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TOWARDS A PROPERTY RIGHTS APPROACH TO COMMUNICATIONS SPECTRUM

by

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I. Introduction

These days, E.T. would be trying to phone home with a cellphone. Not because it's fashionable, but because of sheer probability. Around the world, whether in developed or developing nations, more wireless phones are added per year than wireline phones. Coupled with increased demand for other wireless communications solutions (wireless Internet and LANs, terrestrial and satellite television to name a few), this has resulted in a revolutionary increase in the demand for overall spectrum usage. This demand requires technological as well as regulatory solutions.

On the technological side, major innovations have increased the efficiency of spectrum bands currently in use, as well as allowing bands which were hitherto unusable to be switched from low-value uses (e.g. outside broadcast relays) to high-value uses (e.g., wireless local access). As usual, though, regulatory changes follow technology and demand changes with a substantial lag. The increased technological flexibility has exposed the ossified structure of spectrum regulation, requiring regulatory changes if ever-increasing welfare losses are to be prevented. Equipment that before could be only utilized in a particular band, now can be utilized relatively efficiently in various bands, while innovation is bringing communications solutions in bands hitherto either unused or used for other purposes. Thus, the traditional model of awarding a license to operate a given service in a given band is fast becoming a barrier to innovation as new technology allows the utilization of that band for an alternative, and probably more lucrative, use. These technological shifts have revealed a large latent consumer demand for wireless applications, which increased as wireless solutions gained acceptance.

Regulators throughout the world have responded predictably to this increased demand, using spectrum (as any other resource controlled by government) to maximize political support. The increased demand has only increased the political value of spectrum. Thus, regulators have been busy adjusting band plans, reallocating license holders onto alternative bands, auctioning cellular, PCS, WCS, DBS, MDS and other licenses, while protecting incumbents, especially broadcasters, and in general attempting to handle this technological revolution through administrative means. The outcome, while predictable from a political economy perspective, has generated large rents for incumbents, both wireless and wireline operators, restrained competition in the global telecommunications market, and maintained the regulatory machine in place, while at the same time bending enough to accommodate some of the increased demands.

The purpose of this paper is threefold: first, to provide an analysis of the inefficiencies associated with the administrative allocation of spectrum usage. Second, to provide what we believe are the blueprints for a property rights approach to the allocation of spectrum; and finally, to describe the status of the implementation of such an approach in Guatemala and in New Zealand.

II. Administrative Spectrum Allocation: Keeping the Political Rents Flowing

Telecommunications regulators have kept the political rents from spectrum allocation flowing by restricting access to the spectrum and by limiting the type of uses allowed for each specific spectrum band.

There are good reasons to restrict access, mostly to prevent a 'tragedy of the commons'. Without some access restrictions operators will be interfering with each other, as was the case during the "free for all" period in the early 1900.[1] But as Hazlett (1990) discusses, limiting interference does not require traditional command-and-control regulation. A much simpler method, which we discuss in more detail below, is to create a fully-fledged spectrum property right, granting the spectrum holder the right to use a particular band in any way in a particular geographic area, subject to particular limits on outputs, such as signal to noise ratios.[2] Once these three features of a title are specified, interference can be handled through access to tort law. [3]

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[1] For a good discussion of the period, see Hazlett, Thomas W., 1990, "The Rationality of U.S. Regulation of the Broadcast Spectrum," vol. XXXIII, *Journal of Law & Economics*, pp:133-175.

[2] As De Vany *et. al.* pointed out, the first step in defining property rights is defining the rights in terms of outputs rather than inputs. See De Vany, Arthur, R.D. Eckert, C.T. Meyers, D.J. O'Hara, and R.C. Scott, 1969, "A Property System for Market Allocation of the Electromagnetic Spectrum: A Legal-Economic-Engineering Study, *Stanford Law Review* (3): 145-162, For example, current FCC authorizations specify antenna height and directionality, maximum effective radiated power, and many others, all inputs. The output is the strength of the broadcast signal in the licensee's coverage area and in neighboring areas. An interference problem arises when a licensee A's signal in area B is so strong relative to licensee B's own signal, that the signal-to-noise ratio experienced by B's receivers is unacceptable. Thus, interference provisions are better specified in terms of outputs.

[3] Time could be added as a fourth dimension.

Regulators, however, have restricted access in more subtle ways. In most nations, regulators have been reluctant to allow trading of spectrum titles, both within and across usage. In the United States' telecommunication law, for example, there are specific provisions against "trafficking" and stockpiling.[4] Although difficult to enforce, limits on resale imply that operators with better capabilities to operate a business will not have easy access. Similarly, only recently, and only for very specific applications, has the FCC allowed the partitioning of spectrum bands and its sublease and resale to third parties. Without allowing titleholders to partition their titles in either the time, geographic or frequency dimensions, the ability to extract better use of the spectrum is limited.[5]

There are, however, no good reasons for imposing usage restrictions on specific bands. Regulators, as well as some equipment manufacturers, defend these restrictions also on "interference" grounds, spouting the common refrain that “without usage limitations, the potential for interference is too large, requiring complex monitoring, etc. etc.”[6] This, however, as Hazlett (1990) made it quite clear, is a vacuous statement. As long as individuals or entities may be sued and fined for trespassing on an other’s spectrum rights, spectrum users will have incentives to respect the rights of their spectrum neighbors. The bald reality is that limiting usage provides regulators, or the politicians controlling them, with large political rents to distribute as they see fit. This, and not interference, seems to be the main reason for the long live of access restrictions.

