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DACA Report from the Working Group on New Spectrum Policy, Release 1.0

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Digital Age Communications Act

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I. Introduction and Summary

The central problem in the use of the electromagnetic spectrum is "interference": one party's transmissions interfering with those of another party in the same (or a neighboring) geographic area and/or spectrum band. The method (since 1927) that has been used in the U.S. for dealing with this problem has been to declare that the spectrum is a national resource that should be managed for the benefit of the entire American population and to lodge with a federal government agency (since 1934, the Federal Communications Commission) this stewardship responsibility.

The FCC has exercised its responsibility by: (a) allocating blocks of spectrum to specific uses—e.g., broadcast radio or television; (b) defining parameters of service—e.g., transmitter power; (c) assigning licenses to specific parties for transmitting over specific frequency bands at specific locations (according to the specific service rules) at specific times and for a specified term; and (d) enforcing its allocations, service rules and assignments. The spectrum allocated under this system cannot be transferred from one use to another—e.g., from broadcast television to wireless telephone service—regardless of the relative values of the two services, unless the FCC grants its permission.

The costs associated with inefficient utilization of the spectrum under this "command -and-control" system have become enormous. The system, designed for a limited and static array of services (and perhaps costly even then), is certainly ill-adapted to the explosion of demand for the airwaves for innovative new wireless technologies. New products come to market later and cost more than they should. Competition and innovation are impeded by the need for new services to fit existing regulatory restrictions. Although it is difficult to quantify all of the costs associated with the current regime—especially the costs of innovations forgone or delayed—studies suggest that they could be in the tens of billions of dollars annually or even more.[2]

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1 By design, the Spectrum Policy Working Group is composed of a diverse group of individuals from academia and think tanks with a variety of perspectives. This report represents a consensus view of the working group and it should be understood that not all members of the group necessarily endorse all of the language of the report. In addition, the report represents the work product of the group's members in their individual capacities and the views expressed should not necessarily be attributed to the institutions with which the group's members are affiliated.

2 For example, Hausman estimated that the delay associated with the cellular rollout reduced U.S. economic welfare by at least $86 billion (in 1990 dollars). See Jerry A. Hausman, *Valuing the Effect of Regulation on New Services in Telecommunications,* BROOKINGS PAPERS ON ECONOMIC ACTIVITY : MICROECONOMICS (1997), pp. 1- 38. See also Jeffrey H. Rohlfs, Charles L.

With auctions and measures to provide licensees with greater flexibility, the FCC has taken some steps toward a more market-based approach to allocating the spectrum. But the process of reform has been slow. Much of the most valuable spectrum is not available for private sector uses and, under the terms of FCC licenses, much of the spectrum that is in the private sector is locked away in inefficient uses. Only 7 percent of the most valuable spectrum — between 300 MHz and 3GHz—is currently subject to market allocation.[3] Another 14 percent is slated for market allocation at some point in the future. Seventyfive percent remains under a command -and-control regime, much of it reserved for federal government use.[4]

While there is widespread dissatisfaction with the legacy command -and-control system, [5] there is considerable disagreement (even within this working group) over what should replace it. There is by now a fairly large economics literature on the issue of how to manage the spectrum, virtually all of it concluding that the primary, even if not exclusive, way to reform the current system is by "propertyzing" the spectrum and allowing a market in spectrum property rights to develop. Indeed, economists are virtually unanimous in believing that a market system is the only way to achieve an efficient allocation of most resources, and spectrum fits well into this paradigm—i.e., a market system would assure that spectrum is allocated to its best and highest-valued uses. [6] This idea was suggested in 1959 by Nobel Laureate Ronald Coase and, like

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Jackson, & Tracey E. Kelly, ESTIMATE OF THE LOSS TO THE UNITED STATES CAUSED BY THE FCC'S DELAY IN LICENSING CELLULAR COMMUNICATIONS , National Economic Research Associates, November 8, 1991. Hazlett *et al.* estimate that an additional 200 MHz allocated to mobile phone service would reduce the average price per minute from 11 cents to less than 6 cents and generate $77 billion in consumer surplus annually. Thus, the social gains from improving the allocation of spectrum (a great deal more than 200 MHz are misallocated) are likely to be enormous. Over a five -year period, an additional 200 MHz is estimated to increase capital spending by $33.8 billion and GDP by $96.7 billion. See Thomas W. Hazlett *et al*, SENDING THE RIGHT SIGNALS: PROMOTING COMPETITION THROUGH TELECOMMUNICATIONS REFORM, Report to the U.S. Chamber of Commerce, pp. 69, 104 (Sept. 22, 2004).

3 See Evan Kwerel, SPECTRUM MANAGEMENT 101: NUTS AND BOLTS OF SPECTRUM MANAGEMENT, Presentation to the Federal Communications Bar Association (Dec. 9, 2004).

4 For example, the FCC recently allocated spectrum potentially worth billions of dollars to be used only in satellite or joint satellite-terrestrial systems rather than to allow the spectrum to be used in its highest potential value.

5 This is true at the FCC as well. See, for example, *FCC Spectrum Policy Task Force Report* , ET Docket No. 02- 135 (Nov. 2002); and Gregory L. Rosston and Jeffrey Steinberg, *Using Market -Based Spectrum Policy to Promote the Public Interest*, 50 FEDERAL COMMUNICATIONS LAW JOURNAL 88 (1997).

