiple Access technology widely used in PCS and 3G wireless systems.[428] The Commission decided it did not have the ability to administer such a program, and it was discontinued. The episode demonstrates both the importance of incentives in dynamic optimization, and the administrative difficulty in promoting proper incentives under the current system.

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[425] This view has been articulated by interests opposed to competitive bidding at the FCC: "If we auction spectrum, we will discourage people from inventing new ways of using telecommunications. Why apply to the FCC for an innovative use of spectrum if you know the commission would simply auction that spectrum and you would reap no benefit from your idea? The notion that patent applications protect such ideas is flawed. First, many ideas are not patentable. Second, a patent does not provide any real right except to litigate – a right that frequently does no one but the lawyers any good. It is not a weapon easily exploited by an entrepreneur with a new way of using the spectrum." Wilbur Pritchard, *Auctioning Spectrum – A Bad Idea*, 33 AEROSPACE AMERICA (Nov. 1995).

[426] "The Commission's pioneer's preference rules provide preferential treatment in its licensing processes to parties that develop new communications services and technologies. This fosters the development of new services and improvements to existing services by reducing for innovators the delays and risks associated with the Commission's licensing procedure. True innovators of substantial new communications services and technologies have an opportunity to participate either in the new services that they took a lead in developing or in existing services with regard to which they took a lead in promoting application of new technologies." Federal Communications Commission, *In the Matter of Amendment of the Commission's Rules to Establish New Personal Communications Services: Tentative Decision and Memorandum of Opinion and Order*, GEN Docket No. 90-314, FCC 92-467 (Nov. 6, 1992), Par. 2.

[427] Ibid., Par. 1.

[428] *Qualcomm Spectrum Request Faces Broad Industry Opposition*, TELECOMMUNICATIONS REPORTS (Feb. 28, 2000), 14.

Evidence to support or reject the hypothesis that license auctions tend to slow spectrum allocations should be possible to uncover. One intriguing place to look is the belly of the beast: How do firms lobby?[429] While it may be difficult to identify the entrepreneur who fails to pressure the FCC for access to radio spectrum, incumbent licensees may behave in suggestive patterns. Indeed, in the recent distribution of licenses for digital television, cell-phone and PCS providers argued strongly that broadcast TV stations (who received the new DTV licenses without monetary payment) should pay for licenses through competitive bidding.[430] This is soft evidence in favor of the auctions-reduce-spectrum theory. Incumbents' strategy reveals that competitive bidding would reduce entry.[431]

Some measure of effective demand for spectrum access may be deduced by quantifying the sluggishness of FCC process. Table 8 begins the task of estimating the duration of recent spectrum allocations. Specifically, it charts the time elapsing from an initial request until licenses are auctioned. Measured lags understate actual lags by ignoring unofficial delays. Often the FCC, international agencies, Congress, or the Department of Commerce (regulating government use of spectrum) spend years grappling with an allocation issue before the FCC initiates a rule making. In addition, the process of issuing a license once an auction is complete (the end of the period Table 8 covers) can take over a year.[432]

While the extraordinarily lengthy cellular telephone rule making is difficult to match,[433] recent proceedings do not appear to fast track spectrum allocation. Take the case of 39 GHz, a proceeding triggered by a petition filed September 9, 1994.[434] License auctions ended May 8,

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[429] Interesting research is beginning to illuminate this question. See John M. DeFigueiredo and Emerson H. Tiller, *The Structure and Conduct of Corporate Lobbying: How Firms Lobby the Federal Communications Commission*, 10 J. ECON. & MGT. STRAT. (forthcoming).

[430] Jeffrey Silva, *TV Spectrum Could Convert to Wireless*, 15 RCR 1, 8 (June 24, 1996).

[431] This could be attributed to the fact that a policy was in place giving stations free use of channels for digital TV broadcasting. By promoting auctions (or any form of payment) for the right to provide non-television services, the wireless incumbents seek to impose a tax on competitive services offered by TV stations. This would follow the general logic of the auctions-reduce-spectrum hypothesis, but be a less than general application.

[432] George Gilder, *Don't Crush Wireless Innovation*, WALL ST. J. (Sept. 16, 1997), op-ed page.

[433] Cellular telephone technology was demonstrated by AT&T in 1947, but the FCC denied a petition from the firm to initiate a rule making to allocate spectrum for the service. Not until 1968 was a proceeding formally begun, with spectrum allocated for the service in 1970. Skirmishing over various regulatory issues proceeded for the next decade. Licensing of experimental systems finally began in 1982, with major U.S. markets licensed 1984-86. (Comparative hearings were used for markets 1-30; lotteries thereafter.) Licensees in all 724 U.S. cellular markets (306 Metropolitan Service Areas and 418 Rural Service Areas) were selected by January 1989. Licenses to serve areas not covered in the build-outs of initial licensees were finally auctioned January 13-21, 1997. The process had by then consumed five decades.

[434] Federal Communications Commission, *In the Matter of Amendment of the Commission's Rules Regarding the 37.0-38.6 GHz and 38.6-40.0 GHz Bands*, ET Docket No. 95-183, FCC 99-179 (July 29, 1999), par. 3.

2000,[435] nearly six years later. The General Wireless Communications Services (GWCS) spectrum allocation process can be traced to August 10, 1993, when the Omnibus Budget Reconciliation Act of 1993 (OBRA) became law. This mandated the Commerce Department to identify a total of 200 Megahertz for transfer from government to private use. In 1998, the FCC allocated 5 MHz bands to each of 5 licenses (25 MHz total) in each of 175 Economic Areas covering the United States (875 total licenses). Auctions, initially scheduled to commence in early 1999, have not been held as of mid-2000, and no new date has been set. The clock continues to tick seven years after Congress ordered spectrum be made available to the public, and over six years after the Commerce Department specifically identified suitable frequencies.[436]

While causality is difficult to establish, the era of auctions has coincided with continued––perhaps intensifying—regulatory gridlock in spectrum allocation. Given the spiritual momentum for reform supplied by the successful initiation of competitive bidding, as well as sharply rising demand for wireless applications from industry, the inertia appears anomalous. The median duration for the 13 allocations listed in Table 8 is 6.9 years. The observed sluggishness suggests that, at a minimum, the FCC's administrative process is as fierce an obstacle to progress as ever. Indeed, it leaves open the possibility that license auctions actually diminish the trickle of radio spectrum allocated for productive use.

XI. THE SPECTRUM ABUNDANCE FALLACY

Does new technology make spectrum allocation obsolete? George Gilder,[437] Eli Noam,[438] Yochai Benkler,[439] Tom Bell,[440] and Larry Lessig, [441] press the theme that technical breakthroughs in digitization systematically alter policy options.[442] With more sophisticated

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[435] Federal Communications Commission, *39 GHz Fact Sheet*, www.fcc.gov/wtb/auctions/ 39GHz/39ghfact.html.
[436] Federal Communications Commission, *In the Matter of Allocation of Spectrum Below 5 GHz from Federal Government Use*, ET Docket No. 94-32 (Nov. 25, 1998); Federal Communications Commission, *General Wireless Communications Service (GWCS) Auction: Fact Sheet*, www.fcc.gov/wtb/auctions/gwcs/gwcs1fct.html.
[437] George Gilder, *The New Rules of Wireless*, FORBES ASAP (Mar. 29, 1993); Gilder, *Auctioning the Airwaves*, FORBES ASAP (April 11, 1994).
[438] Eli Noam, *Taking the Next Step Beyond Spectrum Auctions*, 33 IEEE COMM. MAG. 66 (1995); *Spectrum Auctions: Yesterday's Heresy, Today's Orthodoxy, Tomorrow's Anachronism*, 41 J. L. & ECON. 805 (Oct. 1998).
[439] Yochai Benkler, *Overcoming Agoraphobia: Building the Commons of the Digitally Networked Environment*, 11 HARV. J. L. & TECH. 287, 325-6 (Winter 1998).
[440] Tom W. Bell, *The Common Law in Cyberspace*, 97 MICH. L. REV. 1746 (May 1999).
[441] Larry Lessig, Code: And Other Laws of Cyberspace (New York: Basic Books, 1999).
[442] This approach was anticipated in Pool, Technologies of Freedom, supra note __, 148.

packaging of coded information, airwave congestion is defeated and spectrum scarcity moot. The peg on which such arguments hang is the development of spread spectrum technology:

> Whatever the state of radio technology was in 1927, there's an emerging view that broadcasting today does not require spectrum allocation. There is a second architecture for broadcasting (which I will call "Spread Spectrum"—it has a few different names) that would not require any spectrum allocation at all. If broadcasting were done through this technology, the extensive governmental regulation would no longer be justified.[443]

This thinking has led to an attack on property rights in radio spectrum. "New open access and spread spectrum technologies can allow one frequency to simultaneously carry many signals without interference, thus largely eliminating the justification for granting titles to entire blocks of the spectrum."[444] The attack extends to FCC license auctions, taken as a proxy for exclusive rights to use radio spectrum.[445] In Gilder's view, the premises of spectrum exclusivity are rendered obsolete by recent scientific advances:

> Amid the spectrum fever around by the [FCC license auction] bidding, however, new radio technologies are emerging that devastate its most basic assumptions…
>
> Even the language used to describe the auction betrays its fallacies. With real estate imagery, analysts depict spectrum as "beachfront property" and the auction as a "land rush." They assume that radio frequencies are like analog telephone circuit[s]: no two users can occupy the same spot of spectrum at the same time. Whether large 50-kilowatt broadcast stations booming Rush Limbaugh's voice across the nation or milliwatt cellular phones beaming love murmurs to a nearby base station, radio transmitters are assumed to be infectious, high-powered and blind. If one is on the highway, everyone else has to clear out.

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[443] Lessig, Code, supra note __, 184 (footnote omitted).
[444] Bell, *The Common Law in Cyberspace*, supra note __, 1766.
[445] As shown above, however, exclusive use licenses have been assigned by priority-in-use, comparative hearings, or lotteries, as well as by competitive bidding. Moreover, bands regulated by exclusive rights can be, and are, shared. This is discussed below.

> Both the prevailing wisdom and the entrenched technology dictate that every transmitter be quarantined in its own spectrum slot.
>
> However, innovations from companies such as Steinbrecher and Qualcomm Inc. of San Diego overthrow this paradigm. Not only can numerous radios operate at non-interfering levels in the same frequency band, they can also see other users' signals and move to avoid them… If appropriately handled, these technologies can render spectrum not scarce but abundant.[446]

Traditionally, radio regulation has been justified as necessary to prevent tragedy of the commons. "Before 1927," the Supreme Court wrote in Red Lion (1969), "the allocation of frequencies was left entirely to the private sector and the result was chaos. It quickly became apparent that broadcast frequencies constituted a scarce resource whose use could be regulated and rationalized only by the Government."[447] Ronald Coase (and economists to follow) saw the economic fallacy in what became known as the "physical scarcity" doctrine, made famous in Justice Felix Frankfurter's Supreme Court opinion in NBC.[448] Coase responded:

> [T]hese arguments… are based on a misunderstanding of the nature of the problem. Mr. Justice Frankfurter seems to think that federal regulation is needed because radio frequencies are limited in number and people want to use more of them than are available. But it is a commonplace of economics that almost all resources in the economic system (and not simply radio and television frequencies) are limited in amount and scarce, in that people would like to use more than exists… It is true that some mechanism has to be employed to decide who, out of many claimants, should be allowed to use the scarce resource. But the way this is usually done in the American economic system is to employ the price mechanism, and this allocates resources to users without the need for government regulation.[449]

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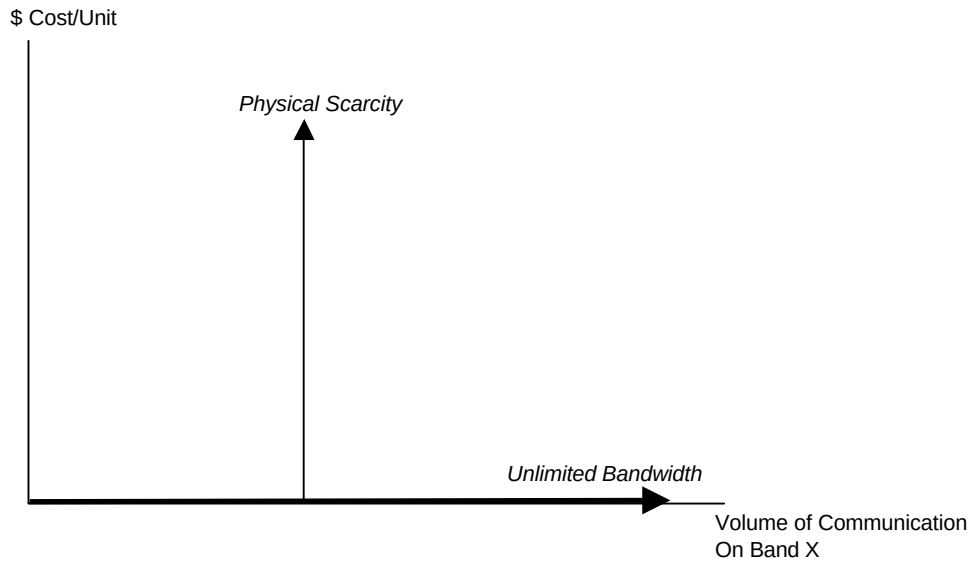
[446] George Gilder, *Auctioning the Airwaves*, FORBES ASAP (April 11, 1994), wysiwyg://62/http://www.forbes.com/asap/gilder/telecosm7a.htm.
[447] Red Lion Broadcasting Co. v. FCC, 395 U.S. 367, 375 (1969).
[448] NBC v. United States, 319 U.S. 190 (1943).
[449] Coase, *The Federal Communications Commission*, 2 J. L. & ECON. 1, 14 (1959).

Figure 11. Technical Doctines of Spectrum Supply



Whatever the "physical scarcity" doctrine's weaknesses as a theory, it has been successful as a legal justification shielding regulation of the electronic press from First Amendment constraints.[450] Now it is a springboard for a new paradigm created by flipping the technical argument on its head: Instead of regulation being mandated by a peculiar form of *scarcity*, open access to spectrum is mandated by a peculiar form of *abundance*. It is inefficient and even unconstitutional to promote property rights, including the de facto rights implicit in exclusive use FCC licenses. Technology dictates that the spectrum should be kept open to all. As jetliner routes in open skies (an example cited by Eli Noam[451]), airwaves should be freely shared: no exclusive rights.[452]

It is undisputed that a true commons would lead to over-exploitation and airwave chaos. "With open access," Noam concedes, "scarcity emerges, the resource needs to be allocated, and a price mechanism is required. But this does not require control over a specific slice of the rainbow." [453] But that is exactly what rationing a scarce resource entails: a controlling authority

[450] See Hazlett, *Assigning Property Rights*, supra note __.
[451] Noam, *Spectrum Auctions*, supra note __, 765.
[452] Noam's analogy is revealing: it is a non-scarce good. At the margin a new, unobstructed air route may be claimed without competition. At very low cost compared to the private advantage gained, planes avoid other planes. However, where competing claims arise and are difficult to spontaneously resolve, ownership is afforded. Rights to take-off and landing slots at major airports are well established. In the United States, they are private property, and are actively traded.
[453] Noam, *Spectrum Auctions*, supra note __, 769.

resolves conflicting demands for specific slices. Indeed, the mechanism recommended by Noam is a complex series of auctions to sell airwave access rights—in tiny increments—to high bidders purchasing "control over a specific slice of the rainbow." This inherently conflicts with the allegedly similar position taken by Gilder that "[y]ou can no more lease electromagnetic waves than you can lease ocean waves… You can use the spectrum as much as you want as long as you don't collide with anyone else or pollute it with high-powered noise or other nuisances."[454]

While Noam implicitly retreats to an exclusive rights position, Gilder, Benkler and Lessig pursue government regulation to police the commons. Power limits and transmission standards imposed by law control radio access to avoid congestion. That users must be made to invest in particular types of wireless systems, giving up less costly alternatives, concedes the existence of scarcity and exposes the spectrum commons paradigm as simply an alternative regime for resolving costly conflicts over resource use. The argument that revolutionary digital technology creates abundance and therefore undermines the existing regulatory paradigm features myriad lacunae in its depiction of (1) the origins of regulation, (2) spread spectrum technology and (3) the economics of spectrum use.

Block Allocation: Inefficient Even for Analog

The spectrum abundance argument precisely inverts the relationship between technology and regulation. Rather than digital technologies obviating old regulations, block allocation has deterred the development of myriad digital services and systems.

Take cellular. AMPS (advanced mobile phone system) was the analog technology imposed by the FCC on cellular. Only in 1988, after licensees had built their big city systems (where capacity was stretched) did the FCC allow digital telephones, creating one of the great standards blunders in modern telecommunications history.[455] PCS rules, conversely, permitted licensees to select their own digital standards. A standards competition broke out, and CDMA—the break-out spread spectrum technology—was one notable result. Here the block allocation system visibly suppressed digital, protecting analog.

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[454] Gilder, *Auctioning the Airwaves*, supra note __.

[455] George Calhoun, Digital Cellular Radio (Norwood, MA: Artech House, 1988). The regulatory error has long-lived consequence. As of the first quarter of 2000, only 49.4% of the 91.8 million U.S. wireless telephone subscribers were digital. Merrill Lynch, *The Matrix—1Q 00* (June 20, 2000), 3.

Take software-defined radio. Eli Noam specifically touts SDR as technology rendering exclusive airwave rights moot.[456] Yet, the SDR expert he cites has alertly noted that the block allocation system stifles SDR by preventing the fluid use of frequencies: "Software radios provide a vast untapped potential to personalize services. But the contemporary process of spectrum allocations takes years to decades and lacks flexibility."[457] Regulation hinders the new technology far more than the new technology hinders regulation.

Spread Spectrum: Not New, Not Unique

The key scientific break-through claimed to unleash unlimited bandwidth argument is frequency re-use. Rather than separate transmissions by frequency buffers, each message using its own dedicated channel to flow to a receiver, spread spectrum technologies transmit multiple messages down the same frequency path. Data which would otherwise be a jumble—lost in the cacophony—are unscrambled by the receiver, thus enabling more intense utilization of the wireless "conduit." Messages also hop from band to band, depending on local traffic conditions, and are reassembled by the receiver. This buys even greater communications throughput. Depending upon the format used and the processing power of equipment, dramatic increases in effective bandwidth over analog systems are possible. And due to the increasing speed and declining cost of computer chips, robust improvements are likely to continue.

Since the dawn of wireless, inventors have struggled to transmit additional information within a given band.[458] Multiplexing techniques, sending more than one stream over a frequency, constitute many of the early advances in radio frequency (RF) engineering. The wireless pioneer Guglielmo Marconi initially believed that no two transmissions could be intelligible within the same region. Innovations later separated messages by frequency, permitting multiple local area

[456] Noam, *Spectrum Auctions*, supra note __, 782.
[457] Joseph Mitola III, *Cognitive Radio for Flexible Mobile Multimedia Communications*, 6th International Workshop on Mobile Multimedia Communications (Nov. 1999), and Appendix D in Joseph Mitola III, *Software Radio: Wireless Architecture for the 21st Century*, Ph.D. dissertation (1999).
[458] Efforts to compact communications signals actually pre-date wireless: "The earliest method used for putting several messages on a circuit at once was frequency division multiplexing. Graham Bell had used it to send messages over the same wire at the same time, by having each set of dots and dashes sound a different note." Pool, Technologies of Freedom, supra note __, 37. Pool also discusses spread spectrum. He characterizes it as another step in the progression of radio techniques: "These three techniques – beamed microwaves, low-power transmitters, and sophisticated multiplexing – all permit a great increase in the number of users who may simultaneously be on the air without interfering with each other." Ibid., 38.

transmissions.[459] A century of progress has led to various spread spectrum techniques, including the important Code Division Multiple Access format for digital wireless communications developed by Qualcomm and heralded by abundance advocates as the organizing principle for a new age of spectrum use. As explained, however, by Qualcomm's vice chairman, Dr. Andrew J. Viterbi, the company built on a very old technique:

> The origins of multiple access date back to Patent No. 7777 awarded in 1900 to Marconi for the "Tuned Circuit" which as the enabling technology for both Frequency Division Multiplexing (FDM) and Frequency Division Multiple Access (FDMA). (FDM refers to transmission of multiple sources from a single location by modulating each on a separate carrier sufficiently separated from the other, while in FDMA the sources and their respective modulated carriers emanate from different transmitters, generally not co-located.) FDM and FDMA are the only multiplexing and multiple access techniques which can be used with both analog and digital transmission.
>
> For digital sources, two alternative technologies have evolved for multiplexing and multiple access: time division (TDM and TDMA) and code division (CDM and CDMA).[460]

It can be argued that progress in spread spectrum systems is non-linear, that the growth rate in data compression efficiency is increasing over time. But it is not convincing to characterize new advances as technical discontinuity. Spectrum (or effective bandwidth) supply continues to slope upward. With more investment and better science more communications are produced. So with analog, so with digital.

A Cornucopia is Not Enough

As with other improvements in radio communications, Gain and Loss functions respond to spread spectrum's capacity-increasing innovations. The result is a higher level of optimal communications volume (T^*). But communications are not unlimited ($T^* <$). For any given

[459] Paul Baran, *Is the UHF Frequency Shortage a Self Made Problem?* Paper delivered to the Marconi Centennial Symposium, Bologna, Italy (June 23, 1995), 1.
[460] Andrew J. Viterbi, *The History of Multiple Access and the Future of Multiple Services through Wireless Communications*, Showcase Feature on GTE web page, www.gte.com/Showcase/Cdma/Feature/editorial.html.

investment in transmission and reception, increased traffic degrades communications; after some volume of traffic, marginal degradation fully offsets the marginal value of additional signals. Spread spectrum does not eliminate interference; it simply increases the range over which it is relatively less important than signal degradation. As the Chief Engineer of the FCC, Dale Hatfield, writes:

> In spread spectrum systems, multiple conversations (*up to some maximum*) simultaneously share the available spectrum in both the time and frequency dimensions. Hence, in a CDMA system, the available spectrum is not channelized in frequency or time as in FDMA and TDMA systems, respectively. Instead, the individual conversations are distinguished through coding; that is, at the transmitter, each conversation is processed with a unique spreading code that is used to distribute the signal over the available bandwidth. The receiver uses the unique code to accept the energy associated with a particular code. The other signals present are each identified by a different code and simply produce background noise. In this way, many conversations can be carried simultaneously within the same block of spectrum.[461]

Even when deploying spread spectrum systems there remains "a maximum" beyond which signal degradation is sufficient to lower the aggregate value of communications. That is why PCS licenses allocated 30 MHz (A, B, and C blocks) were sold at auction for more than four times the price of PCS licenses allocated just 10 MHz (D, E, and F blocks).[462] If band use is unlimited, why pay more to access additional spectrum? Despite the availability of digital formats intensely packing data within, and across, frequencies, the extra bandwidth was worth billions of dollars to users. The standard economic trade-offs apply: more inputs are needed to create more output. Bandwidth remains a scarce, valuable input.

