

# **IEEE** **Communications**

December 1995 Vol. 33 No. 12

MAGAZINE

***Regulatory Reform:  
Unleashing the Competitive Drive  
in the Information Age***



# Taking the Next Step Beyond Spectrum Auctions: Open Spectrum Access

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 allocation technique. Auctions are fine for today, but we should be ready to take the next step.

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**F**or all the Washington talk about building the National Information Infrastructure, its major concrete accomplishment and outstanding success so far has been the introduction of spectrum auctions. In the process, auctions have risen from obscure academic theory to dominant policy orthodoxy. Almost anyone, it seems, loves auctions: many liberals, because it makes business pay its way and generates government revenues; and most conservatives, because it substitutes market mechanisms for government controls.

However, if so many agree with the idea of an auction and for such different reasons,<sup>1</sup> maybe it is time to reexamine it. My own conclusion is that while the present auction system is far better than what we had in the past, it is still not the best way to go in the long run, and that it should be updated by a system of *open spectrum access coupled with a dynamic access fee*. The technology for such a system, while not available, seems within reach; but to develop it requires policy makers to first take the next step, and to think of spectrum use not in terms of exclusive ownership but of multiple access. In the process, the dominant paradigm for spectrum allocation has to change, from *Occupancy* and *Licensed Privilege* in the past, to *Ownership* (or long-term lease) at present, to *Access* in the future.

## The Debate about Auctions

**T**he arguments for auctions are well known. An auction is better than a mindless lottery, or than comparative administrative hearings with their inevitable legal maneuverings. 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. And in any event, private auctions already exist in the form of a resale market.

All this is largely true. However, the issue is

not whether auctions are better than the strange and wasteful systems which we have used in the past, but whether they are better in the long run than other alternatives.

The counter-arguments to auctions are also well known. They are 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 auctions should not extend to them, because:

- They are required to perform public service obligations.
- They have usually already paid for the license once by buying it in the after-market.
- It would be unfair to make them bid retroactively for an asset whose value they had created.

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 were more precisely known; by radio amateurs, who tend a non-profit spectrum garden dedicated to technology experiments and public service in the midst of a commercial and governmental wilderness; and by 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. An influential opposition comes from parts of the public interest community, which fears:

- That regulatory power over TV on behalf of public interest goals would decline if renewable licenses were replaced by permanent property rights
- That an allocation to the highest bidder would raise barriers to small entrants and reduce diversity
- That auctions would squeeze out free public access and non-profit educational activities

Even economists concede that market prices do not necessarily reflect all social value, because social value also includes consumer surplus (i.e., the benefit to a consumer above the market price). For broadcasting, whose economics are

<sup>1</sup> Among economists, the concept was embraced by, among others, such diametrically opposed authors as George Stigler on the right and Abba Lerner on the left [1].

convoluted because it sells audiences to advertisers rather than tickets to audiences, the surplus of social over private value has been estimated to be seven times as high as market price [2]. Thus, if a broadcast channel switches out of TV and into mobile telephony, the overall impact may go far beyond that of a private transaction. Similarly, the buy-out of a competitor may have an impact beyond the private transaction price in that it may lead to higher prices for the users of a service, which is also part of social cost. These social costs and benefits have been used as an argument for a political or administrative allocation of spectrum.

On the whole, the arguments in favor of auctions for new services 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 is a free market perspective. Where such criticism has been voiced it has focused on the specifics of the FCC auction scheme, such as the extent of duration, allocation and flexibility of the licenses involved, not on the concept itself.<sup>2</sup> Indeed, having fought a long, hard, successful fight for auctions, its advocates often seem incapable of viewing skepticism about auctions as anything but a pro-state position.