6 *See* Lawrence J. White, *"Propertyzing" the Electromagnetic Spectrum: Why It's Important, and How to Begin*, in COMMUNICATIONS DEREGULATION AND FCC REFORM (Jeffrey A. Eisenach & Randolph J. May eds. 2001); Federal Communications Commission, *Comments of 37 Concerned Economists, In the Matter of Promoting Efficient use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets*, WT Docket No. 00 -230 (Feb. 7, 2001); and Robert Crandall, Jeffrey A. Eisenach, James Gattuso, Thomas Hazlett, Peter W. Huber, George A. Keyworth, Thomas Lenard, William C. Myers, Peter Pitsch, Kenneth Robinson, Greg Sidak & Adam Thierer, PRIVATIZING THE ELECTROMAGNETIC SPECTRUM, Future Insight 3.1 (Apr. 1996).

many original ideas, now seems intuitive.[7] Although one can identify a number of reasons why a market-based system will not function perfectly (e.g., a wireless service provider's willingness to pay for spectrum rights will not reflect the consumer surplus enjoyed by its customers), there is no serious contender for a system that can be expected to perform as well or better.

However, at about the same time that the market-based approach advocated here has gained wider attention and support, a sharply different vision of spectrum usage has also been advocated. This alternative vision, often described as the "commons" approach, is espoused primarily by a group of technologists and legal scholars.[8] They recommend that the government should allocate large amounts of spectrum to create a commons with open access to all users who follow a prescribed set of rules (e.g., adhere to power limits and priority rules).

We are not persuaded that the commons approach can be the primary direction of spectrum reform. This is so for two central reasons: First, without the possibility of obtaining property rights that guarantee top priority (except in instances of government-declared emergencies), the large investments needed to use the available spectrum efficiently and create new wireless services are likely to be delayed and/or dampened, with adverse consequences for the U.S. economy. We see the benefits of secure priority rights already in the operation of the PCS bands where providers with those rights have made, and continue to make, very large investments. Because there is no mechanism for securing top priority in the commons model, that model provides no comparable incentives for services requiring substantial investments. While the commons model might have some initial appeal for small, innovative providers, we still find the model to be insufficiently specific about how efficient priorities will be established and to be based on strong conjectures about future radio technology.

The second reason why the commons approach cannot be the primary direction of spectrum reform is that this model also fails to move to marketdetermined prices as the mediating mechanism in spectrum usage decisions. For example, there would be no way to determine the opportunity cost of allocating spectrum to commons usage compared with exclusive licensed use. In this regard, the commons model retains a core (negative) attribute of the legacy command -and-control regime.

In addition to these two reasons to doubt that the commons model can be the centerpiece of reform, we are concerned that the commons model is

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7 R.H. Coase, *The Federal Communications Commission*, 2 J.L. & ECON. 1 (1959). For another early paper detailing a property-rights approach, see Arthur S. De Vany, Ross D. Eckert, Charles J. Meyers, Donald J. O'Hara & Richard C. Scott, *A Property System for Market Allocation of the Electromagnetic Spectrum: A Legal -Economic -Engineering Study*, 21 STAN. L. REV . 1499 (1969).

8 For two influential pieces, see Lawrence Lessig, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD, First Vintage Books Edition, November 2002; and Yochai Benkler, *Some Economics of Wireless Communications,* 16 HARV . J.L. & TECH. 4 (2002).

more susceptible to political pressures favoring inefficient outcomes. For example, even if technological developments lead to a situation in which moving millions of Wi -Fi users is efficient, it is difficult to see how there could be the political will do so. Experience indicates that markets are much more likely to adjust continually to underlying conditions of tastes and technology than are political decisions. The private radio "re -farming" proceedings at the FCC provide a vivid example of the need for government involvement to dictate technology choice, and for the inherent problems with such involvement approaching anything near an efficient solution.

II. Major Commons Arguments

Because of the prominence of the commons approach, it is useful to review the major arguments made by its proponents and why we believe that they are flawed.[9]

A. The End of Scarcity

The commons model holds out the vision of a new era of spectrum abundance created by new technologies such as agile (cognitive) radio and mesh networks that create more capacity as the network grows. Commons proponents argue that these technologies could cause the effective supply of spectrum to become so great that interference and scarcity would cease to be relevant, and the spectrum would become a free resource that could be utilized by any and all who wish to do so. In essence, the spectrum would become a huge commons in which a property-oriented system would be unneeded and even deleterious, since the property system would interfere with the utilization of the otherwise free resource by imposing unnecessary transactions costs. Proponents argue that the new technologies are so powerful that, at a price of zero, all actual and potential spectrum users' demands can be satisfied. The marginal value of spectrum would fall to (or close to) zero.

We maintain a genuine skepticism as to the validity of this alternative vision. First, consider the implications of zero price and open entry. In our view, the demand for spectrum use is sufficiently price-elastic that at relatively low prices the demand for most (if not all) spectrum bands would be large enough to exceed the available supply even with very technically efficient technology. This would rule out a zero price as an equilibrium outcome and would also imply that property rights are needed to help allocate the scarce spectrum resource.

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9 For a critical analysis of the commons arguments, see Stuart Minor Benjamin, *Spectrum Abundance and the Choice Between Private and Public Control*, 78 N.Y.U. L. REV. 2007 (2004); and Stuart M. Benjamin, DOES SPECTRUM ABUNDANCE JUSTIFY PUBLIC CONTROL?, Progress on Point 11.9, The Progress & Freedom Foundation, April 2004 .

