SPECTRUM AUCTIONS: YESTERDAY'S HERESY, TODAY'S ORTHODOXY, TOMORROW'S ANACHRONISM. TAKING THE NEXT STEP TO OPEN SPECTRUM ACCESS*

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ABSTRACT

The auction paradigm for spectrum allocation has moved from heresy to orthodoxy, but like its predecessors it will not be the end of history. A better alternative, not driven by the revenue needs of government, is license-free spectrum. Users would gain entry to frequency bands on a pay-as-you-go basis, instead of controlling a slice of the spectrum. They would transmit their content together with access tokens. These tokens are electronic money. Access prices would vary with congestion, set by automatic clearinghouses of spectrum users. Spot and futures markets for spectrum access would emerge. Once technology and economics can solve the interference problem in ways other than exclusivity, the question arises whether the right to use the spectrum for electronic speech is the government's to sell in the first place.

I. SPECTRUM PARADIGMS

A. Three Old Paradigms and a New One

IT will not be long, historically speaking, before spectrum auctions may become technologically obsolete, economically inefficient, and legally unconstitutional.

And it may not be long before a new form of frequency allocation may emerge where spectrum use does not require any license; when information traverses the ether as flexibly as an airplane in the sky instead of being straightjacketed into a single frequency and routed like a train on a track; and where congestion is avoided not by the exclusivity of ownership but by

* I have benefited from the assistance of Po Yi, Bernard Bene, Mobeen Khan, Nemo Semret, and Tracy White: helpful comments by Dennis Carlton, Bruce Egan, Robert Frieden, Thomas Hazlett, Wayne Jett, Evan Kwerel, Terrence McGarty, Milton Mueller, Michael Noll, Jom Omura, Robert Pepper, Peter Pitsch, Ken Robinson, Aaron Rosston, Andrew Schwartzman, Nadine Strossen, John Williams, and an anonymous referee are gratefully acknowledged.

[*Journal of Law and Economics*, vol. XLI (October 1998)]
 0022-2186/98/4102-0021$1.50

access charges that vary with congestion, with the information itself often paying for access with tokens it carries along.

For today, auctions and usage flexibility are still the best way to allocate new frequencies. Yet it is one thing to support them pragmatically, as I do, because they tend at present to be a better approach than the existing alternatives, and quite another thing to behold auctions in dogmatic awe, blind to their technological relativism. Change the technology, and the economics and the law of spectrum use must change, too.

This article suggests the direction that such change will take. It analyzes, in Section II, the inherent problems of auctions—in particular that they become a tool of revenue generation rather than resource allocation, and that they encourage oligopoly. The article then proposes, in Section III, an alternative for the future, a system of unlicensed spectrum use in which users do not control an exclusive slice of the spectrum but rather are free to access various frequency bands by buying access tokens at a market-clearing price that is based on the extent of congestion. These access tokens could travel with the information itself as a form of electronic money. In effect, the information would pay for its way as it proceeds over wire and air toward its destinations.

What we have had in spectrum allocation is a classic case of a paradigm shift, along the lines of Thomas Kuhn's famous essay ''The Structure of Scientific Revolutions''[1] on the rise and fall of schools of thought.

For spectrum, we can distinguish three successive paradigms and an emerging fourth one. In the beginning, there was a brief idyllic stage of spectrum allocation, based on *occupancy*. Entry to the virginal ether was free, and a kind of electronic original state of nature prevailed. Early radio users did not think in terms of permits to spectrum access any more than the Wright brothers considered filing a flight plan at Kitty Hawk. Radio amateurs, early broadcasters, radio telegraph operators, and the U.S. Navy all congregated on the air. But with the transmission technology improving faster for distance than for separation, and with only a few bands under technological mastery, it was not surprising that transmissions soon collided on the unregulated ether.

This inevitable crisis in the occupancy model led to its replacement by the *administrative* paradigm. Frequencies were allocated by the state, of course after it had first taken care of itself generously. The sparse residual was then allotted to various civilian purposes and assigned to private firms based on a combination of first come, best connected, and most persuasive. In some countries, the reception of signals was also licensed. On the whole,

[1] Thomas S. Kuhn, The Structure of Scientific Revolutions (2d ed. 1970).

this was a system that benefited influence brokers (whether in government or out), bureaucrats who could gain off-budget degrees of freedom, politicians who gained some influence over content, equipment makers who gained economies of scale, and incumbent firms that liked state-administered scarcity values and barriers to new entry. This was the orthodoxy—prosperous, powerful, potent.

The only problem was that the system did not work very well. As the utilization of spectrum grew, so did the latter's value. Fights over new allocation became shrill and (of course) lawyer intensive.[2] Competitors were excluded.[3] Foreigners were barred.[4] New technologies were excluded or delayed.[5] Politics intervened ham-fistedly.[6] Some spectrum bands were as deserted as Nevada, others crowded like Times Square, with no usage transfers possible. Government hogged vast stretches. Scarce licenses became highly valued, and fortunes were made in the reselling of licenses from the well connected to the merely efficient.[7] Media firms chased monopoly rents, and politicians chased the firms.[8] Because of their value, some licenses were loaded with requirements for off-budget public services. Licenses were temporary in theory—discouraging investments—but permanent in practice—diluting the attached requirements.

The old administrative paradigm was in crisis, but it had a powerful hold over the benefited mass media and politicians. For a short while, it was substituted by license lotteries, a bizarre system that attracted in the United States almost half a million ''applications'' looking for a windfall. Yet out

[2] Former FCC Commissioner Glen Robinson described spectrum allocation as the FCC's version of medieval trial by ordeal. See John McMillan, Why Auction the Spectrum? 19 Telecomm. Pol'y 192 (1995).

[3] The applicant for a fourth British license was told in 1920 that ''the ether is already full.'' 1 Asa Briggs, The History of Broadcasting in the United Kingdom: The Birth of Broadcasting in the United Kingdom 78 (1961).

[4] In Britain reception licenses were limited to radios made by ''genuine British manufacturers employing British labor.'' Eli M. Noam, Television in Europe 116 (1991), citing Briggs, *supra* note 3, at 112.

[5] For the early history of FM radio, see Eli M. Noam, ed., Edwin Armstrong: A Man and His Inventions (unpublished manuscript, 1998).

[6] After the 1952 election, newspapers that had editorially endorsed Eisenhower had a chance at getting a TV license. Stevenson supporters were left out. In other cases, politicians served themselves directly. For Senator Lyndon B. Johnson's good personal fortune from television licenses, see Robert A. Caro, Years of Lyndon Johnson (1990). In France, the allocation of the third mobile license was decided by the then–Prime Minister Balladour personally.

