Beyond Auctions:
Open Spectrum Access

Eli Noam[1]

Three Old Paradigms and a New One

It won't 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 straight-jacketed 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 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.

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 Thomas Kuhn, in his famous essay on AThe Structure of Scientific Revolutions@[2] on the rise and fall of schools of thought, would have predicted, the new orthodoxy, too, has become complacent. Like generals fighting the last war 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 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 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.*

But now, new technologies, available or emerging, make new ways of thinking about spectrum use possible that are 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 >90s, by Paul Baran[3] and George Gilder[4]. Underlying their arguments is the hope that technology would solve scarcity and spare much of the need to deal with allocation questions[5]. This is not my position[6]. With open access, scarcity emerges, the resource needs to be allocated, and a price mechanism can do it.[7] But this does not require exclusive control over a slice of the rainbow.

Spectrum policy is traffic control, not real estate development. It=s about flows, not stocks. A better though still imperfect analogy are taxi cabs. The traditional spectrum approach can be compared to the granting of a limited set of taxi medallions for free, renewing them nearly automatically, permitting an after-market, and restricting the issuance of new licenses in order to protect their value. This fairly exactly describes the notorious taxi-licensing system of New York City, where rates keep going up in order to assure buyers of medallions a proper return, thereby further raising the price of the medallions, etc, etc. An auction system is similar except for the initial mechanism of distributing medallions before the after-market takes over. Flexibility of usage means that the medallion holder can also function as, say, an ambulance. But open access goes much further. It permits any firm to enter taxi services, without license or usage limitation. And to the extent that congestion on bridges or major roads occurs, taxis must pay at tollgates with tokens whose price is set automatically at a congestion-clearing price.

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 can disagree. But, more importantly, 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 Acompelling state interest@ and through the Aleast restrictive means@ that Amust be carefully tailored to achieve such interest.@[8] A licensing scheme, however the license is given out, is a serious restriction on speech. It forecloses the electronic speech of those without a license and puts conditions on the speech of those who

use it. Until now, government licensing could be justified due to the basic assumption that spectrum is a scarce resource. Some allocation scheme was therefore in order. But suppose that assumption becomes invalid? 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 Ascarce@ broadcasting?[9]

In such an environment of abundance (it is not necessary for it to be unlimited), it would be no more constitutional for the state to auction off rights to access the spectrum for speech purposes than it would be for New York City to auction off exclusive rights to hold parades. The licensing legitimacy turns on managing scarcity and policing interference, not on the needs of the state for revenue or control.

But 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 sound waves? To the frequency high A-flat? What is the difference? Preventing interference is based on the Commerce Clause of the Constitution. But what is the basis of asserting ownership?[10] 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.[11]

Different media of communications enjoy varying degrees of protection against government regulations, directly related to the level of its availability and the barriers to entry.[12] Relative to the print media, broadcasting uses an arguably scarce resource. 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. Based upon the premise of technological scarcity of frequencies, the Supreme Court permitted far more regulation of broadcasting than of print, empowering the FCC to regulate access[13] and content.[14] Where such scarcity does not exist, however, such as in cable-casting, even though there may be some other limitations, the Supreme Court refused to extend the broadcast analogy of reduced speech protection.[15] Although the Supreme Court has not yet ruled on the level of protection of cybercommunications, in two recent federal district court cases the Internet, which the court characterized as Aan abundant and growing resource,@ received the First Amendment protection historically accorded to print.[16]

If technology solves the problem of frequency interference and spectrum becomes an abundant

resource, then the limited level of First Amendment protection that over-the-air electronic speech has traditionally received is no longer constitutionally valid.[17]

For a regulatory scheme to be constitutional under a heightened scrutiny standard, the government must show a "substantial" state interest.[18] The government=s interests, beyond raising revenues, is to prevent spectrum chaos. The second test is whether the chosen means places a substantial and unnecessary burden on free speech, and whether there are less restrictive means available.[19] If a less restrictive alternative is available, the government must abandon a restrictive spectrum allocation system.[20]

The Future Problems with Auctions

Today, almost anyone, 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 been used in New Zealand, the US, the UK, Australia, Hungary, and India. Others will follow, no doubt.

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 auctions do have problems.

1. Auctions Inevitably Deteriorate Into Revenue Tools

The political fact is that auctions were approved, after years of opposition to them by powerful Congressional barons, as a measure to reduce the budget deficit and avoiding spending cuts and tax increases. Allocating spectrum resources efficiently was a secondary goal in the political process. Any 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. It is one thing to sell assets (spectrum rights) and re-invest the proceeds. But ours is a situation of funding current consumption through the sale of long-term assets. Auctions are taking money away from infrastructure-providing telecommunications firms and throwing it into the black hole of the budget deficit. 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. But this does not change the fact.