Second, if technology could cause spectrum to become a boundless resource, a competitive market-driven system would be likely to reach a near-zero price outcome as well. Competitive pressures to adopt each latest (cost-reducing) technology would push property owners toward adoption and aggregate abundance, and the effective supply abundance would cause property owners to reduce their rental charges for spectrum use until demand and supply equilibrated—which would be near or at a zero price.[10]

B. New Technologies

As a corollary to the above, proponents argue that the commons model is more conducive to new technologies ranging from Wi -Fi to cognitive radio, even if they have a less dramatic effect than making the supply of spectrum effectively infinite. The proponents suggest that innovative new products, such as Wi -Fi and Bluetooth, would not succeed in a property-rights environment.

It is true that these products have flourished in the unlicensed environment. This fact does not, however, mean that the commons approach is more broadly appropriate or that a property rights regime is inconsistent with the technologies that have grown up in the unlicensed bands. Particularly for the higher-power versions of this technology (e.g., WiMax), the resulting increase in channel contention and infrastructure investment will tend to favor a property-rights regime over a commons. Even for the lower-power technologies that are popular today, investors could purchase spectrum rights and then license the use of a specific frequency to equipment manufacturers. The consumer would purchase the product—e.g., a Wi -Fi router—and the necessary spectrum rights jointly. In an unlicensed regime, the use of these products is under-priced, because users do not have to pay the opportunity cost of the spectrum that they use.

Further, notwithstanding claims by its proponents, the commons model can hinder free and open innovation. New products and services that are not compatible with the protocols and etiquettes of the commons would be impeded; at a minimum, extra resources (and delay) would be required to bring them into conformance with those protocols and etiquettes.

The argument is somewhat different with respect to cognitive radio—which can shift transmissions between frequencies according to whether there is available capacity. Commons proponents argue that this technology is ideally suited to utilizing the large amounts of spectrum that are underutilized in the current regime. For this as well as other reasons, they would create an "easement" to allow non-owners to use "white space" gaps in existing transmissions without the permission of the owners.

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[10] This conclusion assumes that it is impossible for a small number of license holders to block the adoption of the efficient technologies (e.g., the efficient technology does not require the use of a band cutting across many licenses).

Although the users of white space may not currently be interfering with the spectrum owners' property, the former are nevertheless using spectrum that could in principle be used by the owner instead. However, when the owner needs the white space, evicting a large number of spectrum squatters could be costly. In a competitive spectrum marketplace with secure property rights, mutually (and socially) advantageous deals can be expected to be made between spectrum owners and these potential white space users.

Technologies such as cognitive radio do not appear to favor one regime over another. Indeed, cognitive radio can be especially useful in facilitating the transition to an efficient market-based regime. As we discuss in the next section, a major policy challenge is to design a transition plan that makes it possible for service providers to put together efficient blocks of spectrum without incurring large transactions costs. Cognitive radio can help do this, because it provides the opportunity to provide service on non-contiguous blocks of spectrum. This can ameliorate holdout problems and reduce the transactions costs associated with moving to an efficient allocation of spectrum.

C. Transactions Costs

Commons proponents argue that a commons model is justified by the potentially large transactions costs associated with putting together large packages of spectrum or with large numbers of users having to purchase spectrum for their own use. For example, it would be inefficient if every user of low-power products such as cordless phones, garage-door openers, or Wi -Fi or Bluetooth devices needed to buy her own small sliver of spectrum. Therefore, it is argued, the government should set aside spectrum for these low-power uses and others that will come along.

It is important not to oversell the benefits of a commons model in reducing transactions costs. The market often finds clever ways of economizing on transactions costs when there are benefits from doing so. Thus, in a pure property-rights regime, we would not expect every user of low-power devices, such as cordless phones, to negotiate for spectrum rights. Rather, as has been suggested, manufacturers of these devices might pay a royalty to spectrum owners. As experience is gained, spectrum markets might well innovate and develop wholly new mechanisms.

D. Efficient Prices for Some Uses May Be Zero

Spectrum usage charges should reflect marginal congestion costs. In some cases, once a block of spectrum has been allocated to a set of uses, the marginal cost may be zero. This situation is most likely to arise with very low power uses. For example, the incremental congestion costs of a given garage door opener is very likely zero given that a low-power band has been created. One benefit of the

commons model is that it can support such efficient pricing. However, we believe that the number of instances in which this is appropriate is likely to quite small relative to overall spectrum uses. Hence, the commons model has a limited, but not necessarily non-existent, role in spectrum policy reform.

III. Recommendations with Respect to Commons Proposals

The property-rights system that we recommend would not preclude governments (federal, state, or local) from also creating a commons with some spectrum whose rules would be geared to foster those innovative technologies that might be impeded by a property rights system. Although we make provision for government entities to purchase spectrum for commons uses, we believe that such decisions (as is true for most, if not all, government decisions) should be subjected to a careful benefit-cost analysis. The public provision of spectrum for unlicensed uses can distort the market by (in effect) subsidizing particular wireless technologies that compete with other technologies that do not have a similar subsidy.

If a governmental body were required to purchase in the open market any spectrum that it wanted to allocate to such uses, much as it might purchase land that it wanted to convert into a public park, then that governmental body would be forced to face the opportunity cost of any spectrum allocated to such uses. In this way, the government would have an opportunity to evaluate the tradeoff between setting aside spectrum for a commons and letting market participants compete to acquire spectrum property rights. Of course, private owners might also want to create commons-like arrangements on their spectrum—for example, by licensing usage rights to equipment manufacturers.