[7] Aftermarkets exist as secondary markets for licenses, or for the firms holding them, or for assets tied to licenses.

[8] Thomas W. Hazlett, Assigning Property Rights to Radio Spectrum Users: Why Did FCC License Auction Take 67 Years? (Working Paper Series No. 768, Columbia Inst. for Tele-Info., Columbia Univ., 1995).

of crisis, predictably, a new paradigm was born. And indeed, a new idea, that of spectrum sales to the highest bidder, was advocated first by a law student with little to lose, Leo Herzel,[9] and then by academic intellectuals, Ronald Coase[10] and later Arthur De Vany and colleagues[11] and Harvey Levin.[12] The idea was first dismissed out of hand as too ''academic,'' ridiculed as impractical by the Federal Communication Commission's (FCC) former chief economist, the noted Dallas Smythe, as ''of the realm in which it is merely the fashion of economists to amuse themselves''[13] and ignored or fought off by the established broadcasters. Eventually, however, most economists adopted it. With the intellectual battle won, with the TV community now split between the broadcasters and the newly powerful cable casters, and with mobile technology leading to an explosion of demand for over-the-air capacity, change was in the air. It was then only a matter of time before the need of the state for more revenue overpowered its propensity to micromanage societal resource allocations administratively. Economic efficiency provided the good-government cover for the change.

Today, the advocates of this *auction* paradigm are in the driver's seat. They have become the new conventional wisdom. And they are the darlings of the political establishment, providing it with vast new resources that make otherwise painful spending cuts or tax increases unnecessary. This is a heady experience for the dismal profession. But, just as Kuhn would have predicted, the new orthodoxy, too, has become complacent. Like generals fighting the last war, many of its adherents often reflexively oppose a questioning of the auction paradigm as a defense of the administrative model or of its beneficiaries, because that is where its opponents traditionally came from. Deep down, they believe, as Kuhn would have predicted, that their paradigm is the end of history in this field and that there is no beyond. Any problems are viewed as mere aberrations, probably because the auction concept is not executed with sufficient purity, rather than because of a systemic weakness. In short, the auction has progressed from a better mousetrap to a belief system. This, too, is classic. And it is similarly classic that this will not endure, that a new paradigm will emerge in turn, and that its proponents will be ridiculed as impractical by yesterday's heretics.

The new paradigm is not based on exclusive use, the technological and

[9] Leo Herzel, ''Public Interest'' and the Market in Color Television Regulation, 18 U. Chi. L. Rev. 802 (1951).

[10] R. H. Coase, ''The Federal Communication Commission,'' 2 J. Law & Econ. 1 (1959).

[11] Arthur S. De Vany *et al.*, A Property System Approach to the Electromagnetic Spectrum: A Legal-Economic-Engineering Study, 21 Stan. L. Rev. 1499 (1969).

[12] Harvey J. Levin, The Invisible Resource (1971).

[13] Dallas W. Smythe, Facing Facts about the Broadcasting Business, 20 U. Chi. L. Rev. 100 (1952).

economic foundation of both the administrative and auction paradigms. Indeed, both of these stages have much more in common with each other than their proponents would like to admit. Both basically allocate exclusive slices of the spectrum rainbow and differ only in the early mechanics of that allocation. Seen thus, these two paradigms really collapse into a single one, that of *licensed exclusivity.*[14]

But now, new digital technologies, available or emerging, make new ways of thinking about spectrum use possible that were not possible in an analog world. These new ways can be more daring than the question whether to buy spectrum from the FCC initially rather than from Westinghouse later or whether GE can use its TV channel sideband also for data transmission. The new paradigm is that of *open access,* in which many users of various radio-based applications can enter spectrum bands without an exclusive license to any slice of spectrum, by buying access tickets whose price varies with congestion. These tickets could be carried by the information itself. This brings us back, in several ways, to the earliest stage of frequency use, where there were no licenses. It is possible to do so because soon we can solve in new ways the problem of interference that had doomed the occupancy model and led to the licensing system in the first place.

The rumblings against the auction paradigm emerged in the mid-1990s. On the technology side, Paul Baran, a pioneer of packet switching, and George Gilder, a noted technology guru, argued against auctioned exclusivity. Gilder noted 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.''[15] Underlying Baran's and Gilder's argument is the hope that technology solves scarcity and spares much of the need to deal with allocation questions.[16] My own position, since 1995, has been to go one step further.[17] With open access, scarcity emerges, the resource needs to be allocated, and a price mechanism is required.[18] But this does not require exclusive control over a specific slice of the rainbow.

[14] Resale or flexible use do not negate exclusivity of control.

[15] Paul Baran, Is the UHF Frequency Shortage a Self Made Problem? (paper presented at the Marconi Centennial Symposium, Bologna, 1995); George Gilder, Auctioning the Airways, Forbes, April 11, 1994.

[16] Indeed, there is much new high-frequency spectrum to open up, and much old spectrum to use more efficiently.

[17] Eli M. Noam, Taking the Next Step beyond Spectrum Auctions: Open Spectrum Access, 33 IEEE Comm. Mag. 66 (1995).

[18] It is a similar problem of pricing necessity discussed for the presently ''free'' Internet system as it is experiencing congestion problems. Jeffrey K. Mackie-Mason & Hal Varian, Economic FAQs about the Internet, 8 J. Econ. Persp. 75 (1994).

Many economists and policy advocates have been prisoners to the analogy of spectrum to land. But spectrum access is traffic control, not real estate development. It is about flows, not stocks.

B. Whose Spectrum Is It Anyway?

The emergence of technologies that make it possible for multiple users of spectrum to cohabit and move around frequencies has profound effects. It is not just that it is arguably a more efficient system in terms of technology, economics, and policy. On these points one might disagree. But more important, it is *constitutionally* the stronger system. The argument is simple. Electronic speech is protected by the First Amendment's Free Speech Clause. Therefore the state may abridge it only in pursuance of a ''compelling state interest'' and through the ''least restrictive means'' that ''must be carefully tailored to achieve such interest.''[19] A licensing scheme, however the license is given out, is a serious restriction on speech. Not only does it foreclose the electronic speech of those without a license, but it also limits the electronic speech of those with such a license, if they must comply with its conditions. Until now, government licensing could be justified due to the basic assumption that spectrum is a scarce resource whose uses collided with each other. Some allocation scheme was therefore in order. But suppose that the underlying assumption becomes invalid, and technology can solve the problem of frequency interference. A less restrictive means of control then becomes available.[20] Would not the entire licensing scheme then be subject to question, in the same way that changing transmission technologies in cable TV and computer networking have led to much lower levels of constitutionally permissible restrictions than for the ''scarce''[21] broadcasting?[22]

[19] Sable Communications of California Inc. v. FCC, 492 U.S. 115, 109 S. Ct. 2829, 106 L. Ed.2nd 93 (1989).