In fact, while abundance advocates criticize FCC auctions, they ignore the powerful evidence competitive bidding reveals. Investors are willing to pay substantial amounts to avoid

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[461] Dale Hatfield, *Technological Trends in Wireless Telecommunications*, paper prepared for Gallaudet University (July 11, 1997), 15 (emphasis added).

[462] While C block bids were inflated due to strategic bidding and were largely uncollected, the PCS A and B licenses were sold for an average price of $15.60 per capita (counting each man, woman and child in the franchise area). PCS D, E and F blocks sold for $3.30. *FCC Report to Congress on Spectrum Auctions*, supra note __, 10.

the spectrum commons. That is the choice made in buying an FCC license, as it offers exclusivity in spectrum use. Given the availability of both spread spectrum technology and unlicensed bands (see discussion below), it is curious that firms bid so aggressively to escape the commons. Over $20 billion has been bid in U.S. license auctions, and recent auctions in the U.K. and Germany saw 3G wireless licenses fetch more than the entire U.S. total in each country. Financial markets see huge advantages to being able to optimize the use of bandwidth by excluding non-payers.

"Physical abundance" trips over Say's Law, updated to the Information Age: Spectrum creates its own demand.[463] This is evidenced in the premium financial markets place on developers of enhanced bandwidth. As described in a recent Fortune magazine article:

> These days, speed is everything. That is why not just Qwest but also AT&T, MCI WorldCom, and Williams are turning to these newcomers for the latest optical equipment. In the past, network carriers were conservative buyers that made purchases from a short list of large equipment suppliers—Lucent, Alcatel, Siemens, NEC, Nortel. But now demand for the high speed of optical networks is so great that carriers can't wait. Their impatience fueled an extraordinary run-up in the value of optical-equipment suppliers. One example: Tiny Sycamore Networks, a Chelmsford, Mass., optical-switch company with just $31 million in revenues during its lifetime, boasts a market value of $25 billion… Another example: In August, Cisco paid $7.4 billion for two tiny optical startups, Monterey Networks and Cerent. That's an astounding figure, fully one-third of the total amount Cisco has paid for the 48 companies it has purchased over the past seven years.[464]

The well-publicized "race for bandwidth" is furious. Yet, one can casually stroll when claiming an abundant resource. There will be plenty for everyone without charge. Capacity-increasing technology suppliers prosper as they develop the means for increasing effective bandwidth. The race extends to software design, data storage and caching—any method for

[463] "Broadband is another area that will be getting attention, with [Redpoint Ventures partner John] Walecka adding that 2000 is the 'year of the ramp.' His firm is concentrating on investments in the hardware, software and networking side of broadband. In terms of what will be pushed over these fat pipes, Walecka said the 'new network will support new media.'" Brenon Daly, *Networkers to Network at Confab*, CBS MarketWatch (Apr. 24, 2000).
[464] Eric Nee, *The Upstarts are Rocking Telecom*, 141 FORTUNE 104 (Jan. 24, 2000).

more intense bandwidth utilization. The shares in such firms are valuable only to the degree that customers are willing to pay for increased bandwidth.[465]

Broadband connections—two-way network access at 200 kbps or faster[466]—do not satiate users. After upgrading from 56K dial-up to connections between five and one hundred times as fast, users still desire faster speeds both locally and in the Internet backbone. The additional communications capacity improves network functionality, and unlocks pipe-clogging information packages like video conferencing and video on demand. As more customers gain broadband access and transmit or receive larger files, the capacity limitations will become even more binding—spurring further demands for bandwidth.[467]

The Internet Analogy

This is the architecture of the Internet. Machines have addresses: they collect from the Net packets addressed to that machine. No one allocates a particular channel to your machine; your machine shares the Net with every other machine on the Net. But the Net has a protocol about sharing the commons. Once this protocol is agreed on, no further regulation is required.[468]

The spectrum commons idea is motivated by analogy to the Internet. Yet, the architecture of the Internet—a network of networks—seriously misallocates scarce bandwidth. Because data cannot easily be prioritized, or billed, within the existing Internet protocols, tragedy of the commons appears frequently. High value communications are jammed in congested arteries with massive volumes of data of only marginal significance. Classically, the brain surgeon cannot

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[465] Vivek Ranadive, CEO of Tibco Software (which digitizes financial information for distribution over the Internet) says bluntly: "Speed is God." Thom Calandra, *CEO Sees Software as Great Connector*, CBS MARKETWATCH (Jan. 28, 2000, 2:55 PM ET). See also: John Borland and Ben Heskett, *Is the Fiber-Optic Boom Nearing the End?* CNET NEWS.COM (Jan. 29, 2000, 6:01 AM ET) ("Amid the current high-speed networking craze, a simple rule applies: If you build it, they will come…. Centered around fiber-optic technology, communications companies and their 'arms dealers' equipment makers are reaping huge gains. Collectively, they are betting that the demand for capacity – or bandwidth – on networks will grow exponentially as more people do more-complicated, pipe-clogging tasks on private connections to the Internet.") Not only do advanced wireless digitization techniques in spread spectrum systems bolster effective bandwidth, but improvements in software, optical lasers (through wave splitting and other capacity improving techniques), and microprocessors. For instance, computer chip makers like Broadcom compete to produce products which improve the range and accuracy of wireless and wireline communications systems alike. *Chip Brings Broadband to the Masses*, EE TIMES (July 3, 2000), www.techweb.com/se/directlink.cgi?EET 20000703S0089.

[466] FCC, *In the Matter of Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996*, CC Docket No. 98-146 (Feb. 2, 1999), par. 20.

[467] For an excellent discussion of the race between demand and supply, see Michael Weingarten and Bart Stuck, *Will Bandwidth Ever Be Too Cheap to Meter*? BUS. COMM. REV. (Jan. 1998), 53; Michael Weingarten and Bart Stuck, *The Upcoming Explosion in Customer Demand*, BUS. COMM. REV. (Oct. 1999).

read the life-or-death CT-scan because the Internet backbone is clogged with junk e-mail. The problems have been described by financial analysts thusly:

> It's the economics (of the Internet) not the technology. Nearly two years ago we wrote that the Internet was not fulfilling its potential as a mission critical business platform because the economics behind its "one size fits all" price-quantity-performance offerings were screwed up… Flat-rate pricing and no financial settlement led to inefficient usage and reduced incentive to eliminate bottlenecks. Bandwidth quantity was limited at the last mile and in core interconnection points (NAPs). Many customers who were willing to pay for performance couldn't get it where/when they wanted it, whether it was voice IP (latency), e-commerce (reliability) or entertainment (burstable bandwidth).[469]

Noam concedes that a spectrum commons is analogous to the "presently 'free' Internet system [that] is experiencing congestion problems,"[470] but footnotes a paper by Jeffrey K. Mackie-Mason and Hal Varian[471] presenting an Internet traffic pricing proposal as a solution. It is yet to be adopted,[472] but if it were it would solve the commons problem by instituting tolls for admission—hardly "open access." The authors, authorities on the economics of the Internet, note that open access invites inefficiency:

> We expect that if access to Internet bandwidth continues to be provided at zero cost there will inevitably be congestion. Essentially, this is the classic problem of the commons: unless the congestion is priced, there will inevitably be inefficient use of the common resource. As long as users face a zero price for access, they will continue to "overgraze."[473]

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[468] Larry Lessig, Code: And Other Laws of Cyberspace (New York: Basic Books, 1999), 184 (footnote omitted).
[469] Bill Whyman, PRECURSOR GROUP INDEPENDENT RESEARCH (Oct. 2, 2000).
[470] Noam, *Spectrum Auctions*…, supra note __, 769.
[471] *Economic FAQs about the Internet*, 8 J. ECON. PERSP. 75 (1994).
[472] The inability of Internet policy makers to institute rules promoting efficient use of bandwidth is not surprising, as such policies are public goods and are also stymied by tragedy of the commons. In this sense, the Internet is an appropriate analogy for spectrum access.
[473] Jeffrey K. Mackie-Mason & Hal Varian, "Some Economics of the Internet," manuscript, Univ. of Michigan (Feb. 17, 1994), 14-5.

Substantial progress has been made in improving bandwidth allocation (and, hence, network speed) by privatizing network functionality. By removing key transport and information processing functions from the common areas of the Internet users can bid for services, not simply queue. With both hardware and software innovations, network service providers are building faster Internet ramps, gateways, long distance networks, and content distribution facilities. This infrastructure provides bypass around the commons. As the Precursor Group analyst concludes: "The one-size fits all… Internet is giving way to a more economic (and heterogeneous) Internet. And more importantly, an Internet where providers can price for service!"[474]

The Trade-offs of Unlicensed Spectrum

There are two types of unlicensed spectrum use.[475] The first involves low power transmissions regulated under Part 15 of the FCC's rules. Certain taboo frequencies are protected, but otherwise Part 15 devices are permitted to roam across designated bands. Interference is limited by virtue of strict power limits (effectively granting users de facto private rights over adjacent airspace) and equipment approval by the Commission. In essence, the FCC regulates the wireless equipment manufacturer but leaves users free to police their own localized radio waves. This permits low power users to co-exist in bands simultaneously used for higher power emissions.

Unlicensed use also occurs in allocated bands. The FCC again sets standards and provides type acceptance for manufacturers, but unlicensed users are permitted higher power due to the protections afforded by dedicated (unlicensed) bandwidth. See Table 9. Users in these bands are explicitly liable for interfering emissions they cause but are not protected from interference from others.[476] This means that unlicensed operators lack standing to assert claims against trespassers. Any tenancy enjoyed is via custom (as in transmission etiquette protecting multiple users from interference), economics (as when scarcity is not a factor).

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[474] Bill Whyman, PRECURSOR GROUP INDEPENDENT RESEARCH (Oct. 2, 2000).

[475] For a useful overview of unlicensed spectrum use, see: Charles Jackson, *Dynamic Sharing of Radio Spectrum*, in Rose and Ogielski, eds., WINLAB Focus on the U-NII and Radio Networks for Everything, (Kluwer, forthcoming 2000).

[476] "Devices that run in an unlicensed band are subject to the following (seemingly contradictory) conditions: (1) They may not cause harmful interference; (2) they must accept any interference received, including interference that may cause undesired operation." Carmen Nobel, *FCC to Rule on Hotly Contested 2.4GHz Band*, EWEEK (March 17, 2000), http://www.zdnet.com/eweek/stories/general/0,11011,2469855,00.html.

Table 9. Licensed and Unlicensed Spectrum Allocations

Band	*Bandwidth*	*Use*	*Operators/Manufacturers (partial lists)*
902-928 MHz	26 MHz	Industrial, Scientific, Medical devices (ISM)	Airlinx, CellNet, MetriCom, WaveRider
824-894 MHz	50 MHz	Cellular	AT&T, Alltel, Airtouch, Bell Atlantic, BellSouth, Western Wireless
811.5-866 MHz	14 MHz	SMRS	Nextel
1850-1990 MHz	120 MHz	Licensed PCS	Sprint PCS, PacBell, Omnipoint
1910-1930 MHz	20 MHz	Unlicensed PCS (voice, data)	Airlinx, Lucent
2150-2686 MHz	198 MHz	MDS/MMDS/ITFS	Adaptive Broadband, Cisco, MCI, Nucentrix, BellSouth, Sprint
2305-2360 MHz	30 MHz	WCS	BellSouth, MetriCom, Omnipoint
2390-2483.5 MHz	93.5 MHZ	Unlicensed Data	BreezeCOM, Cisco, Nortel, Proxim, SPEEDCOM, SkyLynx, WaveRider
4660-4685 MHz	25 MHz	GWCS	
5150-5850 MHz	300 MHz	Unlicensed Data	Adaptive Broadband, Airlinx, Cisco
24.25-25.25 GHz	400 MHz	DEMS	Teligent
27.5-31.3 GHz	1.3 GHz	LMDS	HighSpeed.com, NextLink. SPEEDUS.COM, Western Wireless, WinStar
38.6-40 GHz	1.4 GHz	39 GHz	AT&T, Advanced Radio Telecommunications, WinStar
59-64 GHz	5 GHz	Unlicensed Data	Newly allocated

MDS: Multipoint Distribution Services; MMDS: Multipoint/Multichannel Distribution Services; ITFS: Instructional Television Fixed Service; WCS: Wireless Communications Services; GWCS: General Wireless Communications Services; DEMS: Digital Electronic Messaging Services; LMDS: Local Multipoint Distribution Services

Unlicensed access to radio spectrum has pluses and minuses versus licensed spectrum. Eliminating the licensing barrier spurs competition. Once the FCC proceedings open up particular airspace for unlicensed access, spectrum is allocated according to the demands of actual users. Where spectrum is not scarce, or in instances where the costs of interference are born symmetrically (by entrant and incumbent alike), unlicensed bands may provide valuable communications service to the public.

Yet, wherever co-ordination between users is important to efficient spectrum utilization, open access is problematic. Indeed, this reality leads the FCC to mandate technical standards for unlicensed users, enforced through the equipment approval process. “Open access” is not truly open under the FCC’s unlicensed rules. Equipment regulation is used to prevent over-grazing. The rules can and do mitigate signal degradation. Yet, *Type I* or *Type II* errors are possible. The

optimum level of communications remains a delicate balance, varying with local demands and changing technology. In the wilds of the Upper Yukon, unlicensed bands may never encounter serious signal degradation because demand for wireless services is modest. Service providers may cheaply and easily avoid interfering with one another. Yet, in the downtown business districts of cities, unlicensed bands—if allowed to offer popular services—are apt to become over-crowded because success signals new entry.

A fundamental question is why, if spectrum sharing is highly efficient, it takes a government policy banning exclusive use to promote it. Why wouldn't granting licensees the freedom to choose technical standards lead the market to iterate on such powerful new technologies? Given flexible private rights to control radio traffic, band managers could compete to attract communications traffic, charging subscribers, operators, or manufacturers for use of the spectrum. Indeed, firms commonly engage in licensing agreements wherein a patent or trademark owner permits shared use for a fee. Yet Benkler argues that free markets will not produce efficient sharing due to "collective action problems, risk of monopolization, and unnecessary transaction costs."[477] Government policy is needed to pre-empt private rights, promoting unlicensed spectrum instead.

The empirical assertion is uncompelling. Spread spectrum is just one of a number of frequency sharing methods routinely used by licensed wireless operators.[478] Licensees routinely enhance system capacity—when permitted under FCC rules—by employing digital algorithms or other methods enabling spectrum re-use. For instance, wireless broadband access offered by Sprint (operating with MMDS licenses) relies on "sectorization" to deliver higher bandwidth to customers. This is described as "following an old cable path," although the approach is identical to "cellularization" used to provide additional capacity in analog or digital wireless telephony.[479] As reported some years ago by the NEW YORK TIMES, even technologies that now appear mundane were borne out of the basic principle of spectrum re-use:

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[477] Benkler, *Overcoming Agoraphobia*, supra note __, 362.

[478] "Dynamic sharing is not a new concept in radio system architecture. Indeed, the earliest radio communications systems, maritime mobile communications systems in the first two decades of this [20th] century, made extensive use of dynamic sharing." Jackson, *Dynamic Sharing*, supra note __, 3. Analog cellular systems, point-to-point and point-to-multipoint microwave, TDMA, and CDMA spread spectrum are examples of shared systems commonly in use today. See Table 10.

[479] Jim Barthold, *Sprint Using Cable Trick to Build Bandwidth*, CABLE WORLD (Aug. 21, 2000), 33.

> Nature created an abundant electromagnetic spectrum, which ingenious scientists have exploited for radar, television and lasers. But that is small comfort to cellular telephone operators. The Federal Communications Commission has been stingy with the radio frequencies that make wireless telephone calls possible.
>
> But through clever design that largely prevents any two users from electronically bumping into each other, cellular telephones and the networks that serve them have coped with spectrum scarcity—up to a point.[480]

Digital systems employing spectrum re-use have been widely adopted in licensed bands, carrying far more traffic (measured by almost any metric) than unlicensed frequencies. See Table 10. CDMA (delivered via licensed frequencies) is the standard used by 65 million mobile phone subscribers worldwide,[481] and these applications are certain to increase: "Operators on every major continent have chosen CDMA as their technology for 3G."[482] The billions of dollars poured into 3G licenses by the U.K. and German wireless providers went to provide warm, safe, exclusive bands in which to build CDMA spread spectrum platforms.

Table 10. Top Twelve U.S. Mobile Wireless Service Providers

Provider	*1Q00 Subscribers (mil.)*	*Technology*
SBC Communications	11.684	TDMA, AMPS
AT&T Wireless	9.987	TDMA
AirTouch	9.354	CDMA, AMPS
Bell Atlantic Mobile	7.978	CDMA, AMPS
GTE Wireless	7.418	CDMA, AMPS
Sprint PCS	6.560	CDMA
BellSouth	5.637	TDMA, AMPS
ALLTEL	5.124	CDMA, AMPS
Nextel	5.056	GSM
US Cellular	2.707	AMPS, TDMA, CDMA
Omnipoint/VoiceStream	2.103	GSM
PrimeCo	1.527	CDMA, AMPS

Sources: Merrill Lynch, *The Matrix—1Q00* (June 20, 2000); various websites.

[480] Anthony Ramirez, *Next for the Cellular Phone*, N.Y. TIMES (March 15, 1992), F7. The article went on to describe the means by which "digitizing can cram a lot more talk into the spectrum." The transition from analog to digital cellular allowed much more intense use of given bandwidth, and squeezed the additional traffic by more intelligent routing of the electronic signals composing a mobile telephone call.

[481] *Worldwide CDMA Subscribers Double*, RCR (Sept. 4, 2000), 40.

[482] Quoting Perry LaForge of the CDMA Development Group, Costa Mesa, California. Ibid.

Meanwhile, congestion continues to plague many unlicensed frequencies.[483] Intense disputes over what standards underscore that "open access" is only nominally open, and that scarcity continues to force trade-offs between radiated power levels, equipment cost, functionality (e.g., mobile vs. fixed), bandwidth, and signal reliability.[484] To reduce interference, the FCC restricts unlicensed power emissions. Shared use with higher power limits is possible, but requires tighter coordination.

The problem with unlicensed bands face is that restrictions will either be too lenient (*Type I* error) or too strict (*Type II* error). Hitting the optimum is theoretically possible, but will occur only in a (lucky) special case. There is no natural tendency for regulators to converge on this solution, while political forces reliably resist it. Private licensees or band managers, conversely, profit by discovering and implementing value-maximizing traffic strategies. Capital markets are ruthless in efforts to squeeze full value from assets, both in eliminating static inefficiency and in applying new technologies promoting growth. The search for profit extends to allowing decentralized use of the band, regulation permitting.[485]

When unlicensed entry thrives, the characteristic pattern is that over-crowding ensues. The history of unlicensed is a chase up the dial: the 900 MHz ISM band became congested, leading the FCC to open up the 2.4 unlicensed band, which became crowded in major markets,[486] leading the Commission to open up 300 MHz for the U-NII 5 GHz band.[487] The Department of Commerce now warns wireless service providers that spread spectrum is no panacea:

> A number of companies are manufacturing spread spectrum systems that operate under Part 15 rules as unlicensed point-to-point radios in the 2.4-GHz and 5.8-GHz bands…

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[483] "How does one determine the reliability of such [wireless broadband] equipment, particularly in the presence of interference – always a potential problem in the unlicensed bands?" Dan Sweeney, *Equipment for the Unlicensed—Ad Hoc or Fully Adequate?* BROADBAND WIRELESS BUSINESS (June/July 2000), 24.

[484] "The 2.4GHz band is unlicensed, meaning that pretty much anyone can use it, but the FCC still can regulate what goes on in the band, limiting the amount of the band each device uses as the commission sees fit." Carmen Nobel, *Is it Home Appliances vs. Bluetooth?* PC WEEK (March 17, 2000), http://www.zdnet.com/zdnn/stories/news/0,4586,2469855,00.html?chkpt=zdnntop.

[485] "The proof of the proposition that a centralized management algorithm can match or outperform a distributed algorithm based on the same information is obvious. One option for the centralized algorithm is to simulate the distributed algorithm…" Jackson, *Dynamic Sharing*, supra note __, 6.

[486] "'It's a pretty busy band,' said one FCC official. 'It's getting pretty crowded.'" Carmen Nobel, *Is it Home Appliances vs. Bluetooth?* PC WEEK (March 17, 2000), http://www.zdnet.com/zdnn/stories/news/0,4586,2469855,00.html?chkpt=zdnntop.

> These Part 15 radios have essentially created two new point-to-point microwave bands having very rapid growth. Although no licensing delays or cost apply to these radios, no protection against interference is implied or coordinated either. One manufacturer suggests that a useful strategy would be to install a 5.8 GHz unlicensed link and begin operation immediately, while simultaneously applying for a license for operation in the 6-GHz or 6.5-GHz licensed bands. He can install a licensed radio on a permanent basis, perhaps moving the unlicensed radio to another new site where the cycle will be repeated…
>
> The use of the ISM [unlicensed industrial, scientific, medical] bands for high reliability communications is problematic, mainly because there is no assurance that today's adequate performance will remain free of interference in the future… Eventually there may be too many additional systems to expect interference-free operation in crowded locations. Or, maybe not…
>
> [The situation will be similar in the recently allocated] unlicensed national information infrastructure (U-NII) band. This 5-GHz band with 300 MHz total bandwidth is designed especially to support wideband WLANs [wireless local area networks]… As with other unlicensed applications, the possible growth of interference in this band due to uncoordinated use is a potential problem for which no one has sufficient experience to give a convincing answer yet.[488]

Metricom, a provider of unlicensed network access via unlicensed frequencies, has been singled out by Prof. Benkler as a prime example of how unlicensed spread spectrum can and should work: "The difference between [Metricom's] Ricochet system and cellular and PCS providers is that it is provided not by a licensee or spectrum owner, but by a company that found a way to use an environment in which no one exercises control of spectrum use."[489] In fact, Metricom's experience in unlicensed is informative. Thus far, financial markets have yet to embrace unlicensed service providers. While opportunities for unlicensed operation are available, relatively few firms provide service and those that do are valued much less highly than

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[487] This was done in January 1997. Nick Wingfield, *Wireless Networks Get Radio Patch*, CNET NEWS.COM (January 9, 1997), www.news.cnet.com/category/0-1003-200-315692.html.

[488] Robert J. Matheson, *Spectrum Usage for the Fixed Services*, NTIA Report 00-378 (Washington, D.C.: U.S. Dept. of Commerce, National Telecommunications and Information Admin., March 2000), 6-7.

[489] Benkler, *Overcoming Agoraphobia*, supra note __, 326.

firms operating on exclusive licenses. See Table 11. This reflects a business reality: Where an unlicensed firm successfully innovates, open access guarantees imitation. This not only results in competition, a problem seen throughout the economy, but may degrade wireless emissions—perhaps severely. Barring ownership of a patent or other unique asset, economic success spells its own demise. This, of course, deters investment to begin with.[490]

Table 11. Market Values of Licensed and Unlicensed Wireless Data Service Providers

LICENSED		
Company	*Annual Revenues*	*Market Capitalization*
Nextlink Communications	$190.3M	$4,250M
Teligent, Inc.	6.2M	2,400M
Winstar Communications	326.8M	2,250M
Associated Group, Inc.	43.3M	1,290M
CT Communications, Inc.	4.6M	444M
American Mobile Satellite	99.1M	630M
Advanced Radio Telecom	1M	309M
Data Transmission Network	164.4M	290M
Nucentrix Broadband Network	71.2M	215M
SPEEDUS.COM	0.9M	78M
IJNT.net, Inc.	2.5M	53M
HighwayMaster Comm.	80.2M	39M
DBS Industries, Inc.	0.0M	36M
TOTAL LICENSED	**$990.6M**	**$11,977M**
UNLICENSED		
Metricom, Inc.	$17.3M	$1,010M
Cellnet Data Systems	18.6M	84M
SkyLynx Communications	0.7M	24M
TOTAL UNLICENSED	**$36.6M**	**$1,117M**

Source: Yahoo!Finance, November 1999.

