Allocating the Spectrum: The Origins of Radio Regulation

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Knowledge of the electromagnetic spectrum is just over one hundred years old, if we take Heinrich Hertz's experiments at Karlsruhe in 1887–88 as our point of departure.[1] In the years since then, we have accumulated much information about the spectrum, and in the process the spectrum has become an economic resource. Rights of access to the spectrum, or at least to certain segments of it, are now valuable economic assets.

Introduction: Spectrum Scarcity

One segment of the spectrum has acquired a particular economic significance: this is the radio spectrum, ranging from frequencies of about 20 kHz (kilohertz) at one end to perhaps 300 GHz (gigahertz) at the other.[2] The economic significance arises from the fact that we have learned how to use this particular spectral domain for communication. It is only with reference to this segment of the spectrum that concerns about spectrum scarcity have so far been voiced. As a consequence, it is only with reference to this segment that the question of regulation of access by government has become problematic.

Scarcity is an elusive concept when applied to the radio spectrum. On the one hand, there are ultimate limits set by the laws of physics. Below

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[1]Heinrich Hertz, *Electric Waves, being Researches on the Propagation of Electric Action with Finite Velocity Through Space,* authorized English translation by D. E. Jones (London, 1893); John H. Bryant, *Heinrich Hertz: The Beginning of Microwaves: Discovery of Electromagnetic Waves and Opening of the Electromagnetic Spectrum in the Years 1886–1892* (New York, 1988); and Hugh G. J. Aitken, *Syntony and Spark: The Origins of Radio* (Princeton, N.J., 1985), pp. 48–79.

[2]One hertz equals one cycle per second. One kilohertz (kHz) equals 10^3 cycles per second, one megahertz (MHz) equals 10^6 cycles per second, and one gigahertz (GHz) equals 10^9 cycles per second.

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a certain frequency electromagnetic fields radiate poorly if at all. Above a certain frequency we communicate by infrared or visible light. Within these ultimate limits there are contingent limits set by the state of radio technology at any given time. Technological change, largely in response to the pressure of demand on supply, has typically taken the form of opening up higher and higher frequencies—first the "shortwaves" above 28 MHz, then the VHF and UHF segments, and now microwaves. Spectrum scarcity in that sense has been a recurrent feature of radio history—more urgent at some times than at others, but always present.

There is, on the other hand, another sense in which spectrum scarcity results from human institutions. Here property rights and what Adam Smith called "the disposition to truck, barter, and exchange," rather than the laws of physics or the state of technology, become relevant.[3] Spectrum is scarce in the sense that there is not enough of it to give all potential users all they want at a zero price. There is, therefore, a problem of distribution. Spectrum has to be rationed. Rationing can be accomplished either through markets, with prices serving to indicate which demands are most intense and which resources are most scarce, or through some form of governmental or community-based system of allocation. Most contemporary economists appear to prefer the market solution, believing it to be the more efficient way to allocate scarce resources. Given a functioning market, the argument goes, all those wishing to purchase the resource at the market price, and able to do so, will find their demands satisfied. There will be no excess demand at the prevailing price. There will be no queuing. There will be neither a shortage nor a surplus of the scarce resource.

Where markets are not used and no price is established, other criteria of allocation have to be used, and there will be persons (or firms or government agencies) wishing to acquire units of the resource but not permitted to do so. That is a special kind of scarcity, one that results from the absence of markets, or in other words from human institutions. It must be distinguished from the kind of scarcity discussed earlier, which results from physical or technological limits. Much confusion has resulted from failure to make this distinction. It has been argued, for example, that the Radio Act of 1927, my concern in this article, was passed because an economic problem was mistakenly diagnosed as a technical one.[4] There was, in short, no physical scarcity but only the kind of scarcity that results from the absence of markets. If true, this is a

[3]Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations* (Oxford, 1904), 1, chap. 2:18.

[4]William H. Meckling, foreword to *A Property System Approach to the Electromagnetic Spectrum,* by Arthur S. De Vany, Ross D. Eckert, Charles J. Myers, Donald J. O'Hara, and Richard C. Scott (San Francisco, 1980), p. xiii.

serious charge, for the Act of 1927 laid the foundations for the system of radio regulation under which we function today. It is disquieting to be told that the regulatory system that governs electronic communications in America had its origins in an error.

Ithiel de Sola Pool argued several years ago that spectrum scarcity, as economists would define the term, arises only because the spectrum is not priced.[5] It has been formally excluded from the market economy, unlike other natural resources. Permission to use the spectrum can be obtained from government authorities in various ways, depending on the regulatory regime in force, and those rights of access—traded in secondary markets—can become very valuable properties. But the spectrum itself has never up to the present time been treated as a commodity, to be bought and sold at a market price.

How did this come about? In most countries, when the value of the radio spectrum became apparent to civil and military authorities, the immediate reaction was to declare that the spectrum was exclusively state property. Access to the spectrum came to be restricted to organizations that were either departments of government or crown corporations. Private parties, whether commercial users or amateurs, obtained rights of access to the spectrum only by permission of these arms of the state.

In the United States the reaction was different. The radio spectrum was considered part of the public domain and therefore the property of all the people. Access to the spectrum was the right of every citizen, as for many years access to the public lands had been. Radio licensing as it existed in the United States up to 1927 was merely a matter of registration. No bureau of government had the authority to deny a license, or in other words to deny a citizen's right of access to the spectrum. Government ownership of the spectrum—"nationalization" of the resource on the British model—was never seriously proposed in the United States except by the Navy Department, and then only on condition that the navy should hold the monopoly.[6]

Some have seen in this contrast between the United States and Europe a reflection of long-standing differences in attitudes toward hunting rights. Gary Libecap, for example, points out that in the United States since colonial times law courts have held that the right to hunt

[5]Ithiel de Sola Pool, *Technologies without Boundaries: On Telecommunications in a Global Age* (Cambridge, Mass., 1990). The point had been made earlier by R. H. Coase in his "The Federal Communications Commission," *Journal of Law and Economics* 2 (October 1959): 1–40.

[6]Compare Ithiel de Sola Pool, *Technologies of Freedom* (Cambridge, Mass., 1983), pp. 108–12; Asa Briggs, *The History of Broadcasting in the United Kingdom*, vol. 1, *The Birth of Broadcasting* (London, 1961). On the position of Josephus Daniels as Secretary of the Navy in the Wilson administration, see Hugh G. J. Aitken, *The Continuous Wave* (Princeton, N.J., 1985), pp. 254, 281–88.

wild animals belongs to all citizens.[7] In Great Britain and elsewhere that right belonged to the crown and the aristocracy. When crude oil was discovered in the United States, the courts transferred to that migratory resource the same common law of capture that had been applied to hunting and fishing. Game and fish were nobody's property until they were caught. When in 1921 the Court of Appeals for the District of Columbia upheld the principle that the Secretary of Commerce had no authority to deny a broadcast license, the court was upholding a law of capture for the radio spectrum.[8] The government could require that broadcast stations be licensed, as hunters were licensed. But it could not, without new legislation, deny a license to any citizen.

The right to deny access to the spectrum first appeared in the Radio Act of 1927—a statute whose importance grows the more it recedes into history. Pool, for example, saw in its passage a major threat to the First Amendment and freedom of speech. On the grounds that spectrum was a scarce resource (an assumption Pool questioned), it imposed a licensing system on the transmission of ideas that had long been abandoned for the print media, "thereby breaching a tradition that went back to John Milton."[9] That raises a host of questions, questions of immense importance in our new "information age." The concern of this article is different, however. The Act of 1927 was passed by Congress in the hope that it would solve what was regarded as a serious problem of interference—of "chaos" on the airwaves, as it was commonly called. I ask to what extent that perceived problem reflected the limitations of radio technology at that time and to what extent it reflected institutional constraints. By "institutional constraints" I mean specifically the absence of formally recognized markets in which rights to spectrum could legally be traded.

A word about terminology is in order here. The Federal Communications Commission (FCC) uses the term "allocation" to refer to the initial partition of the spectrum into large blocks, such as for AM broadcasting, police communications, and so on. The term "assignment" refers to authorization given to a specific station licensee to use specific frequencies or channels within those blocks. In this article, I use "allocation" in the most general sense to refer to the way in which a scarce resource is distributed among alternative uses.

[7]Gary D. Libecap, *Contracting for Property Rights* (Cambridge, Mass., 1989), pp. 19, 76. See also T. A. Lund, *American Wildlife Law* (Berkeley, Calif., 1980); and J. A. Tober, *Who Owns the Wildlife?* (Westport, Conn., 1981).

[8]Philip T. Rosen, *The Modern Stentors: Radio Broadcasters and the Federal Government, 1920–1934* (Westport, Conn., 1980), pp. 53–54; and Jora R. Minasian, "The Political Economy of Broadcasting in the 1920's," *Journal of Law and Economics* 12 (October 1969): 391–403.

[9]Pool, *Technologies of Freedom*, pp. 2–3.