[20] In Denver Area Educational Telecommunications Consortium, Inc. v. FCC, 1996 U.S. LEXIS 4261, the Supreme Court struck down Section 10(b) of the Cable Television Consumer Protection and Competition Act of 1992, which required cable operators to segregate ''patently offensive'' programming on a leased access channel from viewer access and to unblock it within 30 days of a subscriber's written request. Applying heightened scrutiny standard, the Court considered the availability of technology to block out indecent programming (for example, V-chips and scrambling) that is less restrictive on free speech. Prior to *Denver*, in Carlin Communications Inc. v. FCC (Carlin III), the Second Circuit directed the FCC to reopen proceedings for determining affirmative defenses to prosecution under § 223(b) of the Communications Act if a less restrictive technology became available.

[21] Part of the scarcity is due to the artificially small allocation of such licenses by the state; hence, a certain circularity bootstraps the government's regulatory powers.

[22] Turner Broadcasting System Inc. v. FCC, 512 U.S., 129 L. Ed.2nd 297, 114 S. Ct. 2445 (1994); American Civil Liberties Union v. Reno, 1996 U.S. Dist. LEXIS 7919 (E.D. Penn. 1996).

Instead of loosening the barriers to free entry, the U.S. government is going in the opposite direction, by selling off the spectrum. But is the spectrum the government's to sell in the first place? It is one thing to be a traffic cop, keeping the different users from colliding into each other. But it is quite another matter to assert ownership rights (in effect, to retroactively nationalize the spectrum) and to sell them off. Could the state sell off the right to the color red? To the frequency high A-flat? Preventing interference is based on the Commerce Clause of the Constitution. But what is the basis of asserting ownership?[23] If electronic communications are an aspect of our fundamental free-speech rights, on what ground can these rights be sold to the highest bidder? Imagine the state auctioning off, for perfectly good public policy reasons, the right to travel (in order to prevent overpopulation in Los Angeles), to print books (to protect forests), or to practice medicine (to keep down the cost of health care). Imagine, too, that these auctions are driven by the revenue needs of the state. Regulatory powers do not convey the authority to government to appropriate the economic value from attractive commercial opportunities. Nevertheless, most free-market advocates seem willing to concede this profit to the state.[24]

II. The Future Problems with Auctions

Today, almost anyone in Washington loves auctions: most liberals, because it makes business pay its way and generates government revenues; and most conservatives, because it substitutes market mechanisms for government controls. Auctions have also been used in New Zealand, the United Kingdom, Australia, and Hungary. Others will follow, no doubt.

The arguments for auctions are well known. An auction is better than a mindless lottery or than comparative administrative hearings with their inevitable legal maneuvering. It takes politics out of the process. It gets spectrum resources quickly into the hands of users that value them highest. It rationalizes the assignment process while recovering the value of the spectrum to the public. It creates certainty and incentives to invest. Private auctions already exist in the form of a resale market.

The counterarguments to auctions are also well known. They are either those of existing stakeholders, of potential entrants who feel better served by the political process than the market, or of those who view spectrum as a public sphere subject to public goals. Broadcasters, for example, argue that the auctions should not extend to them, because (*a*) they are required

[23] Wayne Jett, May God Save the Constitution (with Our Help) from Its Friends (unpublished manuscript, 1996).

[24] For an exception, see *id.*

to perform public service obligations, (*b*) they have usually already paid for the license once by buying it in the aftermarket, and (*c*) it would be unfair to make them bid retroactively for an asset whose value they have created by their investments.

Other objections are those of governmental users who fear that their hold over vast chunks of free spectrum might be reduced once its opportunity cost is more precisely known; of radio amateurs, who tend a nonprofit spectrum garden dedicated to technology experiments and public service in the midst of a commercial and governmental wilderness; and of those who believe that vesting ownership based on today's technology will complicate the speedy deployment of new technologies in the future and lead to inefficient allocation. Parts of the public interest community fear (*a*) that regulatory power over TV on behalf of public interest goals would decline if renewable licenses were replaced by permanent property rights, (*b*) that an allocation to the highest bidder would raise barriers to small entrants and reduce diversity, and (*c*) that auctions would squeeze out free public access and nonprofit educational activities.

On the whole, the arguments in favor of auctions are stronger than the arguments against, partly because most legitimate problems raised by the critics can be dealt with in other and often more efficient ways. But this does not make auctions necessarily the best approach for the future.

Surprisingly missing in a critical evaluation of auctions are the free-market and free-speech perspectives. Where market-oriented criticism has been voiced it has focused on the specifics of the FCC auction schemes, such as the duration and flexibility of the licenses involved, not on the concept itself. Indeed, having fought a long, hard, and successful fight for auctions, their advocates often seem incapable of viewing different approaches opened up by future technological options as anything but a prostate position.

A. Auctions Inevitably Deteriorate into Revenue Tools

The FCC auctions have been sophisticated in game-theoretical terms and well executed as an operation. The underlying objective for the auction ''game'' is to raise revenues for government. This is usually denied quite heatedly, and other considerations are cited, such as moving spectrum to the users valuing it most, and so on. But the political fact is that auctions were finally approved, after years of opposition to them by powerful congressional barons and the broadcast industry, as a measure to reduce the budget deficit and to avoid spending cuts and tax increases. Allocating spectrum resources efficiently was a secondary goal in the political process.

The maximizing function may have been constrained in several ways, such as by rules against monopoly control and in favor of diversity. But these additional policy considerations were only the fig leaf on the main reason, raising money for the empty coffers of the federal government. The rest is merely technique. Conceived in the original sin of budget politics rather than communications policy, spectrum auctions are doomed to serve as collection tools first and allocation mechanism second.

Several problems are inexorably tied to the budget-driven auction system. One is a spend-as-you-go approach.[25] It is one thing to sell assets (spectrum rights) and reinvest the proceeds. But ours is a situation of funding current consumption through the sale of long-term assets. Around the world, countries aim to advance the national infrastructure. In the United States, there seems to be a widespread agreement that this should be done without government money. But the spectrum sales end up as the opposite of making public investments. Through auctions, the United States has been taking money away from infrastructure-providing private firms and throwing it into the black hole of the budget deficit. For decades, America's telecommunications system was superior to that of other countries, often because these countries used telecommunications as a cash cow for general government expenses. Now we have embarked on the same road, just as other countries have left it at our urging.