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[4] See Shelanski, Howard and Peter Huber, 1997, “The Attributes and Administrative Creation of Property Rights in Spectrum,” forthcoming, *Journal of Law Economics and Organization.*

[5] The FCC has allowed television and radio broadcasters to perform subcarrier transactions, allowing them to carry paid-for information, such as elevator music or data transmission, in the spare space in their signal not used by the main signal (the vertical blanking interval for TV and the subcarrier for both TV and FM radio). Use of the subcarrier was first permitted in 1955, and largely deregulated in 1983. See Minoli, Daniel, Telecommunications Technology Handbook, Artech House, Norwood, MA, 1991, pp. 256-266. The FCC has also allowed partitioning of rural cellular licenses amongst consortia of rural wireline incumbents, and allowed cellular operator to choose their own digital air interfaces (rather than forcing the use of a nationwide standard, such as GSM in Europe), see Calhoun, George, Digital Cellular Radio, Artech House, Norwood, MA, 1991, pp. 100-114.

[6] See, for example, Comments of Nacional Association of Broadcasters, FCC Docket MM 93-132 at p. 73.

Consider, for example, the case of a Mexican wireless operator, Iusacell, which obtained a radio dispatch license for Mexico City in the 1950s.[7] Eventually (with the growth of cellular telephony) this wireless application lost its financial appeal, and the service was left to decline. With an investment by Bell Atlantic of one billion dollars, Iusacell renewed its interest in operating the radio license but with a different use, this time to provide fixed wireless local access services. As the license did not allow it to change uses, Iusacell requested a license modification. Although Iusacell claims that the government had promised that it would be allowed to operate the new service with the existing license, the regulatory agency never granted the necessary license modification, and as a consequence this spectrum has remained essentially unused.

Why would a regulator prevent a minor change that would surely seem to promote consumer welfare?[8] Both reasons are tied to the large rents involved. Refusing the modification would protect the rents of the incumbent wireline operator, Telmex, and allow extraction of the substantial windfall gains accruing to the licensee from the modification. The extraction of these rents can take various forms: since the licensee is willing to pay for the license modification, these payments may take the form of direct monetary transfers to the treasury, of political payments contributions or of any combination.[9] Reportedly, this license modification will now take place only after the auction of approximately 300 MHz of communications spectrum in the 450 MHz, 1900 MHz and 3.4-3.6 GHz bands, and it will require Iusacell to make a payment proportionate to the per-pop prices realized for similar spectrum in this auction.

The interference argument as a way to limit access to the spectrum and to limit usage changes, then, is nonsensical. Instead, political economy considerations explain why restrictions on spectrum utilization are almost ubiquitous regulatory forms: their purpose is to redistribute rents. Rent distribution, though, is conflicting with technological change and with the explosion in demand for spectrum.

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[7] *Id.*

[8] The regulator in this case would have had merely to strike out the requirement that users be mobile, and the requirement that users broadcast with a minimum power of 10 watts. Note that this was not a maximum power requirement, and therefore it was not an issue of interference protection.

[9] As it turned out, the head of Iusacell fell of grace with the administration, thus, political contributions were out of the question.

This conflict, however, is not the first time when technological change and regulatory procedures have crashed head on. Usually, regulators win, at least for a long while. Consider the introduction of cellular services. While cellular technology was developed by the Bell Labs in the 1950s, it took until 1968-70 for the FCC to authorize cellular service and "pry 110 loose MHz of upper UHF TV from the broadcasters."[10] In 1981, the FCC created the class of commercial cellular radio telephone service, designating 50 MHz of spectrum in the 800 MHz frequency band for two competing cellular systems in each market (25 MHz for each system).The FCC, however, decided to use the process of comparative hearings for the first 30 markets, whenever there was more than one applicant (and there were many such cases). The FCC moved to lotteries for the remaining markets, but even then, it was not until 1984 that operation began for most major markets. By then, though, the AMPS standard put in place by the FCC was becoming obsolete.[11,12] The hearings and lotteries dragged out slowly, with the FCC doling out first metropolitan licenses, and only then rural ones, delaying the build of many rural systems until 1990-92.

On the other hand, in the Nordic countries cellular technology was introduced earlier, with Sweden and Norway beginning service in 1981, and Denmark and Finland in 1982. As a consequence of both the earlier introduction of cellular service (a head start of 3 to 11 years, depending on how one characterizes the FCC's gradual release of licenses) and the relatively higher prices of landline services, the penetration today in the Nordic countries stands at roughly twice that of the US, as shown in Table 1 below:

[10] See Calhoun, George, Wireless Access and the Local Telephone Network, Artech House, Boston MA, 1992, p. 580. Calhoun points out that that the FCC fashioned SMR and other allocations, as well as cellular, from this single concession from the broadcasters.

[11] The AMPS standard used essentially the same technique as conventional analog FM radio in mono.

[12] See Calhoun (1992), *op. cit*, p. 580.

