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# The Spectrum-Allocation Debate: An Analysis

The standard approach to radio-spectrum allocation in the US posits three alternative models from which regulators choose (on a case-by-case basis) to impose basic rules for coordinating wireless activities. However, this regulatory framework often yields anticonsumer outcomes. The author argues that public policy should instead permit competitive market forces to allocate airwave rights among rival users. One mechanism for accomplishing this shift is to move away from administrative allocations to a general regime of exclusive property rights.

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In scarcely two decades' time, wireless has eclipsed fixed networks to become the dominant telephone technology. Globally, more than 2 billion people now subscribe to mobile services – nearly twice the number of landline subscribers. The wireless marketplace that serves this vast, high-growth service space is itself subject to government-imposed constraints. In this emerging wireless age, the question of spectrum allocation is becoming more important and more intensely debated.

Every country has a regime that delineates policies for distributing the rights to use certain frequencies for wireless communications. Regulators, such as those at the US Federal Communications Commission (FCC), police airwave use via powers that, although derived from the assigned task of controlling interference, extend widely. Some of the myriad questions these policy makers face include how many TV stations to license in New York City, what technologies (if any) to

mandate for cellular networks, or whether to raise power limits for wireless Internet service providers serving rural areas.

To articulate its regulatory approach, the FCC issued a Spectrum Policy Task Force Report (SPTFR; [www.fcc.gov/sptf/reports.html](http://www.fcc.gov/sptf/reports.html)) in November 2002. The report summarized a regulator's spectrum-allocation task as selecting from three models:

- *Exclusive use.* A licensee has exclusive and transferable flexible use rights for the specified spectrum within a defined geographic area; technical rules primarily govern those rights to protect spectrum users against interference.
- *Commons.* Unlimited numbers of unlicensed users can share frequencies; technical standards or etiquette governs usage rights, but there are no rights to protection from interference.
- *Command and control.* The traditional process of spectrum management in

the US limits allowable uses based on regulatory judgment.

Essentially, the report states that each of these models has its appropriate place and that regulators should examine frequency use on a case-by-case basis.

This tripartite taxonomy has gained widespread currency. In this article, I attempt to outline the weakness of such a framework, which confuses *access regimes* (how consumers and producers use resources) with *property regimes* (how control over organizing choices is defined). The FCC touts exclusive use and commons as liberal alternatives to traditional regulation, for example, but it ignores the fact that the bureaucratic selection process it recommends constitutes command and control. Thus, some forms of wireless market organization are chosen – and others excluded – not by competitive markets but by administrative allocation.

### The Conventional Framework

To put it bluntly, the SPTFR framework ineptly defines spectrum-allocation policy. First, the “exclusion” uniquely associated with “exclusive use” is just as essential to license-exempt bands or command and control. In each instance, decision makers prohibit certain wireless activities such that others become more productive: “exclusive use” leads to intense spectrum sharing in cellular bands, for example, where liberal use rules yield licensees de facto spectrum-ownership rights. Conversely, unlicensed rules impose limits on users that effectively exclude certain users, uses, or technologies such as Code Division Multiple Access (CDMA). In either “exclusive use” or “commons,” spectrum rules exist both to exclude certain activities and, simultaneously, to facilitate others. Spectrum-sharing among rival users – say, subscribers to a wireless phone network or users of wireless local area networks (WLANs) in two different homes – is thus more easily organized. The essential difference lies in the nexus of control: which parties get to formulate the rules governing spectrum access?

Second, the report’s analysis of policy selection is fatally flawed. Basic property rights don’t uniquely determine the market’s organization; suggesting that a certain type of spectrum access is beneficial doesn’t imply that the government should thus impose that use. The error is most vivid in a specific part of the report that claims the government should allocate spectrum for unlicensed bands:

A mechanism based on markets, such as an exclusive-use model, will be most efficient in most cases. However, government may also wish to promote the important efficiency and innovation benefits of a spectrum commons by allocating spectrum bands for shared use, much as it allocates land to public parks.

In fact, the government doesn’t generally allocate land – rather, it defines ownership rights. Such private property rights enable government to more rationally create public parks. The means by which state agencies acquire land rights (first appropriation, purchase, condemnation, or gifting) are of ancillary importance here. What’s crucial is that the land market actively benefits economic decision-making even when the ultimate access regime is, in the FCC’s parlance, a commons. General property rules eliminate barriers to productive use of assets so that society needn’t wait for the state to set resource-access rules parcel by parcel. Eliminating such barriers actively advances competition in services and fosters innovation. In turn, the asset market provides information about the opportunity cost of alternatives.