### **Auctions: Budget Policy or Communications Policy?**

**T**he FCC auctions have been sophisticated in technical terms, superior to the old system, and well executed as an operation. They benefited from the contributions of game theorists seeking a new field after the end of the Cold War. Underlying any game is an optimization goal. The underlying objective for the auction "game" was to raise revenues for government. This is usually denied quite heatedly, and various other considerations are cited, such as moving spectrum to the users valuing it most and so on. However, the political fact is that auctions were approved, after years of Democratic opposition to them in Congress, as a measure to reduce the budget deficit. Allocating spectrum resources efficiently was a secondary goal at best. Certainly, the objective maximizing function may have been constrained in several ways, such as by rules against monopoly and in favor of diversity; but these additional policy considerations were only the fig leaf over the main reason: raising money for the empty coffers of the Federal Government. The rest is largely technique. But is useful budget policy also good communications policy? There are several problems.

**The Administration's Goal Is to Advance the National Infrastructure** — There seems to be widespread agreement that this should be done without government money; but are we not actually now doing the opposite of making public investments? Through auctions, we are taking money out of the infrastructure and away from

telecommunications carriers 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 FCC auctions *per se* but due to the way the revenues are being used by Congress and the Executive. Therefore, to avoid siphoning resources from the infrastructure into general public consumption — the opposite of a pro-investment communications policy — one would have to complement auctions with a recycling policy that returns the revenues to communications infrastructure and its applications. It is one thing to sell assets and re-invest the proceeds, but ours is now a system of funding current consumption.

**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 small firms and unproven technologies that cannot find partners to share the risks. Therefore, an up-front payment will reduce the pool of entrants. It also tends to exaggerate actual net revenues raised because there is a trade-off between short-term revenue to the treasury 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.

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 after-market. What they seem to have in mind as an alternative to an auction is a lottery system with an after-market, which indeed creates windfalls, transaction costs, and delay. However, suppose the alternative were not such an inefficient (though unfortunately real) system, but a merit-based comparative selection (e.g., based on an explicit scoring criteria and evaluated by an expert panel like a scientific grant proposal) coupled with a ten-year non-resale provision. (This is not the author's recommended solution, but at least it is a more sensible comparative yardstick to the auction than the lottery and resale system, against which almost any alternative looks good). Such a system would have lower entry costs since no bids would have to be paid for; and prices would be lower since, to the licensees, the spectrum would not have much of an opportunity cost that would have to be factored into the service price.

**An Auction Is a Tax** — Auction advocates deny this, arguing that consumer pricing depends on the spectrum's opportunity cost rather than historic basic cost, and that opportunity cost is the same as it is for a lottery and resale system. Put in such a context, they are correct. Yet how can one possibly deny that the billions of dollars raised by an auction are paid for by the private sector and end up with the government? That,

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<sup>2</sup> The exception is George Gilder [3] whose perspective is to overcome scarcity by superior technology. Criticism has also been voiced in the Telecommunications Policy Review published by Ken Robinson.

after all, is the Congressionally mandated point of the whole exercise. When it comes to consumer prices, the argument of the opportunity cost (that prices would not be affected) holds when the lottery and resale system is the one contrasted. If, instead, the alternative described above — objective selection criteria and resale limitations — were chosen, the opportunity cost would drop, and with it prices, in comparison to the auction-based prices. Thus, customers would pay less, carriers would pay less, and the government would collect less.<sup>3</sup>

<sup>3</sup> On the plus side, because the auction payment is an up-front and thus lump-sum tax, it should have little impact on marginal cost or behavior once operation commences, which is a positive feature as far as taxes go.

<sup>4</sup> An example from another level of communications policy: American municipalities receive 5 percent of the revenues of franchised cable television operations. They have now sought to expand this fee (which is rooted in the use of public rights-of-way) to cable alternatives such as direct satellite broadcast and building-based satellite master antenna systems that do not use public rights-of-way, partly to "level the playing field," and partly to protect their revenue source. A future interactive, server-based video service that is accessed Internet-style may have to deal with similar issues.

<sup>5</sup> Similarly, the absence of usage flexibility built into the licenses — a PCS license cannot be used, for example, for TV broadcasting — is likely to reduce the bid prices. The exception to such reduction would be where, as in neighborhood zoning, the positive externalities of an entire frequency band "zoned" for the same use are strong. For example, consumer equipment might become cheaper and therefore widespread if a certain use is clustered in a narrow frequency band rather than scattered throughout the entire range of frequencies.