The Spectrum as a Common-Property Resource

Our starting point is the conception of the broadcast spectrum as a common-property resource and therefore as a resource inherently subject to the dangers of overexploitation, overinvestment, and falling yields that have been thoroughly documented with reference to (for example) fisheries, oil reservoirs, and groundwater basins.[10] Such resources have always presented problems of public policy, essentially because users of the resource do not take account of the full social costs of their actions, and consumers do not pay the full price for what they consume. The pursuit of individual self-interest in such circumstances does not lead to a social optimum.[11]

From the earliest days of radio, few doubted that regulation of some kind was called for. The reason was not interference but the safety of ships at sea. Regulation was required in order that standard wavelengths could be designated as calling frequencies or distress frequencies, to ensure that radio stations using different equipment would communicate with each other, and to mandate that all vessels over a certain capacity carried radio equipment and operators. This is the context in which the Berlin Conference of 1906 and the London Conference of 1912 were held. The problem at that time was not congestion or overoccupancy but rather protocols by which radio operators could locate and communicate with each other in what was virtually empty terrain. The spectrum could be a lonely place in those days.[12]

In this context congestion and its major symptom, interference, did not present major issues for public policy. To be sure, there were

[10]The relevant literature is now extensive. For a sample, see Garrett H. Hardin, "The Tragedy of the Commons," *Science* 162 (1968): 1243–48; J. M. Acheson, *The Lobster Gangs of Maine* (Hanover, N.H., 1988); Arthur McEvoy, *The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850–1980* (Cambridge, Mass., 1986); D. W. Bromley, ed., *Essays on the Commons* (Madison, Wisc., 1990); S. V. Ciriacy-Wantrup and R. C. Bishop, " 'Common Property' as a Concept in Natural Resource Policy," *Natural Resources Journal* 15 (1975): 713–27; Gary Libecap and S. N. Wiggins, "Contractual Responses to the Common Pool: Prorationing of Crude Oil Production," *American Economic Review* 74 (1984): 87–98; Yoram Barzel, *Economic Analysis of Property Rights* (Cambridge, Mass., 1989); and H. Scott Gordon, "The Economic Theory of a Common-Property Resource: The Fishery," *Journal of Political Economy* 62 (February 1954): 124–42. For a fine discussion of the spectrum as a resource, see Harvey J. Levin, *The Invisible Resource: Use and Regulation of the Radio Spectrum* (Baltimore, 1971).

[11]The classic reference is R. H. Coase, "The Problem of Social Cost," *Journal of Law and Economics* 3 (October 1960): 1–44. H. Scott Gordon had expressed the central problem succinctly in 1954: "Wealth that is free for all is valued by none because he who is foolhardy enough to wait for its proper time of use will find that it has been taken by another. . . . Common-property natural resources are free goods for the individual and scarce goods for society" (n. 10 above).

[12]James M. Herring and Gerald C. Gross, *Telecommunications: Economics and Regulation* (New York and London, 1936), pp. 359–61.

occasional systemic failures, as during the *Titanic* disaster of April 1912, when scores of stations competed for occupancy of a few frequencies, rendering effective communication very difficult.[13] But, such tragedies aside, it could hardly be said that up to 1912 spectrum congestion presented a major problem. Certainly, the U.S. Congress did not think so. The Radio Act of 1912 was passed only in the aftermath of the *Titanic* disaster and because a statute was required to implement the provisions of the London Wireless Conference of that year.[14] The only users of the spectrum who were disadvantaged by the statute were the amateurs.[15] To other users—the navy and other government agencies, marine operators, and shore stations—this first regulatory statute did not disturb existing rights of access to the spectrum.[16] It moved the amateurs to their private pasture but left other users undisturbed. And it did not grant to the Secretary of Commerce the authority to deny a license to any citizen. The Radio Act of 1912, in short, did not limit access to the spectrum. That was neither its purpose nor its effect.

Nevertheless, this was the only statute governing radio when the broadcast boom began in 1920–21. The Department of Commerce, when Herbert Hoover joined the Harding cabinet, had no powers to regulate radio other than those specified in this act. Nor did anyone believe, before the advent of popular broadcasting, that additional powers were necessary. With the amateurs out of the way, the major source of interference to commercial and government stations had been removed. International conventions, backed up by treaty and implemented by statute law, provided whatever additional coordination was required.

It is true, nevertheless, that even in those days there were signs of difficulties ahead. The number of stations competing for access to the spectrum was increasing. Indeed, one of the effects of the Act of 1912 was to mandate such an increase. And the technical boundaries of the

[13]See Susan Douglas, *Inventing American Broadcasting, 1891–1922* (Baltimore, 1987), pp. 226–39.

[14]The bill (37 Stat. 302), "An Act to Regulate Radio Communication," was actually reported out of committee before the sinking of the *Titanic*, but the disaster undoubtedly helped mobilize the votes necessary for passage. See Marvin R. Bensman, "The Regulation of Radio Broadcasting by the Department of Commerce, 1921–1927" (Ph.D. diss., University of Wisconsin, 1969), pp. 27–28.

[15]Clinton B. DeSoto, *Two Hundred Meters and Down: The Story of Amateur Radio* (West Hartford, Conn., 1936), pp. 30–31.

[16]Technically, the Act of 1912 was a revision of the Wireless Ship Act of 1910 (P.L. 262), which required that after July 1, 1911, all oceangoing vessels carrying fifty or more passengers should be fitted with efficient radio apparatus and be staffed by one skilled operator. See L. S. Howeth, *History of Communications-Electronics in the United States Navy* (Washington, D.C., 1963), pp. 158–60.

spectrum were constraining. The range of frequencies on which a ship station could transmit was effectively set by the physical size of the antenna that could be erected. This meant that ships were limited to frequencies between 667 and 500 kHz (450 and 600 meters, in the parlance of the time).[17] Shore stations did not suffer from that limitation but rather from a limitation of knowledge—in this case knowledge of radio propagation. The conventional wisdom of the age held that only long waves could cover long distances: wavelengths shorter than 250 meters were thought to be essentially useless for commercial work, which is why they were given to the amateurs.[18] The effect was to confine commercial and government use of the spectrum to a narrow segment. This meant a higher probability of interference as stations multiplied.

Compounding the problem was the state of radio technology. Spark transmitters were intrinsically "dirty"; they spread their signals over an unnecessarily wide band of frequencies. The fact that the key tuning patents were claimed by the Marconi Company meant that other transmitters occupied more spectrum than they needed to, and receivers found it difficult to discriminate among them. Amateurs could build their own tuners, ignoring patent rights. Navy and commercial stations could not allow themselves that liberty. Their transmitters were usually coupled directly to the antenna (the major frequency-determining element in the system); their receivers could usually discriminate among stations received only by the tone of their spark. Broadly tuned spark transmitters and unselective receivers were a prescription for interference.

These were, however, diminishing problems, and for this advances in technology were responsible. First, by the end of World War I, radio technology had been revolutionized by the introduction and diffusion of the vacuum tube. Invented by John Ambrose Fleming and Lee De Forest before the war, converted into a truly usable device by Irving Langmuir at General Electric and H. D. Arnold and H. J. van der Bijl at AT&T, and manufactured in large quantities during the war, the vacuum tube made amplification of radio signals possible for the first time and also (in a feedback circuit) the generation of true continuous waves instead of sparks.[19] Second, in the United States, the structure of the industry had been transformed by the formation of the Radio Corporation of America. RCA controlled the key patents on vacuum-tube technology, plus the tuning patents formerly controlled by the Marconi Company. As the chosen instrument of American telecommunications policy, formed with the blessing of the U.S. Navy, RCA brought to the

[17]A useful approximation: to convert kHz into meters, divide into 300,000.

[18]DeSoto, p. 31.

[19]Leonard S. Reich, *The Making of American Industrial Research: Science and Business at GE and Bell, 1876–1926* (Cambridge, Mass., 1985), esp. pp. 163, 208–10.

radio industry a consolidation of interests such as had never existed before.[20]

In this context, prospects for managing the underlying resource without government regulation seemed immeasurably improved. What need for government regulation could there be? Standard frequencies on the marine radio band were now universally accepted. The gradual phasing out of spark sets and their replacement by continuous-wave vacuum-tube transmitters meant that many more stations could now communicate without interference. The availability of more selective and sensitive receivers worked in the same direction. The Act of 1912, providing for registration and licensing of transmitters by the Department of Commerce, provided all the government supervision that appeared necessary. On the very low frequencies—the only ones, according to the wisdom of the day, that could be used for intercontinental transmission—RCA's engineers were already concerned about congestion and warned that there would never be room for more than a score of high-powered stations.[21] But, that did not necessarily require a government agency to assign frequencies or restrict the number of transmitters. RCA and its corporate allies in the United States and abroad were perfectly capable of working out that problem themselves. None of them elected to invite legal complications and political animosity by asserting property rights in the spectrum; none of them felt any need to do so. Secure rights of access were all that was necessary; RCA, backed by corporations that controlled the technology, the research laboratories, and the manufacturing capacity, already had those.

Broadcasting, Congestion, and Interference

What upset these arrangements was the coming of popular broadcasting and with it an explosively increasing number of new users whose appetite for spectrum seemed insatiable.[22] The idea of using radio to

[20]Standard sources on the formation of RCA are Gleason Archer, *History of Radio to 1926* (New York, 1938), and *Big Business and Radio* (New York, 1939); Josephine Case and Everett Case, *Owen D. Young and American Enterprise: A Biography* (Boston, 1982); and Aitken, *Continuous Wave* (n. 6 above).