IV. Dimensions of a Spectrum Property Right

Interference can be caused by a transmitter's emissions affecting operators in adjacent frequency bands and geographic areas. A straightforward way to assign property rights in spectrum transmission would be as follows: The property right would be defined in terms of the right to transmit over a specified spectrum band and geographic area (and during a specified time period) subject to: (1) an out-of-band emission limit; (2) an in-band power limit (because receivers in adjacent bands may be affected by in-band power even if out -of-band emissions are zero, or as discussed below, there may be other in-band licensees); and (3) a field-strength limit for out-of-area emissions.[11] The out-of-band and out-of-area emissions limits would be defined at the band and geographic boundaries, respectively.

[11] For a discussion of license parameters, see Evan Kwerel & John Williams, A PROPOSAL FOR A RAPID TRANSITION TO MARKET ALLOCATION OF SPECTRUM, FCC Office of Plans and Policy Working Paper No. 38 (Nov. 2002); and Arthur S. De Vany, Ross D. Eckert, Charles J. Meyers, Donald J. O'Hara & Richard C. Scott, *A Property System for Market Allocation of the Electromagnetic Spectrum: A Legal-Economic-Engineering Study,* 21 STAN. L. REV . 1499 (1969).

Transactions costs have led some analysts to favor a property rights regime that allows for underlay licenses. That is, two parties may hold licenses to transmit in the same location, band, and time, where the underlay license holder is required not to infringe the other licensee's rights—property rights that do not exclude "non-interfering" uses but that have priority over non-interfering uses [12] Those wishing to use the underlay could bid for licenses with the explicit understanding that they bear the burden of non-interference. The leading candidate for this approach is Ultra-Wideband (UWB), a new technology that operates with very low power but across a large span of available frequencies. UWB may not interfere with other current uses because of its very low emissions, but the transactions costs associated with gaining access to many frequencies would be large. Hence, it is argued, an easement is needed in order for technologies like this to flourish.

Determining what is non-interfering may be difficult. However, under a market-based approach to spectrum policy, private parties can be expected to reach agreements that ameliorate these problems. For example, if underlay licenses prove unworkable, a single owner might purchase both the primary license and the corresponding underlay license.

Within the geographic, frequency, temporal, and other boundaries of its license, the holder of the spectrum property right would have complete flexibility in the use or uses (or non-use) of her spectrum property.

The renewal expectancy should be designed with investment incentive effects in mind. One way to promote investment incentives would be to sell property rights in perpetuity (although private owners could then decide to use different arrangements, such as long -term leases, in resale markets). Given that there will be many different licenses available, there appear to be few benefits from mandating periodic competition for license renewal. Instead, competitive markets forces can be relied upon to promote efficient use.

A. Establishing the Parameters

Interference is usually costly. Efforts (e.g., through investments or changes in location or behavior) to reduce interference (by emitters and by the "victim" [i.e., the property owner whose transmission is being interfered with]) are also costly. The appropriate social goal (with respect to interference) should be to minimize the sum of all relevant costs (including opportunity costs): the costs of interference, interference abatement, and interference coordination/enforcement. [13]

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[12] Gerald R. Faulhaber & David J. Farber, SPECTRUM MANAGEMENT: PROPERTY RIGHTS, MARKETS, AND THE COMMONS , AEI-Brookings Joint Center for Regulatory Studies Working Paper 02- 12 (Dec. 2002).

[13] By including opportunity costs we thereby incorporate the appropriate social goal with respect to spectrum management more broadly conceived, which should be to maximize net social benefits.

In general, it will not be optimal to require that interference—at a geographic property boundary and at a spectrum band property boundary—be reduced to zero, because at the margin the costs of doing so are likely to be high and the benefits are likely to be low. It also will be difficult a priori to determine the socially optimal interference levels because those levels depend on specific information on the costs and benefits of interference and abatement across a wide array of uses and technologies—information that is best known by the parties themselves.

This suggests that licenses should have positive boundary emission limits that are initially set by the FCC (along with the geographic and spectrum band boundaries themselves) on a best-guess basis as to the limits that would meet the above-stated criterion of minimizing the sum of all relevant costs, with the expectation that the parties themselves should be free subsequently to bargain among themselves to modify those limits.[14] (Kwerel & Williams, op. cit., for example, suggest [p. 45] that the boundary limits that currently apply to PCS would be an appropriate starting point for many [if not all] boundaries.) In making best guesses, it may also be useful to take into account effects on those parties that are unlikely to be (directly) represented in bargaining among license holders (e.g., consumers).

The Coase theorem states that, if transactions costs are very low and there are not significant asymmetries in the information held by the parties involved, bargaining and contracting among the parties will lead them to outcomes/solutions that will minimize social costs. This will be true under any allocation of property rights, so long as the property rights are clearly specified. However, if transactions costs are substantial—if bargaining is difficult, if detection and monitoring are difficult, and/or if many emitters and/or property owners are simultaneously involved—then the initial establishment of parameters and allocation of property rights can be very important for efficiency.

These issues of how the property rights (the out-of-band and out-of-area limits) should be defined initially and the procedures for modifying them over time are quite important, because the specific parameters will be of great importance to rights holders. This is also an issue with physical property. Municipal zoning decisions, for example, are the subject of intense lobbying and rent-seeking behavior. We would expect this to happen also with respect to spectrum. An important question is whether some insulation of this process is possible.

B. Agile Radio and Spectrum Property Rights

An important technological advance of the past decade has been the development of “agile” radio transmitters and receivers. These are transmitters that

[14] For example, the FCC’s initial guess as to the appropriate initial parameters might turn out to be wrong, or the technologies of transmitters and/or receivers could change sufficiently so as to change the cost-minimizing boundary limits.

are able quickly to scan available frequencies, recognize "unused" frequencies,[15] and then use those frequencies for transmissions; the counterpart receivers are able quickly to scan frequencies in a search for appropriate incoming transmissions.