**Auctions Can Lead to Oligopoly** — If one truly wants to maximize government revenue, one should auction off the exclusive rights of the monopoly. The highest auction bid would be the present value of monopoly rent. The winner's profits would be normal, but price would be at the monopoly level. The FCC recognized this and auctioned off several PCS licenses, not just one. This was wise, but it is much harder 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 which aim to collaborate under some rationale of synergy. Second, after the auction, the high bidders will collectively suffer from some "winner's curse" and, after a shake-out period, will collaborate, because otherwise they might not be able to support their bid price's cost. "Sunk costs" are passively accepted only in competitive markets, and after the fact. Oligopolists, on the other hand, will attempt to inflate opportunity cost and other means 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. Even with multiple service providers left nationally, there would be pressures for concentration to take place locally, 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.

This is indeed FCC policy. However, ownership limitations are regulatory in nature, may conflict with potential efficiencies of scale and are at odds with the stated goal of moving spectrum to the highest-value user. Additionally, 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, on the other hand, 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 service B means exit from A. Thus, the FCC's policy in favor of spectrum flexibility may collide with its structural anti-oligopoly goals.

There must also be enough spectrum auctioned off to attack oligopolistic tendencies and reduce opportunity cost; but here, the government is conflicted. Release more spectrum, and its price drops. The quantity released is affected not only by policy considerations, but also by

revenue needs and stakeholder interests. Just as New York cab drivers have used politics to keep the number of taxi cab medallions at the same level since the Great Depression in order to protect their investment, so will existing spectrum holders be united in the desire to stave off the opening of spectrum to new entrants who will not only compete with them for future business but also depress the value of their past investment in spectrum. Government has a related revenue-based incentive to keep spectrum prices high by limiting supply. Thus, government could become the spectrum warehouse and protector of oligopoly, a function it has played historically [1].

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 morally purer than regulation, despite its sledge-hammer style. They seem to have forgotten the political involvements of the Justice Department in virtually every Administration of this century. Some people also seem to love antitrust more as a general theory than as a practice, for example, in the application of the AT&T consent decree.

## Where Is 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. In 1995, for example, the relevant Congressional committees received instruction to raise another \$15 billion. As this takes place, regulatory decisions may be influenced by their impact on revenue. As one Senator put it, an agency ostensibly responsible for regulation could be turned into a giant cash register. Once a certain dependency on revenues from communications has been created, it may affect substantive policy.<sup>4</sup>

It is argued that the auctions are not for full ownership and only for a long-term lease or business license, 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, virtually never for comparative reasons. 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.<sup>5</sup>

Everybody will get into auctions, because everybody has a budget deficit. Even Saudi Arabia and Alaska are hurting. Local governments may start auctioning off cable licenses, but probably not to the first cable franchise, where renewal is protected, only to its competitors.

Internationally, American firms will pay dearly for an auction system. There will be auctions everywhere, in any country in search of hard currency, and American companies, leading the move out of purely national operations, will do a major part of the paying. Since spectrum use is

derivative of international allocations of both spectrum and orbital slots, international organizations could also get into auctions.

For example, the International Telecommunication Union's former Secretary General, Richard Butler, in a speech in October 1995 before the world's largest Telecom event, the ITU's Telecom '95 in Geneva, 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. "For whose benefits should the economic form of rent be applied — one single nation or group of nations or the whole community of nations?" In the same week, his Australian compatriot, foreign minister Gareth Evans, argued to the United Nations that its chronic financial problems should be remedied by "other revenue options that are international and take place within a framework of law and cooperation provided by the United Nations." Joined together, these arguments may well lead to the conclusion that some international organizations and operations should be financed by international spectrum auctions.

International satellite ventures such as the low-orbit Iridium or Teledesic would then be subject either to many other countries' auction systems, or to some international scheme that would inevitably be politicized. The American concept of giving some help to small businesses in an auction<sup>6</sup> might then be carried on to small and poor countries to ensure that they will not be squeezed out.