[21]Ernst F. W. Alexanderson, Alexander E. Reoch, and Charles Taylor, "The Electrical Plant of Transoceanic Radio Telegraphy," *Transactions of the American Institute of Electrical Engineers* 42 (1923): 707–17.

[22]The first broadcast license was issued in September 1921. By March 1922 there were sixty licensed broadcast stations, and by December of that year 576. By February 1927 the total had grown to 733. These figures tell us nothing about increases in average power levels. Hoover estimated that the total power of broadcast stations using 500 watts or more increased by 250 percent between November 1924 and November 1925. See Laurence F. Schmeckebier, *The Federal Radio Commission: Its History, Activities, and Organization* (Washington, D.C., 1932), p. 9. The best recent account of the rise of broadcasting is Douglas (n.

send programs "broadcast" to the general public, rather than from point to point, had played no role at all in the negotiations that led to the consolidation of the post–World War I radio industry. RCA had been formed to serve only two functions: first, to be a radio-operating company for ship and intercontinental traffic; and second, to be a sales agent for radio equipment manufactured by GE, Westinghouse, and Western Electric, the manufacturing arm of AT&T. Similarly, the division of manufacturing rights among the constituent companies had at first seemed simple enough: the "radio group" (GE and Westinghouse) would manufacture receivers and radiotelegraph equipment, Western Electric would be responsible for making radiotelephone transmitters, and AT&T would have a monopoly of radiotelephone service.[23]

Broadcasting made nonsense of these distinctions. Was broadcasting "public telephony for toll"? If so, it was the exclusive province of AT&T, and none of the other companies could use the group's patents in that field. Could Western Electric manufacture receiving sets for use in the home, or was that rich market the exclusive domain of GE and Westinghouse?

We do not need to follow here the complex maneuverings and arbitrations to which these ambiguities led. That story has been told elsewhere.[24] Nor do we need to argue over who was the first true broadcaster—whether De Forest, Reginald Fessenden, Frank Conrad, "Doc" Herrold, or some other. The matter is irrelevant for my purposes. What is of central importance is to recognize that what shattered the carefully built structure of the radio industry in the years immediately after World War I was technological change, specifically, the ability of the vacuum tube to transmit speech and music—plus the ready availability of war-surplus tubes and the knowledge of how to use them that was now widely diffused among radio engineers and amateur radio operators. Once the technical feasibility had been demonstrated, the idea of broadcasting a signal to a multitude of listeners, rather than merely passing traffic from one station to another, was bound to follow.[25]

The advent of the broadcast boom was not accompanied by expansion of the available spectrum. The Department of Commerce at first assigned to broadcast stations only a single frequency—360 meters

13 above). But see also Erik Barnouw, *A History of Broadcasting in the United States*, vol. 1, *A Tower in Babel* (New York, 1966); and Rosen (n. 8 above).

[23]For the arrangements, see Aitken, *Continuous Wave*, pp. 432–513; and Barnouw, 1:59–61, 72–74, 81–83.

[24]See Aitken, *Continuous Wave*, pp. 432–513; and Archer, *Big Business and Radio*, passim.

[25]This is not to minimize the importance of broadcasting as a *social* innovation. On the social construction of American broadcasting, see Douglas (n. 13 above).

(833.3 kHz)—far enough from the amateur band and from customary ship frequencies to avoid interference with those services.[26] But, restriction to a single frequency, when the demand for spectrum was increasing exponentially, was a guarantee of conflict. Other frequencies were made available as time passed, culminating in 1923 in the release for broadcast use of the entire 500–1,500 kHz band, over the strenuous objections of the U.S. Navy.[27] But the number of broadcast stations multiplied faster than the number of available channels, and the potential for interference grew apace.[28]

Statistics of the total number of broadcast stations do not fully disclose the growing potential for interference, since average power levels were rising. Of the fifty-five licensed stations existing in March 1922, few if any exceeded 250 watts of output.[29] When the so-called Class B stations were authorized in August 1922 and given preferred frequencies, they were required to operate at no less than 500 watts of power and no more than 1,000.[30] By the time of the Third Radio Conference in 1924, however, Hoover could report that at least two stations were contemplating using up to 5,000 watts; and David Sarnoff confidently stated that RCA's new "superpower" station would transmit at up to 50,000 watts, "if no regulatory proposals are adopted that would limit

[26]A second frequency was made available for the broadcasting of government bulletins, weather and crop reports, etc.

[27]See Howeth (n. 16 above), pp. 383, 398, and 406. The navy had previously used this band for fleet tactical communications. These frequencies are still the core of the American AM broadcast band today.

[28]Department of Commerce policies during this period have been analyzed in two doctoral dissertations on which I have drawn heavily for references: Glenn A. Johnson, "Secretary of Commerce Herbert C. Hoover: The First Regulator of American Broadcasting, 1921–1928" (Ph. D. diss., University of Iowa, 1970); and Bensman, "Regulation" (n. 14 above). See also Donald G. Godfrey, "The 1927 Radio Act: People and Politics," *Journalism History* 4, no. 3 (Autumn 1977): 74–78; Marvin R. Bensman, "The Zenith-WJAZ Case and the Chaos of 1926–27," *Journal of Broadcasting* 14, no. 4 (Fall 1970): 423–40; George H. Gibson, *Public Broadcasting: The Role of the Federal Government, 1912–76* (New York, 1977); Daniel E. Garvey, "Secretary Hoover and the Quest for Broadcast Regulation," *Journalism History* 3, no. 3 (Autumn 1976): 66–85; Robert W. McChesney, *Telecommunications, Mass Media, and Democracy: The Battle for the Control of U.S. Broadcasting, 1928–1935* (New York, 1993); and Thomas W. Hazlett, "The Rationality of U.S. Regulation of the Broadcast Spectrum," *Journal of Law and Economics* 33, no. 1 (April 1990): 133–75.

[29]Statistics for the number of licensed broadcast stations vary widely. The figure in the text is from D. B. Carson to Herbert Hoover, March 2, 1922, cited in Johnson, p. 88; but compare the totals in Hiram L. Jome, *Economics of the Radio Industry* (Chicago, 1925), p. 70, reprinted in Hazlett, p. 138.

[30]Johnson, p. 101. It is often unclear whether the figure quoted refers to the power input to the transmitter or to the transmitter's power output to the antenna. The relationship between the two figures varied, depending on the efficiency of the tubes and associated circuitry.

the art."[31] This was no idle boast: General Electric's Schenectady station, WGY, had already boosted its power to 50,000 watts, on an experimental basis, in August 1924. In December 1925, RCA's new station, WJZ, at Bound Brook, New Jersey, was authorized to transmit on a regular basis with 50,000 watts.

Not all stations, of course, tried to attain such power levels or could afford to do so. Some stations were and remained little more than amateur transmitters, using low power, relying on phonograph records for program material, and transmitting on "ghetto frequencies." But others were highly sophisticated in a technical sense; well-funded by the radio manufacturers, newspapers, or department stores with which they were associated; and transmitting on clear channels allocated to them by the Department of Commerce. As sponsored advertising grew in importance, there was no argument about which type of station could most effectively deliver listeners to advertisers. The result was increasing differentiation of firms within the industry: those with preferred channels and sophisticated station equipment had a clear interest in restricting the entry of new stations and, indeed, in opposing any expansion of the broadcast band.

Increases in output power of this magnitude had several consequences. First, they extended the range and therefore the market coverage of the more powerful stations. At lower power levels the Department of Commerce could safely allocate the same frequency to stations that were geographically distant from each other. Now that strategy became more difficult, and as a result the competition for clear channels became more intense. Second, higher power levels increased the stratification in the industry. Corporate leaders like Sarnoff were clear about their intention to build stations whose transmissions would blanket, not just a metropolitan area or a section of a state, but whole regions of the country.[32] This put intense pressure on the smaller stations, which had previously survived by serving a limited area. Sponsors preferred stations with wider geographic coverage; and listeners preferred the more expensive program material that superstations

[31]Ibid., p. 164, citing the minutes of sub-committee no. 3 of the third National Radio Conference, October 6–10, 1924.

[32]Readers should bear in mind that in this period network or chain broadcasting was in its infancy. AT&T experimentally linked several stations together in the summer of 1923, using WEAF as the station of origin; and in December of that year six stations were interconnected to carry President Coolidge's first message to Congress. But the National Broadcasting Company, the first company formed solely to conduct chain broadcasting, was not chartered until 1927. The delay may have been partly due to uncertainty over whether the telephone wires that would be used to interconnect stations had the bandwidth to carry music without distortion. On network broadcasting, see Rosen (n. 8 above), esp. chaps. 7, 8, and 9.

could afford to buy. Third, and most obviously, higher power meant more interference.