In fairness, this is not due to the auctions per se but due to the way the revenues are being used by Congress and the Executive. Therefore, to maintain sectoral neutrality and avoid siphoning resources from the infrastructure into general public consumption one would have to complement auctions with a recycling policy that returns the revenues to the communications infrastructure and its applications. Yet such a policy is unlikely (outside of a few crumbs), given budget pressure and the efforts by heavy-hitting constituencies to get more for less. And furthermore, such earmarking creates its own dynamic. The 1996 Telecommunications Act created a Development Fund, aimed at small and minority businesses, to be funded from the interest on auction bids. Vice President Gore advocated the use of auction revenues to finance the wiring of schools for the Internet. Congressional Subcommittee Chairman Fields wanted to fund public television with them. And President Clinton proposed their use for school reha-

[25] The short-term orientation of auction gains is also manifest in its accounting. Net revenues raised tend to be exaggerated because there is a trade-off between short-term revenue collection and long-term reduced tax yields. License payments can be depreciated against corporate income and are also likely to reduce dividends. Under quite reasonable assumptions, each dollar of auction revenue tax is reduced by about 25 cents of reduced tax revenues in present value.

bilitation. As various programs are funded in such a fashion, stakeholder groups inevitably emerge that seek ongoing funding, and therefore ongoing auctions. Once a certain budgetary dependency on revenues from communications has been created, it will inevitably color substantive policy, such as resistance to new technologies if they threaten auction revenues.

When all is said and done, an auction is a tax on the communications sector and its users,[26] based on an artificially created scarcity. It may be an invisible tax on an invisible resource, but its impact on policy will be real. Auction advocates deny an impact on prices, arguing that consumer pricing depends on marginal rather than historic cost and that the auction charge does not necessarily mean higher end user prices if demand is highly elastic or if the rents have previously been squeezed by government in other ways. It may be useful to start with a reality check. How can one possibly deny that the many billions of dollars raised by an auction are taken out of the private sector and end up with the government? That, after all, is the congressionally mandated point to the whole exercise.

The argument is that an auction bid is a fixed, lump-sum cost and not part of short-term marginal cost, thereby not affecting price, and that all an auction does is reduce profits to a normal level. Only demand characteristics count. This view supposes that there are no alternative long-term uses for the spectrum and for capital. But since alternative uses for spectrum exist continuously, the supply of the service using the bid-for spectrum is not fixed and can expand and contract with its expected profitability. Similarly, alternative uses for capital exist. And greater indebtedness may mean higher cost of capital to a firm generally.[27] Firms may price temporarily without regard to fixed cost, but they could not survive doing so in the long run. Hence an auction payment will be reflected in prices, with its incidence on consumers and producers depending on the respective demand and supply elasticities.

And where is all this going to end? Like diamonds, budget pressures are forever. There is never enough money. This creates a dependence on still more auctions, especially ones of the up-front cash type rather than the pay-as-you-go type. Even if a given auction is designed to achieve an efficient allocation, its existence may be based purely on revenue needs.[28] In 1996,

[26] Concern with effects of auction or services prices was raised by the European Commission in a Green Paper. Commission of the European Union, DG XIII, Towards the Personal Communication Environment 26 (January 12, 1994).

[27] McMillan, *supra* note 2, at 196.

[28] The absence of auctions for some spectrum allocations (such as for digital TV) suggests that Congress does not maximize revenues but political support.

for example, both congressional commerce committees were instructed to raise another $15 billion of revenues. Spectrum auctions were the obvious way to go. It had little to do with communications policy considerations.

Since spectrum use is derivative of international allocations of both spectrum and orbital slots, international organizations will also get into auctions. For example, the International Telecommunication Union's former secretary general, Richard Butler, argued that the 1967 Outer Space Treaty excluded a country from appropriating the profits from space frequencies for itself. Such revenues would have to be shared with the rest of the world. This means that they might become the foundation for funding international organizations, by international spectrum auctions.

It has been argued that auctions put a foreign government's decision process into the open, away from influence peddling and corruption, and that auctions thus play a liberalizing role. This might be true in some cases, but the opposite to liberalization is just as likely. A revenue-strapped country is likely to sell off a monopoly license rather than competitive ones because this will fetch the highest bid price.[29] A government's determination of the appropriate market structure will therefore provide ample opportunities for manipulative interventions. And the nonpolitical nature of the auction can be easily undermined by various domestic preference systems,[30] such as requiring bidders to join up with favored local partners, or by requiring bidders to undergo an approval process. After all, even in America foreign bidders are limited to 20 or 25 percent (depending on their corporate structure) of any spectrum, and ''designated entities'' of women, minorities, and small businesses initially received FCC bidding preferences.[31]

B. Auctions Encourage Oligopoly

An auction payment that must be paid in advance is a barrier to entry, unless capital markets are perfect, which they are not. This especially affects new firms and unproven technologies that cannot find partners to share the risks. Therefore, an up-front payment will reduce the pool of entrants.

Advocates of auctions claim that they are neither a barrier to entry nor a tax, because they merely duplicate the past ''private'' auctions of the aftermarket. What they seem to have in mind as an alternative to an auction

[29] Ideally, it would first sell a monopoly license, and later reneg on the exclusivity by instituting spectrum flexibility for other allocations. Such possibility would lower the auction price.

[30] In Canada, a 10-percent national preference exists.

[31] The discount in the narrowband spectrum auction to deregulated entities was up to 40 percent, plus a preferential payment schedule. McMillan, *supra* note 2.

is a lottery system with an aftermarket, which indeed creates windfalls, transaction costs, and delay. But suppose the alternative were not such an inefficient (though unfortunately real) system, but a merit-based comparative selection (for example, based on an explicit scoring criteria and evaluated by an expert panel, as is a scientific grant proposal) coupled with a 10-year non-re-sale provision. (This is definitely not my recommended solution, but at least it is a more sensible comparative yardstick to the auction than the lottery and resale system, against which most alternatives look good.) Such a system would have lower entry costs since no bids would have to be paid for.

The highest potential auction bid would be the present value of monopoly rent. The winner's profits would be normal, but price would be at monopoly level. The FCC recognized this and auctioned off several Personal Communication Services (PCS) licenses, not just one. This was wise, as well as easy, but it is much harder (if not impossible) to bar oligopolistic bids. The highest bidders will be those who can organize an oligopoly. This is facilitated by bidding consortia of companies that would otherwise be each other's natural competitors and who collaborate under some rationale of synergy. Those firms presently already holding market power under, for example, the cellular duopoly would bid highest to maintain it and its profit. And if precluded from bidding in their own territory (as they are in a departure from the highest-value-user principle), they could try to do it by proxy or by mutual back-scratching with other firms similarly situated elsewhere.