It has been argued that at least 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 in facilitating competition. This might be true in some cases, but the opposite to liberalization is just as likely. A revenue-strapped country is more likely to sell off a monopoly license than competitive ones, because this will fetch the highest bid price. The determination of the appropriate market structure therefore will provide ample opportunities for manipulative interventions. And the nonpolitical nature of the auction can easily be undermined by various domestic preference systems, such as requiring bidders to join up with favored local partners or to undergo an approval process.

## **A Better Alternative: Open Spectrum Access**

**T**he alternative to the present auctions is not to return to the wasteful lotteries or comparative 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 good for now, but there is a better next step, a free-market alternative to the present auction system: an open entry spectrum system. In those bands to which it applies, nobody would control any particular frequency. In this system no oligopoly can survive because anyone can enter at any time — large, small, white, black, male, female, American, foreign.

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 (i.e., by the existing congestion in the 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 technology. In the past and present, the fixed nature of a frequency usage had a stability that is indeed reminiscent of land. However, that was based on the relatively primitive state of technology, in which information was coded (modulated) onto a single carrier wave frequency or at most a small frequency range. To prevent 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 was as if a highway were divided into wide lanes for each type of usage — trucking, busing, touring, etc. — 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?

Even the highway scenario has a single-dimensionality to it, with point A connected to point B. Let us imagine instead a big ski resort, with many entrances, dozens of lifts, hundreds of runs and thousands of people cruising through, each headed to their own destination in seemingly random patterns. If any lift or run is crowded, a skier will seek a different path. If congestion is too great, the ski resort will raise the admission ticket price (e.g., set weekend prices higher than for weekdays). In such a system, nobody buys ownership to a slice of the mountain, but rather access to the mountain environment. A similar concept applies to access to the spectrum "cloud."

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. However, absence of scarcity is neither the interesting nor the 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 occur.

The first response to scarcity would be technological (e.g., reducing transmission power, adding more transceiver sites, pushing the frontier of usable spectrum, etc.). The history of radio communications is the history of increasing spectrum utilization through technology. Mar-

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<sup>6</sup> When the U.S. Supreme Court found race and gender set-aside programs presumptively unconstitutional and subject to strict judicial scrutiny in another context, the FCC dropped these aspects of its auction plan in order to prevent uncertainty hanging over the results of its next auction. *Adarand Constructors, Inc. v. Peña*, 63 U.S.L.W. 4523 (June 12, 1995).

Because  
of the  
dynamic  
nature of  
the access  
price, an  
open access  
system  
creates a  
continuous  
bidding.

coni's original contribution was not only to use electromagnetic propagation to transmit information, but to create the means to separate ("tune") different frequencies from each other. Today, it has been said that we can use about 30,000 times as much spectrum as Marconi could [4].

Another technology response is to use spectrum more evenly across frequencies. B might be able to use a frequency usually occupied by A at those times when it is unused. This could be automatized, and radio-based packets could seek free frequency slices, and interleave with or hop to other frequencies where there is less demand. This approach would considerably increase the efficiency of spectrum usage; but it would not solve the allocation problem, only alleviate it. If usage is free — and since different frequencies have different properties that make some less desirable for different purposes — congestion will eventually occur, which leads to an allocation mechanism.

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 would be an "edge price," and give any users of the spectrum the right to enter information into a spectrum band "cloud." 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.

The question is how to implement such a system. Government is one way, but it would be undesirable to involve it beyond the initial spectrum endowment. The best way would be to let the users of the spectrum control the resource by way of a clearinghouse that functions like an exchange. Multiple clearinghouses, one for each spectrum band, are also possible and would provide competition.

In practical terms, it would be a computer that sets access prices based on demand, one operated by a private agent with a stake in the efficiency of the system. A rudimentary example for the clearinghouse concept and its financing is the designated coordinator for the U-PCS band, UTAM, Inc., owned and financed by the equipment industry, under "spectrum etiquette" rules agreed upon by the industry, adopted by the FCC, and embedded in the equipment.