Table 1:

Comparison of Cellular Penetration Rates in Selected Countries[13]

Country	Start Year	Penetration (1/1/97)
Norway	1981	28.6%
Sweden	1981	27.8%
Unites States	1984	16.8%
UK	1985	11.7%
Italy	1985	11.2%
Western Europe[14]		**9.2%**
Germany	1985	7.1%
France	1985	4.3%

Regulators, however, have been adjusting to these massive technological changes. In the US, the FCC has been bending its procedures in response to substantial pressure from both wireless operators, who take their cases to the courts, and most often win, and to some extent from Congress. Wireless operators have been pressuring the FCC to relax its rules concerning license resale, band fragmentation and usage changes. The FCC has, often prompted by judicial reversals, slowly bending its ways. For example, it allowed Nextel to provide a wireless digital service over frequencies that were originally licensed for radio dispatch services. It has also allowed Direct Broadcast Satellite (DBS) licensees substantial flexibility to fragment and lease their spectrum rights. Similarly, it has granted PCS licensees substantial flexibility in their choice of technologies.[15] A major shift in FCC frequency assignment procedures has been the policy of auctioning spectrum licenses. The Congressional mandate to auction spectrum was introduced in the budget bill of 1993. It was, however, not the first such mandate, as spectrum auctions had been used earlier in Australia and New Zealand. Auctions, now, have proliferated throughout the world.

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[13] Data from Donaldson, Lufkin, Jenrette, The Wireless Communications Industry, Spring 1997, p.15, 60.

[14] This population-weighted average also includes all other Western European countries (including former East Germany, Switzerland, Austria, and principalities).

[15] For a discussion of the FCC's movement towards more flexibility, see Shelanski and Huber, 1997, *op cit.*

Although pundits and scholars alike have attached much importance to the shift towards auctions, it is unclear whether auctions by themselves are such an important regulatory change. Auctions are clearly superior to the prior ways of assigning spectrum licenses, whether by lotteries or by administrative hearings, in that some of the transaction costs associated with transferring the licenses to those that can best use them are reduced, particularly if the FCC restricts how license transfers. On the other hand, auctioning service licenses, like auctioning licenses for cellular services, does not change the nature of the FCC spectrum allocation: it still restricts access and usage changes. Although the licensee will probably be the operator with the highest current valuation for the object, the licensee will still be restricted in its ability to change services, to fragment the spectrum, and in general to adapt to future technical and market conditions. Thus, auctions by themselves do not facilitate the regulatory adaptation to technology. What is needed is a more drastic change in the regulatory approach, which has been implemented by certain countries, in particular Guatemala and New Zealand. We discuss their approach and experiences below.

III. The Welfare Cost of Administrative Assignment of Spectrum

Assigning spectrum through administrative procedures generates welfare costs in various forms. First, it grants rents, which will tend to be dissipated through lobbying and other economic and political actions. Second, by assigning frequencies to particular uses it distorts technological change, as equipment producers will concentrate in developing equipment for particular uses in those bands for which those uses are allowed, independently of whether that is the most efficient way of utilizing the spectrum. The endogeneity of equipment innovation to regulatory specifications implies that we currently have a stock of equipment which is more inflexible in its utilization across frequency bands that would have been the case if the market would determine the service or use that each frequency band would be utilized for. Equipment rigidity, however, creates further rents across spectrum bands, which in turn translate into social costs. These rents can be assessed by looking at the different valuations across spectrum bands. For example, consider two frequency bands for which there is equipment that allows it to provide similar services. This is the case for frequencies in the range 470-820 MHz which are currently reserved for UHF television (but often lay totally unused). These bands could also be used to provide cellular services. Kwerel and Williams (1992) have

estimated that reallocating just six MHz from TV to cellular use would have increased consumer surplus by at least 600 million dollars (in 1991 prices) from 1992 to the year 2000.[16] Essentially, Kwerel and Williams (1992) assess the fact that while, circa 1992, a MHz for UHF TV can be purchased for $6 million, a MHz for cellular services fetched from $70 to $160 million. This difference in valuation for spectrum that could be used for a higher value purpose means that there is a large social cost associated with administrative spectrum assignment.[17]

IV. The Basic Building Blocks for a Property Rights Approach to Spectrum Allocation

The idea of a property rights approach to spectrum allocation is not new. The first to suggest a property rights approach in print was Leo Herzel in his 1951 article on the regulation of color television.[18] Professor Herzel's ideas did not fare well, nor did Ronald Coase's own writings and speeches on the subject who were heavily influenced by Herzel's pioneer work.[19] Indeed, it took 37 years for these ideas to take root in a particular piece of legislation. The first legislation that introduced the idea of a property right approach to spectrum utilization was the 1989 Radio Communications Act of New Zealand. This legislation introduced, for the first time in history, the concept of tradable rights as a substitute to administrative licensing schemes.[20] Seven years later, El Salvador and Guatemala introduced legislation pushing further the idea of tradable

[16] See Kwerel, Evan R. and John R. Williams, 1992, "Changing Channels: Voluntary Reallocation of UHF Television Spectrum" Office of Plans & Policies Working Paper Series, Federal Communications Commission, Washington DC.