Further, after the auction, the high bidders may collectively suffer from ''winner's curse'' (winning bids unsustained by adequate profits) and, after some shake-out period, will collaborate, because otherwise they might not be able to support their bid price's cost. ''Sunk cost'' leads to passive acceptance only in competitive markets, and after the fact. Oligopolists, on the contrary, will attempt to raise prices in order to recover their bid price and more. This does not require an explicit agreement, just commonality of interest, and is therefore difficult to identify or control. Even with multiple service providers left nationally, there would be pressures for concentration to take place, similar to the dominance by airlines of ''their'' hub cities.

Oligopoly can be attacked in several ways: by adding spectrum allocations, encouraging spectrum flexibility, imposing structural rules of ownership limitation, and using antitrust law in cases of collusion. This is indeed FCC policy. However, ownership limitations are regulatory in nature, may conflict with potential efficiencies of scale, and are at tension with the stated goal of moving spectrum to the highest-value user. In addition, such structural rules would limit the ability of exit by a spectrum holder from one usage to another, since such exit may well impermissibly concentrate the

market in the departed service. Flexibility of entry, however, is an excellent way to protect against oligopoly. The present auctions do not permit such flexibility, though the FCC is seeking it. But it must be kept in mind that entry into B means exit from A and may reduce competition there.

There must also be enough spectrum auctioned off to attack oligopolistic tendencies and reduce opportunity cost. But here, government is conflicted. Release more spectrum and its price drops. Just as New York cab drivers have used politics to prevent the issuance of additional taxicab medallions since the Great Depression in order to protect their investment, so will existing spectrum holders be united in the desire to stave off new entrants that will not only compete with them for future business but also depress the value of their past investment. Government has a related revenue-based incentive to keep spectrum prices high by limiting supply. Thus, government could become the spectrum warehouser and protector of oligopoly, a function it has played historically.[32]

The other major way to deal with oligopoly is through antitrust law. But that brings government right back, through its role in prosecution, adjudication, and enforcement. Some people consider antitrust enforcement purer than regulation, despite its sledgehammer style. They seem to have forgotten the political involvements of the Justice Department and its Antitrust Division in virtually any administration of this century and the experience of judicial micromanagement of the AT&T antitrust decree.

III. A Better Alternative: Open Spectrum Access

The alternative to the present auctions is not to return to the wasteful lotteries or comparative administrative hearings of the past, but to take a further step forward, to full openness of entry, which becomes possible with fully digital communications. Auctions are mostly good for now, given the state of technology, but there is a better next step, a free-market alternative: an open-entry spectrum system. In those bands to which it would apply, nobody would control any particular frequency. In this system no oligopoly can survive because anyone can enter at any time. There is no license and no up-front spectrum auction. Instead, all users of those spectrum bands pay an access fee that is continuously and automatically determined by the demand and supply conditions at the time, that is, by the existing congestion in various frequency bands. The system is run by clearinghouses of users.

The underlying present auction system is premised on an analogy to land ownership (or long-term lease). This is based on a certain state of technol-

[32] Hazlett, *supra* note 8.

ogy. In the past and present, the fixed nature of a frequency usage had a stability that is indeed reminiscent to land. But that was based on the relatively simple state of technology, in which information was coded (modulated) onto a single carrier wave frequency or at most a narrow frequency range. To forestall interference with other information encoded on the same carrier wave, the spectrum was sliced up, allocated to different types of usages, and assigned to different users. It is as if a highway was divided into wide lanes for each type of usage—trucking, busing, touring, and so on—and then further into narrow lanes, one for each transportation company. Once one accepts this model for spectrum, one can argue about how to distribute the lanes, whether by economics, politics, chance, priority, diversity, and so on. But it is important not to take this model as given and focus one's attention on merely optimizing it. To stay with the example, why not intermingle the traffic of multiple users? And if the highway begins to fill up, charge a toll to every user? And make this toll depend on the congestion, so that it is higher at rush hour than at midnight?

Access rights are economically relevant only when there is scarcity. Whenever there is no scarcity, there is no need to allocate, and the price would be zero. Anybody could enter. But absence of scarcity is not the interesting or usual case. Nobody ''owns'' the air route Cleveland–San Jose, and anybody could enter. But if landing slots or airport gates are scarce, an allocation must take place. In spectrum usage there are times of day and parts of the country where spectrum usage is always low. But it is realistic to assume that if there are multiple potential users and no restrictions, congestion will happen.

To allocate access one need not grant permanent allocation rights, but rather charge an access fee that is set dynamically at a level where the available capacity is fully utilized. The access fee could be an ''edge price'' that gives any users of the spectrum the right to enter information into the spectrum ''cloud,'' or it could provide more limited access. Because demand for transmission capacity varies, the access fee would also vary—a high fee where demand is high, and zero when there is excess capacity.

A. The Open-Access Model

Technologically, the proposed system is not presently available, though its component parts exist or are within reach. It is not my purpose to try to work out the details here. They will evolve with time, discussion, and technology. What is important is the concept. Herzel and Coase did not design a multiround simultaneous Vickrey auction, either.

Such an open-access system might look as follows: For packets of infor-

mation to be transmittable, they would require to be accompanied by an access code. Such a code could be a specialized token, a general electronic cash coin. The token would enable its bearer to access a spectrum band (rather than to a specific frequency), to be retransmitted over physical network segments, and to be receivable in equipment. Price for the access codes would vary, depending on congestion, and be determined by an automatized clearinghouse of spectrum users. Assured access, at a price certain, could be obtained from a futures market.

For example, a mobile communications provider, A, might face heavy for its service during the post–Labor Day morning drive time. It would therefore buy access codes to that capacity from the desired band, to unlock spectrum usage in a network environment. The tokens are bought from an automatic clearinghouse market of all users. Firm A and its customers, when initiating transmissions, add the access token to blocks of their transmitted information. Without the access codes, information could not be passed on to other networks and might not be readable by their intended receivers, if user equipment requires these codes for activation or descrambling.

If A finds itself using less capacity than it needs, it can offer its excess access codes on the clearinghouse's instant spot market to users who experience shortages or who have no real-time needs. In addition, A can assure itself of a long-term supply by contracting in a future market the access codes with B, who then delivers these codes at the time contracted for.

The buyer of capacity does not own any particular slice of spectrum, but rather the right to send so many information blocks over a band. At transmission time its equipment scans for a free frequency before occupying it. This search can be restricted to a single or a small number of frequencies or be free to roam widely across a band or bands. A receiver, similarly, scans for information addressed to it. This is similar to the way computer local area networks (LANs) work over wire-line networks and now also over the air.