The resource a clearinghouse distributes is the spectrum endowment it controls. Access could be acquired in real time. It would also be available in advance, to those that require certainty of price, from capacity brokers. These would issue futures contracts, and would have to deliver on them at the time the contract is due by bidding in the spot market. Other contracts could ensure a certain lesser probability of access.

Prices might be initially announced by a signal of spectrum price being sent out by the clearinghouse, based on supply and demand conditions. Those who transmit accept the price. When capacity is underutilized at that price, the price drops shortly thereafter, and an updated price signal is sent out. The reverse holds true if there is excess demand. The adjustment of demand is 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. There could also be different prices for different frequency bands, because their different propagation characteristics differentiate their attractiveness. Because of the multidimensionality of spectrum usage; the clearinghouse will probably have to define a set of standard contracts.

Wholesale users would signal their usage to the clearinghouse, which would keep tabs on usage and bill users. They could apply their own standards and protocols of frequency use, within general technical parameters of signal strength and so forth. They could either pass the fluctuating prices to their customers, including the price signal, or charge an average price. Most direct spectrum users would be wholesale operations, and a general part of the trade. Their compliance would be watched by their competitors.

Spectrum-agility would not dispossess existing frequency licensees.<sup>7</sup> They would still have the assured right to their spectrum, at no charge (if such is the term of their license). It might be possible, however, for others to use the frequencies, on a compensated access fee basis, at those times when they are not actually being used, or when such usage would not interfere (e.g., due to their low-power nature). Such reselling possibility also establishes a way to in effect buy out existing licenced users.

In some cases, a frequency would be entirely dedicated to a user or usage, based on special circumstances, for example, to protect non-profit, educational, or governmental usage. Alternatively, such users could receive a credit against which they could obtain access in the open-access system, and which they could resell. Additionally, in situations of natural or man-made catastrophes, spectrum blocks would be set aside for emergency communications

Because of the dynamic nature of the access price, an open access system creates a continuous bidding. This permits continuous challenge by entrants, in contrast to the ownership model with its potential for oligopoly. Infrastructure entry and investment would also be eased for small companies because there would be no upfront cost for spectrum by allocating the opportunity cost of spectrum use to marginal rather than fixed costs. And it would be less susceptible to political handicapping by domestic and foreign governments.

Who gets the proceeds? That is a political decision of allocation. It could be the U.S. Treasury (as in the auctions, and with a similar negative potential of use current consumption), or some earmarked functions. The revenue flow to government is smoothed, away from the one-shot deals. The system converts fixed costs of entry into marginal costs of usage. It therefore has a stabilizing function, because marginal costs are otherwise potentially so low as to fail to cover total costs, and hence encourage collusive pricing.<sup>8</sup>

## 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-

<sup>7</sup> The bands in which the new spectrum regime would be instituted should not conflict with international treaty-level allocations, but it might be desirable to renegotiate the antiquated system of international usage-specific allocations.

<sup>8</sup> On the other hand, higher marginal costs increase the stability of a cartel.

makers alike, and a scatter of objections are made, mostly on the grounds of practicality, uncertainty and property. None of these are strong enough to deny the open-access system the opportunity to be tested. Skeptics may want to learn how Ronald Coase came to embrace the concept of spectrum auctions: When the FCC's chief economist and distinguished communications scholar, Dallas Smythe, published a refutation to Leo Herzels auction proposal, Coase was left so unpersuaded by the best arguments marshalled against auctions that he became a convert [1]. Smythe rejected the auction as being "of the realm in which it is merely the fashion of the economists to amuse themselves" and argued against auctions in terms of technical impracticality, citing "intolerable interference on other channels unless the whole is carefully engineered..." [5, p. 100] Today, when it comes to open spectrum access, similar objections are being raised.