Broadcast stations differed not only in their output power but also in their frequency stability. It was all very well for the Commerce Department to assign a station to a certain frequency, but not all stations had the technical capability to maintain that frequency, and not all cared much whether they did or not. In his *Memoirs,* Hoover cites the case of a Los Angeles station owned by the evangelist Aimée Semple McPherson which was notorious for wandering from one end of the broadcast band to the other. After repeated warnings, an inspector from the Commerce Department sealed the station and put it off the air. McPherson's reaction was indignant: she fired off a telegram to Hoover which referred to the department's agents as "minions of Satan" and continued, "You cannot expect the Almighty to abide by your wavelength nonsense. When I offer my prayers to Him I must fit into his wave reception. Open this station at once."[33]

The case was perhaps extreme, but the problem was not unusual. Frequency stability depended on the tuned circuits of the transmitter; even if at first adjusted to the correct parameters, these changed with changes in temperature and humidity. Not all stations possessed calibrated wavemeters, nor engineers skilled in their use. In May 1923, for example, the Ford Motor Company station in Dearborn, Michigan, was found to be without any means of checking its own frequency.[34] The fact of the matter was that, in the absence of close monitoring and vigorous enforcement by the Department of Commerce, the matter was not of great significance to many station owners. No station had its license suspended or revoked for departing from its assigned frequency.[35]

The problem of frequency stability was eased, in principle if not often in practice, by the introduction of crystal control. Developed by Bell Laboratories and Westinghouse, working in cooperation with the Commerce Department's Bureau of Standards, this innovation depended on the properties of piezoelectric quartz crystals which, when inserted into an oscillating circuit, made possible control of frequency with a precision never possible before.[36] But, crystal control of transmitter frequency

[33]Herbert Hoover, *Memoirs,* vol. 2, *The Cabinet and the Presidency, 1920–1933* (New York, 1951–52), pp. 142–43; see also Johnson, p. 222.

[34]Bensman, "Regulation" (n. 14 above), p. 166.

[35]Ibid.

[36]Crystals are still used for this purpose in many items of consumer electronics, though most users are unaware of their existence. Every personal computer and color TV set, for example, depends on a crystal oscillator to control its internal clock. For information on the origins of the innovation, see M. D. Fagen, ed., *A History of Engineering and Science in the Bell System: The Early Years (1875–1925)* (Murray Hill, N.J., 1975), pp. 318, 988; Johnson (n. 28 above), p. 60. The Bureau of Standards began transmitting standard frequency signals

was not without problems of its own—crystals sometimes jumped in frequency for reasons inexplicable at the time—and their use was the exception rather than the rule through the 1920s.[37] Most stations seem to have relied on simple tuned circuits—coils and capacitors—to set their frequencies, and the radio inspectors of the Department of Commerce had no authority to impose sanctions on those who drifted off frequency.

It would be a mistake, however, to blame interference solely on the increasing numbers of broadcast stations and their technical deficiencies. Some of the worst interference came from the navy's high-powered arc transmitters—notorious for generating harmonics—and on navy and coast guard spark sets, particularly on the East Coast and around the Great Lakes. Amateur stations got much of the blame, and probably contributed to the problem, but government stations were prime offenders. Nor was it solely a question of the design and operation of transmitters. Receivers also added to the problem. The typical receiver in the early years of the broadcast boom was the crystal set, broadly tuned and lacking selectivity. When vacuum tubes came into wider use, the single-tube regenerative receiver became popular. These relied on a feedback circuit to build up the strength of the received signal and when properly tuned were remarkably effective. The trouble was that maximum amplification was achieved when the set was just on the verge of oscillation, and it was very easy to turn the regeneration control just a bit too far. When that happened, the regenerative receiver became a miniature transmitter and could wipe out reception over a sizable area.[38] Edwin Armstrong's superheterodyne receiver, developed in 1918–19, became available commercially in 1924 and offered the prospect of vastly improved sensitivity and selectivity.[39] But superhets were expensive, the early models were tricky to operate, and the vast majority of the

in 1923. See Rexmond C. Cochrane, *Measures for Progress: A History of the National Bureau of Standards* (New York, 1951).

[37]Bensman, "Regulation," p. 257.

[38]As an example, the first tests of amateur transatlantic radio communications were a dismal failure, largely because the 250 or so British stations listening for prearranged signals from the United States jammed each other so badly with their regenerative receivers that they could hear nothing from North America. A second series of tests in December 1921, using a superheterodyne receiver, was successful.

[39]On the invention of the superheterodyne receiver, see the articles in *Proceedings of the Radio Club of America,* vol. 64, no. 3 (November 1990), "The Legacies of Edwin Howard Armstrong." Plans and kits for building superhets were available from 1922 on, but only RCA could legally build them. Its Radiola superheterodyne receiver was first marketed in 1924. See Alan Douglas, *Radio Manufacturers of the 1920s* (New York, 1988), 1:xiii. On the problems raised by multiple-tuned circuits, see Arthur P. Harrison, Jr., "Single-Circuit Tuning: An Analysis of an Innovation," *Technology and Culture* 20 (April 1979): 296–321.

listening public continued to make do with simpler apparatuses. The majority of receivers in use as late as 1925 were probably "home brew" rather than commercial models. Informed observers at the time were well aware that much of the responsibility for interference could be ascribed to the large consumer inventory of primitive receivers; but until superhets fell in price, there was not much that either leaders of the industry or government bureaucrats could do about that aspect of the problem.

One could argue, therefore, that increases in transmitter power and weaknesses in transmitter and receiver design were primarily responsible for the interference problem throughout the 1920s. If so, the problem would be properly characterized as a technological one, rather than a political or institutional one. Unfortunately, this argument is incomplete. Technological deficiencies in transmitters and receivers undoubtedly aggravated the problem, but technological advance alone would not have solved it. Equally important was the fact that access to a common-property resource was not institutionally constrained. There were too many beasts foraging in the pasture.

Licensing and Control of Access

That there were too many stations competing for access to the "ether" was obvious to everyone at the time. Why then did the responsible agency, the Department of Commerce, not limit access to the broadcast spectrum? The answer is twofold. In the first place, although Hoover very early in his term as Secretary of Commerce recognized in principle the need to limit the number of broadcast licenses, in practice he had scruples about doing so. To grant access to some but deny it to others was in his opinion the same thing as creating monopoly rights in a national resource. "You will recognize," he told the *New York World* in 1924, "that if anybody should be able to have the exclusive use of a certain wavelength, he would have a monopoly on that part of the ether. That cannot be permitted."[40] Even more explicitly, he informed the *Cleveland Plain Dealer* in 1925 that "if we limit the number [of broadcast stations], the possession of a license becomes commercially valuable, and in a sense, a monopoly."[41] These, of course, were statements for public consumption, echoing standard populist and progressive leitmotivs. Within the Department of Commerce, Hoover's legal and technical advisers knew very well that limitations on the number of stations and strict enforcement of frequency assignments were the only feasible

[40]"The Government's Duty to Keep the Ether Open and Free for All," interview with the *New York World* (March 16, 1924), cited by Bensman, "Regulation," p. 234.

[41]"Hoover Battles to Block Special Privilege in Radio," interview with the *Cleveland Plain Dealer* (May 28, 1925), cited by Bensman, "Regulation," p. 236.

answers to broadcast interference. But, here the second reason for inaction became relevant: the department's legal authority to deny anyone a broadcast license was highly questionable. Only slightly less questionable was its authority to set and enforce frequency assignments.

Hoover had been warned by his staff that his discretionary authority over radio was minimal. In March 1921, for example, his Commissioner of Navigation told the new Secretary of Commerce that his powers with regard to radio were "scarcely more than ministerial."[42] As Stephen B. Davis, chief legal adviser to the Department of Commerce after 1923 later noted, the matter had basically been settled when the Act of 1912 was passed. The Committee on Merchant Marine and Fisheries, responsible for radio matters at that time, had assured the full House that the bill "does not give the head of that Department [of Commerce and Labor] discretionary power over the issue of the license."[43] And the Senate Committee on Commerce had made it explicit that the failure of the bill to grant discretionary authority to the secretary was no oversight. Former bills, the committee noted, had delegated to the President and to the Secretary of Commerce the power to make regulations governing radio which would have the force of law. "That amounted practically, at least in the judgment of some members of this committee, to the surrender by Congress of its powers and the bestowal of legislative power to all intents and purposes upon administrative officers."[44] The statute of 1912 was framed so as to avoid that grievous error: it embodied nineteen regulations and made no provision for the promulgation of more without the explicit consent of Congress.

If any doubts remained as to the secretary's inability to regulate radio beyond the explicit provisions of the Act of 1912, they were dissipated by two legal decisions: the *Intercity* case of 1921–23 and the *Zenith* case of 1926. These have been so thoroughly analyzed by legal scholars and radio historians that they now resemble a thrice-squeezed orange. But perhaps they can still yield some drops of information.

The *Intercity* case had, at first, little to do with broadcasting. The Intercity Radio Company, founded and run by Emil Simon, had a contract with the Hearst newspapers to provide a direct news feed from Telefunken in Germany—one that would be independent of the Reuters-Marconi-RCA system. With that in mind, Intercity Radio in December 1920 built a high-powered radiotelegraph station and sited it in lower Manhattan. From there it communicated in Morse code with

[42]E. T. Chamberlin to Hoover, memorandum, March 17, 1921, cited in Johnson (n. 28 above), p. 63.