New York City, for example, routinely sells “slices” of Central Park by franchising private concessions. It permits restaurant owners to enjoy exclusive rights for a fee, and these revenues help offset the cost of maintaining the park. The ability to reasonably evaluate trade-offs under a regime of exclusive ownership rights drives efficiencies across a wide swath of activities, supporting the provision of public goods. It’s easy to figure out how much additional acreage to expand Central Park would cost the city, or how much revenue it could generate by selling a portion of it. Without private property rights, these values are concealed, and the government agency supplying a public park’s amenities lacks the necessary inputs for efficient decision making. This is the essential short-coming in planned economies – the so-called *socialist calculation problem*.

Eliminating the entry barriers that government spectrum allocation imposes would let entrepreneurs test alternative technologies and business plans in the marketplace. It’s this discovery process, in which asset owners internalize relevant costs and benefits, that reveals an efficient structure for organizing wireless markets. Less exclusive ownership rights also permit investments and transactions, but they limit the scope of the capital market’s discovery process. The power limits government imposes in unlicensed bands enable some useful forms of coordination, particularly in the use of WLANs

where networks are small and simple, but less in others, such as wide area wireless networks (WWANs), where more conflicts are possible.

Transactions between resource owners also reveal the cost of any one particular market design. Trial and error is fundamental here because innovative consumer-pleasing advances generally emerge from uncertainty. The distribution of exclusive ownership rights enables a diversity that encompasses technologies, services, and business models. In short, the property rights structure doesn't preclude a commons – it rationalizes it.

### Property Rules

In 1967, economist Harold Demsetz asked, *why do we see exclusive ownership of some resources, but not others?*<sup>1</sup> He offered a simple model in which property rights are costly to define and enforce,

tures by reconfiguring rights: private property evolves into common property when a corporation is created with the private assets of common shareholders, and state property emerges from private property when a government agency purchases land from an individual owner.

The optimal property rights regime permits beneficial coordination of economic activity. The *tragedy of the commons*, better thought of as a *tragedy of open access*, results when users who could benefit from conserving resources are stymied. This is often framed as a *transaction costs* issue. Such costs occur when parties attempt to engage in trade or some other productive activity, but find they must expend resources to deal with one another. Ill-defined property rights create transaction costs. When they're of sufficient magnitude, socially useful arrangements – such as limiting grazing so that a pasture won't be destroyed – don't occur, resulting in the loss of wealth-creating cooperation.

With spectrum, government policy states that it aims to "minimize interference." But were interference truly minimized, wireless activity would fall to zero. Potential conflicts are a byproduct of productive airwave use; efficient rules maximize the total value of wireless applications rather than minimize disruptions. Rational rules require that each dollop of interference occur where the benefits of the activity causing the conflict exceed the damages that result.

In the US and virtually everywhere else, the basic spectrum property regime is best described as state property, also known as *administrative allocation*. This system defines spectrum-use rights for other parties, such as when "exclusive-use" spectrum rights are assigned by auction, traditional licenses permitting only specified activities and technologies are authorized, or unlicensed bands are set aside for users of FCC-approved equipment. Further reconfiguration of use rights then evolves: in Wi-Fi hotspots, for instance, the state defines nonexclusive spectrum rights, but parties using such rights to set up WLANs often exclude nonsubscribers.

In US cell-phone networks, the state has awarded relatively liberal exclusive rights, approximating de facto private spectrum property. Operators select technologies, applications, network architectures, and price schedules. They reassign use rights in negotiated agreements with select third-party vendors (such as handset makers), content providers (say, to send pictures or music downloads), and rival networks (such as Blackberry).

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such that they arise when benefits exceed their expense. Demsetz reasoned that it was efficient for native tribes in Canada to treat beaver habitats as open to all when demand for skins was quite limited, and then likewise efficient for exclusive rights in beaver-hunting grounds to grow with the rise in the European fur trade, thus increasing the benefits associated with conservation and ownership.

This approach has widely influenced scholars seeking to understand how rules governing economic activity evolve. Over the years, four basic property regimes have emerged from it:

- *open access* allows exploitation without limit;
- *state property* limits use via rules crafted by government officials;
- *common property* limits use via rules crafted by groups of owners; and
- *private property* limits use via rules crafted by single owners.<sup>2</sup>

In general, individuals behave differently under the incentives of alternative property regimes. Economic agents also typically realign incentive struc-

And, of course, they then reassign spectrum access rights – on a mass-market scale – to subscribers. The licensee uses significant sunk capital provided by long-term investors to create an access regime that lets millions of disparate parties usefully share the allotted airwaves. This infrastructure, a complementary input to spectrum in the provision of wireless services, is a key component in productive spectrum deployment. The absence of such infrastructure can constitute a tragedy of the commons symmetric to the destruction of social value via overuse or interference.