The clearinghouse could also auction off long-term access codes. In that case, it would approach the present auction and license system, except that no frequency exclusivity needs to exist, though that could also be instituted.

The access codes are, in effect, like tokens paid by drivers at toll. They could resemble, in concept, the tokens used in one major category of computer data LANs. In these ''token ring'' LANs, in order to avoid congestion and collision of information streams, only that user can transmit bits who possesses a token that circulates from user to user. The prices of the tokens vary according to congestion. The blocks of information carry these tokens with them, together with the address they seek, and pay (that is, transfer the

tokens) at various toll gates and access points. The tokens are thus electronic coins that are transferred from user to carrier and the clearinghouse. They are like money. With electronic cash emerging in the economy, they could be general money, not specialized tokens. In effect, the information not only finds its own way (which packets already do); it *also carries its own money for transit*, picking among various over-the-air and wire-line transmission options depending on price and performance. This resembles a person navigating a transportation system, choosing routes and transit modes depending on price and performance, and paying along the way.

Does this system require carriers? For wireline services, the need is obvious for pathways to be maintained. But for over-the-air transmission, there is no roadway in the sky. Transmission firms resemble airlines or shipping companies rather than railroad companies. They provide transmission and reception facilities[33] accessible by the information packets at a price. These facilities need not permanently control any particular frequency any more than United Parcel Service and Federal Express control a highway or air route.

B. How to Implement an Open Spectrum System

Who would administer such an open-access system? The options are (*a*) the government; but this would create powers of control and administrative inefficiencies that are undesirable. (*b*) The private owner of the spectrum; this is discussed further below. Or (*c*) the users themselves, by way of a clearinghouse that functions like an exchange.

In practical terms, a clearinghouse would be a computer that sets access prices based on demand for the spectrum endowment that it controls. The potential user of spectrum would use some intelligent software agent to deal with the clearinghouse. If the spectrum user is willing to pay the price,[34] which outside of slack periods is unlikely to be zero, it will receive authorization through access codes. Multiple clearinghouses[35] for different bands are also possible and would provide competition. There could also be dif-

[33] Howard A. Shelanski & Peter W. Huber, Administrative Creation of Property Rights to Radio Spectrum, in this issue, at 581.

[34] Prices must be initially announced by a signal of spectrum price being sent out by the clearinghouse, based on supply and demand conditions. When capacity is underutilized at that price, the price drops, and an updated price signal is sent. The reverse holds true if there is excess demand. The adjustment of demand could be facilitated by some packets that are coded with a reservation price. Usage that does not require real time is thus likely to make room when demand spikes occur.

[35] The mechanism of a clearinghouse of providers has precedent. It is the way in which the FCC has dealt with relocation issues in the PCS bands and is a mainstay of electricity distribution.

ferent prices for different frequency bands, because their different propagation characteristics differentiate their attractiveness.

Each user could apply its own standards and protocols, within general technical parameters of signal strength, and so on, to avoid interference. Enforcement of the system is straightforward for those flows of information that are transferred across networks. Without authorization code, they could not flow. For nonnetwork usage, the presence of transmissions without access codes would be closely watched by their competitors, and violators would be sued or reported.

In some cases, a frequency would be entirely dedicated to a user or usage, based on special circumstances, for example, to protect nonprofit, educational, or governmental usage.[36] Alternatively, such users could receive a credit against which they could obtain access in the open-access system and that they could resell.[37]

Who gets the proceeds? That is a political decision of allocation. It could be the user-owners of the clearinghouse; or, alternatively, the Treasury (as in the auctions, and with a similar negative potential of use for current consumption); or some earmarked functions. But the revenue flow is smoothed with the high fixed costs of entry converted into variable costs of usage. It therefore has a stabilizing function, because prices based on marginal costs, without regard to sunk cost, encourage collusive pricing. Transaction costs in an open-access system may be larger than in a traditional spectrum-assignment system, but that is true for any open economic system. The offset is increased utilization and efficiency. And, similar transaction costs would exist if spectrum owners would resell frequencies in a private resale market.[38] There would be incentives to develop new technologies and applications—just as aircraft manufacturers and airlines do for the utilization of airspace—and to create various instruments of contractual rights for access—just as for financial derivatives.

C. Objections to Open Spectrum Access

The concept of buying spectrum access as an input rather than owning a spectrum license is unfamiliar and disturbing to users and policy makers

[36] Existing frequency licensees would still have the assured right to their spectrum, under the terms of their license. It might be possible for others to buy or rent the terms of their license.

[37] In addition, in situations of natural or man-made catastrophes, blocks of access codes would be set aside for emergency communications.

[38] Similarly, the setting of technical specifications would be no more complex in a clearinghouse setting than in an ownership model because a user could employ any technology subject only to general noncollision rules that are set by statute, common law, or agreement of the users. Such an agreement would have less collusive potential, given the transparency of a clearinghouse process open to all users.

alike, and a number of objections are made, on the grounds of practicality, uncertainty, and property.

1. *Technological Considerations.*—There are various building blocks for an open system, all of them subject to rapid technical change. The challenge to technologists and entrepreneurs is to put the various elements together.

a. Signal processing has made enormous progress, pointing to a near future in which radios become portable digital computers. ''Software radio''[39] shifts the processing of the received signal by conducting all functions like demodulation, filtering, and detection in software-defined units rather than, as at present, through manipulations of the electronic signal within hardwired systems. Intensive research is underway on this concept, which would allow, for example, for a single handset to access multiple systems or for a single base station's equipment to carry multiple types of calls.[40]

b. Intelligent agents are software programs that could deal with the clearinghouse and search the spectrum for the best value.

c. Digital communications have now reached broadcasting too. Their extension to packet- or cell-based technology is used in packet radio.

d. Spread spectrum technology permits frequency changing and frequency sharing by multiple users. Civilian applications exist in mobile code division multiple access (CMA). Spread spectrum cordless phones are commercially available. There has also been much progress in the development of dynamic channel assignment and distributed control processes for wireless LANs and wireless Private Branch Exchanges. (Spectrum hopping is also possible without the spread spectrum technology.)

e. Expanded spectrum availability is the result of expansion to an operational range of up to 60 GHz, a much higher frequency range than in the past.[41] Laboratory usage has proceeded to 300 GHz; theoretical range goes still further.

f. Advanced antennas can cover an increasing range of bands. Spatial sig-

[39] Joe Mitola, The Software Radio Architecture, IEEE Comm. Mag., May 1995, at 26.