Benkler's showcase business example has itself abandoned the pure unlicensed spectrum model. Metricom, buying licenses for fixed wireless in the FCC's April 1997 GWS auction, is shifting to licensed bands to support higher data rates and to economize on base stations:

[490] In raising capital for wireless start-ups, David Redick (co-founder of FiberStreet, a very high capacity network access provider) and Bill Frezza (general partner, Adams Capital Management, and columnist, Internet Week) strongly argue that unlicensed business plans are anathema to investors. Redick's view was stated to the author on August 18, 2000, in Saratoga, California. (The author served on the Board of Advisors to FiberStreet.) Frezza's argument was made publicly at the Cato Institute/Forbes ASAP Technology & Society Conference (San Jose, CA; Nov. 4-5, 1999). See also, Bill Frezza, *Open Spectrum Access: Profound Policy Or Fool's Gold?* INTERNET WEEK (June 8, 1998), www.internetwk.com/columns/frezz0608.htm.

> Our network will operate in the unlicensed 900 megahertz and 2.4 gigahertz frequency bands of spectrum. We also will operate in the 2.3 gigahertz frequency band pursuant to licenses purchased from the FCC in 1997. These licenses permit us to use the 2.3 gigahertz band in the Northeastern, Central and Western United States Regional Economic Areas, and in the St. Louis, Missouri, Portland, Oregon and Seattle, Washington Major Economic Areas. This licensed spectrum provides us with the ability to transmit at higher power in those regions and thus attain greater network coverage with fewer wired access points. In areas not covered by our licensed spectrum, we can achieve the same coverage results by deploying additional wired access points.[491]

In addition to ponying up millions of dollars for licensed protection from interference, Metricom will likely migrate to more intensive use of licensed spectrum in the years to come. According to a warning issued to stockholders, spread spectrum technology does not guarantee interference-free transmissions:

> If we are unable to eliminate harmful interference caused by our products through technical or other means or if interference to our service caused by others causes the performance of our service to be unattractive to users, we or our users could be required to cease operations in the band in the affected locations. Additionally, while we design our equipment to operate in the presence of other users, in the event the license-free bands become unacceptably crowded, our business could be adversely affected.[492]

Some unlicensed users attempt to mimic a property rights solution to interference by homesteading frequency space in unlicensed bands.[493] Squatter's rights may be effective in policing airwave traffic, even without legal enforcement, where the costs of interference are symmetric. Otherwise, FCC rule makings adjudicate competing claims by unlicensed spectrum

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[491] Metricom, Inc., Annual Report: SEC Form 10-K (March 24, 2000), 18.
[492] Metricom, Inc., Annual Report: SEC Form 10-K (March 24, 2000), 27.
[493] "Fuzion hopes to establish 'squatter's rights' for use of the U-NII spectrum on as broad a basis as possible,' [Fuzion vice president John] Wind said. 'We're the first ones anywhere to deploy this (AB) technology, but a lot of others are looking at it, including BellSouth,' he added." Fred Dawson, *US West Looks to Broadband Wireless,* BROADBAND WEEK (Nov. 8, 1999).

users. These demonstrate the standard administrative infirmities, producing use restrictions that are either too rigid or too lax.[494] The rule making process often consumes years, is highly politicized, and inevitably consumes rent seeking expenditures. For instance, in the unlicensed 2.4 GHz band, opposing interests recently battled over standards. It was clear that, "regardless of the decision, someone's not going to be happy."[495]

The "Home RF" coalition[496] argued that Proxim's RangeLan2 technology be allowed use of up to 5 MHz in the band—up from 1 MHz—to run wireless networking appliances. The wider bandwidth creates up to a ten-fold increase in speed, to 10 Mbps. Yet, it increases interference with other communications in the band. Rival companies supporting "Wi-Fi" technology[497] run up to 11 Mbps, and adamantly opposed the Home RF proposal. As 3Com, a WiFi supporter, wrote: "The Commission is proposing rule changes that would both crush a nascent industry and degrade more than a billion dollars of communications infrastructure… It would undermine the high-speed wireless LAN industry, which has just reached the state where widespread deployment is around the corner."[498]

Notably, spread spectrum is not the solution to this problem, but the problem itself—spread spectrum devices prefer wider bands, and interference across these frequencies disrupts other low power transmissions:

> Wi-Fi's technology is "direct sequence," meaning information flows through the same lane on a wireless "highway." HomeRF's technology is called, "frequency hopping," meaning the information bounces from lane to lane as it travels to its destination.

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[494] The regulatory bias resulting from incumbent licensee influence at the FCC is also a factor. Licensees may attempt to intercede in rule makings either to promote too much, or too little, entry into unlicensed bands. Either market failure has the practical effect of protecting competing service providers.

[495] Carmen Nobel, *FCC to Rule on Hotly Contested 2.4GHz Band*, EWEEK (March 17, 2000), http://www.zdnet.com/eweek/stories/general/0,11011,2469855,00.html.

[496] Home RF, is supported by Proxim, Intel, Microlore, Siemens AG and Motorola. Ibid.

[497] Wi-Fi supporters include 3Com, Lucent, and Cisco. . Business Wire, *Future of Home Networking Rests on FCC*, CNET INVESTOR (May 22, 2000), www.cnetinvestor.com/newsitem-fd-bloomberg.asp?symbol=923014.

[498] Carmen Nobel, *FCC to Rule*, supra note __.

> HomeRF wants to widen the lanes fivefold, so more information can flow through at a faster rate. Wi-Fi supporters are fighting against HomeRF's proposal because they say it will interfere with their technology.[499]

Spectrum scarcity leads to a highly contentious "mess" at 2.4 GHz, a "tug-of-war" between mutually incompatible demands.[500] Despite the technical abundance assertion, unlicensed spectrum use is not free—which is why standards are called for, on the one hand, and fiercely debated, on the other. Unlicensed standard setting is likely to be more costly than alternative processes undertaken by band managers (licensees with liberal rights to determine spectrum use, or spectrum owners under a property rights regime) who internalize economic costs and benefits resulting from spectrum use decisions. That is because unlicensed spectrum standards are public goods and naturally tend to be underprovided, whereas economic agents enjoying private benefits from efficient standards will undertake all costly efforts (including search) in pursuit of compensatory benefits. This extends to the investment in research and technology innovation, mitigating the risks of appropriation. "'The opposition [to Home RF] is asking us to protect something that's unlicensed,' the FCC official said. 'Unlicensed users aren't protected by [sic] interference.'"[501] In the event, the FCC did not protect existing users, granting the HomeRF request for a rule change.[502]

Table 12. Market Values of Exclusive-Use Wireless Licensees: Voice, Paging, Satellite TV

Company	*Annual Revenues ($millions)*	*Market Capitalization ($millions)*
Vodafone AirTouch PLC	5,510	69,200
Sprint PCS Group	2,100M	38,800
Nextel Communications	2,940	27,300
Alltel Corporation	5,540	23,500
VoiceStream Wireless	355	8,200

[499] "A third wireless standard, called Bluetooth, also operates in the 2.4 GHz portion of the spectrum – and proponents are also against HomeRF's proposal… [as it] 'will cause harmful interference to Bluetooth products,' Bluetooth supporters wrote in a recent letter to the FCC." Business Wire, *Future of Home Networking*, supra note [500].

[500] Wylie Wong, *Networking Firms Shout Over Wireless Standards*, CNET NEWS (Nov. 16, 1999), http://news.cnet.com/category/0-1004-200-1449659.html. "[A]nalysts say the standards war is just beginning."

[501] Carmen Nobel, *FCC to Rule on Hotly Contested 2.4GHz Band*, EWEEK (March 17, 2000), http://www.zdnet.com/eweek/stories/general/0,11011,2469855,00.html.

[502] Rex Crum, *FCC Rules to Speed Up Home Networking*, UPSIDETODAY (Aug. 31, 2000), http://www.upside.com/texis/mvm/print-it?id=39aee5380&t=texis/mvm/news.news.

United States Cellular	1,370	7,620
Centurytel, Inc.	408	5,620
Omnipoint	256	4,420
Western Wireless	581	4,150
Aerial Communications	211	2,660
Triton PCS Holdings	55	2,480
Centennial Cellular	409	1,740
Globalstar Telecommunications	0	1,720
Powertel, Inc.	224	1,650
Price Communications	226	1,140
CoreComm Limited	22	1,050
Leap Wireless International	4	829
Commnet Cellular Inc.	200	721
Rural Cellular	149	461
Clariti Telecommunications Int'l	28	321
CFW Communications	12	290
Arch Communications Group	442	240
PageMart Wireless	324	193
Paging Network, Inc.	1,040	98
Shenandoah Telecommunications	4	94
Shared Technologies Cellular	28	76
Metrocall	569	63
Iridium World Communications	2	60
Aquis Communications	15	19
Chadmore Wireless Group	5	8
U.S. Digital Communications	2	6
Teletouch Communications	52	3
Northeast Digital Networks	1	1
Hughes Electronics Corp.	6,920	15,800
Pegasus	304	2,170
EchoStar	1,370	21,600
TOTAL	**26,168**	**244,303**

Source: YAHOO!FINANCE, November 1999, January 2000.

The essential benefit of unlicensed spectrum is allowing use of fallow airwaves without the barrier of FCC allocation and licensing. The trouble with the existing regime for licensed spectrum is that it affords excessive protection to incumbents. The problem with unlicensed rules, however, is that they afford too *little* protection. The regulatory approach may be salvaged, or at least understood, by dividing the issue of unlicensed into three component parts:

(a) bands allocated to unlicensed spectrum use
(b) localized low-power unlicensed spectrum use
(c) long-distance low-power unlicensed spectrum use.

Bands allocated to unlicensed spectrum use. There is no regulatory justification for regulating which bands offer service on an integrated versus open-access basis. An effective band manager may establish the optimal way to deliver services. The standard existing option is to integrate the ownership of a license with the provision of service. This integration is

effectively mandated by FCC rules. Rules permitting contracting out would allow for the efficient construction of wireless parks or malls. Just as a shopping mall developer provides the infrastructure and ancillary facilities (common areas, parking, etc.), private developers exercising legal control of access to radio spectrum could promote frequency sharing by numerous users, establishing protocols to maximize value.

The private de facto or de jure owner would enjoy significant advantages over a government regulator in discerning, and instituting, efficient standards. By utilizing contracts establishing terms of entry, both the band manager and spectrum users would have incentives to create long-run solutions yielding the most productive use of a given band. Users would negotiate terms in a market setting, paying for favorable terms depending upon their demand (determined by consumer preferences and the availability of alternatives). While private contract enforcement is not costless, it side-steps the very expensive hold-ups inherent in FCC regulation of unlicensed bands. There, incumbent users essentially enjoy veto power over new allocations or rule changes, and can successfully hold up progressive improvements in band usage pending a generous share of the rents generated.

Neither the monopoly problem nor the transaction cost problem is a serious objection to such an approach. Market power is directly attacked by liberal spectrum allocation policies. Rules that generally allow flexible, competitive use of bands is the most reliable remedy to market power; indeed, incumbent interests are protected by so-called unlicensed allocations that fail to offer serious competitive investments in the markets they serve. This is largely the case today, where substantial investments in wireless services are made almost exclusively in the licensed sector (see Tables 11 and 12). It is also straightforward that flexible rules for band managers will allow licensing of manufacturers of wireless equipment rather than individual users. While millions may use cordless phones, the effective owner of a band reserving spectrum space for cordless phone access can minimize transaction costs by collecting fees from a much smaller number of vendors. This mimics FCC procedures, as well as the widespread use of patent licensing. Literally thousands of firms generate substantial revenues (in some cases, most or all firm revenues) from licensing their technology for use by other firms. Mass market consumers purchase products—say, CDMA phones manufactured by Motorola or Ericsson—and are transparently charged for Qualcomm technology in the purchase. Contracts for spectrum

access would be analogous, and many competing firms could simultaneously market devices or provide services in licensed or owned spectrum.

The argument that the market will under-provide such licensing agreements (or "open access" bands) is uncompelling. But, were it plausible, the solution would lie not in continued top-down allocation of unlicensed bands by regulators, but in incremental fixes within a competitive system. Those might include tax reductions for spectrum "parks," or other inducements favoring contracting out over vertical integration.

Localized low-power unlicensed spectrum. For devices used in very localized applications, there is a strong argument for open access. That is because effective control over airwave space is not sacrificed by allowing users to impose interference costs on *themselves*. The standard examples would entail local area network products for office or home use. It is not necessary to police emissions from a wireless printer-PC link—say, degraded UHF TV signals in an adjacent room—if the costs fall on the PC user and no other. The PC user simply adjusts his/her demand for the product, and use of the product, according to costs incurred. This demand effect influences seller behavior in product design and ultimate product sales. There is perhaps a labeling requirement on the part of the vendor, but free access to localized airwaves does not appear a public policy problem. A liberal spectrum regime would also create the opportunity for competing local area wireless standards. Not only would localized devices be given free access to spectrum, band managers would be free to use higher emission levels in exclusive use bands to promote alternatives. Indeed, technology suppliers could individually or through consortia purchase rights to spectrum, standardizing on preferred systems. In the recent debate over unlicensed local area networks, a competitive system would naturally gravitate to a standards competition decided by actual choices between Home RF, WiFi, and Bluetooth networks. Instead, under block allocation, the FCC imposes one set of transmission rules produced by compromise and optimized for none. It does so in its theoretical (even if politicized) model as to what will be best for the public interest, pre-empting an actual market test.

Long-distance low-power unlicensed spectrum use. The FCC's reticence to approve ultra-wideband (UWB) technology as a generic low-power application is curious given the fact that legal devices like Pentium chips emit higher radiation levels in incidental operation (i.e., without providing wireless communications service). The agency's reflex in separating intentional from unintentional radiation is not entirely without justification, however. Where emissions result

from wireless communications service, the authority to "pollute" predictably encourages more congestion. If the technology proves valuable to consumers, potentially large increases in congestion result. The non-communications device emits pollution that is largely localized; a free ride on congestion does not materially affect manufacturer incentives to limit emissions because its harmful effects impact the customer. The cost of congestion is internalized.

With UWB and other low-power technologies, emissions ride for many miles. Indeed, the systems compete with wide area networks and long-distance communications. Relieving entrants of responsibility for emissions allows pollution to be deposited in distant, and not easily identified, localities. The claim of UWB proponents is that the costs are small; power levels are so miniscule that even massive increases in UWB use will not amount to anything more than background noise. Of course, the background noise of today is the communications conduit of tomorrow—that is the precise claim of UWB champions. No one can ascertain how important the external damage will prove. Hence, the safe and effective solution to long-distance low-power transmissions is to define property rights and treat the power increments used by low-power service providers as exclusive use spectrum. They may be defined as "underlay rights," composed only of low-power (extremely low, defined typically in millionths of a watt) blocks for emissions defined in frequency space.[503] Under existing procedures, for instance, the FCC could define a license as covering 5 millionths of a watt of power between 2 and 4 GHz, with similar power allocations being licensed from 4-6, 6-8, 8-10, 10-15, 15-20 GHz, and so on.[504] Several licenses could be allocated per band, up to the ceiling set by the "noise floor" limits extended licensees transmitting over the underlay rights. If UWB advocates are correct, licenses will be easily affordable for parties—perhaps consortia—purchasing rights in order to lease access to UWB manufacturers. That is because any one of the competitive licenses would serve to accommodate virtually an unlimited number of devices. Importantly, efficient algorithms allowing maximum bandwidth use would be possible given private control over access.

[503] The FCC allocated so-called overlay rights in the PCS proceeding, as discussed in the next section. With overlay rights or the underlay rights introduced here, preferential rights are held by incumbent (or primary) users. Secondary rights are issued to entrants which operate so as to leave existing operations materially unaffected.

[504] If bandwidth across allocated licenses are needed for efficient operations, as is claimed in some UWB policy statements, aggregation of licenses or roaming agreements between licensees would allow for seamless access across multiple bands. Alternatively, bandwidth can be assigned to licenses more broadly. That limits the number, and perhaps competitiveness, of the resulting allocation.

XII. DEREGULATION PAST

Important lessons are available in the numerous spectrum policy reforms taking place in the U.S. or abroad. We have learned that, despite (rational) political resistance from interest groups, allowing firms greater flexibility to use radio waves results in improvements for consumers without offsetting losses. Tragedy of the commons does not appear, nor do public goods suffer under-investment. As discussed below, both problems are strong reasons *for* liberalization. The short review of past reforms illustrates the orderly manner in which efficiency gains can be realized by shifting spectrum use decisions from administrative rule makings to markets.

Perhaps the earliest identifiable domestic spectrum deregulation occurred in 1964. The Federal Communications Commission then allowed limited use of occupied frequencies by land mobile operators who assumed liability for any resulting interference.[505] This effectively (if partially) reallocated these frequencies according to market demand. Importantly, private responsibility policed interference—an alternative mechanism to public interest rules.[506]

Not many such examples are found until more recent times. In the early 1980s, the FCC approved general waivers requested by some licensees permitting enhanced use of spectrum beyond that originally planned in the initial allocation. One instance involved the sub-carrier channels used by broadcasters for paging, dispatch, data and other services. Another permitted instructional television licensees in the microwave band to lease their channel space to "wireless cable" companies. [507] Television stations were permitted to use the vertical blanking interval for delivering additional signals, notably for closed captioning of TV programs and teletext data transfer.[508] In 1991, the FCC waiver granted Fleet Call allowed SMR dispatch licenses to be used for cellular telephone service, as detailed earlier in this paper.[509] This was a formidable departure from block allocation orthodoxy.

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[505] Federal Communications Commission, *Secondary Frequency Assignments in California*, 29 Fed. Reg. 4808 (1964).
[506] See Richard W. Stevens, *Anarchy in the Skip Zone: A Proposal for Market Allocation of High Frequency Spectrum*, 41 FED. COMM. L. J. 43, 50 (Nov. 1988).
[507] See Douglas Webbink, *Radio Licenses and Frequency Spectrum Use Property Rights*, 9 COMM. & L. 3 (June 1987).
[508] 47 C.F.R. § 73.646 (1989).
[509] See discussion in text around footnote __.

Common Carrier Point-to-Point Microwave Radio Service

Pursuant to the success of Microwave Communications, Inc. (MCI) as a wireless entrant in the long-distance telephone market,[510] the Federal Communications Commission received a number of applications to provide additional point-to-point fixed microwave radio service on a common carrier basis (CCPMRS). Many of these proposed services would create interference with each other. Instead of pursuing the standard spectrum allocation procedure, which would entail selecting among the mutually exclusive proposals, the Commission issued rules for all applicants to access the CCPMRS band.

The essential features were as follows.[511] First, exclusive licenses were issued to microwave service providers. These licenses permitted access to unoccupied frequency space (i.e., the right to create non-interfering transmissions) and to "additional capacity... that they are likely" to require with future growth. To obtain such rights, CCPMRS licenses mandated that operators not interfere with any previously established communications service. Hence, de facto property rights to spectrum were awarded on an open entry basis.

Second, applicants were themselves responsible for creating and filing engineering plans which would allow their service to be delivered in a non-interfering transmission mode. Third, the Commission did not mandate interference parameters. Instead, the definition of interference was left to users. FCC engineer and policy analyst John Williams described the outcome of this bold departure from precedent in a 1986 Commission study:

> Perhaps the interesting aspect of the CCPMRS technical regulations is what they do not contain. Except for the antenna point rule (and of course the general allocation constraint) there are no a priori restrictions on the selection, location or orientation of specific frequency assignments. There are no prior allotments of channels to markets, as in the broadcast services; no pre-channelizations of the band, as in the-private microwave and most other services; and no minimum mileage separations as in the private land mobile services. Perhaps most notable of all is the absence of even a working definition of harmful interference. Individual licensees are allowed to set their own protection ratios. While this could theoretically lead to abuses or confusion, that apparently has not happened.

[510] *Microwave Communications, Inc.,* 18 F.C.C. 2d 953 (Aug. 13, 1969).

> Whether because of the threat of appeal to the Commission or possible retaliation against one's own future applications, or perhaps just an unwritten code of ethics, there appear to be few cases in which licensees have been unreasonably protective of their facilities. In fact, while the Commission has not required it, a consensus appears to have emerged for adherence to a single, uniform set of interference criteria as a voluntary standard in order to facilitate the general co-ordination process.[512]

Within a private rights framework, decentralized spectrum management proved effective: "the regulatory approach seems to be working quite well**.**[513] Administrative costs were shifted from regulators to private parties attempting to access spectrum: "These policies ensure that interference conflicts are resolved through private negotiations before applications are filed.**"**[514] The change in liability created social gains by eliminating free rider and common property inefficiencies: "these policies allocate interference avoidance costs to applicants, thus encouraging system designs and frequency selections that minimize interference and [insure] that each new use ultimately implemented has a value at least as great as the cost of interference it causes.**"**[515]

PCS Rules v. the Cellular Allocation

The contrast in regulatory strategies used to allocate spectrum for PCS vs. cellular is striking.[516] The cellular rule making was initiated in 1968, with licenses awarded (in the first thirty markets by comparative hearings, in the final 704 markets by lottery) between 1984 and 1989. The PCS rule making officially opened in 1990, with licenses issued by auction between

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[511] *First Report and Order*, 29 F.C.C. 2d 870 (May 25, 1971).
[512] John R. Williams, *Private Frequency Coordination in the Common Carrier Point-to-Point Microwave Service*, Federal Communications Commission OPP Working Paper No. 21 (Sept. 1986), 16-17.
[513] Ibid., 2.
[514] Ibid., 4.
[515] Ibid.
[516] "Personal communications services" were envisioned as the next generation of mobile telephone service following cellular, a technology in which a single telephone number would connect to a given user. This was predicted to involve a mobile device that would plug in at home, travel to work, and then be attached to an office telephone system. The network would always locate the device, and the device was mobile with the user. Indeed, users would have just one telephone number throughout a lifetime. Of course, PCS has not developed this way. It has proven important as a direct competitor to cellular telephone service, as well as to paging and messaging services, despite the fact that users tend to have more telephone numbers (and email addresses) than ever before.

1995 and (at least) 2000. While spectrum allocation advanced under similar administrative constraints, regulatory outcomes differed widely. PCS licenses were more numerous per market, granted operators relatively wide latitude in selecting standards and services, and encompassed larger regions. In an important FCC innovation, licenses contained "overlay rights," allowing new PCS operators to access frequency space already in use, allocating it according to market incentives.