[43]Stephen B. Davis, *The Law of Radio Communication* (New York, 1927), p. 36.

[44]Ibid., p. 35, citing Report on Bill 698 to accompany S. 6412, 62d Cong., 2d sess., pp. 7–8.

Telefunken stations in Germany and, overland, with other Intercity stations in Detroit, Cleveland, and Chicago.[45]

A more unsuitable location for a high-powered radiotelegraph transmitter would be hard to imagine. When the Intercity station was on the air it completely wiped out radio reception in most of the New York metropolitan area—including, by an unhappy coincidence, a receiving station operated by the *New York Times* only 400 yards away, a U.S. Navy marine communications facility, and, of course, a large number of privately owned broadcast receivers. But was Intercity doing anything illegal? Construction permits were not required in those days. The company had a valid license. Intercity had as much right to use the radio spectrum as anyone else. And Simon, backed by Hearst with his well-known antipathy to eastern capital and Washington bureaucrats, was not one to back down meekly.

Despite numerous complaints, the Commerce Department moved cautiously. In May 1921 it revoked Intercity's license on the grounds that it was interfering with ship-to-shore traffic. Intercity went to court, and after sundry legal maneuvers the case ended up in the Court of Appeals for the District of Columbia Circuit.[46] There, on November 17, 1921, the department was ordered to issue a license to Intercity on the grounds that the Act of 1912 gave the Secretary of Commerce no discretionary power to refuse a license. At Hoover's request the Justice Department moved to appeal the decision, and a writ of error to the Supreme Court was allowed. In the meantime, however, Intercity went into bankruptcy, and in September 1924 the case became moot and was dismissed.[47]

There was never any doubt about what the central issue was. Could the Secretary of Commerce read implied powers into the Act of 1912, or was he restricted to the nineteen regulations explicitly spelled out in that statute? The fact that the case was finally declared moot clouded the issue somewhat and enabled the department to continue a semblance of control over licensing. But after *Intercity*, no one concerned with broadcasting could have been unaware that the legal underpinnings for Department of Commerce policy were decidedly shaky.

The *Intercity* decision called into serious question whether the Commerce Department had the power to deny a radio license. It did not question, however, the department's power to assign a wavelength or to define the hours during which a transmitter might be on the air. Indeed, a layman's reading of the statute might suggest that these powers were

[45]Research has not disclosed what type of transmitter Intercity used, but one suspects either an arc or a quenched spark.

[46]Court of Appeals, District of Columbia Circuit, November 23, 1921 (not reported), and *Hoover v. Intercity Radio Company*, 286 Fed. 1003.

[47]266 U.S. 636.

expressly provided. Did not Section 2 declare that the Secretary of Commerce "shall state the wave length or wave lengths authorized for use by the station for the prevention of interference and the hours for which the station is licensed to work"? Relying on these powers, which *Intercity* left intact, the department from 1921 to 1926 did assign a wavelength when it issued a broadcast license, and it did limit hours of operation. Without this exercise of authority, the problems of spectrum congestion and interference would have been much worse than they were. The department might not legally be able to limit the number of beasts grazing in the pasture, but it could assign them specific locations, and it could limit their appetites.

The *Zenith* decision eliminated even these powers.[48] The case began quietly enough. The Zenith Radio Corporation, headed by Eugene F. McDonald, owned and operated station WJAZ, located at the Edgewater Beach Hotel outside Chicago. In May 1924 the station was sold to WGN, owned by the *Chicago Tribune*, but McDonald asked for and received permission to retain the WJAZ call letters for a new station that he planned to build. He was warned, however, that all the available frequencies were already assigned and that he would have to make arrangements to share time with other stations. McDonald raised no objection and asked for a wavelength of 322.4 meters. Notified by the department that this would bring him too close in frequency to WSAI in Cincinnati and KOA in Denver, he gave assurances that this would cause no problem, as the Zenith station intended to operate only between 10:00 P.M. and midnight on selected nights. "Our station," he wrote, "is constructed with the sole purpose of giving to the public the highest form of entertainment in but a limited time. We have felt that to do this, sufficient high class talent could not be secured throughout the year for more than two hours per week."[49]

McDonald was at this time president of the National Association of Broadcasters and had already made known his views on broadcast policy. While professing unbounded admiration for Hoover personally, McDonald's preference was for the establishment of a regulatory commission that would have the authority to limit entry into the industry.[50] Like most established broadcasters, he saw little to be gained by unrestricted licensing of new stations. This was also the position endorsed in November 1925 by the Fourth Radio Conference which, for the same reasons, opposed any expansion of the broadcast band.

[48] *United States v. Zenith Radio Corporation*, 12 Fed. 2d ser. 614.

[49] Eugene F. McDonald to Stephen B. Davis, June 26, 1925, cited in Bensman, "Regulation" (n. 14 above), p. 310.

[50] Eugene F. McDonald, "The March of Radio: Hoover's Suggestions for New Radio Legislation," *Radio Broadcast* 7 (March 1925): 890–92, cited in Bensman, "Regulation," p. 230, and Johnson (n. 28 above), p. 171.

The legal staff at the Commerce Department may well have wondered whether McDonald's aspirations were as modest as they at first appeared. If so, they did not have to wonder for long. McDonald's request for limited hours was cleared with the General Electric Company, owner of KOA, and with the U.S. Playing Card Company, owner of WSAI. Neither raised any objections, provided that the new station caused no interference and was on the air for only the two hours that had been requested. Accordingly, on July 22, 1925, McDonald received the license he had asked for, authorizing the station to broadcast on a wavelength of 322.4 meters (930 kHz) for the two hours each week that he had specified.

Up to this point McDonald had received all that he had asked for. Shortly before or after the issuance of the license, however, part ownership in station WJAZ was sold to the *Chicago Herald Examiner.* The tone of exchanges with the Department of Commerce now altered remarkably. There was no more talk of giving the public "the highest form of entertainment" for only two hours a week. Now it was a question of being treated on a par with other powerful stations and other important newspapers. As McDonald wrote to Davis, solicitor to the department, "We divide [our] wavelength with the Denver station, K.O.A., and consider the division of time inequitable, as we have only two hours per week for our share. In other words, Denver has one hundred and sixty-four hours of the week and we are allowed only two hours. The Chicago Daily News, the Chicago Evening Post, and the Chicago Tribune, each receive on their respective wavelengths eighty-four hours per week, and in addition to this the Chicago Tribune, through its subsidiary, the Liberty Magazine, also enjoys two additional wavelengths. It is obvious that we cannot adequately serve the public in two hours per week."[51]

It is tempting to speculate that the entry of a major newspaper as an important stakeholder had changed the rules of the game and, in the process, McDonald's idea of public service. "Serving the public" was now defined, not as delivering high-quality programming to listeners, but as delivering the largest possible number of listeners to advertisers. This may indeed be true; but it is not inconsistent to suggest that McDonald had his own agenda, which was to challenge the department's authority to assign wavelengths, undercut the quasi-legal structure of regulation that Hoover had created, and thereby strengthen the drive for legislation.[52] McDonald's next move was certainly one that the department could not ignore.

[51]Eugene F. McDonald to Stephen Davis, November 12, 1925, cited in Bensman, "The Zenith-WJAZ Case" (n. 28 above), pp. 423–40.

[52]Rosen (n. 8 above) appears to regard this as self-evident and compares McDonald to Swift, Armour, Insull, and other Chicago-based firms that "rebelled in order to bring about government regulation for their corporations" (pp. 93–94).

Radio waves show no respect for international boundaries. Much of southern Canada, then as now, was within easy range of U.S. broadcast stations. To save the bulk of the Canadian population from being swamped by American broadcasts, nine of the available frequencies in the broadcast band had been set aside for the exclusive use of Canadian stations, leaving some eighty-nine for the United States. No treaty, convention, or other formal agreement mandated this arrangement; it was no more than an understanding, observed up to this point by both countries. As such, it provided an ideal opportunity for McDonald to test the Commerce Department's position.

In early January 1926 WJAZ shifted its frequency to 329.5 meters (910 kHz), a frequency then in use by seven stations in Canada. This move could not be overlooked, since diplomatic sensitivities were involved, and on January 14, 1926, the U.S. Attorney in Chicago was instructed to begin a vigorous prosecution. The decision in the case was rendered on April 16. It went far beyond *Intercity* in circumscribing the powers of the Department of Commerce.

The decision turned not on the facts of the case, which were undisputed, but on interpretation of the Act of 1912, and particularly on differences in the language in Section 2 and that in Section 4 of the statute. Section 2 described the licensing authority granted to the Secretary of Commerce in rather general terms, although it did specify that each license granted should state "the wave length or wave lengths authorized for use by the station to prevent interference." Section 4, however, enumerated nineteen specific regulations to be enforced by the Secretary of Commerce. These included limits on the frequencies to be used and restrictions on hours of operation if commercial stations caused interference to naval or military installations. But it did not specifically empower the secretary to assign a particular frequency to a particular station, nor to designate its permitted hours of operation. And, most significantly, neither in Section 4 nor anywhere else in the statute was the secretary empowered to issue additional regulations.