[40] First-generation products utilizing this technology are already on the market for wireless infrastructure equipment, where the battery power and size are not the limiting factors. It allows a service provider to use the same equipment for multiple channel types in the same frequency band, for example, both analog and digital channels for mobile service. The biggest challenge faced by such equipment is the present inadequacy of processing power required for the massive computations that are required to be performed in real time, for interactive communications like voice. But this processing bottleneck is being reduced rapidly and will, no doubt, be solved in time. Rupert Baines, The DSP Bottleneck, IEEE Comm. Mag., May 1995, at 46. The number of operations per second per chip is in the hundreds of millions now and is becoming sufficient and affordable for digital mobile radio applications; Mitola, *supra* note 39.

[41] Simon Forge, The Radio Spectrum and the Organization of the Future: Recapturing Radio for New Working Patterns and Lifestyles, 20 Telecomm. Pol'y 53 (1996).

nal separation by directional beams permits space division multiple access (SDMA).[42]

g. Signal compression uses algorithms to reduce necessary transmission needs, especially for video, thereby reducing required bandwidth.

h. Encryption has made enormous progress. It could be used for the access codes that permit transmission to be part of a network. It could also be used to charge end users for reception and to prevent transmission without access codes.

i. Electronic cash is related to encryption and has made similar rapid development in order to serve commerce on the Internet. It could be used for the access-code tokens, making these access codes, in effect, electronic coins used for toll gates.

On the regulatory front, some steps in the direction of openness have been taken by the FCC in 1985 in its Part 15 rules, which increased the unlicensed use of spectrum bands used by industrial, scientific, and medical (ISM) low-power applications (such as garage openers) to a higher transmissions strength of 1 watt, provided that spread spectrum technology was used. Examples for new uses were wireless LANs and wireless bar-code readers.

The concept was expanded in 1994 to unlicensed personal communications (U-PCS), open to all users of asynchronous data and isochronous time-division duplex voice. The dynamic real-time coordination of use accomplished by users following a ''spectrum etiquette'' agreed on by the industry and approved by the FCC. These rules are, basically, ''listen-before-transmit'' on a channel, ''don't talk too long without listening again,'' and ''don't talk too loudly,'' that is, limitation on transmission power. A potential user seeking transmission, when encountering a ''busy'' channel, either switches to another or awaits his turn. This etiquette is embedded in the device itself. The etiquette does not require interoperability between the various devices or exchange of information among them.

Coordination, including the relocation of existing users and definition of channels and geographical regions, is administered by a private nonprofit company, UTAM, owned by equipment manufacturers and supported by them in proportion to their U-PCS equipment sales. UTAM is basically a cooperative.

The next steps in this evolution was initiated by two petitions to the FCC in 1995, by WIN Forum for a limited range high-speed Shared Unlicensed Personal Radio Network (SUPERNet), and by Apple Computer for a National Information Infrastructure (NII) band. In 1997, the FCC[43] allocated

[42] *Id.*

[43] ET Docket No. 96-102, January 9, 1997.

300 MHz of spectrum in the 5 GHz band for unlicensed National Information Infrastructure (U-NII) devices. The FCC also opened the band above 40 GHz to unlicensed usage.[44]

The main weakness of the unlicensed access approach in its present stage is that it deals with scarcity and congestion by a technological ''etiquette,'' which cannot ensure real-time access if demand is high. The best-working etiquette for the allocation of a scarce resource in our society is a market-clearing price. Without it one may reenact the rise and fall of citizens band (CB) radio. CB radio is the poor man's open access. CD radios are unlicensed, and their usage was tremendous, even though much of it proved to be a fad. The weakness of CB radio was the absence of congestion prices and of commercial incentives for content provision.

2. *Regulatory Considerations.*—Auction advocates tend to stress the rapidity of its allocation, in contrast to the messiness of market trading. But this focuses on the short term. It is true that efficient resource allocations are accelerated by auctions. But soon thereafter, given the dynamics of markets and technology, an aftermarket must take over anyway. Spectrum efficiency therefore depends more on a smooth aftermarket than on the initial allocation mechanism.[45] Since the auction-based allocation system may lead to a spectrum oligopoly due to potential oligopolists' ability to bid higher, such a system may well end up requiring more government intervention than presently hoped for, in order to maintain market competition. In contrast, a system of continuous open entry makes it harder to sustain oligopolistic prices. In such a system, the government's role is that of providing an initial endowment (the same function as in an auction) and assuring nondiscriminatory access to a clearinghouse. Establishing multiple and competitive clearinghouses for different spectrum bands would add still further openness. It is true that government could intervene, but selling full property rights in spectrum does not eliminate opportunities for regulation either, just as private use of land is often heavily regulated.

3. *Property Rights Consideration.*—Without secure long-term tenure there may be less investment. In the exploitation of frequencies, however, greater competition also spurs innovation and investment. One needs to balance certainty with contestability. Uncertainty exists in every business, and no firm can control every input. Spectrum is no different in that respect from a gas station that cannot be certain of the price of its vital input, wholesale gasoline, or of a bakery that needs to buy flour at varying prices. Similarly, employers do not ''own'' their employees and are not dispos-

[44] ET Docket No. 94-124, February 10, 1997.

[45] Arthur De Vany, Implementing a Market-Based Spectrum Policy, in this issue, at 627.

sessed by their departure to firms offering higher salaries. But when it comes to spectrum, much of private industry is so used to the concept of long-term control (whether by ownership or license) that it finds it hard to conceive of regularly buying spectrum access like another input. Of course, for some firms certainty will be considered necessary, and for that purpose futures markets for capacity will evolve.

Couching the discussion in the terms of property rights is not helpful.[46] Even the old license system was one of property rights, regardless of the 1934 Communications Act's declaration that it did not establish ownership right.[47] It is similarly argued that the FCC auctions are only for a long-term usage rights, not for full ownership. But this is a legal distinction without a real difference. The strong expectation is that the lease will be almost automatically renewed, just as it has been for TV broadcast licenses, where of more than 10,000 renewals between 1982 and 1989, less than 50 were challenged and fewer than a dozen were not renewed, usually because of some malfeasance. A postcard suffices to renew a license. In cable TV the nonrenewal of franchises is similarly rare. For all practical purposes, the auctions are for permanent occupancy, though the slight uncertainty will lower the prices a bit.