Overlay Rights. The 1850-1990 MHz band allocated to PCS was already in use, providing about 4,500 point-to-point microwave links for railroads, oil drilling rigs, utilities, and local governments.[517] These incumbent users encumbered a small fraction of total band capacity, but possessed a strategic position in regulatory proceedings that could be used to block re-allocation. The microwave incumbents strenuously argued that they provided crucial services to vital industries and to public safety. Any relocation of existing services was branded a threat to life and property. [518] Political impasse ensued, stalling the PCS rule making.

The FCC eventually resolved the situation by creating overlay rights.[519] These allowed PCS operators to use allocated spectrum while respecting (not interfering with) incumbents. Over a multi-year period incumbents would be relocated to higher frequencies.[520] If the PCS licensee desired an incumbent to move earlier than the deadline imposed, thus making valuable bandwidth available for use, it could negotiate compensation to achieve such a result. Despite bargaining costs,[521] the system basically worked. Airwaves were moved from an underutilized allocation and opened to more intense usage offering enhanced consumer surplus. Indeed, the ratio of benefits to opportunity costs in the PCS band re-allocation is startling.

The upper bound on the cost of microwave relocation was established during the spectrum allocation debate. Incumbent microwave licensees sponsored a study estimating it would cost up

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Yet, "PCS" lives on as an official regulatory category at the FCC. The stranding of an acronym is a relatively benign illustration of the inability of planners to accurately identify future trends.

[517] See Cramton, et al., *Efficient Relocation*, supra note __.

[518] Anita Faff, *Microwave Users Bent on Keeping Their Spectrum*, NETWORK WORLD (June 15, 1992), 31.

[519] "Overlay rights" are a variant of an old spectrum allocation institution. For decades, bands have been assigned for use by "primary" and "secondary" users. Overlay rights are similar to being assigned "secondary" status, although the ability of secondary licensees to negotiate and buy-out primary users was an important innovation.

[520] "In allocating broadband PCS spectrum, the FCC… [gave] the new licensees the right to relocate the incumbent licensees but delaying that right three to five years." CBO, *Where Do We Go From Here?*, supra note __, 9. Entrants bore the cost of providing comparable facilities on higher bands. The move-with-compensation option was added by the FCC due to predicted hold-out problems. These problems could be relatively serious given the non-profit status of many of the microwave incumbents. See Cramton et al., supra note __, 663-68.

[521] See Cramton, et al., *Efficient Relocation*, supra note __.

to $1 billion to relocate to unused frequencies provided by the FCC at 4, 6, and 12 GHz.[522] This implied that a nationwide swath of 140 MHz could be effectively "bought" for about $4 per pop, with existing users fully compensated for moving to different frequencies. This was approximately 1.25% of the 1990 market value of cellular telephone licenses, allocated 50 MHz (25 MHz for each of two licenses per market).[523] Looked at from the reverse angle, there was an 80-to1 productivity improvement in the re-allocation of 1850-1990 MHz from existing uses to PCS (not adjusting for the difference in bandwidth).[524] The ensuing auctions for PCS licenses brought in much less than the per-MHz-per-pop valuations for cellular telephone licenses, likely due to increased competitiveness (which distributes gains to consumers rather than producers). The PCS auctions, nonetheless, raised over ten billion dollars. Hence, the efficiency gains in re-allocating the 1850-1990 band from microwave to PCS, by the most conservative estimates, exceeded 1000%.[525] Overlay rights help unlock these gains by allowing PCS licensees to use cost-benefit calculations to execute efficient trades. Overlays establish property rights for both incumbents and entrants. Market transactions then determine efficient resource use within the band, taking into account technology, embedded base, switching costs, investor risk, and consumer demand. In short, a textbook application of the Coase Theorem.[526]

License Flexibility over Standards and Services. The FCC mandated that cellular telephone systems be constructed according to the analog Advanced Mobile Phone Standard (AMPS), a decision that appears to have blocked technical progress and economic efficiency. According to one leading expert, "The story of analog cellular radio will be written in vivid hindsight as one of the classic technological miscues of modem history, on a par with, say, the Zeppelin airship."[527] Digital technologies were permitted in 1988, but the FCC rule change came

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[522] Edward M. Greenberg and Catherine M. Lloyd, POP *Out: The Changing Dynamics of the Cellular Telephone Industry*, Morgan Stanley—U.S. Investment Research (23 April, 1991).

[523] The National Telecommunications and Information Administration of the U.S. Department of Commerce estimated that licenses in the 306 metropolitan statistical areas (i.e., ignoring the 428 rural license areas) were worth approximately $80 billion. NTIA, U.S. *Spectrum Management Policy: Agenda for the Future* (United States Department of Commerce, NTIA Special Publication 91-23; February 1991), 59-84.

[524] This calculation assumes that producer surplus, as capitalized in the price paid for licenses, is a good proxy for total value (including consumer surplus).

[525] Given that PCS licenses increased competitiveness and improved consumer welfare by lowering prices, it is likely that social gains are under-represented in this benefit calculus (where benefits are quantified in prices paid for licenses). That makes the efficiency gains even larger.

[526] Ronald Coase, *The Problem of Social Cost*, 3 J. LAW & ECON. (1960), 1.

[527] George C. Calhoun, Digital Cellular Radio (1988), 15. Calhoun sees the FCC's cellular spectrum allocation delay as, ironically, a missed opportunity: "In effect, cellular technology had become obsolete even as it was reaching the marketplace. It is a commonplace in our era that by the time a new technology reaches the market, a better, faster,

late for metropolitan cellular systems (where the capacity advantages of digital technology are most valuable) having already completed or, at least, commenced construction.[528] This relaxation, interestingly, came in response to a request to mandate cellular carrier interoperability, with the Commission deciding to give individual licensees flexibility to choose a standard. The Commission soon after also relaxed prohibitions on services to be offered by cellular operators, permitting paging, for instance, in 1990.[529]

In contrast, PCS operators were given substantial freedom to select technical standards from the beginning. The result has been a standards competition among three digital mobile wireless rivals: GSM (global mobile service standard), TDMA (time division multiple access) and CDMA (code division multiple access). Each boasts advantages and disadvantages, and a healthy debate rages over which will prove the superior long-run technology. In fact, the adoption of each of the three standards by different PCS providers suggests that the competitive race is fairly close. That is because operators have strong incentives to select standards which consumers prefer and which will have long-run viability. Their selections factor in such considerations as the embedded base (pushing down equipment costs via economies of scale), functionality (including roaming capabilities), and expandability (including the capacity for emerging data services).

The relatively broad PCS service definition embedded in the FCC's rule making impacts directly on both the technology issue and voluntary reallocation of radio spectrum. The PCS licensee was permitted, via a 1996 amendment to the rules, to subdivide the license's allocated bandwidth. In this manner, firms or other third parties wishing to utilize radio waves could lease bandwidth from the PCS licensee.[530] This is particularly important in the developing market for wireless, high-speed Internet access, and other innovative services for which demand is as yet uncertain.

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cheaper version is already well established in the laboratories. This is taken into account in normal product planning cycles. The obsolescence of analog FM-based cellular radio was far more fundamental. By sheer bad timing, the ten-year delay in cellular deployment straddled what will come to be seen as one of the great 'revolutions' in communications technology of this century." Ibid.

[528] *Report and Order in the Matter of Liberalization of Technology and Auxiliary Service Offerings in Public Cellular Radio Telecommunications Services*, 3 F.C.C. Rcd 7033 (1988).

[529] *Memorandum Opinion and Order*, 5 F.C.C. Rcd *113* 8 (1990) (Cellular Radio).

[530] *FCC Agrees to Let PCS Companies Lease Portion of Airwaves*, WALL ST. J. (Dec. 16, 1996), B7.

Larger Service Areas. The atomized U.S. cellular market, creating some 734 non-overlapping franchises, whereas no other major country created more than ten.[531] While the large number of licenses created by this policy was popular with Congress, it created substantial lags in licensing; even under the lottery method, individual applications had to be processed by the Commission. Moreover, after licenses were issued, the forced deconcentration of the national cellular market imposed high roaming costs on consumers and led to a long string of mergers, joint ventures and consolidations that is yet ongoing. While a fraction of total re-aggregation costs, the brokerage fees associated with license sales were alone estimated by the FCC at over $190 million annually.[532]

PCS licenses were delineated more broadly, with 51 Major Trading Areas (MTAs) and 493 Basic Trading Areas (BTAs), divisions made in a Rand McNally mapping of business markets in the United States. Two PCS licenses were issued in each MTA, four in each BTA map. (See Table 13.) The advent of license auctions facilitated this process, allowing instant aggregation of licenses across markets. While the PCS auctions were broken into several parts, PCS operators could bid to acquire regional or national footprints. Aggregating licenses within a market, enabling bandwidth increases, was permitted up to a 45 MHz "spectrum cap."[533]

Table 13. Cellular v. PCS Allocation

Allocation	*Years to Market*	*Spectrum Allocated*	*Licenses Nationally*	*Restrictions in addition to Spectrum Cap*
Cellular A	16-21	25 MHz	734	Wireline
Cellular B	16-21	25 MHz	734	Non-wireline
PCS A	7	30 MHz	51 (MTAs)	
PCS B	7	30 MHz	51 (MTAs)	
PCS C	11+	30 MHz	493 (BTAs)	Designated Entity
PCS D	8	10 MHz	51 (BTAs)	
PCS E	8	10 MHz	51 (BTAs)	
PCS F	11+	10 MHz	493 (BTAs)	Designated Entity
SMR	40+	10 MHz		

[531] Both Japan and Canada issued ten regional licenses. Eva Kalman, The Economics of Radio Frequency Allocation (Paris: Organisation for Economic Co-operation and Development, 1993), 85-86.
[532] *The FCC Report to Congress on Spectrum Auctions*, supra note __, 22.
[533] Bandwidths assigned licenses are listed in Table 13. See, *Notice of Proposed Rulemaking In the Matter of 1998 Biennial Regulatory Review – Spectrum Aggregation Limits for Wireless Telecommunications Carriers*, WT Docket No. 98-205 (Dec. 10, 1998).

More Spectrum, More Competitors. The PCS allocation notably spawned competition. The cellular allocation, while rejecting the "natural monopoly" argument suggesting only one licensee could survive per market, nonetheless produced a duopoly scheme that resulted in anemic rivalry. This is clearly seen in the price reaction to PCS entry. In 1998, an analyst cited by the FCC estimated that average mobile telephone rates fell 20 percent, while the Bureau of Labor Statistics puts the 1999 rate decline at 11.4%. These rate reductions, and concomitantly large increases in mobile telephone subscriber penetration, are attributed to the advent of PCS competition by the FCC.[534]

This could be the result of additional spectrum in use *or* more competition between licensees. What demonstrates the anti-competitive output restriction of cellular providers under the original cell-phone duopoly is that the incumbents responded to PCS by dramatically *increasing* their subscribership. Rates have not fallen due to decreased pressure to access cellular systems; those bands are used more intensively than ever. New cellular capacity has been "found" via investments adding cell sites and base stations. Competitive entry created this pro-consumer result—revealing an overly conservative license allocation in cellular.

WCS and 39 GHz

Some post-PCS spectrum allocations have exhibited, and extended, the relatively liberal rules used successfully in PCS. In particular, the service definitions for "General Wireless Communications" and "39 GHz" have been broad, allowing latitude for market participants to determine spectrum deployments and technical standards. While the Commission has mitigated the effect (in the case of WCS) by imposing tight power limits effectively precluding valuable (mobile) wireless services, the marketplace model operates well over the range of choice allowed.

Regulatory rigidity is defeated by vague service categories in radio station authorizations. Hence, licenses defined generically as "Wireless Communications Services" and "39 GHz" permit relatively flexible use. There is no "physical scarcity" of bureaucratically restrictive service titles, and this seemingly trivial turn in nomenclature is an indicator of policy progress. In WCS, the FCC permits licensees to "provide any fixed, mobile, radio location services, or satellite Digital Audio Radio Services ('satellite DARS'), consistent with the international Radio

[534] Federal Communications Commission, *Annual Report and Analysis of Competitive Market Conditions With Respect to Commercial Mobile Services – Fifth Report*, FCC 00-289 (Aug. 18, 2000), 4-5.

Regulations."[535] The service definition is pointedly broad, with the Commission specifically citing several types of permissible service. In addressing which of these services, if any, will ultimately be selected by the winning applicants, the Commission agnostically writes: "We anticipate that the most likely uses of WCS will be..."[536]

The Commission relies, albeit in a restrictive and perhaps overly conservative manner, on interference parameters in defining WCS licenses. It focuses on what power levels and emission standards will protect communications in adjacent bands.

Geographic scope is also thrown open to the market in WCS:

> [W]e are proposing to allow WCS licensees to desegregate portions of their assigned spectrum and partition geographic service areas through a transfer of FCC license authority. In addition, licensees would be permitted to "franchise" portions of their spectrum and geographic service areas on a leased basis, where the WCS licensee would retain ultimate responsibility for meeting interference and other licensing requirements.[537]

The departure from previous FCC allocations, including PCS, is important. This newer methodology reverses the traditional block allocation process wherein the rule making focuses on the cost and benefits associated with the licensed service, and interference issues are decided when the specific technology to be used in the allocated band is mandated. When freedom is granted licensees to determine services and standards, then the Commission must establish explicit interference contours.

Similarly, the FCC allocation for 39 GHz was very liberal by historical standards: "39 GHz licensees may provide fixed communications including point-to-point and point-to-multipoint communications. Mobile communications are subject to the development of inter-licensee and inter-service interference criteria."[538] These licenses have been auctioned and are being incorporated into national fixed wireless broadband networks being constructed by Winstar and Advanced Radio Telecom. For these particular frequencies, the permissive regulatory regime comes close to the claim that it allows the market to allocate radio spectrum.

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[535] *Notice of Proposed Rule Making, GN* Docket No. 96-228 (Nov. 12, 1996), par. 3.
[536] Ibid., par. 14.
[537] Ibid., par. __.

PLMR

The FCC has found that the search for solutions to airwave congestion in open access bands naturally leads to property rights. Private Land Mobile Radio (PLMR) bands have traditionally been allocated on a shared basis, leading to unacceptable degrees of congestion. Despite the availability of new techniques to use PLMR frequencies more intensely, sharing rules have proven ineffective. The FCC's Wireless Telecommunications Bureau recently considered the possible options, including "how certain market-based incentives such as exclusivity with the right to lease excess capacity, spectrum user fees, and/or competitive bidding can be introduced into the PLMR bands to promote more efficient use of this spectrum."[539]

The Bureau noted that the in the PLMR bands used for community repeater stations "licensees sought and received regulatory relief from the FCC… on a non-profit cost-shared cooperation basis." Such "multiple licensing" allowed prime relay stations to serve multiple users. The arrangement yielded such efficiencies that "third party entrepreneurs" went into business, investing in facilities offering service to licensees who technically "shared" the use of the frequency under FCC rules.[540]

Before 1958, users of shared PLMR bands[541] were mandated to coordinate via direct negotiations. Then, however, private frequency coordinators were introduced to police transmissions so as to cause the "least amount of interference."[542] While PLMR license applicants could bypass these coordinators by conducting their own "field study" to determine where they should be allowed to transmit, the Commission eliminated this option in 1986. This removed the FCC from the technical business of interference mitigation, after certifying one private frequency coordinator per band (except for the Specialized Mobile Radio services band, where multiple coordinators were allowed). This not only indicates the Commission's concern over the necessity of maintaining coordination in shared bands, but indicates that the actual

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[538] FCC, *39 GHz Fact Sheet*, www.fcc.gov/wtb/auctions/39 GHz/39ghfact.html.
[539] Federal Communications Commission, Wireless Telecommunications Bureau, *Private Land Mobile Radio Services: Background*, Staff Paper (Dec. 18, 1996), 21, www.fcc.gov.
[540] Ibid., E-8.
[541] The spectrum allocated to these services represents considerable bandwidth: 25-50 MHz, 150-174 MHz, and 450-470 MHz. This is prime airspace for mobile communications, dominating the 50 MHz allocated for cellular in the 900 MHz band. Ibid., Figure 1, E-13.

logistics of directing traffic are best handled in complex, multiple-user situations by private firms or organizations—as per the revealed preference of the FCC.[543]

Senator Pressler's Proposal for TV Band Overlay Rights

An ambitious proposal to promote spectrum liberalization was advanced by a powerful member of congress in the Spring of 1996. The legislation crossed over a Line of Regulatory Death, challenging not only the sanctity of FCC spectrum allocation, but brushing aside TV broadcasting's special role in the palace guard surrounding "public interest" regulation. Not only did the idea fall into the waste bin of political non-starters, its author—Chairman of the Senate Commerce Committee—soon tumbled into the abyss. Sen. Larry Pressler (R-SD) was the only incumbent U.S. Senator to be defeated for re-election in Nov. 1996.

That the Chairman of the Senate Commerce Committee embraced a radical plan to improve competitiveness in the wireless communications sector, however, is meaningful. In hindsight, it is clear that had Pressler's idea moved into law, the U.S. would today be far ahead of global competitors (as it is not, today) in developing and deploying so-called 3G wireless technology.

On May 9, 1996, Pressler introduced a "discussion draft" of legislation he called the "Electromagnetic Spectrum Management Policy Reform and Privatization Act."[544] The measure, said Pressler, was intended to continue the reform path begun in the Telecommunications Act, signed into law by President Clinton Feb. 8, 1996. Specifically, the Senator warned that without better regulatory approaches, "a vast array of new spectrum-based products, services, and technologies will go unrealized for the American people."[545] To avert this outcome, and to jettison an "antiquated model [wherein] the Government—not consumers—decides who uses frequencies, what they are used for, and how they are used,"[546] the legislation laid out five major reforms.

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[542] Ibid., E-11. See Federal Communications Commission, *Amendment of the Commission's Rules Governing the Industrial Radio Services to Delete, Modify and Create Services and Effect Changes in the Availability of Frequencies*, First Report and Order, Docket No. 11991, 23 Fed. Reg. 4784 (1958).
[543] Ibid., E-12.
[544] CONG. REC. – SEN. (May 9, 1996), S4928-36. The author served as an informal consultant to the staff of the Senate Commerce Committee in constructing this proposal.
[545] Ibid., S4929.
[546] Ibid.

1. *Exhaustive allocation and licensing*. The FCC would be mandated to allocate all requested bands for private use, assigning licenses via auction. Existing wireless users in such bands would be protected from interference; entrants would have subordinate rights.
2. *Full flexibility for existing licensees*. This would allow wireless users to provide whatever services, via whatever standards, the market would support, subject only to non-interference rules. Licensees would essentially own, and be responsible for, the airspace within the interference contours of currently licensed services. "Simply put, frequencies should be treated more like private property."[547]
3. *Spectrum privatization*. The federal government, claiming "nearly one-third" of frequency space,[548] was ordered to "relinquish one-quarter of its spectrum stockpile."[549]
4. *TV band overlay rights.* TV broadcasters would receive new digital TV licenses, paying only a deposit (refunded when analog station licenses were turned back to the FCC). No standard would be mandated for digital TV, and broadcasters could use assigned channel bandwidth to provide non-TV services in addition to—entirely in place of—broadcasting. All radio spectrum in the 402 MHz TV band was to be allocated to overlay licenses assigned via auction. Winning bidders would have the right to use all bandwidth not encumbered by current analog TV or future digital TV stations, "A market-based alternative to a Government mandated and dictated transition policy."[550]
5. *Public safety.* Instead of the FCC regulating local fire, police and emergency communications, blocks of spectrum rights would be granted to all 50 state officials (as well as the District of Columbia, Puerto Rico, Guam, and the Virgin Islands). These jurisdictions would be free to use spectrum in a flexible, non-interfering manner.

[547] Ibid.
[548] Ibid.
[549] Ibid., S4930.
[550] Ibid., S4932.

The proposal was bold. It generated little support and, while a rival plan was advanced by Sen. John McCain (R-AZ) who would assume the Commerce Committee chair upon Pressler's defeat,[551] neither were enacted. The spectrum allocation system was not liberalized, and the TV band is still vastly under-utilized, as analog and digital TV transmissions continue to use only a fraction of available bandwidth. (See discussion below.)

New Zealand's "band management rights"

In the Radiocommunications Act of 1989, New Zealand undertook far-reaching reform of wireless telecommunications policy.[552] The measure introduced government plans to auction both "apparatus licenses" and "spectrum management rights." The former are analogous to licenses issued by the FCC—essentially operating permits for physical equipment and specific businesses. The latter category, however, allows private parties to determine radio wave usage. The band manager issues licenses to wireless operators (including itself), and is responsible for emissions generated within the band (including those that interfere with communications in other bands). The band management rights maximize spectrum flexibility, as rights are constrained only by interference parameters. As the New Zealand Ministry of Commerce states:

> A "management right" to a range of frequencies (i.e. frequency "band") entitles the owner of that right, known as the manager, to issue "licenses" either authorizing persons to transmit radio waves or to ensure specified levels of interference are not exceeded... A key characteristic of management rights is that they carry with them no requirement that limits use to any specific telecommunications or broadcasting application.[553]

The Ministry of Commerce has produced thoughtful analyses of its mission in overseeing the provisions of the 1989 Radiocommunications Act.[554] New Zealand's regulatory structure has adapted to band management rights by becoming more transparent, establishing clear rights for

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[551] Christopher Stern, *No Deposit, No 2nd Channel*, BROADCASTING & CABLE (May 13, 1996), 16.
[552] For a general description and analysis, see Robert W. Crandall, *New Zealand Spectrum Policy: A Model for the United States?* 41 Journal of Law & Economics 821 (Oct. 1998).
[553] Ministry of Commerce, *Radio Spectrum Management* (16 May, 1994), available at www.govt.nz/com/rsp/pib17.html.
[554] In particular, see: Ministry of Commerce, *Radiocommunications Act Review* (December 1995), available at www.govt.nz/com/rsp/act_review.

market participants. The "Register of Radio Frequencies," a computerized publicly-accessible database, was created to track both technical and legal aspects of spectrum use. "Management rights and licenses are recorded in a public register which also tracks mortgages, caveats and changes of ownership in a similar manner to land."[555] The Register invites entrepreneurs to assess available opportunities in providing wireless services: An underutilized band implies a profitable investment opportunity.

The first band management rights covered spectrum previously targeted for cellular telephone or microwave, multipoint distribution service (MMDS). The management rights granted winning bidders gave licensees the freedom to utilize these frequencies for other services. Such users are subject to the incentives of economic efficiency the targeting of already allocated radio spectrum blocks allowed any efficiencies from the administrative planning already achieved (in coordination, of course, with international spectrum assignments and equipment standards popular elsewhere) while permitting band manager flexibility to take advantage competing alternatives which might be discovered.

New Zealand band management rights were created with explicit borders defined by two metrics:

- AFEL—adjacent frequencies emission limit
- PL—protection limit

The AFEL of band A is the maximum allowable "spillover" from A to other bands. The PL is the maximum level of interference from other bands. This is analogous to a "noise floor." While the initial rules prompted this PL to be set sufficiently high such that various low powered devices would easily fall under the floor (while keeping the Crown, which sells management rights to private parties, to escape liability for minor interference), the Ministry has proposed tightening the interference protection or abolishing it altogether. The technical reason is that certain new communications applications, including "spread spectrum," usefully operate in the low power "noise floor" zone, while the economic reason is that leaving any space without an effective owner may cause perverse resource use (a tragedy of the commons).