Agile radio should be an enhancement for the system of market-driven spectrum allocation that this proposal advocates, for the following reason: A user of spectrum that contemplates needing a specified amount of bandwidth may no longer need to acquire adjacent frequencies; this will reduce the "hold-up" problem that the spectrum user might otherwise face in trying to acquire the necessary amount of adjacent frequencies (and will similarly reduce the need for government-imposed "zoning" of certain adjacent frequencies for a restricted set of uses).[16] Of course, it may also reduce some of the problems associated with a spectrum commons.

V. How to Get from Here (FCC inflexible and inefficient licenses) to There (efficient "propertyzed" spectrum)

The problem of transitioning from the current system of spectrum allocation to a system of market-based allocation is considerably more complicated than if we were simply establishing a market-based system *de novo*. The current system of spectrum allocation involves an FCC-specified allocation of spectrum transmission licenses that implicitly involve a set of "rights" as to spectrum usage and protection from interference. Some current users received their spectrum usage rights directly from the FCC, for free; others bought their spectrum usage rights from previous holders, subject to the FCC's approval; yet others (within the last decade) bought their spectrum usage rights directly from the FCC, through spectrum auctions.

Regardless of the origins of the rights, those rights today are usually extremely valuable, as is evidenced by the large sums that have been paid in the FCC auctions and in private transfers. Equivalently, those rights have large (and generally recognized) opportunity costs. Thus, any method of transforming the current allocation system to the property-rights system described above must address the non-trivial issue of how to deal with the current rights holders.

The next section describes alternative transition schemes for moving to a property-rights regime, recognizing that there are three broad classes of spectrum: [17]

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[15] In practice, it can be extremely difficult to recognize whether a transmission will interfere with a (passive) receiver because of the geometry of signal propagation. Hence, one should be careful not overstate the benefits of agile radio in the absence of an explicit scheme for radio systems to identify themselves to one another.

[16] See Gerald R. Faulhaber, *The Question of Spectrum: Technology, Management and Regime Change*, 4 JOURNAL OF TELECOMMUNICATIONS AND HIGH TECHNOLOGY LAW (2005).

[17] Excluding government -held spectrum, which we discuss in Sec. VIII.

1. Spectrum that is exhaustively, exclusively (or with well -specified priority rights), and relatively flexibly licensed, with licenses purchased at auction, e.g., the PCS licenses. This class of spectrum is (for the most part) already operating under a market-driven regime. Under our proposal, it would be formally propertyzed and, other than that, would largely be unaffected.

2. Spectrum encumbered by current use constraints, either on the nature of the service offered or on the time and scale of the service offering. This spectrum may have been licensed by auction or by other mechanisms, and may be exclusively or non-exclusively licensed (e.g., time-shared under a sharing etiquette such as a "listen-before-talk" requirement). The key feature is that the current licensee has less-complete property rights than will attach to the spectrum in the future under a market-based, fully allocated rights regime. Generally, spectrum in these bands is not exhaustively licensed; instead, these licenses give the users the right to operate certain equipment in defined frequencies and geographic areas at defined power levels.

3. Unassigned spectrum, including white spaces—the unused and unencumbered portions of spectrum licensed under category 2.[18]

The transition options discussed below apply to the second and third classes of spectrum. Each of the options establishes property rights immediately, but the configurations of those rights differ, which has distributional implications and implications for the transactions costs of transitioning to an efficient spectrum allocation.

A. A Spectrum Registry

Regardless of the transition plan chosen, a national "spectrum registry", comparable to local land registries, should be established and maintained. In principle, one or more private entities could maintain the registry; or, following the practice in real estate, a government entity could maintain the registry. In the latter case, either the FCC or the NTIA would be logical organizations in which this function should be housed.

The purpose of the registry would be to facilitate spectrum transactions and to assist in the enforcement of property rights. It would help buyers and sellers

[18] White space is usually defined by the FCC as all spectrum space within a band that is not encumbered by existing licensees —i.e., that can be used without interfering with incumbents. Spectrum may be encumbered by incumbents in adjacent bands as well as by those within the band being transitioned. For example, some of the new AWS (advanced wireless services) bands may be restricted to extremely low powers or limited to certain deployments (e.g., no mobile transmitters) to protect PCS receivers in nearby bands. How the interference rights of different groups of incumbents are defined could reduce significantly the amount and/or value of usable white space.

identify potential counterparts and would aid in the identification of interferers. It would also provide information needed for parties to negotiate changes in the various parameters of spectrum rights. Such negotiations will be an integral part of the transition to an efficient spectrum rights regime.

The registry would list all participating incumbent occupants and, to the extent that they choose to make the information public, their current property rights (e.g., license conditions and interference protections). It would also list all unassigned spectrum, including the white space in bands not exhaustively licensed.[19] Whenever spectrum rights were bought or sold, or the conditions of use (i.e., the applicable set of property rights) changed through negotiation, the owner would register those changes in the registry.

B. An FCC-Driven or Applicant-Driven Process for Unassigned Spectrum?

There are two ways to move unassigned spectrum, including overlay licenses for white spaces, into the market:

1) The FCC could identify packages and arrange for auctions. This is the current process that has been used in establishing the PCS bands and that is being followed in establishing the AWS bands. If the FCC were able to assemble large bundles of spectrum (encumbered and unencumbered) that could be auctioned simultaneously (see discussion of the "big bang" proposal below), this might lead to a more rapid restructuring of spectrum to its most efficient uses.