[17] Similarly, the large differential in the market value between UHF and VHF licenses can be attributed to artitificial scarcity introduced promulgated by the FCC.

[18] Herzel, Leo, "'Public Interest' and the Market in Color Television Regulation," *University of Chicago Law Review*, 18, pp:802-16. See, also, his assessment of how he reached his conclusions in Herzel, Leo, 1997, "My 1951 Color Television Article," forthcoming, *Journal of Law and Economics*.

[19] See, in particular, Coase, Ronald, 1959, "The Federal Communications Commission," *Journal of Law & Economics*, II, pp:1-40. See also, Professor Coase's own assessment of his FCC article in Coase, Ronald, 1997, "Comment on Thomas W. Hazlett," forthcoming, *Journal of Law & Economics*.

[20] See Crandall, Robert W., 1997 "New Zealand Spectrum Policy: A Model for the United States?", forthcoming, *Journal of Law & Economics.*

rights.[21] Differing from New Zealand, in both El Salvador and Guatemala all spectrum not currently assigned to broadcasters became subject to licensing under tradable permits without usage restrictions.

To understand whether these regulatory changes are revolutionary or not, it is important to discuss what are the basic building blocks that will permit the development of a market for tradable permits in spectrum without usage restrictions.

There are three basic building blocks for the creation of a working market in tradable spectrum permits:

a) Right to sell, fragment or lease, in other words, right to property;
b) Right to use over right to provide a service;
c) Handling of interference problems, in other words, prevention of trespassing.

We discuss them seriatim.

i. Right to Property

The first issue to discuss is property over what? The traditional administrative assignment of spectrum rights consisted on specifying the use for which the spectrum would be utilized,[22] the frequency band, time of broadcasting, power, location of the transmitting facility, and if appropriate its directionality and location of the receiving antenna. This right could be construed as property if it were allowed to be sold at will.[23]

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[21] The authors helped design the reforms of the telecommunication sectors and draft the Telecommunications Laws passed in 1996 by the legislatures of both countries.

[22] Traditionally there have been a sharp distinction between broadcasting and communications. The introduction of broadcasting technologies for communications (i.e., cellular, PCS, etc.) has made a mockery of this regulatory difference.

[23] The right would, under some conditions, have very little value in alternative use. For example, a right to a point to point transmission over a certain frequency from the headquarters of a particular company to one of its branches would have very little value in alternative uses, as a buyer of that right interested in using it for an alternative use will have to obtain also the right to retransmit from the two end-points to the two end-points the buyer is interested. Under other conditions, it could have a large value, in particular if the permits involve broadcasting types of services, like radio, TV, satellite, or mobile telephony licenses of any sort.

A property right approach to the spectrum would grant the right to transmit over a particular frequency band, over a particular geographic area. The right to transmit goes hand in hand with the right to receive free of interference.[24]

The right to transmit at a particular frequency band over a particular geographic area, however, is not enough to assure flexibility and innovation.. For spectrum utilization to be transferred to the highest use value, it is necessary that this right be transferable as well as fragmentable. For this right to be fully transferable and fragmentable, the right cannot be specified in terms of service, but rather in terms of usage or outputs.

ii. Right to Use over Right to Provide Service

To some extent the right to use rather than to provide a particular service is the most drastic departure from the standard administrative spectrum allocation process. As discussed before, only recently, and only for very specified spectrum bands, has the FCC provided service flexibility to licensees. [25] Thus, although the FCC has moved to some extent towards a right of use doctrine, such move has been haphazard, hesitant and ad-hoc. This right, though, is essential for new technologies to be introduced rapidly.

iii. The Handling of Interference

As discussed above, though, the laws of physics do not allow for an easy definition of the boundaries of the right to transmit. This is particularly problematic for two of the three dimensions of the right: the geographic area and the spectrum band.

Under a property rights approach as that outlined by De Vany et. al. (1969),[26] spectrum users should care about outputs, in this case, the signal strength in their defined coverage area. But even regulating signal strength directly may be an unwarranted intrusion in individual economic liberty – why not apply the famous maxim 'your liberty ends where my nose begins' to the domain of spectrum rights? What is needed is a clear set of rules

[24] The right should also imply a right to prevent undesired reception. On this, see, Shelanski and Huber, *op cit., supra.* 4.

[25] The FCC, for example, reclassified (with Congressional authorization) SMR licenses as Commercial Mobile Radio Service (CMRS) licenses, permitting dynamic sharing and interconnection to the PSTN of dispatch radio channels. Other countries have followed in increasing flexibility. Chile, for example, in the granting of PCS licenses has left, as in the US, at the discretion of the licensee the decision of what technology and of what type of service to provide over those spectrum bands.

[26] See De Vany et.al., *op. cit. supra* note 2.

that defines individuals right to private "enjoyment" of their spectrum, allowing action by others which interfere with such enjoyment to be punishable through tort law.

The important characteristic of a broadcast signal is the received signal to noise ratio (SNR), because, as determined by Shannon's Law, the information content of a radio signal (to common users, its quality) is a logarithmic function of the received signal to noise ratio. As the signal progressively weakens relative to surrounding noise, degradation accelerates. What is needed, then, is SNR protection, and this is what the FCC tries to do in its engineering function. When a request for a new transmitter license comes in, the FCC plugs into its engineering models data on all the surrounding transmitters, plus the new one, as well as terrain data, and attempts to compute whether existing licensees' SNR will be adversely affected and sufficiently good SNR can be afforded to the petitioner.