### ***Does Open Spectrum Access Mean More or Less Government Intrusion than an Auction?***

An auction is only the beginning of ongoing headaches because the market structure in a service will tend to become oligopolistic if potential oligopolists can bid higher. Therefore, an auction-based allocation system will require continued government intervention. The better alternative is to establish open entry at any time, because high prices will not be sustainable under such contestability. In such a system, the government's role is that of providing an initial endowment (the same function as in an auction), and assuring the right and need of each user to clear access through a clearinghouse. It is true that government could interfere in the clearinghouses, but selling full property rights in spectrum does not eliminate opportunities for interference either, just as land use may be heavily regulated even if fully owned. Establishing multiple clearinghouses, each for a different spectrum band, avoids the need for supervision. The only way to argue that government's making businesses pay it billions of dollars by auction constitutes "less government" is to hope for full economic freedom based on full ownership; but this would be based on optimism, not on history or law.

### ***Is Ownership Important?***

True, without secure long-term tenure, there may be less investment. On the other hand, greater competition can spur investment. 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 which cannot be certain of the price of its vital input, wholesale gasoline, or of a bakery that needs to buy flour at varying prices. Employers do not "own" their employees and are not "dispossessed" by their departure due to salaries that are below market price. Even in real property, investors build immense immobile structures without owning the land.<sup>9</sup> However, when it comes to spectrum, much of private industry is so used to the concept of control (whether by ownership or license) that it finds it hard to conceive of buying

spectrum access like another input. Of course, certainty may be considered necessary, and for that purpose, future markets for capacity will evolve.

### ***What about Property Rights?***

Couching the discussion in the terms of property rights is analytically not helpful, because just about anything transferrable and excluding can be described as a property right. Even the old license system was one of property rights. 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." [6, p. 33]

Property, in law, is a bundle of rights rather than a single right. Many people, when they advocate property rights, are really talking about what the law calls "fee simple absolute," but there are many more limited property rights such as future rights, contingent rights, life estates, mineral rights, rights-of-way and so on. Thus, a transferrable frequency access is just as much a property right as a fee simple is, only of a shorter duration.

### ***Could an Auction Winner Administer an Open System Itself by Becoming a Reseller?***

If it had market power in spectrum, it would charge spectrum users monopsony prices, price-discriminate, and appropriate the efficiencies of rivals. It would be like having the old AT&T auction off the right to compete against it. Under such a system, would MCI have emerged? Where no market power exists, a spectrum owner could not charge a monopoly price. In a world with a hundred wholesale spectrum band managers, each of whom control substantial spectrum and transact with retailers of spectrum, a substantial openness would indeed be achieved. Such a world is unlikely, however, given the small number of spectrum licenses issued, and the history of concentration of an oligopoly in this industry. And where spectrum slices are narrow, the benefits of spectrum agility would be limited. There was never any meaningful resale of spectrum access by broadcasters (or by cable companies for their bandwidth). In New Zealand, where "spectrum management rights can be acquired since 1990, they have not been resold to others" [7]. In telecommunications, resale exists primarily due to legal common carriage obligations, and its application to grant access to competitors has been strenuously resisted. The basic problem is the resistance to providing a competitor with a vital input at a price that permits entry [8, 9]. Competition is better ensured by letting the retailers have direct and continuous access to the spectrum resource.

### ***This Leaves a Final Question: Is the Concept Practical?***

Technologically, the proposed system is not

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<sup>9</sup> Rockefeller Center stands on land that used to be separately owned by Columbia University and leased to the Rockefeller Center Company for 99 years. The Center's financial health was stronger under that arrangement than it is now. No causality is implied.

*Technologically, the proposed system is not presently available, though its component parts are within reach.*

presently available, though its component parts are within reach. It is not my aim to try to work out the details here. They will evolve with time, discussion and technology. The important thing is the concept. Herzl and Coase did not design a multiround simultaneous Vickrey auction, either. It is important to recognize that, generally speaking, radio applications are not as stand-alone and separate from wireline networks as in the past. They can be controlled as part of more general network management functions. Access to a frequency would require a signaling mechanism that would also help to compute and transmit an access price and frequency, and keep a tab on charges incurred. A packet- or cell-based technology is not essential to open access but is helpful. Packet radio exists, as does frequency-changing spread spectrum technology that permits multiple users to share a frequency band. Spread spectrum cordless phones exist. There has been much progress in broadband digital radio and signal processing [10], suggesting a future in which radios become portable digital computers [3]. There has also been much progress in the development of dynamic channel assignment and distributed control processes for wireless LANs and wireless PBXs [9].