[555] Speech by Wayne Wedderspoon, Manager, National Radio Spectrum Policy, Communications Division, Ministry of Commerce, *Personal Communications Services (PCS) Spectrum Allocation in New Zealand* (June 1996), www.govt.nz/com/rsp/pcs_nz.html.

This view is reflected in the Ministry's bias against unlicensed, or "shared," spectrum. Private band managers have profit incentives to promote intensive use of their bandwidth by contracting with multiple users, networks, or wireless device manufacturers. A computer maker, for instance, could negotiate to produce wireless modems for local area networks by accessing spectrum space it is licensed to use by a private band manager. In commenting on requests to allocate "non-exclusive bands," the Ministry notes that shared use is entirely possible in privately managed bands where the band manager "retains responsibility for all transmission."[556] It goes on to say: "The concept of a non-exclusive management right is altogether different... The Ministry is not attracted to this concept. This could involve substantial transactions costs and intractable interference problems."[557]

The New Zealand market has experienced only moderate growth in its wireless telecommunications sector since spectrum deregulation. Robert Crandall notes that the regulatory model adopted still gave considerable discretion to administrators who decide which services shall be licensed and what bands shall be governed by management rights.[558] Crandall also believes the limited success is due to the difficulty in promoting new uses in a small market; scale economies in equipment manufacturing render such markets hostage to progress in larger countries.[559] Yet, one clear lesson is that defining spectrum rights in terms of generic interference parameters has not led to chaos. Regulators are not forced by wireless technology to limit rights, issuing only permits to transmit with specific equipment. Pablo Spiller and Carlo Cardillo find that this experience demonstrates that "spectrum property rights… are an immediately viable option."[560] And some informed New Zealanders believe that their reforms will move their economy "beyond the protectionist and prescriptive model inherent in telecommunications since *the ITU [International Telecommunications Union] was formed over 130 years ago."*[561]

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[556] Ministry of Commerce, *Radiocommunications Act Review* (December 1995), Ch. 5, 5.
[557] Ibid., 6.
[558] Crandall 1998, supra note __, 838.
[559] Crandall 1998, supra note __, 839.
[560] Pablo T. Spiller and Carlo Cardillo, *Towards a Property Rights Approach To Communications Spectrum*, 16 YALE J. REG. 53 (Winter 1999) (abstract).
[561] Wedderspoon speech, supra note __, 3.

Spectrum Liberalization in Guatemala[562]

An even more interesting story is unfolding in Guatemala, the country with perhaps the most liberal radio spectrum regulatory policy in the world. There the wireless licensee gains an explicit right to radio frequencies: *Titulo de Usufructo de Frequencia* (*TUF*). Rather than *TUF*s being allocated and assigned by the state, users petition the state for rights to control unoccupied frequencies. The rights are awarded on request. Auctions are used when competing claims are made. Hence, the market—not bureaucrats—allocates radio waves.

The spectrum allocation system was revamped in a sweeping November 1996 law.[563] "The basic building block of Guatemala's approach to the spectrum is that all spectrum not currently assigned to [users]… can be requested by any person."[564] Allocation of Guatemalan radio spectrum is bottom-up. This sharply differs from top-down block allocation, with bandwidth use administratively determined. The apparent success of the reform provide clues as to the practical elements to be included in spectrum liberalization schemes elsewhere.

First, an independent regulatory body was established, the Superintendent of Telecommunications (SIT). Under the previous state telecommunications monopoly, there were no private firms to regulate.[565] Alternatively, existing courts—or a newly established Spectrum Court (with technical expertise)—could have enforced the new law.[566] The newly created body was conceived as an administrator to enforce specified rules. The broad political discretion of the public interest standard is not allowed the SIT, which—like law enforcement agencies or the

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[562] The origins of the law can be traced to the work of Giancarlo Ibarguen S., an economist and engineer at Universidad Francisco Marroquin. His 1992 monograph detailed the essential logic of spectrum reform. See Ibarguen, *Privatizar Las Ondas de Radio* (Guatemala City: CEES, Feb. 15, 1992)**.** In 1996, the author was retained, as was Prof. Pablo Spiller of UC Berkeley, as an expert by the Government of Guatemala to advise on telecommunications reform legislation. The privatization and deregulation of wireline telecommunications in Guatemala are described in Pablo Spiller and Carlo G. Cardilli, *The Frontier of Telecommunications Deregulation: Small Countries Leading the Pack*, in T. Bell and S. Singleton, eds., Regulators' Revenge: The Future of Telecommunications Deregulation (Wash. D.C.: Cato Institute, 1998), 38.

[563] Ley General de Telecomunicaciones, D.C.A. 14 de Noviembre de 1996 (Guat.).

[564] Spiller & Cardillo, *Towards a Property Rights Approach*, supra note __, 75.

[565] Guatel, the state monopoly, was reorganized as Telgua in 1997. It was then sold to private investors in 1998. See *Communications in Guatemala*, National Economics Research Center (CIEN) (1999).

[566] I favored this alternative on the grounds that regulatory agencies are susceptible to capture. Prof. Spiller argued that Guatemalan courts were not sufficiently neutral as to offer superior rights adjudication. However, Spiller now writes: "We believe the responsibility for adjudicating spectrum property rights should lie with the judiciary." Spiller & Cardillo, *Towards a Property Rights Approach*, supra note __, 73. The problem of insulating spectrum rights enforcement is a difficult one, and it is not made easier by the uniformity with which nations have used regulatory agencies (or state monopolies) to police radio interference.

courts—assumes a reactive role. Essentially, the SIT is constituted to respond to private claims and to adjudicate disputes over airwave rights.[567]

Second, a registry of all uses of the communications spectrum was produced by the SIT. This computerized database is, by law, easily accessible to the public. This was a vital step in creating transparency for private wireless users (and potential users). It effectively displays information on telecommunications opportunities, easing entry into unoccupied bands.

Third, existing users were granted flexibility in the use of radio waves. Frequencies assigned to licenses may be employed according to market conditions so long as emissions are confined to the original bandwidth assigned. Since the state telecommunications monopoly, Guatel (now privatized under the name Telgua), was the dominant incumbent in Guatemala, this firm was grandfathered with over 900 frequency rights, as were radio and television broadcasters and the erstwhile cellular monopolist, ComCel.

Fourth, entrepreneurs, firms, or organizations wishing to access frequencies are allowed to petition the SIT for the right to use any unoccupied bandwidth. The process goes as follows:

- A private party surveys existing spectrum use in the spectrum registry.
- The party applies to the SIT for the right to unused frequencies.
- The application is evaluated and public notice issued. Parties objecting to the proposed new use file formal complaints. Grounds for opposition are limited to technical interference.
- Complaints, if any, are quickly adjudicated via binding arbitration.
- Other spectrum users are allowed to file competing claims to requested bandwidth rights.
- If no competing claims filed, then petitioner receives rights without auction (or payment).
- If competing claims filed, then the SIT must quickly schedule competitive bidding process to determine ultimate licensee.
- Rights extend 15 years and are renewable (without competitive bidding) at the discretion of the user.
- Rights are freely tradable
- Regulation is limited to interfering emissions.

The result of this law is observed in the wireless license itself. (See license form, below.)

[567] Any regulatory authority implies some degree of discretion; a regulator without discretion is called…. a *judge*. How to institutionally achieve effective, low-cost rights enforcement while minimizing legal discretion is the issue at the heart of the Regulatory Agency v. Court debate.

No. Orden: **No. Registro:**

LA SUPERINTENDENCIA DE TELECOMUNICACIONES DE GUATEMALA

Con base en el Artículo 57 del Decreto 94-96

Otorga el Presente

Título de Usufructo de Frecuencia

A:

Banda o Rango de Frecuencias :

Horario de Operación :

Potencia máxima efectiva de radiación :

Máxima intensidad de campo eléctrico o potencia máxima admisible en el contorno :

Fecha de Emisión :

Fecha de Vencimiento :

_____

Instead of merely licensing a particular business or "radio station," as in the U.S. (see Figure 9), the Guatemalan wireless licensee effectively owns the spectrum resource for a limited time period (fifteen years). The *TUF* is defined in a one-page form listing six basic variables:

(a) frequency
(b) location (included on actual *TUF*s but not a line item in the form)
(c) hours of operation
(d) maximum power transmitted
(e) maximum power emitted at the border of adjacent frequencies
(f) duration of right (beginning and ending)

As in New Zealand, the small market status of Guatemala has a pronounced impact. Yet, the benefits of spectrum flexibility are apparent. Unlike El Salvador, where a similar 1996 reform ended abruptly when the appointed regulator followed the law by issuing a petitioned radio license and was instantly sacked by the ruling party, the Guatemalan law has been observed.[568] Despite similar political pressures to protect incumbent interests, requested *TUF*s have generally been issued. All told, over 3,400 new rights were awarded under the spectrum reforms as of March 2000. See Table 14. Both the FM radio market and the cellular telephone markets have seen substantial entry since liberalization.[569] In the latter market, four operators are now licensed with three operational. (BellSouth plans to begin operations in late 2000.) Entry occurred in April 1999 (the second cell firm, Telefonica, began operations) and October 1999 (Telgua).

Table 14. Spectrum Rights Issued by Guatemalan SIT
Source: SIT (March 2000)

Titulos de Usufructo	*Telgua rights grandfathered*	*Independent non-competing rights*	*Rights issued by competitive bidding*
3724	930	918	1876
100%	25.0%	24.7%	50.4%

[568] Some political favoritism in the application of the law has been observed. The essential structure of the spectrum reform law has survived, however, despite continued rent seeking.

[569] The government did manage to delay the issuance of new licenses under the spectrum reform until after the state telecommunications monopoly was privatized in 1998. This inflated the price of that transaction, deemed politically advantageous. The government of Guatemala sold 95% of its share in Guatel (renamed Telgua) to LUCA SA, a consortia of local investors for US$700 million. LUCA SA was formed by Banco Americano, Financiera de Inversion, Centrans International SA, Optimal Investment Financial Corp, and Grupo Bancrecer. LUCA SA also assumed US$240 million of Telgua's debt obligations. Telgua workers received 5% of the firm shares. Pyramid Research, *Telecoms & Wireless in Latin America* (August 11, 1997; October 23, 1998).

While awaiting more comprehensive analysis, the preliminary results in Guatemala are strongly positive. Cell-phone subscribership rose from 64,197 at year-end 1997 to 570,000 as of August 2000. See Table 15. Annualized subscriber growth, 133%, was impressive both absolutely and relative to the same period growth in telephone lines supplied by the recently privatized monopoly system. Telgua saw its land line count increase just 17%, annualized, over the same 31-month period. In other words, cellular phone penetration rose from just 15% of wireline, to 89%. The steep and rapid rise in wireless is correlated with competitive entry under the new law, and is likely caused by it. The Guatemalan market would not be so competitive were regulators allowed more discretion. Indeed, only one other Central American country has as many as three cell-phone competitors.[570] Streamlining regulatory structure has allowed new competition to flourish, and an ambitious approach to marketplace spectrum allocation has seen an orderly transition to pro-consumer results.

Table 15. Telephone Penetration in Guatemala, Year-end 1997 – Aug. 2000

	Year-end 1997	*Aug. 2000*	*Annual Growth Rate*
Cellular (total)	64,197	570,000	133%
ComCel	64,197	240,000	67%
Telgua	0	200,000	--
Telefonica	0	130,000	--
BellSouth	0	0	--
Telephone Land Lines	429,712	640,000	17%

Sources: 1997 – ITU World Telecommunication Indicators Database, 1999. 2000 – estimates of Ing. Enrique Castellanos, Director Comercial, Telgua (Sept. 1, 2000).

XIII. PRIVATIZING RADIO SPECTRUM

> As the airwaves grow ever more congested with modern wireless communications, the federal government is developing plans to open up the spectrum by in effect treating its frequencies as commodities to be bought and sold as routinely as pork bellies or soybeans in the open market.[571]

At an intellectual level, the idea of spectrum liberalization is uncontroversial today. Government planning inefficiently allocates resources, and the grinding rule making process

[570] El Salvador hosts three cellular competitors. Pyramid Research, *Telecoms & Wireless in Latin America* (August 14, 1998).
[571] Stephen Labaton, *F.C.C. to Promote a Trading System to Sell Airwaves*, N.Y. TIMES (March 13, 2000), A1.

combines the failures of socialism with the special interest control associated with rent seeking in a capitalist economy. The damage extends throughout the communications sector, where inefficiency hinders development of advanced information technologies. A wide range of government reports outline these failures,[572] as have studies in the academic literature since Ronald Coase's seminal work.[573]

Meanwhile, the advantages of spectrum liberalization are increasingly manifest.[574] The rigidities of the spectrum allocation system trip leading competitors in the vaunted "race for bandwidth," frustrating network formation. "What a tragedy it would be if, right as we're on the verge of the Internet migrating to inexpensive handheld devices and offering real hopes of truly democratizing the technology, the movement would be stymied by overloading the spectrum," comments FCC Chair William E. Kennard.[575]

Three paths are possible in the current "spectrum shortage" crisis.[576] First, the government can continue to address frequency allocation decisions through rule makings. The results of this process are well known. The FCC cites the problems inherent in this regulatory approach in advocating "a radical overhaul" of spectrum policies.[577] Second, policy makers may substantially scrap the present system, allowing markets to allocate spectrum in place of regulators. This requires changing the nature of radio spectrum rights, shifting the non-ownership regime to one of private property rights. These rights could then be used, and traded, to meet consumer demands without surmounting the obstacles posed by administrative rule makings.

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[572] U.S. Department of Commerce, U.S. Spectrum Management Policy: Agenda for the Future (NTIA Special Publication 91-23, Feb. 1991); U.S. Congressional Budget Office, *Auctioning Radio Spectrum Licenses* (March 1992); Kwerel & Williams, *Changing Channels,* (Nov. 1992), supra note __; Rosston & Steinberg, *Using Market-Based Spectrum.*.. (Jan. 1997), supra note __.

[573] One substantial example is a 1968 study by the late Hofstra University economist Harvey J. Levin. "[B]ecause different users… cannot at present compete for spectrum in any organized market, there is no readily available market valuation of frequencies in alternative uses. Nor is there any market-type constraint to guarantee that spectral inputs will be combined optimally with other factor inputs by any or all Government and non-Government users, in ways, that is, that would maximize their contribution to Gross National Product. Neither is it clear that the economic efficiency impaired by any of our current allocational policies is in fact offset by the furtherance of the regulatory-legislative priorities presumably incorporated into the managers' preference functions." Levin, *The Radio Spectrum Resource*, 11 J. Law & Econ. 433, 435 (Oct. 1968). See also, Pool, Technologies of Freedom, supra note __; Peter Huber, Law & Disorder in Cyberspace (1997); Bruce M. Owen, The Internet Challenge to Television (1999).

[574] See, e.g., Peter Passell, *Managing the Airwaves for Productivity and Profits*, N.Y. TIMES (March 9, 1995), D2.

[575] Quoted in: Stephen Labaton, *F.C.C. to Promote a Trading System to Sell Airwaves*, N.Y. TIMES (March 13, 2000), A1, A18.

[576] "There is a severe spectrum shortage," according to Professor Peter Cramton, an economist at the University of Maryland. Ibid. At a regulated price of zero, excess demand for spectrum is not surprising.

[577] Ibid., A1. "[T]he communications agency's top officials warned that demand is so outstripping supply that it may lead to a spectrum drought, making the scarce spectrum even more valuable to haves and have-nots alike."

Competition and profit incentives would substitute for "public interest" determinations by the FCC. This is the policy shift advocated in this paper.

Third, federal regulators may elect to endorse reform in theory, while operationally co-opting it. This is, in fact, the reflex already demonstrated. On May 31, 2000, the FCC held a half-day hearing on the creation of secondary markets for radio spectrum. In November 2000 it plans to auction 700 MHz licenses allocated spectrum protected as "guard-bands" for adjacent public safety bands. A total of 6 MHz per market is allocated for licenses issued to "band managers" who may lease or disaggregate the frequencies with few limitations. The FCC Chair refers to the auction as "putting our toe into the water" of spectrum liberalization.[578] The reality, however, is that the FCC's toe is soaked. For decades, experiments in market allocation have quietly provided mountains of practical evidence of consumer benefit. Timidly limiting today's policy innovation will continue to stall innovative radio-based services now queuing at the FCC.

The leap to markets challenges policy makers, bureaucrats, and incumbent telecommunications operators. Full license flexibility breaks down cartels. Easy entry for wireless innovators dilutes market shares of established service providers, reducing profits. Occasionally, this thrills regulators, who bravely side with consumers. The standard risk-averse regulatory response, however, is to defend stability. It is the politically safe choice. Regulation to limit competition creates rents, and these rents mold political coalitions. The regulator who boldly invites competition drives down rents—and quickly hears from Congress and the White House. The feedback signal enjoys clear reception.

The normative goal of spectrum reform should be to enable market allocation of radio spectrum. FCC planning would yield to private, decentralized decisions determining radio wave use. Government would facilitate the definition and adjudication of rights, while allowing firms and individuals wide latitude to discover the most advantageous means for providing wireless service to the public. Just as the ultimate deployment of spectrum is not easily forecast, new regulatory institutions will largely depend on spontaneous development. Basic principles can fundamentally alter the legal framework, but specific rules and administrative details must be resolved in legal processes to follow such basic reforms. Proposals of interested parties and trial and error will be required to fill in the details, as in the standard evolution of law.

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[578] Stephen Labaton, *F.C.C. to Promote a Trading System to Sell Airwaves*, N.Y. Times (March 13, 2000), A18.

Suggestions offered here may modestly prod the process. This paper approaches the practical issues of reform in the following way. First, in this section, it discusses the basic debate surrounding liberalization, offering answers to questions pointedly posed to challenge a move towards privatization of spectrum rights. Second, in the next section, the paper speculates about various measures that might be taken to advance competitive use of the radio spectrum. These reforms are roughly grouped according to ambitiousness: Deregulation Small, Medium, and Large.

Opposition to Reform

The tyranny of the status quo is real. Moving public policy is politically risky, particularly when simply criticizing the current system delivers many of the political benefits of actual deregulation. One recent public briefing held by two U.S. Senators demonstrated the basic strategy. Senator John D. Rockeller, IV (D-WV) and William Frist (R-TN) heard the testimony of a wireless operator complaining about his firm's inability to gain access to spectrum to provide 3G services. This was cited as a hindrance to economic growth, technology development, and U.S. competitiveness—serious concerns for the U.S. Congress.

Sen. Rockefeller took the complaint as such, and proceeded to grill a Clinton Administration spectrum policy maker. "These companies are very concerned that they are being held back by a lack of spectrum. The struggle highlights a much larger need, and that is to find a way for the U.S. government to engage in…strategic spectrum management." NTIA chief Gregory L. Rohde, while conceding that spectrum allocation was "cumbersome," "defended the government's spectrum management policies, saying, 'We do have a spectrum plan in this country. It's just that it's always changing."[579]

The comical response demonstrates the low hurdle existing policies must clear. In practice, it is sufficient to have "a spectrum plan," even if in reality there is no plan at all—and even if that plan is impeding economic opportunity for business and consumers alike. Even more striking, perhaps, was the Assistant Commerce Secretary's embrace of the very system blocking

[579] *VoiceStream CEO Stanton Criticizes Spectrum Policies*, TELECOMMUNICATIONS REPORTS (Sept. 11, 2000), 35. The idea that the federal government needs to develop a spectrum plan has been one of the longest running themes in U.S. regulatory history. In 1968, for instance, when the FCC grappled with the question of whether to allocate radio spectrum for cellular telephone service, Commissioner Nicolas Johnson "harshly criticized the Commission itself for failing to develop any 'consistent, rational policy of spectrum management.'" Calhoun, Digital Cellular Radio, supra note __, 48.

spectrum utilization as the answer to the wireless bandwidth bottleneck: “Mr. Rohde said U.S. officials need to assess 3G spectrum needs before proceeding with allocations, and they should explore ways that 3G users can share spectrum with incumbent users.”[580] That U.S. officials are “assessing” and “exploring” policy options *is* blocking market access to radio spectrum, leading to the very shortages of bandwidth that were the subject of the public hearing.

The logical disconnect is not an anomaly. It is routine in the debate over spectrum policy that the processes actively sabotaging consumer interests will be advanced as solutions to such sabotage. Regulators have material reasons to advance further government process, while vested interests are eager to encourage dilatory public interest determinations with friendly testimony, papers, studies, lawsuits, and reports. In the contentiousness of a rent-seeking competition, arguments are strategically interjected into the public debate. The superior access to information enjoyed by vested interests, and the relatively high cost of processing conflicting arguments for observers (including journalists and voters), invites ambitious argumentation. Given the “public good” nature of public policy, mechanisms for sorting out plausible, good faith assertions from implausible, anti-competitive smoke screens are weak. Non-market failure is likely.[581]

When vested interests oppose reform, one standard strategy is to generate a substantial level of noise in the policy debate. Strident arguments, and attacks on opponents, create a confusing dataset for non-vested parties to decipher. This raises the costs of acquiring information for casual participants in the debate, shifting the balance of power to interested parties who oppose reform. In 1995, for instance, television broadcasters conducted a nationwide advertising campaign announcing that competitive bidding for digital TV licenses could spell "the end of free TV."[582] This was simply false: *TV licenses* are just that, and those holding them are mandated to provide continued TV broadcasting service (or the permit is revoked). Bidding for such licenses would have transferred wealth, but not affected the number of on-air stations. Yet, as revealed by their substantial investment in the ad campaign, broadcasters believed that dispensing misinformation furthered policy goals.

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[580] *VoiceStream CEO Stanton Criticizes Spectrum Policies*, TELECOMMUNICATIONS REPORTS (Sept. 11, 2000), 36.
[581] Charles Wolf, Markets or Governments: Choosing Between Imperfect Alternatives (Cambridge, MA: MIT Press, 1989).
[582] Neil Hickey, *What's At Stake in the Spectrum War?* COLUMBIA JOURNALISM REVIEW (July/August 1996).

Chaos Will Result from Abandoning Central Allocation

Responding to a 1995 proposal "that virtually all spectrum should be auctioned to the highest bidders who will use it for its 'best' purpose," broadcast industry attorney Ellen P. Goodman wrote: "Some immediate problems come to mind that even Calvin Coolidge and Herbert Hoover (not noted as champions of big government) foresaw when they launched government spectrum management. Who would set and police interference curbs, particularly if the victims are consumers unaware that the defects in their television service are attributable to improperly made microwave ovens or malfunctioning pizza delivery radios?"[583]

Contrary to the assertion, chaos was not a product of the common law. As discussed at length above, radio broadcasting in the United States blossomed under priority-in-use rules. Central allocation of airwaves is neither necessary nor sufficient to maintain order. Even under public interest mandates, regulators have relied upon de facto property rights to maintain order. Regulators do not scan the airwaves for traffic violators, but simply enforce licensee rights. While harmful interference is quickly reported to authorities to resolve, very little takes place because it is not in the economic interest of private parties to invest in wireless communications without secure rights to use radio waves.