The question, as posed by the presiding judge, was whether the specific regulations of Section 4 supervened the general regulatory authority implied in Section 2. And he decided that they did. The logic was simple. If Congress had intended to delegate general regulatory power to the Secretary of Commerce, then the statute was unconstitutional, since Congress could not delegate lawmaking authority to an officer of the executive branch without defining the test or standard intended to control the discretion of that officer. This the Act of 1912 had not done. The governing rubric was that, in considering an act of Congress, a construction that might render it unconstitutional, or even raise grave doubts as to its constitutionality, was to be avoided. There-

fore, the Act of 1912 should be read as stating that the Secretary of Commerce had the powers enumerated in Section 4, and only those powers.

A formalist interpretation such as this may strike us today as somewhat antique. It was less so in 1926. There was no hint in the court's ruling that the Department of Commerce might properly act under powers implied by the act, though not explicitly stated in it. There was no exercise of creative jurisprudence to interpret the law in such a way as to make it relevant to circumstances quite different from those in which it had been passed. There was, indeed, no attempt to get at the original intent of the legislators, which (one might plausibly argue) had been to give to the Secretary of Commerce the licensing powers necessary for orderly use of the spectrum. Other courts might have ruled differently; but to speculate along those lines would be to exceed acceptable limits for hypothetical history.

Hoover did not appeal the verdict. In fact, for two-and-a-half months after the Zenith decision he did very little about broadcasting, beyond warning that, if stations were free to select their own frequencies, the outcome would be "utter chaos." When in July 1926 he did move, it was to secure from the acting Attorney General an opinion that in all essentials confirmed the ruling of the Chicago court.[53] True, the Commerce Department did appeal to broadcasters not to move from their assigned frequencies. Statistics were collected which sometimes suggested that only a few stations were "jumping frequency," sometimes that many were. And Hoover did encourage station owners to test their common-law rights in court, if other stations encroached on their normal frequencies. But there were no new initiatives, no attempt to elicit some form of self-regulation from the industry. Every year since the broadcast boom began, Hoover had convened a Washington Radio Conference to debate the problems facing the industry and suggest remedial action; but not this year.

The most plausible explanation for Hoover's inactivity is that he intended to put pressure on Congress. Two bills to regulate radio broadcasting were before Congress at this time, one in the House, the other in the Senate. This was no new thing: some thirty radio bills had been introduced in Congress since the end of World War I, and none had become law. Radio interference, it had become evident, was something congressmen might deplore but not something on which they were in any hurry to legislate. And as long as Hoover's quasi-legal assignment of frequencies seemed to be working, as long as station

[53]Opinions of the Attorney General, vol. 35, no. 126 (1926), as cited in Coase, "Federal Communications Commission" (n. 5 above), p. 5, n. 10.

owners could and would negotiate time-sharing agreements among themselves, legislation had not seemed urgent.

Hoover's intention now was to convey that sense of urgency, and the *Zenith* decision gave him the ideal opportunity. He had his preferences about the kind of legislation he wanted. Unlike McDonald and the National Association of Broadcasters, who sought an independent commission, Hoover preferred to retain authority within the Department of Commerce with an appointed commission serving as a form of appeals court. In this he had the support of President Coolidge, who had no liking for independent commissions, and of Representative Wallace White of Maine, who with remarkable pertinacity had been introducing radio bills in the House regularly since 1921.[54] But Senator Clarence Dill from the state of Washington, who was the key figure in the upper House on radio matters, preferred an independent commission. Congressional compromise eventually produced the Radio Act of 1927 and the Federal Radio Commission. Most people regarded the statute as progressive legislation: it brought order to the airwaves; it preserved the ether as, in principle, a public domain; and it promised to prevent a "monopoly in the air" by RCA and the other major radio corporations.[55] It can hardly be said, however, that Congress showed much enthusiasm for the new enterprise or viewed it as a permanent solution. The commission was originally established for one year only, and no funds were appropriated for its support.

The Act of 1927: Alternative Interpretations

The term "chaos" is frequently used to describe conditions in American radio broadcasting between the *Zenith* decision and passage of the Act of 1927. Hoover used the word, and it has become part of the classic rationale for government regulation. It may not be entirely appropriate. Certainly, it is true that, within this brief period, many stations changed frequencies. Others increased their power. And more than two hundred new stations began broadcasting.[56] But it is not self-evident that these trends would have continued. Removal of bureaucratic controls over entry was certain to cause transitional difficulties. The question is whether firms in the industry could have settled down to a reasonably stable accommodation, without the imposition of government control.

[54]For Coolidge's attitude toward independent commissions, see Johnson (n. 28 above), p. 205.

[55]McChesney (n. 28 above), p. 17.

[56]Stephen B. Davis, "The Law of the Air," chap. 5 in *The Radio Industry: The Story of Its Development*, by the Harvard Business School (Chicago, 1928), p. 169.

The answer to this question depends on the interpretation of the events leading up to the Act of 1927. There are three main lines of interpretation. The first is the traditional view and has been referred to as the "chaos theory"; it rests essentially on a scarcity argument, in the sense of physical scarcity. There were not enough wavelengths in the broadcast band to accommodate all the stations that wished to broadcast, without a level of interference which was intolerable and which created, in effect, chaos on the airwaves.[57] Interference was caused by the unrestricted entry of new firms into the industry, together with increases in power by established firms, and could be eliminated only by government intervention. This view, reflected in Supreme Court decisions, finds support in the recent literature on common-property resources.[58] Interference was a symptom of the overexploitation that results from open access; overexploitation sharply reduces the value of the resource and dissipates the rents of those using it. Absent some form of self-regulation, the remedy is to be found in the imposition of superior authority—Hobbes's Leviathan, if you will—with power to control access.

The second interpretation is commonly associated with the name of Pool, but its analytic foundations are to be found in earlier work by Ronald Coase and before him Leo Hertzel.[59] This view holds that scarcity by no means implies government control over access. If the broadcast spectrum was an overexploited resource, the reason was that the resource was not priced. Instead, it was made available without cost to all applicants. In those circumstances, the semblance of scarcity was inevitable. There was not enough to satisfy all potential users when the price was zero. The fundamental problem, then, was not scarcity in any absolute sense but an institutional defect: the absence of defined property rights and of a market in which those rights could be freely traded. The Act of 1927, in short, was passed as a result of error: an institutional limitation was mistaken for a physical one.[60]

This second line of interpretation, though attractive to many economists, has not gone unchallenged. Its basic assumptions are that no market in spectrum rights existed in the 1920s, that spectrum rights

[57]Compare *National Broadcasting Company Inc. v. United States,* 319 U.S. 190 (1949), pp. 212–13, and *Red Lion Broadcasting Company Inc. v. Federal Communications Commission,* 395 U.S. 367 (1969), p. 380.

[58]See the works cited in n. 10 above.

[59]See the references cited in n. 5 above, and Leo Hertzel, " 'Public Interest' and the Market in Color Television Regulation," *University of Chicago Law Review* 18 (1951): 802–9.

[60]Compare Meckling (n. 4 above), p. xiii. Meckling, like Pool, raises the fundamental question "why political democracy has created and perpetuated a system of rights that is not only grossly inefficient but also presents a real threat to freedom of speech."

were not priced, and that passage of the Act of 1927 was irrational, in the sense that participants would have been better off under some alternative arrangement, such as a spectrum auction.

These assumptions have been sharply questioned by Thomas W. Hazlett.[61] Passage of the 1927 act, he argues, was not the result of error; on the contrary, the statute yielded an equilibrium political solution, in the sense that each of the influential parties received a share of the rents created in proportion to their political influence. All major players ended up better off than they would have been under alternative nonlicensing arrangements.[62]

If the major participants were the regulating agency, members of the House of Representatives and the Senate, and the established firms in the broadcast industry, the logic of the argument is clear. The broadcast industry got what its leading members had long desired: free access to a public resource, plus restrictions on the entry of new firms, enforced by an agency with undisputed legal authority. For the more heavily capitalized and technically sophisticated broadcasters, regulation was a blessing, confirming their de facto property rights in the spectrum and establishing a mechanism by which those rights could be protected.[63]

Political decision makers received their rents in a different currency: the ability to influence the allocation and renewal of licenses and, indirectly, the programming decisions of broadcasters. Hazlett cites with approval the authoritative history of the Federal Radio Commission to the effect that "probably no quasijudicial body was ever subject to so much Congressional pressure as the Federal Radio Commission."[64]

The third major participant was the regulatory authority. Hoover suffered a minor setback with passage of the Senate version of the bill, but this was of territorial significance only. A regulatory body was created which rapidly acquired its own vested interest in survival and expansion—in the protection and enhancement of its budget and in the enlargement of the powers of its staff. So in this sphere too rents were created, in the appropriate currency, that would never have come into existence had rights of access to the spectrum been bought and sold in a market.

[61]Hazlett (n. 28 above).

[62]Ibid., p. 168.