Under a pure property rights approach, this detailed engineering by regulators could be rendered unnecessary by simply distributing the SNR rights, and letting the spectrum holders figure out to what uses their spectrum may be put without infringing on their neighbor's rights. In a sense, the basic limits to a right holder are the rights of the other right holders. Each right holder's right to transmit free of interference limits what the other right holders can do. But the concept "free of interference" is also not well defined, and will naturally depend on the application that a particular right holder is doing of its spectrum right. A right holder who uses its spectrum for a very low power application, will receive interference from multiple sources. Thus, to avoid being interfered, and to avoid interfering with others, the right to transmit over a particular geographic area, time, and spectrum band has to be also limited by a set of minimal technical configurations. Unfortunately some residual regulatory engineering will be required, as the SNR right is relative and not absolute. A user might experience a poor SNR, but it could be because she is using insufficient transmission power, and not due to malfeasance (i.e., interference) from her neighbors.

The right therefore needs to be framed in terms of a specific enforcement effort made by the user.[27] A practical means to do so is to specify a reference signal strength, which is measured in practice by the field strength (FS). Provided that the right-holder is at

[27] In the same way that individuals should use precautionary measures to avoid being hit by a car.

maintaining her minimum FS, she enjoys a right to the minimum acceptable SNR. These two parameters, in turn, determine the maximum strength of the background noise.

A further requirement is necessary, however, as noise from multiple sources is cumulative, and it would de difficult to ascribe to a particular source the effect on quality degradation. This noise externality would rapidly escalate power levels, as users try to drown out background noise with ever increasing transmitter power. The chain of events is very similar to a crowded cocktail party, where very soon everybody has to shout to make themselves heard over the din. The spectrum property right needs therefore to specify a maximum signal strength. Again, we should regulate outputs, not inputs. Instead of the detailed FCC-type regulation of antenna heights and transmitter power, it is simpler to specify (1) a maximum field strength at the boundary of the coverage area (to protect geographically adjacent users of the same frequency from co-channel interference), and (2) maximum levels of out-of-band emissions (to protect users of adjacent frequency bands in the same area from adjacent channel interference).

This framework also gives us a natural definition of a coverage area, which could be specified in terms of certain field strength.[28] But nowhere has it been said what the "natural" S/N ratio should be for a particular frequency band at a particular time of day in a particular geographic location. Thus, some amount of engineering is required by the regulator when crafting the original rights, simply to ensure that the set of original rights is not conflicting, and that the defined rights are actually useful (power levels could be set too low, just as zoning restrictions can sometimes kill commercial development). But that is as much as needs to be specified. A right-holder would retain the individual determination as to whether to maintain the minimum field strength (and thus enjoy the minimum SNR protection), and whether to do this through many small transmitters, or one large one.[29] With these two technical configurations, we can then define “injurious interference.” Injurious, or prejudicial, interference is the one that violates the right holder's right to transmit and receive free of interference, given the technical characteristics of its right.

[28] This approach is already used by the FCC and other agencies, requiring TV and radio stations to file charts showing their signal’s field-strength contours.

[29] Changes to these technical restrictions could be adopted as long as "neighboring" spectrum holders do not object.

This discussion, then, shows that if a particular right holder is transmitting in a geographic area and in a spectrum band with no "neighbors," whether in the spectrum dial or in the geographic area, it can substantially increase its power without creating injurious interference. Thus, there is no need to set power limits, as done in the standard administrative process. If, however, a new right holder shows up next door, then, the original right holder will have to adjust its transmission to avoid interfering with its new neighbor.

Although most countries have set maximum power levels for each transmitting antenna, interference is the rule of the day in most developing nations. The obvious reason is enforcement of transmission rights. Thus, to have a well functioning market for transmission rights, a method to enforce of such rights must be developed. With well working judiciaries, clear liability and appropriate penalties would be enough. Indeed, injurious or prejudicial interference is a tort. And the US Supreme Court recognized it as such more than 50 years ago, utilizing no more than common law.[30] Thus, in the same way that companies sue each other for patent violation, for industrial secrets, for breach of contract, or individuals sue each other for injuries arising from car accidents, companies could sue each other for prejudicial interference, and obtain compensation for damages.

It could be said, that in the same way that suing for car injuries does not stop uninsured motorists from driving and imposing damage on others, that the threat of legal action for prejudicial interference would not deter pirate transmissions. While valid, this concern does not take into account that pirate transmissions are difficult to avoid even under today's administrative assignment procedure. Furthermore, in a property right environment, right holders could collect damages from the violator of its right. Thus, differently than today, right holders will have an extra incentive to find and prosecute those broadcasters that interfere with their transmission rights.