Regulation looks orderly, but it creates a reverse chaos—too *little* use of radio waves. That can be worse than anarchy. It is most dangerous because it goes so easily undetected. Year after year vast tracks of valuable frequencies are walled off, while communications networks, inventors, and wireless entrepreneurs go begging for access to airwaves. So long as rights to spectrum are vested in private parties with freedom to contract, order is maintained by owners with recourse to enforcement.

Broadcasting is Special

Broadcasting has a very special place in American politics, regulation, and First Amendment jurisprudence. While the exceptional treatment afforded broadcasters was legally justified on the "unique" characteristics involved in the physical propagation of radio waves, particularly their allegedly limited number, it is ironic that—in terms of physics—radio and

[583] Ellen P. Goodman, *Superhighway Patrol: Why the FCC Must Police the Airwaves*, Wash. Post (Aug. 5, 1995), op-ed page. The author was identified as an attorney with Covington & Burling, representing "broadcasters, trade associations and other communications companies." The argument is boilerplate in industry statements opposing liberalization.

television broadcasting is simply ordinary. As seen in auctioning over 8,000 FCC licenses since 1994, characteristics of radio spectrum do not require assignment of rights by non-market methods. The excess demand created for broadcast licenses was purely an artifact of the FCC decision to price licenses at zero.

The actual rationale for treating broadcasters to lucrative franchises, protecting them from competition, and then demanding that they perform obligations as "public trustees" was political. The bargain that created government spectrum allocation in 1927, and exists still, is the quid pro quo: lucrative licenses to broadcasters in exchange for content controls. Broadcasters gain rents, public officials gain some discretion over a powerful and influential component of the free press. That this press is otherwise protected by constitutional rights to free speech has forced the quid pro quo to be couched in vague terms such as "public interest, convenience and necessity." But the system has withstood judicial scrutiny, and produced benefits for the coalition that forged this marriage of convenience some seven decades ago.[584]

The political equilibrium still resists reform. Ex-FCC Chair Reed Hundt, sometimes heard extolling the virtues of a free market in radio spectrum, advanced with even greater enthusiasm the polar opposite thesis that market competition for bandwidth would undermine the public interest in broadcast regulation. The argument was market failure in the under-production of public goods such as children's educational programming or free time for political candidates.[585] Regulation, however, has not procured the public goods justifying limits on competition. Educational programming for children is seen on television—almost entirely by public broadcasting (direct subsidy) and cable television (not regulated).[586] Broadcast regulation, in deterring cable competition and continuing to protect "broadcast spectrum" from competitive entry harms development of child-friendly networks today. Robust public debate is heard over the airwaves—but far more of it has been heard since the FCC abolished the Fairness Doctrine, a mandate that radio stations cover controversial issues from balanced perspectives, in 1987.[587] Only with deregulation did the "talk" and "news/talk" formats become popular on both AM and

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[584] See Hazlett, *Physical Scarcity…*, supra note __; Hazlett, *Assigning Property Rights*…, supra note __.

[585] Hundt advanced the opposing arguments together in one article. See Reed E. Hundt and Gregory L. Rosston, *Spectrum Flexibility Will Promote Competition and the Public Interest*, IEEE COMMUNICATIONS MAG. 40 (Dec. 1995).

[586] Thomas W. Hazlett, *Is the "Public Interest" in the Public Interest? The Broadcast License Bargain of 1927*, in Donald Alexander, ed., Telecommunications Policy: Have Regulators Dialed the Wrong Number? (Westport, CT: Praeger, 1997), 49.

FM radio. The equal-time rule, a statutory requirement for broadcasters since 1927, has actively discouraged presidential debates.[588] TV networks have refused to cover debates with minor party candidates, and only by congressional measures undoing the equal time rule for presidential debates have voters been given the opportunity to see Republican and Democratic nominees face-off in national forums televised on broadcast TV. Even so, cable television provides far more coverage of debates in presidential primaries, and much more extensive reporting on election campaigns generally, than the broadcast networks. This is despite the regulatory obligation of broadcast licensees, and the unregulated status of cable networks such as CNN, CNBC, MSNBC, Fox News Channel, and C-SPAN.[589]

The irony is that broadcast *de*regulation had to occur in order that TV viewers would have the right to choose cable-only fare "Animal Planet" or "The Learning Channel" over public interest programming "Jerry Springer" or "Friends." Opening up the airwaves to still more competition would further invigorate the programming competition—and quality upgrades—wrought by cable and satellite. More extensive use of the TV Band for non-TV services could advance high-speed Internet service, making broadband more affordable and thereby more accessible to millions of households and small businesses. Allowing unoccupied TV channels to provide wireless 3G or other communications services would drive down wireless telephone access charges, encouraging mobile phone use among low-income and occasional users. Dispersion of ubiquitous, universal access promotes social goals, including public safety. Crime calls are made more often by people with wireless telephones. Storm warnings disseminate faster when wireless network access is cheap and ubiquitous. In contrast to the public goods promised by regulation, the social benefits of enhanced competition are real.

Public Safety is Special

Public safety is another key issue advanced in arguments opposing property rights to radio spectrum. As Professor Rob Frieden writes, "Even as billions of dollars chase wireless telephone and Internet-access spectrum, other types of spectrum… should remain in government

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[587] Thomas W. Hazlett and David W. Sosa, *Was the Fairness Doctrine a 'Chilling Effect'? Lessons from the Post-Deregulation Radio Market*, 26 J. LEGAL STUD. 279 (Jan. 1997).
[588] Lucas A. Powe, Jr., American Broadcasting and the First Amendment (Berkeley: Univ. of California Press, 1987); *Presidential Debate History*, http://cnn.com/ALLPOLITICS/1996/ debates/history/index.shtml.
[589] See Thomas W. Hazlett, *Digitizing Must Carry Under Turner Broadcasting v. FCC (1997)*, 8 S. CT. ECON. REV. 141 (2000).

hands…[G]overnments must safeguard parts of the radio-frequency spectrum for users who should not have to bid for the privilege."[590]

A daring and innovative 1951 article by University of Chicago law student Leo Herzel provided the first cogent assessment of the economics of radio spectrum allocation in the academic literature.[591] Herzel's student note was mauled in a rebuttal by Dallas Smythe, a University of Illinois professor who had formerly served as Chief Economist of the FCC.[592] The response was so frantic and unpersuasive, in fact, that Coase, who had not been completely convinced by Herzel's initial explanation, came to grasp it wholeheartedly: "if this was the best that could be brought against his proposal, Leo Herzel was clearly right."[593]

Yet, the political marketplace would not be so unforgiving. The rhetorical response of Smythe, while "incredibly feeble" analytically,[594] contained a clove of garlic that opponents of reform have worn ever since. "Surely it is not seriously intended," wrote Smythe, "that the non-commercial radio users (such as police)… should compete with the dollar bids against the broadcast users for channel allocations."[595] Herzel enthusiastically gushed, "It certainly is seriously suggested,"[596] and challenged Smythe to explain why—when police departments compete for all sorts of inputs—they should be peculiarly exempted from market participation here. Herzel's argument has no serious opposition among contemporary economists, but it has remained a political non-starter. The system of block allocation is taken to improve public safety, with market allocation a threat to vital social services.

The situation is analogous to saying that police officers should be paid $1 million per annum on the grounds that the local protection they provide is too important to shop for bargains in the labor market. Which brings up the *public safety* problem in creating special spectrum policies for public safety. Artificially inflated input prices create inefficiency. This is as true in providing public services as in any other economic endeavor. If public agencies overpay for

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[590] Rob Frieden, *Get Yer Spectrum Here*, INDUSTRY STANDARD (May 1, 2000), http://www.thestandard.com/article/article_print/0,1153,14525,00.html.

[591] Note, *"Public Interest" and the Market in Color Television*, 18 U. OF CHIC. L. REV. 802 (1951). Herzel did not come to the argument for auctions by studying under Chicago's free market economists. In fact, he was a student of "market socialism," in particular Abba Lerner's The Economics of Control (1944). Herzel saw competitive bidding as simply an efficient way to allocate a government resource.

[592] Dallas Smythe, *Facing Facts about the Broadcast Business*, 20 U. OF CHIC. L. REV. 96 (1952).

[593] Ronald H. Coase, *Law and Economics at Chicago*, 36 J. LAW & ECON. 239, 249 (1993).

[594] Ibid.

[595] Quoted in Coase, *The Federal Communications Commission*, supra note __, 15.

[596] Leo Herzel, *Rejoinder*, 20 U. OF CHIC. L. REV. 106 (1952).

radio spectrum—or police officers—they automatically reduce the level of service they can provide for a given public expenditure.

By choosing standards and setting rules for spectrum use at the federal level, the regulatory system produces something similar to the old Soviet economic model. Society foregoes cutting edge advances in wireless applications—applications that could make a wide range of public safety services far better in saving lives and protecting property. Your local fire department (wisely) does not ask a federal government agency to produce its emergency vehicles. Yet, their radio systems are allocated spectrum and given mandated technical standards by the FCC.

There is no conflict generated by the co-existence of public subsidies and privately owned spectrum, just as the existence of private real estate is not a threat to the National Park Service or the Smithsonian. Indeed, tangible public benefits flow from enhanced competitiveness in wireless communications markets. Among these are the substantial gains to be made in crime control (from ubiquitous mobile phone use for citizens,[597] advanced wireless networks for police, and sophisticated wireless security devices[598]), in medical treatment (particularly in out-patient monitoring), and in education (with such services as wireless Internet access yielding on-campus mobility). The Tennessee Disability Coalition has urged the FCC "to allow for the flexible use of [UWB] technology in order to maximize its benefits to people with disabilities…"[599]—an exceedingly logical stance for citizens whose demand for advanced communications services is relatively intense. At bottom, benefits from development and dispersion of wireless technologies are distributed widely throughout society. Indeed, the FCC has touted recent spectrum-opening initiatives to address the "digital divide."[600]

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[597] An astounding 40% of "911" calls are made from mobile phones. Jeffrey Silva, *Reality-Based Wireless*, RCR (Sept. 4, 2000), 12. Competition lowers service prices, increasing penetration – and public safety.

[598] An important Time Domain ultra-wide band invention is a device sold to police departments that literally sees through walls. Needless to say, this is an extremely valuable tool for public safety agencies – an "anti-killer app." Under a limited license granted in June 1999, Time Domain can sell up to 2500 such devices to fire and police departments. Federal Communications Commission, *In the Matter of Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems: Notice of Proposed Rule Making*, ET Docket 98-153 (May 11, 2000), footnote 16. Constraining distribution of this technology is a graphic illustration of the public safety losses in overly conservative spectrum allocation policy – *Type II* error. It is safe to say that cautious allocation of spectrum is overly protective here because potential radio interference is both localized and clearly subordinate to the extant emergency use. (In other words, disrupting a nearby cell-phone call, or FM radio broadcast, incurs paltry costs compared to the value of ascertaining if armed gunmen are hiding in the house about to be rushed by a SWAT team.)

[599] Heather Forsgren Weaver, *FCC Finds Itself in Ultra-Wideband Conundrum*, RCR (Sept. 25, 2000), 78.

[600] Patricia Fusco, *FCC Opens Airwaves to Close Digital Divide*, ISP NEWS, www.internetnews.com (Jan. 7, 2000).

Conversely, the rigidities of block allocation lead to catastrophic failures in the delivery of public safety services. Take the hypothetical case of a Northern California police department that uses an FCC police band license to communicate to officers. The license is "free," and is embedded in a "public interest" allocation that has received administrative priority. Yet, the grant is extremely costly to society.

This non-random example graphically illustrates the magnitude of loss associated with inefficient public sector communications. At approximately 10:45 pm on Friday, October 1, 1993, twelve-year-old Polly Klaas was abducted at knife-point from her mother's home in Petaluma, California. Eyewitnesses were present, and a distress call to police at 11:03 pm included a description of the kidnapper. At 11:09 pm, Petaluma police radioed this information to other law enforcement authorities; at 11:13 pm a more detailed description of the abductor was broadcast.

At 11:42 pm, Sonoma Sheriffs received telephone call from a woman reporting suspicious behavior by an intruder on her property east of Santa Rosa, 20 miles north of Petaluma. Two deputies arrived at 12:08 am (Oct. 2). The officers found a driver whose white Ford Pinto had gotten stuck. They questioned the man, whose name was Richard Allen Davis, for 38 minutes. Davis told the officers he was "out sightseeing," and announced that he was on parole. The deputies searched his vehicle, and radioed for a report on Davis. After determining that there was no outstanding warrant for Davis, the officers helped pull his car from a ditch, and departed the scene.[601] The Sonoma Sheriffs were unaware that a man fitting the description of Richard Allen Davis was wanted in a kidnapping reported just minutes prior just a few miles away.

Davis was later arrested, convicted, and sentenced to death for the rape and murder of Polly Klaas.[602] His lawyer reported that, at the time he was questioned by the Sonoma Sheriffs, Polly Klaas was still alive. It is unknown if this is true. But it is brutally apparent that antiquated communications cost innocent lives. While Polly Klaas' abduction was quickly reported to police, nearby officers on patrol did not receive this vital information until hours later.

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[601] *Questions Haunt Klaas Case,* S.F. CHRONICLE (Dec. 4, 1993), A22. Michael Taylor, *The Polly Klaas Case: Two Months of Missed Opportunities,* S.F. CHRONICLE (Dec. 6, 1993), A6.
[602] *Before Being Sentenced to Die, Killer Disrupts a Courtroom,* N.Y. TIMES (Sept. 27, 1996), A16.

It was delayed by what authorities labeled a "communication snafu."[603] This occurred when the report issued by Petaluma police—by teletype—was identified "not for press release." This prompted the Sonoma Sheriff's office to refrain from issuing an all-points bulletin, which would be available to journalists or others (including criminals) scanning police bands. Private communications networks, with priority information going quickly to all officers but not to the general public, are neither difficult nor expensive to construct. Indeed, the Sonoma Sheriff's department response to the Polly Klaas tragedy was to request "a $500,000 computer system that will enable officers in squad cars to have ready access to confidential information about suspects." Yet, it is chilling to note, if local police agencies had utilized state-of-the-art digital networks, instant distribution of priority, time-sensitive data could have averted tragedy.

Modernization of wireless systems improves public safety, but block allocation stifles modernization. As Joel Brinkley writes, "In the mid-1980s, a new group was clamoring for [spectrum] space—the manufacturers and users of two-way radios. Police departments, ambulance services, commercial delivery companies. Motorola made most of these radios and led this lobby."[604] The public safety lobbyists are still waiting for access to the unoccupied UHF spectrum they sought to use then. It remains largely vacant today. Access was initially blocked to reserve space for high-definition television, which is not likely to be provided.[605] And despite the existence of abundant unoccupied bandwidth after the digital TV license awards, transitional concerns (moving UHF TV stations) continue to delay the implementation of new services.[606]

Windfalls and Consumer Welfare

It is sometimes asserted that large corporate interests will realize windfalls from liberalizing property rights to radio spectrum, and that monopoly control of wireless markets is a likely outcome.[607] In fact, loosening restrictions on spectrum use would relax barriers to enter

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[603] Ron Sonenshine, *Polly Search Problems Outlined*, S.F. CHRONICLE (Jan. 11, 1994), A14.
[604] Brinkley, Defining Vision, supra note __, 8.
[605] Hazlett & Spitzer, *Digital Television and the Quid Pro Quo*, supra note __ .
[606] Similar bureaucratic delays plague public safety opportunities elsewhere in wireless. A White House report completed in September 1997 focused on the growing use of cellular telephones as an opportunity to improve emergency communications such as natural disaster warnings. Yet the study is yet to be released. "A White House aide… said the report is being held up because it has not been decided which federal agency or agencies should take the lead in publicizing it." "'It's very frustrating and disheartening,' said Douglas (Bud) Weiser, immediate past president of the Cellular Emergency Alert Services Association. 'Why does it take three years to make their own report public?'" Jeffrey Silva, *Political Pressure Not a Factor in Emergency Alert Report Delay*, RCR (Sept. 4, 2000), 24.
[607] Webbink 1980, supra note __, 35.

and promote competition, precisely why incumbent licensees have historically supported the spectrum allocation regime against reform.[608] Under current rules, large firms accumulate valuable licenses and exclude newcomers by forging alliances with regulators. If outsiders could access unused frequencies, competition would flourish.

In any event, there is nothing to preclude traditional antitrust remedies in spectrum markets. The New Zealand government, pursuant to the Competition Act, re-auctioned a management rights band after just two firms (Bell South and Telecom New Zealand) emerged overwhelmingly dominant in previous rounds.[609] The FCC has imposed a "spectrum cap" of 45 MHz to limit the market power of cell-phone operators. Given the 180 MHz allocated to commercial mobile radio services (cellular, PCS, and SMR) in each local market, this imposes about a 25% market capacity ceiling. U.S. antitrust agencies routinely examine telecommunications mergers, practices, and market structures for efficiency.

Windfalls would attend a sharp move to property rights regime in spectrum, but they would accrue largely to equipment manufacturers and technology suppliers, firms benefiting from the intensification of local service competition. Operators with extensive sunk investments in existing technology would suffer negative returns, as would regulators, lobbyists, and public interest advocates with extensive human capital specific to the old regime. Members of the communications bar would probably lose on average, although it is surely true that in the transition to new rules many law firms would increase business. While intellectual property tied to the fading regulatory regime would be depreciated, the demand for new contracts, corporate forms, transactions, and property delineations would increase. For the knowledge base that is transferable to the new spectrum order, returns would be high. (The rolodex for FCC staff may decline in value; technical knowledge of spectrum and property law would likely increase.) Finally, the general public would gain substantially from enhanced spectrum efficiency, both directly as end users of wireless services, and generally as workers, consumers and taxpayers. Greater efficiency in enterprises using superior communications systems results in increasing productivity and profits, even while churning out better products at lower cost.

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[608] See, e.g., the opposition of the National Association of Broadcasters to the flexible use proposal considered by the U.S. Department of Commerce. National Telecommunications and Information Administration, *U.S. Spectrum Management Policy: Agenda for the Future* (Feb. 1991), 82.

[609] Robert W. Crandall, *New Zealand Spectrum Policy: A Model for the United States?* 41 J. L. & ECON. 821 (Oct. 1998), __.

XIV. DEREGULATION FUTURE

Spectrum reform should be framed as an effort to move away from central administrative control (block allocation) to a regime of property rights.[610] Such a regime streamlines the process by which frequency users are protected from airwave "pollution." Shifting spectrum allocation into rights delineation allows market competition to replace government planners. And devising methods for the efficient adjudication of interference claims strips incumbents of the power to fend off entry by manufacturing technical arguments. Because every additional use of airwaves increases the probability of interference with existing wireless services, even the most conceptually liberal allocation scheme can be defeated by overly conservative protections. Current regulatory procedures fail to expeditiously license innovative wireless services precisely because competitive concerns and interference issues are collapsed into one administrative proceeding. Incumbents will naturally argue against any possible encroachment of their existing airwave rights, and are permitted to argue for more—protection from competition—at a price of zero. Efficient utilization of spectrum relies on minimalist procedures bounded by clear standards. Because the possible scenarios for spectrum liberalization are so diverse, this paper offers a series of reforms in three doses: Small, Medium, and Large. All are advanced as normative policy improvements; implementation strategy is beyond the scope of this essay.

Small

1. Spectrum Registry. It is difficult to ascertain how spectrum is used in the United States. This is somewhat surprising; given the regulatory rigidities of the block allocation system, one might think that the precise nature of each band would be easily discernible. Just the reverse is true. The official log maintained by the FCC, the "Table of Frequency Allocations,"[611] offers only a vague zoning guide. It lists broad classifications, which often overlap, and does not indicate actual uses, intensity of traffic, or other operational information. Hence, it does not reveal unoccupied or under-utilized frequency space. Legal and engineering firms specializing in researching spectrum allocation exist, but costs deter innovation.

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[610] For a similar approach, see Peter Huber, Law and Disorder, supra note __, Spiller & Cardillo, *Towards a Property Rights Approach…*, supra note __.

[611] §2.106 – "Table of Frequency Allocations" of the *FCC Rules and Regulations*. The Table is online: http://www.fcc.gov/oet/info/database/spectrum/Welcome.html.

Firms specialize in the investigation of allocation information. These firms, and others, ought to be given the opportunity to bid to create a spectrum registry that actually reveals what the Spectrum Inventory Table purports to—"information on how the radio spectrum is used in the United States so that you can select the most appropriate spectrum to support your needs and determine the impact of your proposed deployment on existing operations."[612] Computerized and accessible online, this would lower costs of entrants seeking to use radio waves in innovative applications. The registry created by the Guatemalan Superintendent of Telecommunications might serve as a model. The system should be so transparent, user-friendly, and rich in detail, that journalists could access the database, reporting on spectrum allocation trade-offs to the general public. It is not necessary to devise such a system a priori. Competing vendors would be encouraged to bid to design and operate the mapping function.

2. Privatize Public Safety Communications. Vital radio services could best be provided by market mechanisms, improving both the communications available to selected groups *and* the resources available to such groups. These added resources could fund further advancements in telecommunications, or other services of value to constituents.

A remedy is to cede title to radio bands to public safety agencies. Local and state agencies, removed from block allocation restrictions, would be free to innovate. Quality improvements via re-allocation, similar to that engineered on the SMR band by Fleet Call/Nextel in 1991, would naturally follow. Federal, state or local governments could also invite private firms to submit bids to meet particular public safety needs. Competitive bidding lowers costs, introducing efficient technologies.[613] Local agencies with equity interest in radio spectrum could simultaneously generate revenues and improve service to the public.[614]

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[612] Federal Communications Commission, *Spectrum Inventory Table, 137 MHz to 100 GHz*, DA 96-1704 (Oct. 16, 1996), 1.

[613] Many countries, including developing nations, are using competitive bidding to bring basic and advanced telecommunications to unserved areas. For instance, Peru has recently attracted bids from five private firms to provide telephone and internet access to 3,000 rural towns, many of which have no access to voice or data networks. *Five Groups Line Up for Rural Peru Telecoms Projects*, REUTERS (Sept. 1, 2000), http://biz.yahoo.com/rf/000901/n0177973.html.

[614] Perhaps the clearest example of a public agency creating efficiencies when vested with spectrum property rights is, ironically, in the People's Republic of China. "In the early 1990s, the People's Liberation Army was eager to create a network that would let generals talk to field commanders without fear of eavesdropping. CDMA, or code division multiple access, in fact is a civilian application of a technology originally developed for military communication. And by coincidence, the Chinese Army owned the radio spectrum that CDMA uses, the 800 MHz band. By building a commercial CDMA network with its spare spectrum, the army figured it could dominate the mobile-phone market, using profits and expertise gained from that business to modernize its own communications." Matt Forney, *For Qualcomm, China Has Beckoned Twice and Then Hung Up*, WALL ST. J. (July 13, 2000), A1. It

The 1996 Pressler Plan included a provision to divest public safety bands to state governments. The states could then experiment with innovative policy responses. Police departments, for example, could pursue sophisticated wireless communications via design competitions held at regular intervals. Private bidders would take into account the market value of public safety bands. It is conceivable that monies generated by the flexible use policy would subsidize part, all, or more than all the cost of wireless communications for local and state agencies. Wherever franchise competitions are effectively managed, public safety services could be quickly modernized, instituting cutting-edge technology.