[63]Compare the argument in George Stigler, "The Theory of Economic Regulation," *Bell Journal of Economics and Management Science* 2, no. 1 (Spring 1971): 3–21. Stigler argues that regulation is typically not forced on an industry but is actively sought by it. Regulation is a service that industries demand and the political process supplies. See also Harvey Levin, "Federal Control of Entry in the Broadcast Industry," *Journal of Law and Economics* 5 (October 1962): 49–67.

[64]Schmeckebier (n. 22 above), p. 55. Compare Barnouw, *Tower in Babel* (n. 22 above), pp. 211–19.

Such an interpretation must please those who like to identify the rational component in human behavior. But does it tell us much about the thinking of those involved? Was regulation imposed in order to prevent the emergence of a market in spectrum rights? Was such a market a realistic alternative to regulation? The rhetoric of the time suggests otherwise. Members of the Senate were not the only ones to state eloquently that the airwaves were a national resource and that the ether belonged to all the people. Broadcast licenses issued by the Department of Commerce were for terms of only three months, specifically in order that no vested rights in the ether might be created. Hoover compared radio channels to channels of navigation, which should be open to all and not the property of a few. The standard view, espoused both by the regulating agency and by political representatives, was that, as a matter of law, no ownership rights in the spectrum could exist. And where no property rights exist there can be no market.

And yet broadcast stations were bought and sold, at prices that reflected the market value not just of their buildings and equipment but also of their frequency assignments, power levels, and authorized hours of operation. And this has continued to the present day. Pool faulted policy makers in the 1920s and 1930s for overlooking the market option. But he also recognized that the absence of a market is an illusion: "In fact . . . there is a market in spectrum. . . . The government initially gives away licenses for free; these are then sold in a second hand market. What is excluded from market allocation is only the initial grant of a frequency by the government to its first owner."[65] Today, as in the 1920s, the regulatory authority must approve license renewals and license transfers, and this introduces some small uncertainty into the transaction. But in the overwhelming majority of cases, renewals and transfers are routine. As the solicitor general of the Commerce Department told Congress in 1926, "We recognize the purchaser as stepping into the shoes of the licensee."[66] The clearest example was the purchase by RCA of AT&T's New York station, WEAF, in September 1926. The purchase price was $1 million, of which only $200,000 was for physical facilities; the larger portion was for the clear channel frequency assignment.[67] Smaller-scale transactions of the same nature were common, as were cash purchases of broadcast time from other stations sharing the same frequency.

[65]Pool, *Technologies of Freedom* (n. 6 above), pp. 133, 137.

[66]*Radio Control: Hearings before the Committee on Interstate Commerce,* U.S. Senate, 69th Cong., 1st sess. (1926), pp. 118–19, cited by Hazlett, p. 144. More formally, the position of the Department of Commerce was that "the license ran to the apparatus" and that it would recognize a sale, and license the new owner, if there was no good reason to do otherwise.

[67]Barnouw, *Tower in Babel* (n. 22 above), p. 185.

This shared confidence that licenses and their spectrum assignments would be transferred when stations changed hands makes it possible for Hazlett to state flatly that "the price mechanism was the institutional tool used to allocate frequencies in the 1920s . . . such chaos as potentially could exist was explicitly remedied by federal establishment of property rights, followed by market trading to assign such rights to their highest valued employments."[68] If we accept this view, we have to dismiss the "error theory" that underlies standard critiques of the Radio Act of 1927. The act emerges, on this interpretation, as a preemptive strike; a regulatory apparatus had to be established promptly, since otherwise property rights in the spectrum would become a reality.

What kind of property rights would these have been? Would they have had status in law, or were they no more than a set of expectations about what the Commerce Department would very probably do?

The critical evidence is provided by the *Oak Leaves* case, decided in November 1926.[69] Station WGN in Chicago was owned by the *Chicago Tribune* and broadcast on a frequency of 990 kHz. Its program listings were published in the newspaper, and it had built up a loyal following of listeners. Station WGES was owned partly by the Oak Leaves Broadcasting Company, partly by the Coyne Electrical School, and partly by one Louis Guyon, who ran the Paradise Ball Room, a dancehall in downtown Chicago. WGES was originally located in Oak Park, a suburb of Chicago. In September 1926, it moved to the Paradise Ball Room. At the same time it changed its frequency, moving to 950 kHz, a location on the spectrum distant only 40 kHz from that of WGN. The Tribune Company entered a complaint, alleging interference with its radio broadcasts and—interestingly—damage to the circulation of its newspaper.

The Department of Commerce at that time required that stations geographically close to each other maintain a channel separation of 50 kHz. The Tribune Company clearly believed that the Oak Leaves station was deliberately "crowding" its frequency in the hope that listeners, tuning their radios to a familiar spot on the dial, would end up listening, not to WGN, but to WGES instead—and, perhaps, patronizing the Paradise Ball Room.

The defendants claimed, first, that a wavelength could not be made "the subject of private control," and second, that they had not in fact interfered with WGN, since a 40-kHz channel separation was quite sufficient, if listeners' receivers were of proper design and properly

[68]Hazlett, p. 145.

[69]*The Tribune Company v. Oak Leaves Broadcasting Station Inc., Coyne Electrical School Inc., and J. Louis Guyon,* Circuit Court of Cook County, Illinois. The decision of Judge Francis Wilson may be found reprinted in the *Congressional Record* (Senate), December 10, 1926, pp. 215–19.

tuned. The judge, accordingly, had to decide two major questions: whether WGN had any rights that the court should protect, and whether, if such rights existed, WGES had infringed on them.

The first question was a matter of the jurisdiction of the court and, if jurisdiction could be established, of common law and principles of equity; the second, however, required a judgment on a matter of technology. Equity considerations arose because the federal government, in the Act of 1912, had not specifically preempted the field of radio regulation. Citing the opinion of the acting Attorney General that the act gave to the Commerce Department no powers to regulate radio other than those specifically enumerated, Judge Wilson concluded that, since Congress had made no other provision for regulating the use of wavelengths and since the act made no provision for the protection of private rights in wavelengths, "the question becomes one as to whether or not under such circumstances the fundamental or common law of the States will undertake . . . to protect the rights and interests of citizens." And, while admitting that the present case was "novel in its newness," he had no great difficulty in finding precedents in western water rights cases and in the protection given by the common law to property rights in trade names. On that basis he ruled that WGN did indeed have rights to its frequency—rights that would justify a court of equity in assuming jurisdiction. And he stated the general principle, which must have been music to the ears of all established broadcasters, that, under the circumstances of this case, "priority of time creates a superiority in right."

The second question—whether WGES had actually caused interference with WGN—might seem to involve only a question of fact. But matters were not so simple. Attorneys for WGES claimed that, if the WGN transmitter were properly adjusted, and if radio receivers in the listening area were properly constructed and operated, no interference would take place even though the channel separation was only 40 kHz. Implicit in this claim is the argument we have made earlier: that interference in the 1920s was as much the result of the large consumer inventory of nonselective receivers as it was of the proliferation of transmitters. It so happens that 40 kHz is the channel separation normally maintained by the FCC today for stations in the broadcast band transmitting in the same general area.[70] The defendants' argument, in other words, was not in itself unreasonable; but it did make an unreasonable assumption, namely, that households in the listening area either had or would acquire modern receivers, such as the superheterodynes then being marketed by RCA. The judge trod carefully. He noted

[70]James M. Moore, *Radio Spectrum Handbook* (Indianapolis, Ind., 1970), p. 56.

that the technology of broadcasting was changing from day to day and that within a short time a channel separation of 40 kHz might be enough. But in November 1926, he decided, it was not. He declined to prohibit the defendants from using any particular wavelength, but he enjoined them from broadcasting over any wavelength that caused material interference to WGN. And he made clear the feeling of the court that a separation of 50 kHz would do the job.

The concern here is not whether the court's decision was correct or not, but with the considerations that it took into account and with what it might have meant for spectrum allocation, if the Radio Act of 1927 had not supervened. The decision clearly required taking into account both institutional and technical factors: on the one hand, the failure of federal legislation to define and protect the rights of spectrum users; on the other, the limitations of radio technology, particularly as they affected receiver selectivity. The court correctly identified the key variables. Any system of spectrum allocation, whether regulatory or market-based, would have had to face the same set of issues.

What did *Oak Leaves* mean for the future? Hazlett strongly suggests, if he does not explicitly assert, that *Oak Leaves* would have been accepted as setting a precedent, and that a market system, based on property rights defined and protected by common-law principles of equity, would have emerged and flourished—if federal legislation had not intervened. This is a heavy burden to place on a single decision in a single state court. *Oak Leaves,* however, was no ordinary decision. It was widely noted and widely discussed. It had the potential, if accepted as a precedent, to determine the future of the broadcast industry. Senator Dill knew what he was about when he had the court's ruling inserted into the *Congressional Record.* Congress had shown itself singularly reluctant to pass any type of regulatory statute for broadcasting. Legislation of that sort was politically hazardous to vote against in view of the public clamor that something be done about the interference problem. Creation of a new agency, however, nominally independent of both the legislative and executive branches, was not something most congressmen wanted to vote for. *Oak Leaves* made it very difficult to procrastinate further. Whether that decision would have been accepted as a precedent, in other courts and other states, is impossible to say; that it served to accelerate legislative action is highly probable.