All this develops its own dynamic. The 1996 Telecommunications Act created a Development Fund, aimed at small minority businesses, to be funded from the interest on auction bids. Vice President Gore wants to auction revenues to finance the wiring of schools. Congressman Fields wants to use them for public

television. President Clinton, for school rehabilitation. As this takes place, stakeholder groups emerge and 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 by slowing the entry of new technologies if they threaten auction revenues. It may be an invisible tax on an invisible resource, but its impact on policy will be visible.

When all is said and done, an auction is a tax on the communications sector and its users.[21] Auction advocates deny this, 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.

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.

2. Auctions Encourage Oligopoly

The highest bidders will be those who can organize an oligopoly. This is facilitated by bidding consortia of companies which would otherwise be each other's natural competitors, and who collaborate under some rationale of synergy.

After the auction, the high bidders will 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. Oligopolists will attempt to raise prices in order to recover their bid price and more.

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 tension 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.

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.

3. 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, i.e. 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 technology. 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, 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, etc. 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 Washington-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 to charge an access fee that is set dynamically at a level where the available capacity is fully utilized. 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.

An Example for the Open Access Model

Technologically, the proposed system is not presently available, thought 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 multi-round simultaneous Vickrey auction, either.

Such an open access system might look as follows:

For packets of information to be transmittable, they would require to be accompanied by an access code. Such a code could be a specialized token, a general elctronic cash coin. The token would enable its bearer to access a spectrum band, to be retransmitted over physical network segments, and to be receivable in equipment. Price for access would vary, depending on congestion and be determined by an automized clearing house of spectrum uses. Assumed 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. A can also 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 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 work over wireline 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 local area networks. In these Atoken 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 varies according to congestion. The blocks of information carry these tokens with them, together with the address they seek, and pay (i.e. 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 clearing house. 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), but also carries its own money for transit, picking among various over-the-air and wireline 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 are more like airlines or shipping companies rather than railroad companies. They provide transmission and reception facilities[22] accessible by the information packets at a price. These facilities need not permanently control any particular frequency any more than UPS and Federal Express control a highway or air route.

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 8 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. The resource it distributes is the spectrum endowment which it controls. Access could be acquired in real time. 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 going price, it will receive some form of use authorization. Access could also be available in advance, by 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 assure a certain lesser probability of access. Multiple clearinghouses for different bands are also possible and would provide competition.[23] 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.

Prices might 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 out. The reverse holds true if there is excess demand.[24] There could also be different 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, etc., 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 non-network usage, the presence of transmissions without access codes would be closely watched by their competitors for business and for spectrum access, and violators would be sued or reported.[25]

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, blocks of access codes would

be set aside for emergency communications.

Who gets the proceeds? That is a political decision of allocation. It could be the Treasury (as in the auctions, and with a similar negative potential of use for current consumption), or some earmarked functions. But the difference is that the revenue flow is smoothed, away from the one-shot deals. Instead, the system converts fixed costs of entry into marginal costs of usage. It therefore has a stabilizing function, because prices based on marginal costs are otherwise potentially too low to cover total costs, and hence 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 also exist if a spectrum of owners would resell frequencies in a private resale markets. 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 non-collision rules that are set by statute, common law [26], or agreement of the users. Such an agreement would have less collusive potential, given the transparency of the clearinghouse process open to all users.

Objections to Open Spectrum Access

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 marshaled against auctions that he became a convert (Hazlett, 1995). Smythe rejected the auction as being, "of the realm in which it is merely the fashion of the economists to amuse themselves," and argued that auctions were of technically impractical, citing "intolerable interference on other channels unless the whole is carefully engineered..." (p.100) Today, when open spectrum access is raised as a possibility, the objection of practicality needs to be addressed.

On the regulatory front, some steps in the direction of openess were already 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 the higher transmissions strength of one Watt, provided that spread spectrum technology was used. This led to a very successful expansion of usage. Examples are 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 is accomplished by users following a Aspectrum etiquette@ in real time, based on rules agreed upon by the industry and approved by the FCC. They are, basically, Alisten-before-transmit@ on a channel, Adon=t talk too long without listening again@, and Adon=t talk too loudly@, i.e., limitation on transmission power. A potential user seeking transmission, when encountering a Abusy@ 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 non-profit company, UTAM, Inc., 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 were 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. Both systems propose a built-in etiquette [needs update]. The main weakness of the unlicensed access approach in its present stage is that it deals with scarcity and congestion by a technological Aetiquette,@ 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 re-enact the rise and fall of citizens band 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.

Could an auction winner administer an open system itself?