Unlicensed bands aren't "commons" – they're administratively allocated. The mechanism used to coordinate spectrum use is equipment regulation, which generically consists of power limits. These exclusionary devices separate users geographically because radio waves attenuate over distance. The intent of such rules is to privatize airwaves in local areas, allowing users to coordinate their activities by reusing frequencies from place to place for such devices as cordless phones or Wi-Fi routers.

In an actual commons, a group of owners sets access rules and then internalizes costs and benefits from resource use. In unlicensed spectrum, an outside party – the regulatory agency – imposes rules to determine basic resource-appropriation issues. Costs or benefits are internalized only as they're communicated politically. The US experience with public-interest spectrum regulation underscores that these decisions characteristically squander rich possibilities for efficient airwave utilization.<sup>3,4</sup>

The fact that a given set of users – say, enterprises using unlicensed spectrum for WLANs – has extracted valuable opportunities from spectrum use under administrative allocation rules fails to remedy its generally anticonsumer consequences. Economists are fond of pointing out that "there is no free lunch." A given set of state-property rules blocks alternative property regimes from governing the airwaves, and these would yield valuable opportunities, as well. Alternatively, the popularity of a given wireless application that uses airwaves allocated administratively might well be more efficiently provided via investor-owned airwaves allocated by competitive markets. The widespread use of WLANs accessing the 83.5-MHz unlicensed band at 2.4 GHz demonstrates the economic triumph of nonexclusive spectrum rights vis-à-vis exclusive spectrum rights to some analysts. But with investment in cellular services, handsets, and infrastructure (using exclusive rights) dominating Wi-Fi investments by about two orders of magnitude, this

comparison is inapt even on its own terms. Moreover, the basic analysis – which ignores the spectrum's opportunity cost – is flawed. By illustration, TV broadcasting has also proven popular. Americans purchase close to 25 million TV sets annually, investing roughly US\$8 billion<sup>5</sup> – far more than expenditures for Wi-Fi routers or modems. The TV band is nonetheless a textbook example of socially wasteful underutilization (overallocation) of radio spectrum. Government planners set aside bandwidth with very high value for an over-the-air delivery platform that nearly 90 percent of US households pay to bypass via cable or satellite. Given that the incremental cost of moving to 100 percent cable and satellite distribution for broadcast TV content is on the order of just US\$3 billion, whereas the social value of the 402 MHz now walled off for broadcast TV services is likely to exceed US\$2 trillion,<sup>6,7</sup> the state property regime for radio spectrum dissipates vast economic value. Society could have all the benefits of TV broadcasting and, by using more efficient distribution platforms, abundant and highly valuable wireless services as well. The fact that consumers are willing to purchase millions of devices that can receive signals on these frequencies fails to remedy this anticonsumer outcome.

### Maximizing the Social Value of Wireless

The FCC believes that "the Commission's rules for unlicensed transmitters have been a tremendous success"<sup>8</sup> and that it should allocate more spectrum for unlicensed use. But this is based on the central planning precept that government can judge the marginal value of additional spectrum based on rough observation of popular services. By this logic, the fact that the average US household features 2.7 TV sets ([www.leichtmanresearch.com/research/notes06\\_2005.pdf](http://www.leichtmanresearch.com/research/notes06_2005.pdf)) suggests that the government should allocate *more* spectrum to the TV band.

The FCC's approach to incremental unlicensed allocations lacks the needed multilayered analysis. The first layer should identify the appropriate margin: the productive use of one set of frequencies doesn't imply gains from additional bandwidth. South Korea has the highest concentration of Wi-Fi hotspots in the world, but it uses only the 2.4-GHz Industrial, Scientific, and Medical (ISM) band. Korean regulators have yet to authorize either the 1997 U-NII or 2003 US allocations for unlicensed devices in the 5-GHz band – some 555 MHz in aggregate. This implies that, regardless of the pop-

ularity of devices using existing allocations, additional increments of unlicensed bandwidth might not produce much value. The limited economic activity observed in the unlicensed 5-GHz or Personal Communications Services bands (30 MHz in the 2-GHz band allocated to cell-phone use in the mid 1990s) in the US is consistent with this view.

At a second layer, policy makers should identify actual property rights alternatives. Wireless activities aren't uniquely associated with particular property regimes. Unlicensed devices such as Wi-Fi routers or cordless phones can use licensed frequencies; networks can supply cellular phone service via licensed bands (as it typically is) or unlicensed frequencies (as for some links created via multimode handsets).