As Richard Posner observes, ''In economic, though not in formal legal terms, then, there are property rights in broadcast frequencies. . . . Once obtained the right is transferable. . . . And it is for all practical purposes perpetual. The right-holder is subject to various regulatory constraints, but less so than a public utility, the principal assets of which are private property in the formal legal sense.''[48]

Today, scrambling and encryption technologies permit producers of information to exclude unauthorized access to it. Holders of information can thus create ''bottoms-up'' property rights through access control, and markets evolve. This means that the protection against the unauthorized transmission need not be accomplished through licensing but can be left to market forces governing the transfer of the information in networks.[49]

[46] Just calling some rights property does not make them the base of an economic efficiency. Under feudalism and absolutism, many rights and privileges were property and for sale, such as military commands and titles of nobility. People could sell themselves into bondage or buy their freedom. Yet by no stretch could one describe these systems as efficient. It all depends on the context, which in economics means on the market structure. A property-rights system that has a built-in tendency to oligopoly, for example, would not be efficient.

[47] 47 U.S.C. 301.

[48] Richard A. Posner, Economic Analysis of Law (2d ed. 1977).

[49] Eli M. Noam, The Revolution in Access Control: Markets for Electronic Privacy (paper presented at the Aspen Summit '96: Cyberspace and the American Dream, Aspen, Colo. August 1996).

4. *Could an Auction Winner Administer an Open System Itself?*—An appealing alternative route to the unlicensed open-access system would be for private spectrum managers to conduct the resale of their capacity. This would require the spectrum ownership to be diverse, because if a firm has market power in spectrum, it would charge monopsony prices, discriminate in prices, and appropriate the efficiencies of rivals. It would be as if, in the predivestiture days of AT&T dominance, AT&T could have auctioned off the right to compete against itself. Under such a system, MCI would not have emerged. If a market could evolve with many wholesale spectrum band managers controlling a lot of spectrum to make resale transactions with many resale users practical, a substantial openness would indeed be achieved. But such a world seems unlikely; even if a government would license many spectrum owners, there would be consolidation, as has been argued, toward oligopoly. Furthermore, for meaningful access to be provided by a wholesaler, it would need to control a significant band, which is not likely to be affordable by any but the largest of telecommunications consortia. Imagine a firm buying half the VHF TV broadcast band for resale to broadcasters. As Robert Crandall points out in an article on the New Zealand experience with spectrums of management rights[50] (the only concrete example to date for an effort to institute a resale system), on the basis of recent auctions, a single nationwide gigahertz would be worth about $300 billion in the United States, 12 times the value of the giant RJR Nabisco leveraged buyout. ''It is far from clear who would be able to 'bid' for such a franchise if the U.S. government were to offer it as a management right at an auction.''[51] Milton Mueller, similarly, finds that in New Zealand ''spectrum management rights can be acquired since 1990, but they have not been resold to others.''[52] Only two local bidders showed up for the management auction in New Zealand, the previous monopolists in telecommunications and broadcasting. It is hard to imagine that their motivation is to encourage usage by competitors.

Alternatively, spectrum slices for wholesalers could be drawn narrowly, but then the spectrum agility of users' access moving around the spectrum would be curtailed, and the system would be the traditional ''slice-and-dice'' of spectrum licensing, whose consolidation and utilization would impose major transaction costs.

Advocates of resale markets need to explain the empirical fact that there was never any meaningful resale of nonadvertising time slots for spectrum

[50] Robert W. Crandall, New Zealand Spectrum Policy: A Model for the United States? in this issue, at 821.

[51] *Id.* at 825.

[52] M. Mueller, New Zealand's Revolution in Spectrum Management, 5 Info. Econ. Pol'y 159 (1993).

access by broadcasters, even in multistation markets (or by cable companies for their bandwidth). Partly this was due to FCC restrictions, but there did not seem to be major complaints against these rules, and one suspects that few TV stations would become time brokers or common carriers even if they could, as they now partly do. In telecommunications, to take another example, resale exists primarily due to legal common-carriage obligations and has been strenuously resisted by incumbents everywhere. The basic problem is the resistance to provide a competitor with a vital input at a price that permits entry.[53]

Some resale is taking place in satellite transmission. Here, the huge hardware and launch costs and the need for government backing in international bodies cause indivisibilities and entry barriers that lead to a limited number of capacity providers reselling transponders (channels) to large and stable tenants. Such a market is moving in the right direction as long as the need of the handful of firms to shield their huge investments does not lead to a significant anticompetitive cooperation. PCS licensees are also able to resell their spectrum. But it appears this will be done primarily by the ''small business'' winners of small regional bids (Basic Traffic Areas) who resell to larger nationwide firms (excluded from the small business auctions) that complement their own spectrum holdings. Thus, resale is taking place upward to large aggregative firms rather than downward to multiple users.

Resale is clearly a step toward open access. It should be encouraged. It is likely to exist in some limited fashion. But it is not likely to generate a widespread openness of access.

IV. Conclusion

The open-entry spectrum exchange will not solve every problem of today's auctions. New ones will emerge. Many of these problems may be resolvable once the technologists focus on them, but to do so requires first that we get out of the box of the exclusivity paradigm.

Even if the open-access system has some flaws, the constitutional issue must still be answered. Efficiency of resource allocation and lower transaction costs do not overcome the protection of fundamental rights of which free (electronic) speech is one. If an open-access system is less restrictive than an auction/ownership model without causing spectrum chaos, the granting of exclusive speech rights may not pass the test of constitutionality. Even some inefficiencies and transaction costs cannot defeat constitutional rights.

What are some of the policy implications? First, it is not to stop auctions,

[53] Eli M. Noam, Beyond Liberalization II: The Impending Doom of Common Carriage 18 Telecomm. Pol'y 435 (1994); Noam, *supra* note 49.

since in the present state of technology they are still usually the better solution. But it means to limit the duration of auctioned licenses, in order to preserve future flexibility for other approaches.

Second, resale and spectrum use flexibility should be permissible to facilitate resale markets. License holders should be able, in most cases, to slice up the spectrum and resell and sublet them to others for various applications.

Third, experimentation and innovation in spectrum usage schemes should be encouraged. This would include expanding the unlicensed spectrum concept and dedicating frequency bands to the open-access, access-price model. Better to approach spectrum use in a pragmatic and searching fashion than with an ideological mind-set that equates the free market with one and only one particular technique. We should be ready to take the next step. The tremendous success of the Internet should lead us to seek its openness in spectrum use too. The Internet, with its multiple-route system, is an example for an open-access model in the wire-line environment. Here, too, congestion charges are being considered. Open does not mean free or nonprofit.

It took Leo Herzel and Ronald Coase almost 50 years to see their auction paradigm implemented. Similarly, the proposed open-access paradigm is not likely to be accepted any time soon. But its time will surely come and fully bring the invisible hand to the invisible resource.

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