2) The process could instead be applicant-driven, with a tight timetable for the FCC to respond and, if necessary, arrange auctions for spectrum in response to private applications.[20] For example, any qualified applicant could apply for available spectrum (which would be listed in the registry). In the unlikely event that only one party were interested in owning these rights, that entity would get them. If, as is far more likely, multiple parties expressed interest in the same spectrum, the FCC would (on a rapid timetable) arrange for an auction. An applicant-driven process might get spectrum out into the market more quickly than the FCC-driven process.[21]

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[19] As indicated in the previous footnote, the constraints on white space due to the need to protect incumbents from interference may be difficult to define completely and can vary across prospective spectrum buyers depending on the specific uses that they contemplate. Participants in the spectrum marketplace will need to do additional research, beyond consulting the spectrum registry, to determine what they can do with a particular block of spectrum. Similar research is often required for real estate transactions.

[20] The idea here would be to define a timetable that gives the FCC extremely limited discretion in order to limit the ability of incumbents to slow the introduction of new users. For example, within 10 days after the FCC receives an application, it notifies the public of the application received; it then allows another 20 days for competing applications; if one or more competing applications are received, an auction is held within another 30 days.

[21] For a discussion of an applicant -driven process, see Gregory L. Rosston, *The Long and Winding Road: The FCC Paves the Path with Good Intentions,* TELECOMMUNICATIONS POLICY , Vol. 27, No. 7. 501 - 515, August 2003.

The feasibility and attractiveness of the two alternative methods will also depend on which of the following options for transitioning encumbered spectrum is chosen.

VI. Transition Options for Encumbered Spectrum

These options would apply to spectrum that has been licensed, but where the license contains constraining terms and conditions inconsistent with market-based approach we recommend (category 2 above). There are two central issues to address in making the transition from the current system to a flexible and efficient market-driven one. First, to what degree should current licensees, who may or not may not have paid for their licenses (payments could either have been at an initial spectrum auction, in a secondary spectrum market, or through the purchase of an existing licensee) be allowed to retain their licenses? Second, and closely related, if current licensee retain their licenses, should the government simply give existing licensees broader rights, or should the government try to claim for itself the value of the expanded rights it will confer by charging the incumbent licensees for the greater flexibility they will receive? The options are listed in order of the rights that they confer to incumbents, starting with the option that confers the weakest rights to incumbents.

Option 1: Auction spectrum with the rights to clear incumbents immediately without compensation. This option is the closest to starting *de novo*. The federal government would declare current licenses (other than those paid for in auctions) no longer applicable and hold a set of frequency-band and geographic-area auctions, with the spectrum property rights that are auctioned specified by the FCC (according to its initial best guesses as to efficiency parameters for bundles) along the lines discussed above. Under this option, an incumbent would have the following possible courses of action: she could purchase spectrum, including her current assignment, in an auction; she could try to negotiate with the auction winners, including possibly negotiating rights to keep her current assignment; or she could cease operations. This option could be modified by giving incumbents the right to remain in operation temporarily. This would give incumbents some leverage, but it would complicate the definition of the new property rights for auction winners, which would need to accommodate interim use by incumbents.

Pros:

- In theory, this method would have the advantage of immediately establishing a property rights regime along the lines discussed above.

- It would entail relatively low government transactions costs. (Government transactions costs include administrative costs and, perhaps more importantly, the costs of delay associated with a program that requires

decisions involving competing interests and is complicated to implement). •

Avoids hold-out problems.

- May maximize auction revenues.[22]

Cons:

- It would be fiercely opposed by incumbent spectrum users. Entities who recently (or not so recently) bought spectrum from incumbents (e.g., by buying a radio or TV station) would argue (correctly) that they had paid for their spectrum. Almost all spectrum users would be able legitimately to claim that they had invested real resources in facilities for using their spectrum and that therefore they should at a minimum receive compensation for those investments.

- Some private transactions costs.

- The lack of compensation may raise questions about the commitment of the government to guarantee future "property rights." This could deter investment in spectrum-based services.

- To the extent that transactions costs and asymmetric information prevent efficient bargaining, this option could also result in inefficient over-clearing because the new licensees who benefit from clearing would not bear the costs.

Option 2: Auction spectrum with rights to clear incumbents with compensation. The FCC would auction spectrum, either under an FCC- or applicant-driven process. Winners would have the right to clear incumbents from the spectrum that they have bought at auction. Clearing would entail either paying relocation costs or, if the value of the operation is less than relocation costs, paying the incumbent to cease operations. The right to clear incumbents can be immediate or delayed; as with Option 1, the latter case requires that the property rights for new entrants be designed to prevent interference with interim use by incumbents. Delaying the right to clear incumbents also potentially allocates a share of the surplus market spectrum value to incumbents, since they can bargain for premiums in exchange for clearing earlier than is otherwise required. The longer is the voluntary period of earlier clearing, the greater will be the potential premium.

[22] We recognize that there are dangers to an excessive focus on the size of auction revenues. At the limit, efforts to maximize auction revenues could cause the government to try to act as a monopolist with respect to the allocation of spectrum, with all of the inefficiency that follows. Nevertheless, because of the "deadweight loss" inefficiency that accompanies the taxation that is the primary source of government revenues, the size of auction revenues should not be wholly ignored either.