Assuming that additional bandwidth for a "spectrum commons" is desirable, delivering benefits in excess of opportunity costs for the spectrum, a path to that end must still be devised. The implication of the SPTFR's tripartite decision tree is that this assumption requires imposition of unlicensed-access rules by regulatory fiat. But this approach fails to incorporate secondary rights reassignments, seeing only one path – administrative allocation – to obtain the desired outcome. For instance, assigning exclusive spectrum ownership to multiple competitors would facilitate the creation of a "commons," if that model were to prove profitable. More important, competitive market forces would search, test, and reveal a variety of alternatives, gauging their value. As FCC spectrum analysts Evan Kwerel and John Williams write:<sup>9</sup>

Future expansion of dedicated spectrum for unlicensed use could be obtained through negotiation between the manufacturers of such devices and spectrum licensees... Competition between licensees would ensure that fees reflect the opportunity cost of the spectrum. Alternatively, manufacturers of low power devices might form a bidding consortium to acquire additional spectrum in our auction. If there is a continued desire as a matter of public policy to provide spectrum for such devices on a "free" basis, the FCC itself might purchase the spectrum in the auction, essentially reducing overall proceeds to the Treasury. This would have the advantage of making the opportunity cost of such allocations more explicit.

What the FCC calls a "private commons" isn't simply a theoretical possibility. Cellular networks organize complex spectrum sharing, equipping customers with handsets, frequency-access rights, and wireless network infrastructure in exchange

for subscription fees. Some access is "free" (within-plan, on-net, or off-peak minutes, as well as text messaging), and customers use the network without discrimination.

The fact that the forms of coordination differ from the manner in which unlicensed bands operate doesn't imply that wider use of the unlicensed regime should be mandated. Quite the contrary: to the extent that cellular networks are liberally regulated, the market adopts organizational modes that serve consumer interests. Included here, most notably, is customers' demand to utilize extensive fixed-network infrastructure. The transaction costs of providing wide-area networks under unlicensed rules are prohibitively high, resulting in a lack of investment that deprives consumers of desirable options from these value-creating networks.

The third layer should consider the spectrum-allocation process as a whole. What are the implications of allocating spectrum in the current tripartite case-by-case regime versus a liberal ownership regime? The general consensus among economists is that the latter eliminates the barriers to competition posed by the current system, permitting consumers, technology suppliers, service providers, and asset owners to make rational economic decisions in which resources are deployed to satisfy the most intense consumer demands. This doesn't reflect a preference for one type of market organization over another; economists are agnostic as to what type of network architecture or non-network wireless devices are optimal under various circumstances. As Kwerel and Williams offer in their argument for a "big bang" that creates an active spectrum market,

One possible arrangement would be for a licensee or group of licensees covering a particular band throughout the US to charge manufacturers a fee for the right to produce and market devices to operate in that band. Such contracts could provide different grades of access for different fees, thus providing for a wider range of uses than are possible under the current rules.

The passage suggests two critical considerations. First, there are myriad ways to coordinate wireless use, even assuming usage patterns that resemble unlicensed access. The trial and error of the market is a reliable mechanism for testing alternatives.

Second, imposing designated market structures isn't efficient. When the state imposes rules on licensed or unlicensed use, it constrains consumers and producers and limits the search for improved,

innovative modes. To assume that only government regulation can provide such a “commons” is to mistake an *access regime* for a *property regime*. And to assume that forcing a particular set of unlicensed rules on spectrum users creates efficiency is to ignore the underlying characteristic of administrative allocation: the state lacks the information or incentives to effectively evaluate the trade-offs among rival alternatives.

The pro-consumer policy framework dispenses with the state’s case-by-case rule makings – a cumbersome and protectionist process – and instead distributes exclusive spectrum ownership rights. No doubt, some recipients will be public agencies, and the unlicensed bands that host wireless devices, such as the 902- to 928-MHz and 2.4- to 2.4835-GHz bands, would remain de facto state property.

Indeed, the reallocation of unlicensed bands is difficult due to the transaction costs that unlicensed rules generate. The widely misunderstood transactional efficiency of ownership rights is that a responsible party – not the FCC – coordinates spectrum sharing. Some commentators characterize licensing costs as an expense associated with the award of exclusive rights.<sup>10</sup> In reality, such costs are a byproduct of the regulatory system, and more efficient government policy can mitigate them. The costs of trading exclusive rights are modest in the wireless phone market, in which global customers purchase more than 5 trillion minutes of use each year. Each call constitutes a transaction, with a network operator reassigning spectrum access to its airwaves and network in exchange for monetary compensation.