3. Create a federal spectrum budget. A vast portion of available radio space is consumed by federal (including military) use.[615] There is little disagreement that public sector spectrum use is inefficient, as no incentives exist to make it otherwise. If an agency manages to save bandwidth, it is not rewarded. Indeed, as investments in spectrum-saving technology are costly, the agency budget is taxed. The result is that governmental units do not economize on scarce spectrum inputs. Hence, equipment used in various public operations could be improved to deliver better service while making spectrum available for alternative uses.

In recent years, Congress has directed the Department of Commerce to identify various quantities of bandwidth to transfer to the FCC for re-allocation from federal to private use. For instance, the PCS allocation of 140 MHz came from the so-called Emerging Technologies Band, 220 MHz transferred to the FCC's jurisdiction by legislation. This ad hoc method, where an act of Congress orders agencies to transfer a politically mandated quantity of bandwidth, is a mechanism for identifying underutilized frequencies. It is extremely cumbersome, political, and ad hoc. A more systematic method of evaluating government-controlled spectrum bands would deliver very substantial public benefits.

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should be noted that CDMA can be used in many bands outside 800 MHz, and that the government later reneged on the property rights allocation, intervening to disrupt the military-built civilian CDMA network (called "Great Wall"), limited to four cities. The Ministry of Posts and Telecommunications eventually succeeded in blocking build-out of the Great Wall network, favoring development of a China Unicom network based on the GSM standard. GSM runs on 900 MHz – which the Ministry itself owns. Ibid.

[615] It is difficult to tell how much spectrum space is reserved for public use. Only a relatively small fraction of the spectrum below 300 GHz is reserved exclusively for public (1.4 percent) or private (5.5 percent) use. Over 93 percent is allocated on a shared basis, meaning that access is difficult to categorize. In each shared band, actual deployment depends on the state of rule makings, progress in issuing licenses, and the cost of compliance with FCC rules. By the Department of Commerce's estimate, the federal government has re-allocated over 5 GHz of radio spectrum from public to private use since 1978. Larry Irving, *Spectrum Management: A Balancing Process*, IEEE COMMUNICATIONS MAGAZINE (Dec. 1995), 44, 45.

Privatizing radio spectrum rights would remedy this situation. Government would buy (or rent) the spectrum it desires to use at market prices. The government chooses to purchase all manner of vital inputs—from nuclear reactors, to labor, to Air Force fighter jets—rather than procure them by force. Mission critical supplies are not only available from the private sector, they are more efficiently obtained when competitively produced. The logic extends to radio services.

In Small Deregulation, the suggested approach is for each agency using radio spectrum to complete bi-annual spectrum budgets (in collaboration with spectrum specialists at the FCC or Department of Commerce) identifying how assigned bands are used and the estimated benefits accruing from such use. The reports would be submitted to the Congressional Budget Office, the General Accounting Office, or the Office of Management and Budget. They would detail the use of wireless services, including:

a. Bandwidth costs: How much could the bandwidth used by the agency be worth to private sector users licensed to provide the most lucrative services deliverable?

b. Contract costs: What would a private firm charge to provide an equally productive and reliable level of communications? What ancillary services or upgrades could be included, including other services to the public?

Consulting firms or financial analysts could be retained to help produce such estimates. Public Comment would be invited. As an additional step, formal Requests for Proposals (RFPs) would allow firms to bid to provide wireless services to the government (as in the public safety wireless services market contemplated just above), offering packages of services for individual agencies. To invite serious bids, government agencies would have to catalogue current services and future demands and possess the authority to accept offers improving spectrum use. Such authority would necessarily entail relaxation of FCC spectrum allocation.

Medium

1. *Overlay rights—use the Pressler Plan to liberate the TV band.* The 1996 Pressler proposal prescribed full flexibility for existing licensees coupled with the issuance of exhaustive overlay licenses in the TV band. Overlay rights, patterned after PCS licenses, would permit entrants to use the TV band so long as existing wireless communications were respected. The

approach builds on existing rules and standards. Yet, it effectively frees bandwidth for uses valued by consumers. The components of this plan are as follows:

- *Grant existing wireless licensees complete flexibility*. Since implicit interference contours have already been created in the allocation used to license existing broadcasters, deregulation is most straightforward here. Simply allow existing licensees to provide any service via any technology so long as the interference parameters currently in place are not abrogated. The transition to new services will lead users to request clarifications, as well as to demand new emission boundaries. These are analogous to emission boundary questions raised by a de novo entrant. The existence of licensed operators, however, should allow negotiated settlements among adjacent users. The Commission should implement arbitration procedures to facilitate efficient adjudication of disputes.
- *Overlay rights exhaustively license TV band.* The TV band encompasses 402 MHz of prime, VHF/UHF radio spectrum (67 channels allocated 6 MHz each). The average U.S. television market (weighted by household size) receives 13 analog TV station broadcasts.[616] Each television station received an additional channel for digital broadcasting (DTV) in 1997. Analog channel licenses are scheduled for return to the FCC in 2006. The transition (and analog return) is delayed, however, wherever less than 85% of the local households are unable to receive DTV. Given this, it is likely that the transition will be delayed some years beyond 2006, as only 200,000 households (of over 100 million TV households) had purchased DTV-compatible sets as of mid-2000.[617] If TV stations keep both their analog and digital channel licenses indefinitely, only 26 six MHz channels will be occupied in the average U.S. market. That leaves 41 (67—23) channels available for re-allocation. Yet, that process, when done by the FCC's central planning mechanism, takes years and results in prolonging the rigidities found in block allocation. (See discussion of 700 MHz re-allocation, below.) A superior solution is to auction a number of national licenses—say five—with overlay rights. High bidders would win the right to use an 80.4 MHz band to provide any non-interfering service—

[616] Nielsen Media Research sources cited in, Congressional Budget Office, *Completing the Transition to Digital Television* (Sept. 1999), supra note __, I-4.

[617] By Spring 2000, when high-definition televisions had been on sale nearly three years, U.S. households had purchased only about 202,000 sets. By contrast, nearly 28 million analog TVs were purchased in 1999 alone. Su-Jin Yim, *Customers Shy Away from Pricey High-Definition Television Sets*, The Oregonian (May 22, 2000).

from broadcast TV or radio, to subscription telephone or Internet access. This would unleash an enormous swath of productive radio spectrum into the marketplace, and allow the United States to begin catching up (in particular) in the global race to 3G.[618]

2. *Underlay right—use an innovative scheme to unleash UWB.* The overlay rights concept has a corollary. *Underlay* rights could give entrants the right to conduct low-power emissions *beneath* existing users. These operators would utilize the untapped communications capacity in the "noise floor," as sophisticated systems filter out background interference. Rights could be exclusive over a particular frequency block, or be non-exclusive. In the latter instance, a finite number of operators could co-exist in a band, communicating underneath pre-existing high-power emissions. Power limits would be set such that existing high-power communications proceed without material degradation. Underlay users co-existing in the same band, or across bands, could coordinate and partition capacity, subject to antitrust oversight.

The shared arrangement would differ from open access in that underlay rights would be limited in number, with each controlling access to a fixed level of low-power emissions within a band. Pure unlicensed entry makes user coordination costly. Lacking spectrum rights, actions taken by parties to economize on available spectrum are threatened. Free riders can appropriate the benefits of efficient resource management. Underlay rights could remedy this by allowing owners to determine how a given low-power space is used. Technologies and services could then be crafted such that optimal band use was achievable; under- and over-exploitation both represent wealth losses to rights holders. With rights fully flexible and transferable, such rights would likely be acquired by UWB technology owners and licensed to manufacturers and/or service operators by contract.

Incumbent operators could yet deter UWB by raising the specter of interference. Under the public interest standard, the argument is essentially free. The only cost-benefit weighting is

[618] This approach offers a great improvement over current regulatory strategies for moving spectrum into productive use. In a recent news report entitled, "Wireless Future Tangled in Red Tape," federal policy makers announced yet another delay in spectrum allocation for 3G – while characterizing it as fast-track regulation. "On Oct. 13, President Clinton announced a timeline for rearranging U.S. airwaves to make room for third-generation (3G) wireless technology… After the government frees up space now crowded by broadcasters, government agencies and others, it will host a mammoth auction in 2002." Amy Doan, *Wireless Future Tangled in Red Tape*, FORBES.COM (Oct. 17, 2000). Of course, the FCC has been telling prospective users of the TV band to be patient since at least 1985, when land mobile interests asked to use unoccupied UHF airwaves and were told to wait until high definition television received its spectrum allocation. So long as the process of moving incumbents requires the FCC to "rearrange U.S.

political—and the politics favor incumbents. UWB has, in fact, been delayed for over a decade while various interests (including NASA and the Federal Aviation Administration) complain that the technology will interfere with important public safety communications.[619] In a more liberal regime, interference is resolved by entrant liability. Proof of financial viability—sufficient to indemnify for potential damages—would substitute for FCC adjudication of interference disputes. Entry would be permitted upon issuance of a credible guarantee that existing users in a band would not suffer material harm as per the transmissions of a UWB entrant. Such operators would compensate parties that do, in fact, suffer harm. Such an approach encourages private testing, and the emergence of a competitive certification market. Insurers, contracting with laboratories and engineering firms, would engage in due diligence before assuming liabilities. Products would need to satisfy scientific scrutiny, establishing credibility with investors guaranteeing that UWB use does indeed fit *under* existing communications.

Large

- *Abolish the FCC and replace it with a Spectrum Court.* One of the great historical ironies of economic policy is that Alfred Kahn, the Cornell University professor and dean of regulation economists,[620] was appointed to head the Civil Aeronautics Board by President Jimmy Carter. Kahn aggressively moved to dismantle the agency, ending the CAB's anti-competitive role in fixing airline fares and blocking entry. With the able assistance of other CAB policy makers, and support from key congressional leaders, Kahn succeeded in phasing out the Board—once thought an impossibly radical policy solution. Kahn's work has been widely praised by economists. Consumers are better off—by billions of dollars in cost savings—as per the departure of the CAB.[621]

But Kahn was disappointed when Pres. Carter tapped him CAB Chair; he wanted to head the FCC. Alas, the Administration already had Charles Ferris tapped for that slot. Of course,

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airwaves," licensees will stall regulators, holding out for favorable terms. As seen in the PCS allocation, allowing overlay licensees to negotiate with incumbents is a much more effective airwave-clearing approach.

[619] ""[W]hile the FCC began talking with developers of ultrawideband technologies in 1989, the issue got nowhere until the mid-1990s when lobbyists and lawmakers pushed for action." Mark Wigfield, *Tiny New Economy Company Spends Heavily on Lobbying to Push U.S. to Test Technology*, WALL STREET JOURNAL (July 14, 2000), A16.

[620] Kahn's book, The Economics of Regulation, Principles and Institutions (Cambridge, MA: MIT Press, 1988), has been the standard text in its field since its first publication (in two volumes by John Wiley & Sons) in 1970.

[621] Steven Morrison and Clifford Winston, The Economic Effects of Airline Deregulation (Washington, D.C.: The Brookings Institution Press, 1986).

Kahn did well in his assigned role, but the question lingers: If he had been chosen to chair the FCC, might we today be blessed with competitive telecommunications markets, and harbor only fond memories of a defunct Federal Communications Commission?

Not only can one imagine an Alfred Kahn-like solution to communications regulation, it is difficult to imagine the government's block allocation system—with its wild forecasts of wireless service demand, imposed market structures, and political debates over optimal technical standards—surviving the new century. The FCC's marketplace is increasingly dominated by the likes of Intel, Cisco, Microsoft, Qualcomm, Nokia, Lucent, Compaq, H-P, AT&T, Sun, AOL, Nortel Networks, Oracle, Sycamore, Akamai, and Motorola. These are the most unpredictable network builders on the planet, and the economic structures they (and a multitude of competitors to be named later) are constructing will not conform to the guidelines of an FCC rule making. The long-run equilibrium is clear: The FCC will cease. The questions are: When? How?

Soon and in *favor of a Spectrum Court* are the *A+* answers. Once a spectrum registry is established (see Deregulation—Small), the next step is to invite new entrants into whatever vacant spectrum space they can find. Of course, abolition of FCC spectrum regulation would eliminate the public interest standard for gaining access to radio waves. It should be superceded by a statutory declaration that all non-interfering entry is lawful, and that private property rights to radio waves may be registered with the Spectrum Court. The common law rule of priority-in-use, building on institutions and practices of wireless providers under the existing regime, would govern spectrum allocation. The following measures are appropriate:

- *Grant de novo entrants a presumptive right to use unoccupied frequencies*. Remove any burden for establishing a "public interest" in enhanced competitive entry. Allow new competitors to access unoccupied, or underutilized, bands by petitioning the regulatory authority and claiming an interest in such usage. The Commission would have a fixed (short) time to allow responses, and a fixed (short) time to resolve interference disputes by binding arbitration. (No other opposition is allowed.) Wherever multiple requests are made for the same bandwidth, auctions will assign rights. Strict time limits will again apply.

- *Local area wireless devices are permissible*. So long as low-power devices are localized, creating material signal degradation only within the user's immediate jurisdiction, unregulated use is permissible. Manufacturers should be liable for damages. But the ability of

an individual household or office to internalize damage to alternative uses of the spectrum removes the necessity for imposing truly local spectrum ownership rights.

- *Grant complete flexibility to existing licensees*. Remove regulatory constraints on licensees. The implied bandwidth contours remain. Any service the licensee can profitably supply is legal, so long as transmissions stay within the implied emission boundaries of the original radio station authorization.

- *Pure interference adjudication*. As FCC experience has shown, the degree to which parties can agree on interference standards is surprising—when it is not profitable to quibble. The United States now has a long history of technical rulings establishing the substance of reasonable protections in spectrum use, and this body of precedent can form the basis of spectrum property law. The essential reform is to abandon administrative authorizations to operate "radio stations" in favor of private ownership of frequencies. Band owners will have profit incentives to maximize the competitive value of their airspace. Included in that maximization calculus will be proper incentives to protect against interference, presenting cogent arguments to courts as to what degree of protection is warranted. A technically sophisticated Spectrum Court, perhaps initially composed of Administrative Law Judges from a defunct FCC, could serve as the venue for such claims. An important aspect of such proceedings is that entrants could gain a right to proceed with allegedly interfering transmissions before final adjudication wherever they assume liability for damages. Indeed, parties indemnifying themselves against damage claims should be given wide latitude to provide service, as liability will privatize interference adjudication, increasing efficiency.

This combination of institutions—a spectrum registry, binding arbitration with time limits, the option of immediate entry where liability is voluntarily assumed, and an expert Spectrum Court to back it all up—would encourage entry while protecting existing service providers from appropriation or interference. Fundamentally, it would replace the regulator with wide discretion with a regulator with little or no discretion—in short, a judge. The net effect would be to flip the *top-down* spectrum allocation structure. Users of spectrum would have the presumptive right to use whatever radio waves were unoccupied; service providers—and, via imputed demand, their customers—would allocate radio spectrum *bottom-up*.

The success of this reform program would necessitate two further policy changes.

- *Recast Competition Policy*. As spectrum regulation switches to a property regime, antitrust rules need to adapt. Under the current system, FCC rules clearly delineate how many firms are to offer particular wireless services. Under a more liberal regime, entry into a market may occur from many directions; only consumer demand and the cost of service limit market rivalry. Accordingly, spectrum ownership becomes a newly important concept in evaluating market concentration. Rules allowing open access to unclaimed bands will instantly provoke new antitrust determinations. The use of generally applicable competition policies and enforcement tools is a beneficial aspect of the transition to a liberal spectrum environment.[622]

- *Congress imposes taxes, subsidies*. When regulatory proceedings promote implicit transfers, no coherent accounting exists. Regulators can only estimate taxes paid through rent creating spectrum allocation policies, or the benefits implied by in-kind transfers. This is not conducive to informed policy making, democratic government, or to economic efficiency. Should the expertise of an independent agency be important to crafting legislation, Congress could rely on consultation with a Spectrum Court (or the Congressional Budget Office, General Accounting Office, Congressional Research Service, etc.) to evaluate taxing and spending options, before taking legislative action.

Market transactions—bounded by the standard protections of property, contract, and antitrust law—allocate radio spectrum under the proposed reforms. Owners assure the resource is deployed in its most valuable use, just as they do in wireline markets. There, where ownership rights in fiber optic transmission facilities are secure, bandwidth is routinely traded on multiple organized exchanges.[623] Rudiments of spectrum market formation are already visible when wireless service providers like Winstar engage in "capacity swaps" with Williams, a fiber optic network owner.[624] Rather than attempting to *create* such markets, regulators should allow traders

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[622] Michel Kerf and Damien Geradin, *Controlling Market Power in Telecommunications: Antitrust vs. Sector-Specific Regulation*, 14 BERKELEY TECH. L. J. 919 (Fall 1999).
[623] Corey Grice, *Enron Rings Opening Bell for Bandwidth Exchange*, CNET NEWS.COM (Dec. 2, 1999); web page of RateXchange, "which will be the leading electronic exchange for global trading of telecommunications capacity," www.ratexchange.com (Jan. 27, 2000).
[624] Corey Price, *Tricks of the Bandwidth Trade*, CNET NEWS.COM (Dec. 18, 1999).

to devise contracts, units, and auction mechanisms for transacting, just as they have in countless other markets. [625]

Table 16. Spectrum Policy Liberalization Summary		
Small	*Medium*	*Large*
Spectrum Registry	Overlay Rights – liberate the TV band	Abolish FCC; grant private rights to bands under priority-in-use
Competitive Bidding for Public Safety Services	Underlay Rights – unleash UWB	Create Spectrum Court (with Registry) to adjudicate claims under property law
Federal Spectrum Budget		Binding arbitration for interference disputes
		Use expert agency (NTIA?) to study markets, recommend taxes/subsidies

XV. THE FCC'S FATAL EMBRACE?

Current restrictions on use prevent licensees from providing services which will benefit consumers because the government has decreed (sometimes more than 50 years ago) that a specific piece of spectrum should be used to provide a narrowly defined service. We have very little idea of what technological changes will occur in the next decade, not to mention the next 50 years. In this age of digital convergence, we at the FCC must remove the roadblocks that prevent spectrum from flowing to its most valued uses….

> There are some who argue that the Commission has a duty to "manage" the spectrum and therefore should determine each and every use. If technology or demand changes, the Commission can change the rules to allow the new, more valuable use. However, in the digital age, innovation is far too rapid for anyone to predict accurately what the best use of the spectrum will be five years from now. In addition, incumbents and competitors have incentives to slow down the FCC process and keep their protected status as long as possible. They may use the administrative process to block efficient spectrum use and retard innovation.
>
> FCC Chairman Reed Hundt, Dec. 1995[626]

[625] Huber states that a standardized spectrum package must precede a private market in spectrum rights, and that the government needs to define such units. Huber, Law & Disorder, supra note __, 72-73. That is demonstrably false. Markets typically form without government-defined commodity units, as have wireline bandwidth exchanges.

[626] Reed E. Hundt and Gregory L. Rosston, *Spectrum Flexibility Will Promote Competition and the Public Interest*, IEEE COMMUNICATIONS MAG. (Dec. 1995), 40, 41.

The substance of this argument is unexceptional: it simply restates the pitch for market allocation of radio spectrum made by Ronald Coase in 1959,[627] Harvey Levin in 1968[628] and 1971,[629] Arthur DeVany, et al., in 1969,[630] Jora Minasian in 1975,[631] Douglas Webbink in 1979,[632] or a host of analysts since.[633] Even the identity of the statement's co-author, the then Federal Communications Commission Chair, was mundane: Chairman Hundt (appointed in 1993 by Pres. William Clinton) was mimicking his predecessor, FCC Chairman Mark Fowler (appointed in 1981 by Pres. Ronald Reagan). In a 1982 article, Fowler had espoused deregulatory views, extending the argument to broadcasting.[634] Today, FCC Chairman William Kennard issues well-publicized calls for market mechanisms to remedy the "spectrum drought," and agency experts concede that existing allocation mechanisms harm consumers and economic growth. Top policy makers in Congress, the FCC, and the Commerce Department, publicly denounce regulatory micro-management of spectrum, calling for markets to replace regulation. By consensus, spectrum liberalization is intellectually compelling.

Yet, the system they ostensibly manage resists fundamental change. Indeed, while Chairman Hundt was busy touting his commitment to market allocation of radio spectrum, the Spectrum En Banc hearings held by Hundt's FCC in March 1996 told panelists to discuss "Future Spectrum Demand" by addressing these questions:

- How do we rank priority among various uses?
- What methodology should be used to choose among competing demands?
- How does international, long-range planning affect allocation policy?
- What trends are driving demand for new services?
- How accurately can future demand be forecast?
- How can we improve our planning relative to changing demands?[635]

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[627] Coase, *The Federal Communications Commission*, 2 J. L. & ECON. (1959), 1.
[628] Levin, *The Radio Spectrum Resource*, 11 J. L. & ECON. (Oct. 1968), 433.
[629] Levin, The Invisible Resource (Baltimore: Johns Hopkins U. Press; 1971).
[630] Arthur S. DeVany, et al., *A Property System for Market Allocation of the Electromagnetic Spectrum*, 21 STAN. L. REV. 1499 (June 1969).
[631] Minasian, *Property Rights in Radiation: An Alternative Approach to Radiofrequency Allocation*, 17 J. L. & ECON. (April 1975), 221.
[632] Douglas Webbink, *A Working Paper on Frequency Spectrum Deregulation Alternatives* (Wash. D.C.: Federal Communications Commission, 1979).
[633] Ascribing the desirability of reform to the new challenges presented by "the digital age" is a popular marketing device, but it lacks substance. As noted elsewhere by Hundt himself, the historical pattern of anti-consumer regulation was established in an analog world, and prompted Coase's 1959 call for market allocation.
[634] Mark Fowler and Daniel Brenner, *A Marketplace Approach to Broadcast Regulation*, 60 TEXAS L. REV. 207 (1982).
[635] Federal Communications Commission, *AGENDA, En Banc Hearing on Spectrum Policy*, March 5, 1996. The author testified on the first panel, and the agenda was sent via email.

The questions posed by an agenda-setter can decisively determine outcomes. So here with the Commission's approach to spectrum allocation: the agency still attempts to plan band usage, top-down. Even as Chairman Kennard touted wireless bandwidth markets in early 2000, an unnamed FCC official was telling the NEW YORK TIMES: "There's no mechanism to move spectrum to higher-valued uses, like in the coal, natural-gas or transport markets. That makes it difficult to match supply and demand."[636]

The reform rhetoric may be bold, but the centralized spectrum allocation structure erected stands firm. The FCC, not the market, allocates frequencies to competing uses. The agency, not the market, ranks demands. The "forecasts" used are actually guesses gleaned from a montage of industry executives, interest group lobbyists, and various experts. Answering the above En Banc questions, for example, were a billionaire cellular entrepreneur now developing a satellite telephone project with Bill Gates, spokespersons for Nortel Networks, MCI, the National Association of Broadcasters, a communications software consortium, and a non-profit organization lobbying for the disabled, a regulator, and an academic.[637] No one presented an econometric model of future demand, which—given the level of speculation required—would not have impressed the audience. Everyone, however, brought an opinion.[638]

The Commission's cognitive dissonance vis-à-vis reform is striking, as has been noted even by Commission members:

> Claims that FCC actions have promoted spectrum flexibility are "outrageous," Mr. Furchtgott-Roth said. "There's a practical disconnect between the rhetoric and actual practice on spectrum flexibility." In fact, the FCC has "done a lot to restrict the use of spectrum," he said.