Pros:

- Clearing with compensation to incumbents for clearing costs in most cases yields an efficient solution with minimal transactions costs (so long as clearing costs are readily known or quickly adjudicated). [23]

- If compensation is paid, incumbents are no worse off than before.

- Avoids hold -out problems.

- Giving incumbents a limited right to stay gives them additional bargaining power. This would allow them to extract some rents from the entrants and would increase incumbents' support for the transition.

Cons:

- Higher government transactions costs than Option 1, because clearing costs may not be readily known or quickly adjudicated, and it may be difficult to determine what is comparable spectrum or service. There are also private transactions costs associated with this process.

- Errors in determining compensation may lead to inefficient degrees of clearing.

- Giving incumbents a limited right to stay will ultimately reduce social welfare, including a loss of producer surplus for bidding firms caused by the delay of spectrum availability and increased bargaining costs. Some of the loss of producer surplus will be reflected in lower auction revenues. There would be an additional loss of consumer surplus due to the delay in new services and/or reduced competition. (However, the overall transition delay may be reduced by the increased support by incumbents for the transition.)

Option 3: Auction spectrum without rights to clear incumbents from the auctioned spectrum. New entrants purchase property rights (i.e., overlay rights to the white space) consistent with interference protection for incumbents. Negotiations would be required to change the configuration of those rights. Incumbents would retain their existing rights to start with. Following the recent British proposed method of providing flexible, technology-neutral spectrum rights, incumbents would also have secondary "restrictive" rights if they want to change their use of the spectrum, which are the same for all users and would initially require lower transmission levels than the existing "specific" rights. [24] (This option also is similar to a 1996 proposal by Senator Larry Pressler that would have

[23] See Peter Cramton, Evan Kwerel, & John Williams, *Efficient Relocation of Spectrum Incumbents,* 41JOURNAL OF LAW & ECONOMICS 647 (1998).

[24] See Ofcom, SPECTRUM FRAMEWORK REVIEW, issued June 28, 2005.

provided for exhaustive, flexible overlay licensing for the entire 402 MHz of television broadcasting spectrum.[25])

The British proposal is illustrated by the following example of a cellular operator acquiring UHF broadcasting spectrum: [26]

- Broadcaster A indicates to a 3G operator that they would be willing to trade part of their spectrum. Were this to happen the 3G operator would only be able to use the restrictive spectrum usage rights. These would be too restrictive to allow the 3G operator to provide a viable service;

- Before entering into detailed negotiation with the seller, the 3G operator consults with the owners of the neighboring channels, who are broadcasters. The 3G operator reaches an agreement in principle with them that were it to buy broadcaster A's spectrum it would abide by certain restrictions on siting base stations and make compensatory payments of an agreed amount to the other broadcasters. In return, the other broadcasters would agree on a new specific property right which would be close to the 3GPP [3rd Generation Partnership Project] specification;

- The 3G operator builds a business case based on the new specific spectrum usage rights and compensation payments and decides on the maximum it will pay broadcaster A for its spectrum. It then re -enters negotiation with broadcaster A; and

- If the business case is viable, the trade proceeds.

Pros:

- Provides a market-driven mechanism to move to efficient allocation of spectrum over time.

- Relatively low government transactions costs.

- Gives incumbents maximum bargaining power.

[25] See Senate Spectrum Reform Discussion Draft, May 9, 1996. [26] Ofcom, p. 64.

Cons:

- Potentially significant private transactions costs. There may be hold -out and other difficult bargaining problems.

- May produce lower auction revenues relative to Options 1 and 2.

- The resulting payments to the incumbents may be seen as unfair and trigger extensive (and costly) litigation.

Option 4: "Big Bang" auction with unassigned and encumbered spectrum. [27] There are two basic variants of this option depending on how incumbents are treated. The first variant permits incumbents to repurchase their existing rights at no net cost to themselves. The second variant would give incumbents transferable auction vouchers (tradable for cash) to compensate them for mandatory clearing of their spectrum. This second variant would permit the FCC to repackage and auction the spectrum as totally clear of encumbrance.

Pros:

- Potentially can accomplish major spectrum restructuring all at once.

- It forces incumbents to confront an explicit opportunity cost of holding on to their spectrum.

- Variant 2 would give bidders more certainty, because potential strategic hold -outs would be prevented; greater bidder certainty and lower transactions costs would translate into higher auction revenues.

- Both variants are protective of incumbents' rights and potentially assign them a share of the increased value of the spectrum that they clear.

[27] See Kwerel & Williams, op. cit. Note that this option, as in Kwerel & Williams, involves incumbents' voluntarily bringing their spectrum to the auction process.

Cons:

- If incumbents have the ability to repurchase their existing rights at no net cost (variant 1), then this may limit the amount of restructuring that can be done at the outset. After the auction, the situation is potentially similar to option 3 for incumbents who do not sell.

- Variant 2 permits more restructuring and, thus, might be opposed by incumbents because they wouldn't retain the *status-quo-ante* option. However, the more efficient restructuring may make at least some incumbents better off (i.e., yield voucher payments greater than the expected value of their licenses given the uncertain outcome of postauction bargaining).

- It is a complicated plan to implement, entailing relatively high government transactions costs.

- There are also private transactions costs associated with developing a strategy for this option.

- Payments to the incumbents may be seen as unfair and trigger extensive (and costly) litigation.

Option 5: Give incumbent licensees full property rights to the spectrum they use. Spectrum owners would gain immediate flexibility in terms of the inputs that they could employ and the uses to which they could put their property (so long as any change did not generate interference with another spectrum owner's existing property rights), as well as gaining the immediate ability to add parcels and/or subdivide parcels. Spectrum restructuring would take place through negotiations and other marketplace transactions.