The challenge to technologists is to put the various elements together. Of course there are technical problems, but there is no reason to believe that they cannot be overcome. The main obstacle is mindset.

Some steps in that direction were sanctioned in 1985 by the FCC 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 1 W, provided that spread spectrum technology was used. This led to a very successful expansion of usage. Examples are wireless LANs and 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 is accomplished by users following a "spectrum etiquette" in real time, based on rules agreed upon by the industry and approved by the FCC. They are, basically, "listen-before-transmit" on a channel, and limitations on transmission power and duration. 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 [9].

Coordination, including the relocation of existing users and definition of channels and geographical regions, is administered by a private non-profit company, UTAM, Inc., owned by equipment manufactureres and supported by them in proportion to their U-PCS equipment sales [10].

The next step in this evolution was two petitions to the FCC in 1995. The first, by WIN Forum, was for a short- to medium-range high-speed Shared Unlicensed Personal Radio Network (SUPERNet). The second petition, by

Apple Computer, was for a National Information Infrastructure (NII) Band, with a range of up to 10 miles [10]. Both systems propose a built-in spectrum etiquette.

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.

## Conclusion

As Paul Baran, a pioneer of packet switching, writes:

"Governmental agencies tend to be staffed by lawyers who view a frequency as a unique property right. If I owned a frequency, then you can't use my frequency. It's mine, exclusively mine. Yet, communications engineers know that statistical averaging of large blocks of frequencies can allow for better usage." [4, p. 8]

Baran goes on to advocate a laissez-faire approach to spectrum:

"Anyone and everyone would be allowed to use the spectrum, without the barriers to entry that keep out the true innovators. Of course, there will be some minimal rules necessary, such as maximum allowable power and power densities. The micro-managed regulatory approach of today, such as who can use any single frequency is neither necessary nor desirable."

George Gilder argues similarly that:

"You 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." [3]

Both Gilder and Baran, in effect, aim to solve scarcity by technology, and are thus spared the need to deal with allocation questions. This is not my position. Within open access, scarcity inevitably emerges, the resource needs to be allocated, and a price mechanism can do it. It should be noted that a reservation price (Vickrey) auction (in which the highest bidders pay the market clearing price) has also been proposed for the presently "free" Internet system because it is experiencing congestion problems [13].

The open entry spectrum exchange will not solve every problem of today's auctions. New ones will emerge.<sup>10</sup> Many of these problems may be resolvable once the technologists focus on them, but to do so requires first that policy-makers get out of the box of traditional thinking about spectrum.

Why not expand the unlicensed spectrum concept and dedicate a few bands to the open-access, access-price model? Its practicality is a matter of technical evolution and market realities. Eventually, it may reach TV broadcasting. Better to approach spectrum use in a pragmatic and searching fashion than with an ideological mindset that equates the free market with one and only one particular technique. Auctions are fine for today, but we should be ready to take

<sup>10</sup> For example, antenna efficiencies may impede wide frequency variations. Wide spread-spectrum band requires stringent synchronization. Close signals may drown out distant ones [14, 15]. On the nontechnical side, some players may try to find new ways to game the spectrum system by manipulating prices.



the next step.

It took Leo Herzl [16] and Ronald Coase [17] almost 50 years to see their concept implemented. Similarly, the proposed open spectrum access system will not be adopted anytime soon. But its time will come, and fully bring the invisible hand to the invisible resource.

### Acknowledgments

This article is dedicated to the memory of Harvey Levin, who served as Affiliated Fellow of the Columbia Institute for Tele-Information, and whose book *The Invisible Resource* [18] helped change thinking about spectrum. Comments and responses by Bruce Egan, Robert Frieden, John Friedman, Thomas Hazlett, Evan Kwerel, William Lehr, Terrence McGarty, Milton Mueller, Jim Omura, Robert Pepper, Peter Pitsch, Ken Robinson, Aaron Rosston, Andrew Schwartzman and John Williams are gratefully acknowledged.

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