In environments in which courts are not very effective, alternative methods of resolving prejudicial interference could be designed. Guatemala and El Salvador developed an administrative procedure to resolve such interference. Their solution is to use private

[30] See, *Tribune Co. v. Oak Leaves Broadcasting Station*, a 1926 Cook County, Illinois, Circuit Court decision. See, also, Hazlett (1990), *op. cit., supra note* 1, for a discussion of this issue, and in general of the evolution of US regulation of the spectrum.

companies to provide evidence on prejudicial interference. With such evidence, right holders may request from the spectrum agency that the prejudicial interference be eliminated. A trial-type process ensues in which the presumed violator has to either show that it is not currently violating the plaintiff's right, or pay a pre-specified fine. The original burden of proof is on the plaintiff, who has to show not only the existence of prejudicial interference, but also its source.[31]

V. The International Experience with the Introduction of Spectrum Property Rights

i. The New Zealand Experience

New Zealand's 1989 Radiocommunications Act set up the first experiment with spectrum property rights.[32] The Act authorized the Ministry of Commerce to introduce tradable rights as a substitute for the traditional administrative assignment process. This scheme has been called the "spectrum-management" approach. In this approach spectrum segments are sold to spectrum managers, who in turn resell or rent the right to utilize their spectrum to third parties.

Since the passage of the 1989 Act, New Zealand has moved relatively slowly towards a property rights approach. On the one hand, it has sold only a small amount of the spectrum to private individuals under the spectrum management approach, using mostly simultaneous second (and later, first) price auctions. Most spectrum, however, is still administered under the old administrative process.

Although successful in transferring the administration of segments of the broadcasting spectrum to the private sector, there have been substantial problems with this effort. First, so far spectrum managers have failed to do much management, with few transactions taking place. Crandall, 1997, *supra*, reports that the MDS management rights lie almost completely fallow,[33] although their holders paid approximately $800,000 for the rights.

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[31] To make this process work, all transmission devices have to be registered with the spectrum agency, so that presumed violators could be identified.

[32] See Crandall, 1997, *op cit.* for a discussion of this experience.

[33] There have been only minor uses for non-video transmission. Crandall, 1997, *op cit.* p.22.

Second, the auction mechanism utilized by the Ministry of Commerce created substantial political concerns, as there were large differences in prices for similar objects. In other instances bidders paid less than half their winning bid, while in other instances bidders entered very high bids accompanied by lower bids to assure winning the auction, but with lower bids so that their final price not be that high.[34] As a consequence, there was substantial amount of strategic defaulting, whereby a winning bidder defaults so that the property is transferred to its own lower bid, who in turn pays the bid below it; there were also complaints of collusion;[35] and others obtained properties for zero price.[36]

Overall most of the criticism of the New Zealand effort has been centered in its auction system, and the fact that it raised substantially less that was expected and, seemingly, less than what the US raised for similar bands. But, as Crandall (1997) shows, once corrected for population and band differences, the differences in average prices between US and New Zealand auctions may reflect the higher per capita income of the US.

The reasons for the lack of substantial private reassignment of the spectrum are unclear. On the one hand, the spectrum management approach may have been applied in the wrong bands. It could well be the case that the bands for which spectrum management would work best is for those where the standard administrative assignment would be most difficult, like in point-to-point uses. It is unclear whether in the cellular or MDS segments selling large spectrum segments does not create potential competition problems. Indeed, given the smallness of the New Zealand market a policy that tends to concentrate spectrum in few hands may not be the most desirable policy. It is in this respect that the Guatemala experience may be more instructive.

ii. The Guatemala Experience

In 1996 the National Assembly passed a revolutionary General Telecommunications Act. The 1996 Act completely deregulated the telecommunications market. It allowed free entry into all segments of the service, it required operators to grant access to a limited set of essential resources (basically, origination and termination services) based on private

[34] It is not clear that this was a rational strategy, but was nevertheless utilized.
[35] See Crandall, 1997, *op cit.*
[36] This was the case of a college student who entered a bid for a TV station. Since no one else bid, it was granted the license for zero price, as it should have been the case. See Crandall, 1997, *op cit.*

negotiations to be arbitrated by the regulatory agency under very specific and narrowly specified guidelines, [37] and introduced a property rights approach to spectrum utilization. Spectrum rights would be granted in fully transferable and fragmentable frequency usage titles (TUFs for Títulos de Uso de Frecuencias). The TUFs will have no "service" limitation, but will have technical limitations to protect against prejudicial interference.

The basic building blocks of Guatemala's approach to the spectrum is that all spectrum not currently assigned to the government, to radio and TV stations, to other license holders, or defined as "free", can be requested by any person.[38] Following a request, the regulatory agency must determine whether this request does not infringe on any other person's rights, and if it so decides, a period of protest opens up where other interested parties may object to the granting of a right. The objection may be for two reasons. First, it may be the case that such person already has a right which would be violated by the request. Second, that person may also want a portion of the requested spectrum. In the former case, if the protest is substantiated, the request is not granted. In the latter case, the regulator must start an auction procedure. The law requests from the regulator that if fragmentation would promote competition, that it auctions the requested spectrum in a fragmented fashion. The law also requests that in this case, the auction be of a simultaneous, ascending multiple round format.

Since the law came into effect in January 1997, the regulatory agency faced more than 7,000 requests for spectrum use rights. Although the law specifies a very fast process, with approximately four months being the supposed maximum time that it may take from request to auction, in fact the law does not penalizes the agency for delays. As a consequence, the auction process has been a little more drawn out.