The Spectrum as Public Domain

Institutional defects had much to do with the impasse that led to this attempt to claim property rights in the spectrum and, shortly thereafter, to the assertion of federal authority. But one additional factor influenced both the reluctance of the Department of Commerce to restrict

the issuing of broadcast licenses and the refusal of Congress to accept a property rights regime. This was the conception of the radio spectrum as part of the public domain.

Throughout the 19th century there had been a political consensus that federal land, grazing, and mineral rights should be distributed quickly and at zero or minimal cost to individuals on an egalitarian basis. Federal land policy established a general expectation that citizens had the right to access the public domain, claim sections of it as their own, and convert what had been public property into private. In the case of the radio spectrum, this expectation collided directly with public and political insistence that the broadcast spectrum should under no circumstances become private property. It belonged to all the people, not just to those who could afford to build and operate a broadcast station. Broadcasters could use the spectrum, but they should not own it. Two sectors of the public domain were, in short, defined differently in a cultural sense and treated differently as matters of public policy.

Why the difference? The question admits of no easy answer. This is partly because of the force of conservationist ideologies, most strongly voiced by legislators from the western states who had inherited the populist tradition. Partly it is because of public recognition of the abuses to which federal land policy had been subject. Partly it is because, as more than one senator expressed it, the spectrum was the last remaining public domain, and it was scarce in a sense in which public land never had been.[71] And partly too it is because there was a sense that the radio spectrum was a special kind of resource, conveying as it did information and ideas, shaping the thoughts and feelings of listeners.

There is a conflict here—a contradiction in American ideologies. Political sentiment in the 1920s regarded private ownership of the broadcast spectrum as unacceptable. That is, it refused to treat the spectrum as a commodity, to be allocated through markets and a price system. Expressed in other terms, it rejected commercialization of the spectrum. Yet, commercialization of the spectrum was exactly what was happening, and what has continued to happen from that time to our own. Few public resources can ever have been commercially exploited as rapidly and thoroughly as the broadcast spectrum between 1920 and today. And yet, in ideological terms, what other natural resource available to the American people has ever been as thoroughly insulated from the marketplace as the radio spectrum has?

[71]A bill (S. 2813) introduced by Senator Howell of Nebraska and passed by the Senate on April 7, 1925, affirmed "the use of the ether for radio communication or other-wise to be the inalienable possession of the nation." See Davis, "The Law of the Air" (n. 56 above), pp. 156–88. I have found no evidence that anyone at this time thought of the oceans as a scarce resource.

Logicians might call this an antinomy, a contradiction in principles. In this case one set of principles governed the treatment of the physical public domain—lands, minerals, forest resources; another set governed the electromagnetic spectrum. One of the functions of politics is to bridge such antinomies, to make contradiction seem like consistency. How was it done in this case? The answer is the licensing system, as established by the Radio Act of 1927 and reinforced by the Communications Act of 1934. One function of these statutes was precisely to make possible vigorous commercial exploitation of the radio spectrum while simultaneously stipulating that the spectrum could never become private property. Every radio license issued by the federal government requires the licensee to abjure all claims to *ownership* of the spectrum. And, at least in theory, the licenses themselves are for limited terms and are revocable. None of this has in any way impeded the development of a vigorous market in broadcast stations and the creation of very valuable rights of access to the spectrum.

The conviction that the radio spectrum was a physically scarce resource was one constraint on communications policy in the 1920s. The belief that in this case traditional commercial methods for allocating a scarce resource—property rights, prices, and markets—were inappropriate was another. These two constraints produced the Radio Act of 1927 and have served as the ideological infrastructure for American communications policy from that day to the present. In our own time, however, each of these contraints has been relaxed, partly by technological change, partly by shifting beliefs as to the efficacy of the price system as compared with regulation. And, as a result, communications policy has begun to change too, moving away from the regulatory procedures and assumptions that have been normal for more than six decades.

Innovations in procedures for allocating "new" spectrum have been particularly instructive. To cope with the explosive growth in the demand for cellular telephones, pagers, and other wireless communication services, and to avoid the lengthy, expensive, complicated, and uncertain process of comparative hearings, the Federal Communications Commission has until recently conducted lotteries to allocate channels in the spectrum above 800 MHz. These lotteries have attracted much criticism, since—as with any lottery—they invite the filing of multiple applications and the winner, selected by chance, reaps very large unearned capital gains (an estimated $50 million in one case). While lotteries (or "random selection") will still be permissible, the FCC now intends to distribute frequency assignments by auction. Winners of these auctions will become, if not in the literal sense owners of the radio channels, at least holders of exclusive rights to their use—rights which,

one presumes, they will be free to sell at a market price.[72] At the moment these auctions will apply only to spectrum above 800 MHz and perhaps to spectrum that may later be released by the Department of Defense and other government agencies. There is no suggestion so far that spectrum already allocated for broadcast use—the radio and TV channels with which we are all familiar—should be auctioned.

This innovation reflects not merely a change in bureaucratic procedures but also a change in political ideology. In the 1920s, claiming that the spectrum was a public resource owned by all the people, legislators set their face against its alienation to private interests. Today, a significant segment of public opinion is willing to believe that the public domain is likely to be managed at least as efficiently by private firms as it is by government agencies and furthermore that the public treasury should reap some return from disposing of rights to the public domain that have up to now been given away free or at nominal cost.[73]

A property-rights approach to spectrum management is, in consequence, now no longer a matter of abstract theorizing but rather one of current policy formation. The nuts-and-bolts aspects were spelled out more than a decade ago by Arthur De Vany and his associates, members of a Presidential Task Force on Communications Policy.[74] Congress authorized the FCC to conduct spectrum auctions in August 1993 as part of the Budget Reconciliation Act.[75] The issue, in short, has gone beyond theoretical speculation and has entered the realm of politics and public finance. In that arena fiscal considerations will play an important role.[76] The fundamental intellectual rationale, however, as spelled out by theorists more than three decades ago, rests not on budgetary savings but on efficiency in resource allocation.

[72]An auction that conferred exclusive rights of occupancy without also conferring marketability would be merely a fiscal change in the system, raising money for the public treasury but offering little prospect for increased efficiency in resource allocation. A market approach, strictly interpreted, requires that spectrum owners be able to use their spectrum for any purpose they choose (subject to the usual laws governing libel, treason, etc.) and to sell their spectrum to anyone they wish. One can, however, imagine "zoning ordinances" for the spectrum coexisting with an active market in property rights.

[73]In this sense spectrum auctions reflect the same policy initiative as recent increases in fees for the use of federal minerals and grazing land.

[74]De Vany et al. (n. 4 above).

[75]See Title VI section 6002 of the Omnibus Budget Reconciliation Act (P.L. 103-66) of August 1993.

[76]See Executive Office of the President, Office of Management and Budget, *A Vision of Change for America* (Washington, D.C., 1993), p. 83 and app., p. 127. This document estimates the revenue to be raised from spectrum auctions from 1994 through 1998 at $4.2 billion. The Budget Reconciliation Act sets the five-year total at $10.2 billion. See the *New York Times*, Sunday, August 8, 1993, national sec., p. 22.

If this market approach to spectrum allocation becomes generalized, it can eliminate spectrum scarcity in the economists' specialized sense of the term. At the same time technological change has, at least for the time being, banished the ghost of spectrum scarcity in the physical sense. It has become commonplace to suggest that in the near future we will have more communications channels available for our use than we know what to do with. Microwave technology has vastly expanded the bounds of the usable spectrum. The advent of digitized communications and new techniques for compressing data flows have expanded the capacity of existing networks such as the telephone system. Fiber optics and coaxial cable provide multiple-channel communications without requiring any allocation of spectrum at all.[77] And communications satellites make point-to-point communications possible without an intervening ground-based network. If technological advance does indeed eliminate physical spectrum scarcity, and if a market-based system for making new spectrum assignments ensures that there will be neither a shortage nor a surplus of spectrum at the market price, the assumptions that have underlain communications policy in the past are no longer valid. A rewriting of the Communications Act of 1934, which, despite six decades of ad hoc tinkering, is still fundamentally based on the scarcity rationale, becomes highly probable.

But are matters really so simple? Spectrum auctions have up to this time been presented as convenient for the FCC, beneficial to the Treasury, and acceptable to the industry. No counterarguments, on those grounds, have been offered. There may, however, be less tangible issues involved: perhaps the past does not give up its hold over us so easily. What were, at the root, the fears and anxieties that shaped communications policy in the past? They were concerns about concentrated economic power, about control over the creation and movement of information, and about equal access to the means of communication by all members of society. Those concerns are still with us, however transformed by new technology. There may, in other words, yet persist some residue of the sentiment that the electromagnetic spectrum is a special kind of natural resource, affecting the public interest in a distinctive way, and not to be treated as just another kind of real property.

[77]Signals carried in a coaxial cable are at radio frequencies, but in perfectly shielded cable the electromagnetic fields are completely confined within the outer conductor. Many commercially installed coaxial cables, however, are "leaky"; they can pick up interference, and they can cause interference to on-the-air stations.