This would be an appealing alternative route to open access. It would require a competitive spectrum market because if a firm has 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, MCI would not have emerged. In a world with a 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. For meaningful access to be provided by a wholesaler, it would need to control a significant band, which is likely to be unaffordable 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[27] (the only concrete example to date for an effort to institute a resale system), based on recent auctions, a single nationwide Gigahertz would be worth in the U.S. about $300 billion, 12 times the value of the giant RJR Nabisco leveraged buy-out. AIt 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.@[28] Milton Mueller similarly finds that in New Zealand, Aspectrum management rights can be acquired since 1990, but they have not been resold to others@.[29] Only two local bidders showed up for the management auction in New Zealand, the previous monopolists in telecommunications and broadcasting, respectively. 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.

Resale is clearly a step towards 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.

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.

But 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? It is not to stop auctions, 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.

Secondly, resale and spectrum use flexibility should be encouraged 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.

Thirdly, experimentation and innovation should be encouraged. Why not, for example, 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. 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 wireline environment. Open does not mean free or non-profit. Here, too, congestion charges are being considered.

It took Leo Herzel (1951) and Ronald Coase (1959) almost fifty years to see their auction paradigm implemented. Similarly, the proposed open access paradigm is not likely to be accepted anytime soon. But its time will surely come, and fully bring the invisible hand to the invisible resource.

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[1] Professor of Finance and Economics, Columbia University, Graduate School of Business; Director, Columbia Institute for Tele-Information; former new York State Public Service Commissioner; licensed Radio Amateur, Advanced Class. Harvard A.B. (1970); Ph.D. (1975); J.D. (1975).

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[2] Kuhn, Thomas S., *The Structure of Scientific Revolutions,* 2nd ed., Chicago: University of Chicago Press, 1970.

[3] Baran, Paul, AIs the UHF Frequency Shortage a Self Made Problem?,@ Unpublished paper, presented at the Marconi Centennial Symposium, Bologna, Italy, 1995.

[4] Gilder, George, AAuctioning the Airways,@ *Forbes*, April 11, 1994.

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

[6] Noam, 1995

[7] It is a similar problem of pricing necessity discussed for the presently "free" Internet system as it is experiencing congestion problems (MacKie-Mason and Varian, 1994).

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

[9]*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).

[10]Jett, Wayne, AMay God save the Constitution (With Our Help) From its Friends.@ unpublished paper, 1996.

[11]For an exception, see Jett, *ibid.*

[12]*New York Times Co. v. United States*, (APentagon Papers@), 402 U.S. 415 (1971).

[14]In *Pacifica*, the Supreme Court upheld a governmental ban of indecent materials on radio broadcast.

[15]In Turner, where the issue was the constitutionality of the AMust-Carry@ rules in the Cable Television Consumer Protection and Competition Act of 1992, the Supreme Court found that the rationale for low First Amendment protection for broadcasting -- spectrum
scarcity and signal interference -- does not apply to cable regulation. The Court, therefore, held that cable should receive more free speech protection than broadcasting, but still not as much as that reserved for print.

[16]A three-judge panel in the Eastern District of Pennsylvania invalidated the Common Decency Act, recently passed as Title V of the 1996 Telecommunications Act. *ACLU v. Reno*, 1996 U.S. Dist. LEXIS 7917 (E.D. Penn. 1996). *Shea v. Reno,* 1996 U.S. Dist. Lexis 10720 (SDNY, 1996).

[17]The Supreme Court recognized in *Denver Area Educational Telecommunications Consortium,, Inc. v.*

FCC that the First Amendment Ahas been applied to new circumstances requiring different adaptation of prior principles and precedents.@ 1996 U.S. LEXIS 4261. It is difficult for government regulations to pass the strict scrutiny test.

[18]*Turner Broadcasting System Inc. V. FCC.*, quoting from *Ward v. Rock Against Racism*, 491 U.S. 781, 15 L.ed. D. 661, 19 S. Ct. 2746 (1989).

[19]In *Denver*, 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 Apatently 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 (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.

[20]An openness to spectrum is not the creation of Acommon carriage@for spectrum. Common carriage means the nondiscriminatory provision of service by a private entity to others. Here, we are dealing with the fundamental rights against the state. Common carriage applies with respect to Delta Airlines. The freedom to travel applies with respect to government.

[21] 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*, January 12, 1994 p. 26

[22] Shelanski and Huber, 1996

[23]Different frequencies have different characteristics making them suitable or unsuited for certain types of applications. Some of these frequency characteristics are in-building penetration of the frequency, antenna size, cost of radio components, effects of atmospheric and climatic conditions, usable coverage, bandwidth and speed of transmission.

[24]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.

[25]Spectrum-agility would not dispossess existing frequency licensees. 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 buy out existing licenced users.

[26] Huber, Peter []. Oxford University Press, forthcoming.

[27]Robert W. Crandall, *New Zealand Spectrum Policy: A Model for the United States?* In this volume.

[28]Ibid, p. 6.

[29]M. Mueller, ANew Zealand=s Revolution in Spectrum Management,@ *Information, Economics and*

Policy, vol. 5, 1993, pp. 159-77.