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[636] FCC official quoted in, Kathy Chen, *FCC May Let Firms Trade Licenses to Ease Congestion of Airwaves*, WALL STREET JOURNAL (March 14, 2000), online edition.

[637] Specifically, the individuals were: Craig McCaw, Chairman and CEO, Eagle River Communications; Richard Parlow, Associate Administrator, Office of Spectrum Management, National Telecommunications and Information Administration; David Twyver, President, Wireless Networks Division, Nortel; Philip L. Verveer, Wilke, Farr and Gallagher; Chairman, Public Safety Wireless Advisory Committee; Lynn Claudy, Senior Vice President of Science and Technology, National Association of Broadcasters; Peter Murray, Vice-President UTAM, for UTAM/WINForum; Susan Mayer, Senior Vice President Corporate Development, MCI Telecommunications Corporation; Tom Hazlett, Visiting Scholar, American Enterprise Institute and Director, Program on Telecommunications Policy, University of California, Davis.

[638] The point is not that a formal forecasting model would have solved the problem. Quite the reverse: such testimony is not taken seriously. Regulators and lobbyists understand that projections are speculative. Dressing up conjecture in ill-fitting statistical garb lacks credibility.

> If the FCC really wants to advance the concept of spectrum flexibility, it should "apply more property rights to the ownership of spectrum," he said. "We should not restrict use, and we should make clear that there are substantial liabilities for interference" with other license-holders.[639]

Despite important incremental rule changes demonstrating the technical viability and economic efficacy of liberalization, the essential structure of spectrum allocation is unchanged from the Radio Act of 1927. Regulatory rigidities and lengthy rule makings continue to block new competition, frustrating wireless entrepreneurs and lowering the value of wireless technology to the American public. Even the cause of liberalization is swallowed up the FCC's administrative process, as the Commission is now considering rules to create secondary markets in radio spectrum. Serious reforms may be strangled by the FCC's loving embrace.

The pose of the Commission is that it leads the way in promoting productive use of the airwaves, ushering new technologies to market, helping upstart rivals compete against established suppliers.[640] The less appealing reality, however, can be seen in ongoing Commission battles over ultra-wide band (UWB) and re-allocation of 700 MHz from TV to 3G.

Ultra-wide band: 11 years and waiting. In a rare glimpse into the policy calculus facing new communications technology vendors, the WALL STREET JOURNAL recently reported on the lobbying efforts by a leading UWB supplier, Time Domain.[641] The company, based in Huntsville, Alabama, is aggressively attempting to generate political support for UWB.[642] Since late 1996, the company's CEO, Ralph Petroff, has traveled to Washington, D.C. over 100 times. The firm has hired the prestigious Patton Boggs law firm to lobby the FCC, White House, and Congress. Former FCC commissioner Mimi Dawson has been retained for additional lobbying, as has Ray Cole—until 1999 a staffer with Sen. Richard Shelby, an Alabama Republican. It is

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[639] *Furchtgott-Roth Questions FCC on CALLS Plan, Spectrum Use*, Telecommunications Reports (March 20, 2000), 19.

[640] The rhetoric/reality ratio approaches infinity in Reed Hundt's recent book: "By auctioning spectrum with no rules attached and preempting all state regulation, we had totally deregulated the wireless industry." Yet, the FCC today concedes that license rigidities are choking wireless telecommunications, causing a "spectrum drought." Hundt, You Say You Want a Revolution, supra note, __, 98.

[641] Mark Wigfield, *Tiny New Economy Company Spends Heavily on Lobbying to Push U.S. to Test Technology*, WALL STREET JOURNAL (July 14, 2000), A16.

[642] Recall that UWB technologies, while potentially powerful communications systems, emit minute levels of radiation, below what personal computer Pentium chips discharge. Because UWB emissions are not spurious (the radiation is intentional) FCC rules bar the technology.

yet an uphill battle. As another Time Domain lobbyist, former Clinton White House aide Greg Simon, says: “You have entrenched groups that view any change as bad before the facts are in.”

As a start-up operation that hopes to bring new technology to the market, the tax levied by the spectrum allocation process is significant. On 1999 revenues of $700,000, Time Domain invested some $720,000 on efforts to pressure both legislators and FCC decision-makers—a lobbying-expense-to-sales ratio of 103%. Support has been received from numerous public officials, including FCC commissioners and Sen. Shelby, Time Domain’s home state champion. Shelby’s spokeswoman states that UWB foes should not be allowed to get the regulatory system “to crush emerging technology.” Shelby and Alabama Democrat, Rep. Robert Cramer, are pushing for federal funds to test UWB’s interference patterns. While UWB has been a topic of conversation at the FCC since 1989, an official proceeding was only opened in 1998. In May 2000 the Commission ruled that it would go forward to issue rules for UWB.

“Spectrum is the lifeblood of industry,” Petroff enthuses. The JOURNAL notes: “Ultrawideband’s solution is to turn ‘garbage’ spectrum—now occupied by background radio emissions of such devices as computers and electric shavers—into usable airwaves for a host of new devices.” But this potential opportunity for innovation and efficiency is stuck in administrative process. Government testing to resolve interference claims is ongoing. In the rule making opposing factions contest rivals’ claims as to the costs and benefits of UWB. The Commission is incapable of quickly adjudicating the public interest. Time Domain CEO Petroff says: “It’s awful what you have to do to get permission to transmit 50-millionths of a watt.”

HDTV blocks land mobile in 1985, 3G in 2000. The TV band consists of 67 channels, 6 MHz allocated to each, some 402 MHz in all. Since 1985 the FCC has walled off this band from competing users, particularly those wanting to offer public safety and mobile telephone service, on the grounds that advanced television would consume remaining capacity. That has proven false. Even after the issuance of a second TV license to every broadcast station in the United States for digital transmissions, the average market features just 26 TV licenses (13 analog and 13 digital, many of the latter broadcasting little or no programming). While broadcasters and regulators have long argued that extensive intervals need be left vacant between local broadcasts (“taboo channels”), the current allocation vastly under-utilizes the band. With digital technology, not only can adjacent channels be used for broadcast or other services, but existing TV signals can be subdivided to deliver multiple channels or, alternatively, compacted so as to make room

for data services (like Internet access). In short, a vast array of services could be provided without sacrificing current broadcasting programs.

The waste of spectrum, from the beginning of television in the 1940s up through today, is striking. As explained by Internet pioneer and communications entrepreneur Paul Baran:[643]

> In reality, the major spectrum hog is analog broadcast transmission. In the US and to an extent in other countries a spectrum analyzer will find much of the allocated VHF and UHF TV spectrum unused, even in big cities. The UHF television band is punctured with vast empty holes called taboo channels. These channels are left unoccupied because of the frequency selectivity limitation of early era television receivers. Today we know how to build far better receivers than when this early rule was adopted and when those frequencies were set aside. We should never forget that any transmission capacity not used is wasted forever. It's water over a dam. And, there has been water pouring here for many, manv years, even during an endless spectrum drought.[644]

The inefficiency is hardly subtle. The 402 MHz allocated to TV service dwarfs that made available for cellular (50 MHz) and licensed PCS (120 Mhz) combined. As of June 1999, 82% of U.S. households subscribed to cable or satellite video service, meaning that a rapidly dwindling minority of Americans use over-the-air TV.[645] Subscription services and broadband Internet connections facilitated by cable modems and digital subscriber lines are clearly reducing broadcasting stations to adjunct status in the delivery of video programming. Meanwhile, the value of TV band spectrum soars for alternative applications such as 3G.

The FCC has been conscious of the misallocation for years. In 1986, the FCC was about to allow mobile radio users to access vacant UHF TV channels, only to be deluged by the

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[643] Baran pioneered work on distributed communications networks, the basic element in Internet architecture. See Katie Hafner and Matthew Lyon, Where Wizards Stay Up Late (New York: Simon & Schuster, 1996); *Internet Pioneers*, http://www.ibiblio.org/pioneers/baran.html.

[644] Paul Baran, *Is the UHF Frequency Shortage a Self Made Problem?*, paper delivered to the Marconi Centennial Symposium, Bologna, Italy (June 23, 1995), 3. Baran is being charitable in crediting taboo channels to the primitive state of technology in the early days of television. As discussed above, the Du Mont plan (and others) would have allowed the FCC to provide for greater use of the TV Band in 1952. The inefficient licensing scheme served the interests of the broadcasting cartel, and of regulators alleging to promote the public interest through cross-subsidy requirements. Nonetheless, it is appropriate to point out that while progress in technology now allows much more intense, economical use of the TV Band, FCC rules largely deny this opportunity to be realized by the public.

broadcasting lobby's HDTV gambit. High-definition was nowhere near ready for deployment, and there was zero evidence that consumers and broadcasters were willing to pay the costs of upgrading TV signals (including the spectrum costs). But within the public interest allocation system, the argument that fallow spectrum had to be preserved to deliver HDTV at some unspecified date could be used to delay new services.[646] It was; the band was frozen. The Commission was not oblivious of the social loss. In November 1992, an FCC staff report found that even the UHF-TV spectrum that was *in use* was worth up to nearly *two hundred* times as much when deployed in mobile wireless. The study recommended "voluntary re-allocation" be allowed, with TV stations permitted to sell or lease allocated spectrum to cellular operators.[647] In 1996, then-Chairman Reed Hundt pledged to have the FCC itself re-allocate Channels 60-69 to mobile telephone service. Results are not yet realized.

While the Commission has ruled that it will move four of the ten channels to public safety and will auction licenses allocated the spectrum from the other six (i.e., 36 MHz), administrative delays have ground the transition to a halt. The broadcasters have access to lower TV channel assignments, and guarantees of full compensation for moving costs (retooling to use the new frequencies, paid for by winning bidders in upcoming FCC auctions, analogous to the "overlay" right). Yet, station owners are holding out, refusing to move. Because they have the power, through a mixture of legal rights and political clout, to effectively block re-allocation, incumbent licensees do not see cost-recovery as just compensation. They eye the total value of the spectrum they are vacating—or a large fraction of it—as a just split of proceeds. As Lowell "Bud" Paxson, CEO of Paxson Communications, the largest owner of stations on channels 60-69, puts it: "I kept telling everybody the name of the game is spectrum, spectrum, spectrum. I labored in a desert and built a network; now people are finding an oasis with oil under my

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[645] Federal Communications Commission, *Annual Assessment of the Status of Competition in Markers for the Delivery of Video Programming: Sixth Annual Report*, CS Docket No. 99-230 (Jan. 14, 2000), ¶5.

[646] "[M]ost cities had only eight or ten TV stations at most, so fifty or more of the channels set aside for television broadcasting lay fallow. Some of those were left unoccupied on purpose, to reduce interference between adjacent channels. Still, more than half of the channels allotted for TV service in most cities were sitting idle. Why not give some of those channels to us? Land Mobile asked. By 1986, the FCC had pretty much decided to do just that. Several vacant UHF channels in ten big cities were to be taken away from the broadcasters and given to Land Mobile." Brinkley, Defining Vision, supra note __, 8.

[647] Kwerel & Williams, *Changing Channels*, supra note __, 8. KTIE, Channel 63 in Oxnard, was sold in 1987 for $5.5 million. In 1989, one of two Los Angeles cellular licenses, was sold to McCaw/Lin for $4.16 billion. The TV station license was allocated 6 MHz, meaning that the price/MHz was $0.9 million. The cellular license was allocated 25 MHz, for a price of $166.4 million/MHz – 185 times as much. (Note that while the Oxnard station could not be seen in most of Los Angeles, the FCC would place no other station on Channel 63 in the L.A. area.)

sand…. I was a farmer and I got lucky. Now people want to build a mall on my farm… God bless America."[648]

In fact, the spectrum does not belong to Paxson Communications (or General Electric, a 32% shareholder), and the network—or "farm"—Paxson built has not created the value it now seeks to extract. Paxson may offer its UHF-TV programs equally well on a channel between 14 and 59. Yet it refuses to go quietly, seeking to extract not compensation for the fruits of investment in broadcasting, but a pay-off to quit blocking efficient use of radio spectrum. The public interest allocation process has produced no resolution despite many years of effort. Now, "the transition has turned into a political quagmire."[649]

U.S. wireless penetration lags many European and Asian countries.[650] Various factors influence this outcome,[651] a crucial one being time-to-market. While several countries had issued digital mobile phone licenses by March 1992,[652] the United States did not begin awarding digital PCS licenses until 1995.[653] Many countries are now issuing 3G licenses. The United Kingdom auctioned five in May 2000, receiving some $34 billion in total bids. Germany auctioned six in August 2000, receiving $45 billion.[654] Investors anticipate robust consumer demand for services.

Despite the FCC's commitment to a "flexible, market-based approach" as "the most appropriate method for determining service rules in this band,"[655] bureaucratic roadblocks deter access to radio spectrum. The Commission has been reticent to issue overlay rights to new 700 MHz users. While that would shift band clearing to the private sector, it would raise bidder

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[648] Nicole Harris and Jill Carroll, *Paxson Could Reap Billions in Talks with Phone Companies*, WALL STREET JOURNAL INTERACTIVE (Aug. 11, 2000).
[649] Ibid.
[650] At year-end 1998, cellular penetration (subscribers per capita) in Finland was 58.18% compared to just 24.75% in the U.S. Other countries: Sweden, 51.44%; Italy, 35.43%; Portugal, 30.17%; U.K., 22.15%; France, 19.2%. Merrill Lynch, *The Next Generation III: Wireless in the US*, Global Securities Research & Economics Group (March 10, 1999), 32.
[651] Robert Crandall & Thomas W. Hazlett, *Telecommunications Policy Reform in the United States and Canada*, AEI-Brookings Joint Center for Regulatory Studies Working Paper (July 13, 2000).
[652] Just counting OECD members, this list included Austria, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland and the United Kingdom. Kalman, Radio Spectrum, supra note __, 86.
[653] Cellular licenses had been issued in the 1984-89 period, but systems were mandatorily constructed with analog technology. While digital technology was permitted in a 1988 reform, the major market licenses had been issued by 1986 and were already under construction or completed – using the analog standard.
[654] Philip Coggan, *The Telecoms Generation Game*, FT.COM (Aug. 18, 2000), sysiwyg://74//news.ft.com/ft/gx.c…iew&c…iew&c=Article&cid=FT3YDN6N32CC&live=true.
[655] Federal Communications Commission, *FCC Adopts Rules for Licensing and Operations in Portion of 700 MHz Band Reallocated from Television Channels 60 through 69*, News Release (Jan. 6, 2000).

uncertainty and heavily encumber the rights sold.[656] Prices offered at auction would be reduced accordingly. Given the high European 3G bids, negative political fall-out could result. The perverse outcome is that the government seeks to improve auction prices by delaying licenses to reach transitional agreements with broadcasters, keeping services from the public yet longer.[657]

Postponing license auctions scheduled for June 2000 and then (again) September 2000[658] guarantees that the UHF TV band will be withheld from petitioners for a minimum of 16 years. See Table 8. The American economy, deprived of valuable spectrum inputs, is handicapped in the race to deploy advanced services. As former FCC official Rudy L. Baca writes,

> The lack of a coherent, efficient, forward-looking spectrum management policy and process could hinder U.S. wireless operators' ability to compete in providing global interconnected "seamless" advanced communications… The reality of spectrum management in the U.S. in 2000, and for the foreseeable future, is **chronic spectrum shortages**… The total amount of spectrum available for commercial mobile uses in the U.S. is only 210 MHz compared to an average European allocation of 355 MHz…. Investors need to be aware that U.S. companies are relatively disadvantaged in "New Economy" growth in *wireless* Internet and E-commerce.[659]

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[656] "Bidders feared their newly won licenses would wind up being held ransom for huge fees by broadcasters." Jill Carroll and Leslie Cauley, U.S. Firms, *Regulators Face Hurdles to Access Broadcast Frequencies*, WALL ST. J. (Aug. 2, 2000),wysiwyg://124/http:dowjones.work.com /index.asp? layout=story&doc_id=1908.

[657] Perhaps even more perverse is the political spin: President Clinton recently announced a federal initiative to auction 3G licenses by Sept. 30, 2002. "Bill Clinton took time out from wrestling with war in the Middle East on Friday to sign an executive order clearing the way for next-generation wireless services in the United States. The order sets forth an aggressive timetable that would have the Federal Communications Commission auctioning off licenses for so-called 3G wireless services in less than two years." Patrick Ross, *Clinton Makes the Call for Third-Generation Wireless*, CNET News.com (Oct. 13, 2000), http://news.cnet.com/news/0-1004-200-3183865.html. The ability of regulators to successfully characterize a 17-year lag as "an aggressive timetable" facilitates delay. To wit, while the Administration was publicizing its "aggressive timetable," reports surfaced that the Administration defeated legislation to mandate that federal agencies make spectrum available for 3G services, a mandate that "wouldn't have been subject to coming political changes." Jeffrey Silva and Heather Forsgren Weaver, *3G Policy in Limelight*, RCR (Oct. 16, 2000), 1, 85.

[658] An auction is now scheduled to begin March 6, 2001. *Wireless Industry Praises Delay of 700 MHz Auction*, TELECOMMUNICATIONS REPORTS (Aug. 7, 2000), 10.

[659] Baca, *U.S. Disadvantaged by Spectrum Scarcity*, PRECURSOR GROUP INDEPENDENT RESEARCH (July 25, 2000) (emphases in original).

The U.S. appears over-regulated—compared to the *European Community*. Until recently, EC countries were debating whether to privatize state monopoly PTTs. That U.S. spectrum allocation is parsimonious relative to these highly regulated economies is sobering.

Despite deregulatory bravado, U.S. policy makers still reflexively veer in the anti-competitive direction—at least until safely out of the political hot seat. A good example is the contrasting policy approaches to 3G by the current and (immediately) former FCC Chairs. Reed Hundt, a consultant and venture capitalist since retiring from the Commission in 1997, has tagged the 36 MHz allocation out of channels 60-69 paltry: "we are still about 200 MHz short of what needs to be in commercial use."[660] Hundt's recommended solution is to sweep all UHF TV channels off the air, giving them the right to be carried on local cable television systems. "All told, that's more than 300 MHz of spectrum—enough to serve the needs of wireless data over the next decade."[661]

This goes a bit further than Hundt was willing to propose (let alone enact) as Chair—about five times as far. William Kennard, the current FCC Chair, is not willing to ratchet up the UHF spectrum allocation. Indeed, he is attempting to assure investors (i.e., auction bidders) that there will not be "any move to hike the amount of spectrum" allocated for use.[662] As useful technologies now queue to gain access to unoccupied UHF frequencies even at 95 GHz,[663] public interest spectrum allocation continues to over-protect the radio resource.

Spectrum Scarcity in the Information Age

Radio spectrum is vital to the New Economy. The frantic race for bandwidth reveals the increasing value of communications networks and the wireless links that form, connect, and extend them. The vast investments being made in technologies intensifying the utilization of spectrum bandwidth demonstrates the continuing scarcity of frequency space, as do the price tags attached to licenses guaranteeing some measure of exclusivity in the use of radio waves. While efficiencies are driving spectacular increases in bandwidth throughput, there is no limit to the

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[660] Elisa Batista, *Spectrum Auction Still on Horizon*, WIRED NEWS (Aug. 1, 2000), http://www.wired.com/news/print/0,1294,37944,00.html.

[661] Ibid. Hundt's notion that requisitioning cable and satellite system spectrum will ease wireless spectrum shortages is extremely dangerous, as "must-carry" rules already in place have taxed investment in new systems and seriously undermined consumer interests. See Thomas W. Hazlett, *Digitizing "Must-Carry" under Turner Broadcasting v. FCC (1997)*, 8 S. Ct. Econ. Rev. 141 (2000).

[662] Ibid.

[663] See, e.g., www.endwave.com.

imaginative applications for wireless, applications driving quantum increases in demand for access to radio waves.

Spectrum is a valuable, scarce commodity. Yet, telecommunications markets have been distorted by skewed rules. Wired bandwidth—"spectrum in a tube"—enjoys legal protections not available to wireless. The propertied interest enjoyed by the owner of fiber optic lines, coaxial cables, or copper telephone wires effectively draws sellers to where consumers will pay for bandwidth. But competition from wireless goes untapped, as consumer demands do not attract band owners—spectrum outside the tube cannot be private property. The result is under-investment in the development and application of wireless conduits. While technology soars, networks grow and applications multiply, little utilized bands languish. The FCC identifies a "spectrum drought," while frustrated builders of advanced systems bemoan the rigidities denying them access to airwaves.

Property rights allow markets to allocate resources. Band owners striving to maximize values compete to supply users, investing in technology to improve operations, innovating in business models, network architectures, and consumer applications to encourage new traffic. Where free to do so, entrepreneurs eagerly mix and match systems, technologies, and frequencies, iterating on efficient solutions. Competitive markets discover low-cost ways to provide high-value services. Band managers endeavor to produce the preferred combination of traffic and signal quality—the static optimum—and are alert to adopt new methods or platforms yielding extra value through enhanced capacity—the dynamic optimum.

Private markets police behavior. Capital owners are quick to eliminate managers who fail to maximize asset value, including who ignore opportunities to supply frequencies to manufacturers or users on an open entry ("unlicensed") basis. The entire panoply of consumer bids, including those tied to complementary use with embedded capital, is exploited by profit maximizing managers. With full private rights attached, the passive licensee, offering services dictated by FCC rule makings, becomes an aggressive experimenter, an imaginative service packager, an evolving, morphing change agent driven to raise the value of bandwidth owned.

The scramble to invent and re-invent profitable wireless businesses can be replaced by an administrative process, but it cannot be duplicated. Owners competing to succeed produce distinct results from those imposed by regulators forecasting spectrum values ex ante. There is no serious case to be made for the efficiency of the latter; FCC regulators themselves herald

market allocation as the solution to current bandwidth bottlenecks. And while the structure of regulation is yet defended by incumbent interests, broadcasting—the key industry protected by regulation since the genesis of "public interest" allocation—is fading in social and economic importance. Economic transformation in the tech sector is driving demand for unrestricted access to bandwidth, producing tensions challenging old rules.

The cutting edge of reform appeared years ago, as quiet reductions in FCC micro-management began. Important policy experiments have been performed in this country and elsewhere. The consumer benefits of market mechanisms have been manifest. Liberalization is settling in as conventional wisdom. Ronald Coase may be pleased to know that the joke is no longer on him. His suggestion of a market in bandwidth is not nearly so funny as a 16-year rule making for re-allocation of UHF-TV spectrum to Land Mobile.