The source of transaction costs is most obvious in Nextel’s history.<sup>4</sup> Decades ago, the FCC allocated specialized mobile radio (SMR) licenses for delivery dispatch services. Allocated up to 19 MHz per market, the SMR band was adjacent to the 800-MHz cellular bands. Cellular licenses began trading in secondary markets in the mid 1980s, revealing the business opportunity to be extremely valuable. Spying an opportunity, a former FCC lawyer named Morgan O’Brien began purchasing SMR licenses. He effectively used market data on opportunity costs to figure out what the FCC could not – that the SMR bands, if digitized, could provide superior dispatch services and yet have abundant capacity to provide cellular service. The firm O’Brien founded, Nextel, obtained license waivers to allow the upgrade, and what was virtually worthless spectrum emerged as the key input in cellular service for 16 million subscribers. Sprint purchased Nextel for US\$35 billion in 2005.

Notably, Nextel aggregated more than 40,000 SMR licenses, incurring transaction costs that could have been avoided had the FCC issued fewer licenses (say, one nationwide permit). In any event, the company’s value was created by aggregating unproductive spectrum rights, creating an advanced, complementary nationwide network (that eventually required an FCC deregulation), and then reassigning the spectrum rights to consumers. Critics often say that markets work as advertised only when transaction costs are zero, but markets are, in fact, quite effective in discovering how to achieve efficient transactions.<sup>11</sup>

Liberalizing spectrum policy clears the path for several Nextels – not by special waivers, but by general policy. It empowers competitive spectrum owners to experiment with alternative network architectures or access models. It also lets govern-

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ments evaluate, with economic data gleaned from actual transactions, whether particular forms of spectrum access need to be subsidized. Just as a public park is best provided when the costs of the park are known and competitive alternatives permitted, so exclusive spectrum ownership can facilitate efficiency across diverse access regimes.

Some regulatory regimes are starting to liberalize. Countries such as Australia, New Zealand, Guatemala, and El Salvador instituted sweeping reforms in the 1980s and 1990s, radically advancing the distribution of exclusive spectrum rights. The UK recently adopted a framework for simultaneously eliminating license restrictions and expanding the bandwidth allocated to such liberal licenses, aiming to allocate roughly 70 percent of spectrum under 3 GHz in such a manner by 2010.

Yet, the US framework continues to allocate spectrum case by case. Since December 2002, the FCC has enmeshed itself in rule making to regulate TV-band “white space.” The policy would impose rules to determine how unlicensed devices and broadcast stations coexist. An alternative means of organizing shared use would be to issue TV-band

overlay rights, giving new licensees full flexibility, subject to interference protection for incumbents. This would delegate the creation of an access regime to competitive owners. Senator Larry Pressler (Rep.-South Dakota), then chair of the US Senate Commerce Committee, proposed this solution in May 1996,<sup>4</sup> but political interests, including TV broadcasters, opposed it. Today, regulators simply ignore the licensed overlay as an alternative regime choice.

Much has changed since the 1990s, when Apple Computer argued that wireless LANs needed additional unlicensed spectrum. Without considering the option that Apple could acquire spectrum rights and configure them for LAN services, the FCC mandated a spectrum, imposed standards (including listen-before-talk), and set power limits. Yet, to date, virtually no one has made use of the 30 MHz the FCC has allocated for unlicensed PCS (U-PCS) — and adjacent licensed PCS bands host intense traffic. The 30 MHz squandered on U-PCS would provide billions in annual consumer surplus gains (through lower prices and more minutes of use on wireless phone networks) if PCS operators could acquire them.

Apple suffers no penalty from this misallocation, and such an obvious lack of accountability demonstrates a *tragedy of the antimarket*. The future is unknowable, and the value of rival technologies, each with its own optimal mode for organizing spectrum access, is uncertain. Society loses the benefits of market competition when it socializes risky deployments of radio spectrum.

Instead, corporations arguing for unlicensed allocations ought to be allowed to make the investments they recommend. If the 402-MHz TV band could be divided into five nationwide overlay licenses of approximately 80 MHz each and then sold at auction, five rival spectrum-sharing plans would emerge.<sup>4</sup> Rationalization of the TV band, including rechannelization of TV stations, would expand wireless opportunities and unleash new technologies, services, and networks. Consumers, vendors, application suppliers, content owners, and investors would reward those creating the greatest value. Nothing requires a decade of rule making. To sacrifice the social gains of this exclusive ownership path is to incur another tragedy of the antimarket. □

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