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[37] Under pressure to privatize the national incumbent operator, the Guatemalan legislature passed in late 1997 reforms to the General Telecommunications Act that have the potential to substantially limit competition in international telecommunications services, and to makes interconnection negotiations more difficult to resolve. These reforms did not change the spectrum allocation policy.

[38] For obvious political reasons, radio and TV stations were grand-fathered, being granted rights of use of their spectrum bands. Other private concession holders would not be able to renew their concession upon expiration.

The SMR Auction

The first auction started in June 4th, 1997, and lasted for two weeks.[39] The auction was for 20.8MHz of nationwide spectrum in the 800 MHz range, which currently is used in the region for "trunking" or specialized mobile radio (SMR).[40] There were initially 11 bidders, 10 companies and one individual. Of the 10 companies, one was the national telecommunications company, GUATEL. The bidders deposit payments that allowed them to bid initially for more than 60 MHz. The 20.8MHz of spectrum was fragmented in pairs of outbound and inbound bands, and also in two types of bands, seven band pairs of 1 MHz each, and twelve band pairs of 200 kHz each. The 1 MHz bands were contiguous as were the 200 kHz bands. The auction ended after two weeks of intense bidding, with total payments of almost $3 million (17.2 million Quetzals). Seven, out of the initial eleven, bidders won at least one lot.

It is interesting to compare this result to the auction results in the US. The population of Guatemala is approximately 11 million people, its average per capita income is just three thousand US dollars. Thus, on a per MHz/POP, the Guatemala auction resulted in a value of approximately 1.2 US cents. A similar auction in the US has resulted in 24.5 US cents per MHz/POP.[41]

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[39] The authors participated in the design of this particular auction. The auction was carried out with *LAMP*®, a software tool developed by the Law & Economics Consulting Group, Inc.

[40] Specialized Mobile Radio (SMR) is terrestrial mobile communications system originally designed to operate in "dispatch" mode, allowing two-way, communications between a group of mobile and/or fixed users, such as taxicabs or security guards. The users agree on a given frequency channel, and they can all listen in, and take turns using that channel for transmission. Each end user or group of users is allowed the use of only one channel, so that if the end user's assigned channel is already in use, the user must wait until the channel is available to transmit. With “trunked” or “enhanced” SMR (ESMR), microprocessors in the handsets scan multiple frequency channels, automatically searches for an open one, allowing more users to be served at any one time. The system is also interconnected to the PSTN, permitting ESMR users to dial PSTN users, as well as dialing other end-users on the ESMR system, instead of broadcasting to all users in the group. While ESMRs are currently mostly used for cellular-like voice communications, digital systems are also being developed for data, facsimile, two-way acknowledgment paging and inventory tracking, credit card authorization, automatic vehicle location, fleet management, inventory tracking, remote database access, and voicemail services.

[41] The FCC’s SMR auction consisted of 20 ten-channel blocks (10 x 2 x 12.5 kHz = 250 kHz per block) in the 900 MHz band in each major trading area. The auction lasted 168

Table 2:

Comparison of SMR Auction Results in the US and Guatemala

Country	$GDP/head	Population (million)	MHz-POPs Auctioned[42] (Millions)	Auction Proceeds (US$ MM)	SMR price (¢/MHz-POP)
Unites States	27,607	266	830.7	204	24.6
Guatemala	3,080	11.3	235.0	2.8	1.2
Ratio	9x				20.5x
US premium					2.3x

Although the spectrum bands auctioned are not directly comparable due to variations in equipment standards,[43] we find the comparison telling of the importance of the property rights approach. Adjusting roughly for the very large differences in personal income, the realized price per MHz-POP in the US was just over twice that in Guatemala. This premium can be understood as resulting from a number of factors: the higher fragmentation of the US auction (blocks were much narrower); the relative scarcity of SMR spectrum in the US (Guatemala auctioned over six times as much effective spectrum); the higher proportion of the US population employed in the finance, insurance and retail trades (FIRE);[44] and environmental factors such as the greater monetary, political and regulatory stability of the US.

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rounds, closing in April 1996. Notably, incumbent licensees in the band retained the right to operate under their existing licenses and the right to co-channel and adjacent channel interference protection. The new licensees were awarded the right to authorize expansion of existing systems. The FCC published as part of the bidders' package its estimates of the extent of incumbency for each block and MTA, while disclaiming any responsibility for the accuracy of this information, cautioning bidders to do their own research. The FCC estimated that on average only 3 of the nominal 5 MHz were usable.

[42] The US data are adjusted for incumbency according to the FCC's published estimates.

[43] SMR commonly operates in either the 800 MHz or the 900 MHz band. Systems in the 800 MHz band use two paired 25 kHz channels, while 900 MHz band systems use two paired 12.5 kHz channels. Because of the different sizes of the channel bandwidths between the 800 MHz and 900 MHz systems, traditional SMR equipment is band-specific and incompatible with the other. The narrower channel bandwidths in the 900 MHz band also tend to result in better spectrum utilization.

[44] Cardilli et. al. (1997) show that the value of SMR spectrum in the US auctions bears a strong positive relation to the proportion of the labor force employed in the FIRE

In fact, these factors in favor of the US must have been counterbalanced by some of the unique Guatemalan positives. Guatemala's higher population density (approximately 3 times that of the US) must have helped,[45] as well as its lack of wireline penetration. But we believe that by far the most important factor that managed to put the Guatemalan auctions in the same ballpark as the US was the unique property rights that were for sale.

Winners also knew that they could resell airtime on their ESMR systems to any group of users, or resell their licenses, in whole or in part (by frequency, geographic area, or time-of-day), to other potential operators, for uses not yet invented. In fact, although the prior utilization of these frequencies in Guatemala was exclusively for non-interconnected SMR, at least one of the winners of the 1 MHz bands declared its intention to deploy fixed wireless applications, while others were announcing their intention to deploy advanced ESMR systems to grab a slice of the large cellular market.[46]

The FM Auctions

On August 4th, 1997, Guatemala started a second round of auctions in three stages, each two weeks apart. In total, thirty three FM regional and city range radio stations were auctioned, with some in the nation's capital. A total of 37 bidders registered, with 19 bidders winning various radio holdings. A total of 3 million dollars was obtained.

It is interesting to compare these numbers with those derived from New Zealand's massive radio station auctions. New Zealand, with a per capita income three times as large as that of Guatemala, obtained just slightly more than $6 million (US) for more than

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sectors, extending the Moreton and Spiller's (1996) analysis of the impact of FIRE employment, *inter alia*, on PCS license valuations. See Cardilli, Carlo, Stuart Jack, Daniel Vincent, Gerry Wall, and Leonard Waverman, "Assessment of Market Values of Canadian Cellular, PCS and ESMR Licenses," Report to Industry Canada #U4200-6-0008, February 1997, Ottawa, Canada; and Moreton, Patrick S., and Pablo T. Spiller, "What's in the Air: Synergies and their impact on the FCC's broadband PCS License Auctions," working paper presented at the Law and Economics of Property Rights to Radio Spectrum, July 1995, and "Multi-license Bidding Strategies in the FCC Broadband PCS Spectrum Auction," UC Berkeley working paper, January 1997.

[45] Cardilli et. al., *supra*, also show that the value of SMR spectrum in the US was strongly related to the population density of the license area.

[46] While cellular represents one in seven Guatemalan access lines, there is currently only one operator providing only analog (AMPS) service.

the 300 AM and FM stations, or the equivalent of less than $18,000 per station.[47] Guatemala obtained approximately $60,000 (US) per station. These two values are difficult to compare, as the Guatemalan stations were all FM, while the New Zealand ones were a mixture of AM and FM. Furthermore, it is not clear whether the extra value obtained in Guatemala reflect that the regulator has created artificial radio scarcity, or that it reflects the usage flexibility associated with the Guatemalan TUFs.[48]

The Guatemalan experience is interesting because it is the first experiment implementing a property rights approach to spectrum utilization. Although it has started only recently, it has already proved feasible. The private sector has been willing to bid what are large amounts for Guatemala, even though the scheme to protect against interference is novel and has not yet been tested. Furthermore, the participation in the auctions has been nothing short of widespread. The eleven participants at the SMR auctions, and the 37 participants at the radio station auctions show the value of spectrum fragmentation, particularly in what may be relatively thin markets. This, indeed, may have been the basic strategic failure in New Zealand.

VI. Conclusion

The pressure unleashed by technological and demand forces on spectrum regulators is mounting, forcing them to abandon, albeit ever so slowly, the detailed regulation they so favor. In its PCS auctions, the FCC has implicitly granted, what seems to many, enormous use flexibility to licensees, allowing any terrestrial use other than broadcasting. It even allowed licensees to choose the transmission standards (unlike Europe, which mandates GSM). In the WCS auction, the FCC even abandoned buildout requirements. Under pressure from the likely mass default in the C-block, the FCC might allow even more latitude as a means of allowing the licensees to generate more revenue and thus

[47] Crandall 1997, *supra,* pp:12-13.

[48] FM stations can be quite valuable, as FM subcarrier techniques can allow substantial one-way audio or data transmission, such as paging, news, stock prices, sports scores, elevator music, second language programming, and so on and so forth. Of the 200 kHz available in a standard FM radio slot, over 40 kHz are unused by standard FM transmission and available for data transmission, permitting a data stream of 100 kb/s or more, depending on the subcarrier technique used, see Minoli (1991). Of course, the Guatemalan property rights approach would allow a right-holder to use the entire 200 kHz slot for data transmission if he so wished.

avoid default.[49] Although these developments push the regulatory agenda towards property rights, they remain quite distant from what we perceive as the ultimate reform needed to adjust the sector to the current and future technological onslaught– fully fledged property rights in spectrum. Two pioneering free-marketing countries have taken the lead, and we should view these as ambitious experiments. The New Zealand experiment has been slow to bear fruit, for reasons outside the scope of this paper. The Guatemalan experiment is proceeding in earnest, on track to become the most ambitious spectrum privatization ever. There is the potential for the experiences in these countries in the next five to ten years to point to the substantial welfare gains associated with such an approach. And if there is any value to advertising, perhaps increase the pressure for regulators from other countries to follow on their bold path.

[49] See De Vany, Arthur (1996), "Implementing a Market-Based Spectrum Policy," forthcoming, *Journal of Law & Economics.*