Pros:

- In the absence of extensive litigation this method would quickly establish a property-rights framework, with the least amount of initial transactions costs.

- Existing incumbents, who may have made large investments in complementary assets and/or may have paid for spectrum other than through an initial auction, would not see their past investments devalued. Protecting incumbents in this way could be seen as both fair and as preserving an economic environment in which private parties can invest with confidence that their investments will not be undermined by shifts in government policy.

Cons:

- This method would begin with the existing (legacy) rights, not the property rights system that has been described above. Consequently, there could be significant transactions costs, as the new *de jure* property holders bought, sold, and adjusted their spectrum band and geographic territory holdings and interference limits so as to optimize their holdings in conformance with the new property rights regime.

- Government transactions costs associated with specifying how to assign spectrum that is encumbered by multiple incumbents as well as administratively deciding conflicting claims to white space.

- This option may be perceived politically as a "giveaway" to the incumbent spectrum holders of "the public's property", although the effects on incumbents would in fact be ambiguous, with some incumbents suffering losses as a result of increased competition.[28] A potential variant of this option would be to charge a set fee to incumbents for the added flexibility, whether or not they actually make use of the increased flexibility (unless they forgo the license entirely). Flexibility payments would have to be mandatory in order to avoid distorting the decision to take advantage of increased flexibility. This variant would have a number of complications, of course, including setting the price for added flexibility and accounting for the fact that additional flexibility may have differing values for different kinds of licenses. The primary virtue of this variant is that it would reduce the extent of perceived "giveaways."

- Potentially significant private transactions costs, including those associated with conflicts over competing claims to the white space. Settling such disputes without an auction could be very costly.

VII. Recommendation with Respect to Transition Options

We believe that Options 1 and 5 should be ruled out. Option 1 lacks any mechanism to compensate incumbents who, in many instances, have paid for and invested large sums in the spectrum they occupy. This would be unfair and would produce pressures for delay (including litigation) with consequent large social costs.

Option 5 entails the perception of large giveaways that are likely to be unacceptable to many people. Giving the current incumbents increased flexibility would increase efficiency, but the reality is that there would be winners and losers, which would also be perceived as unfair and would likely lead to substantial litigation, delaying the transition to a market-driven regime.

[28] See Thomas W. Hazlett, PROPERTY RIGHTS AND WIRELESS LICENSE VALUES, September 16, 2005.

Properly implemented, options 2-4 are all reasonable choices, and—if private parties do not recognize that options 3 and 4.1 may be equivalent to option 5 in terms of the windfalls enjoyed by current incumbents—are more likely to be politically feasible than options 1 and 5. Each of the three middle options would provide a transition to a property-rights regime. Each of them has advantages and disadvantages, but none of them is clearly dominant. Each of them involves a market-based transition process as well as providing protection for incumbents. We believe that these are essential for an efficient and timely transition to a market-driven regime.

VIII. Government-Held Spectrum

Governments at all levels (federal, state and local) now hold about a third of all available spectrum. How should government-held spectrum fit into a propertyrights regime?

So long as spectrum is a "free" resource to a government agency, there is no clear incentive for the agency to do other than to hoard its spectrum against the possibility that it may be useful sometime in the future. Even if a private market in spectrum establishes prices and thus the opportunity costs of holding spectrum, so long as the agency's budget is not directly affected by its use—or non-use—of spectrum, its hoarding proclivities are unlikely to be changed. Similarly, even if spectrum held by government agencies was propertyzed, if the agency leadership believes that the proceeds from sales of surplus spectrum will have to be transferred to the central treasury or, even if retained by the agency, will be fully offset by future reductions in budgetary allocations, then the incentive for hoarding will remain intact.

Nevertheless, there are measures that can be taken to promote more efficient use of the publicly held spectrum, and we suggest several here:

1. Include government-held spectrum in the registry. First, there needs to be an up-to-date government inventory, probably under the auspices of NTIA, of who has been allocated what. All existing government allocations should be entered into the registry, to the extent that doing so does not create national security problems. This will help private parties determine what white space is available so that they can bid for it accordingly.

2. Require that NTIA prepare and submit to Congress an annual report on spectrum usage by the government. This report should contain data on spectrum usage by various agencies and should also evaluate the efficiency with which the spectrum is being utilized. This information could then be used to develop recommendations for reallocating spectrum to the private sector or for purchasing more spectrum for some government purposes.

3. Establish reward structures that encourage government employees to economize on their agencies' uses and holdings of spectrum . Just as government employees are currently rewarded—e.g., bonuses, promotions, special awards, etc. — for their initiatives in reducing costs and improving efficiency, so too should they be rewarded in the sphere of spectrum holding and use.

4. Government entities should be expected to purchase additional spectrum rights. As a property-rights regime takes hold in the use of spectrum, government agencies should be required to buy or lease any additional spectrum (just as they buy or lease their police cars, their fire engines, their munitions, their office space, etc.).

5. Try innovative ways to promote efficient use of government spectrum. Even if government entities continue to receive some spectrum allocations free of charge, there still may be innovative ways to help assure that the spectrum is efficiently used. For example, spectrum for public safety purposes (e.g., the 24MHz from the DTV transition that has been set aside for public safety purposes) could be granted to the states with the express proviso that the states put out for bid contracts to provide the needed public safety services in return for rights to use the spectrum. Contracts would specify the public safety service features (including the degree of exclusivity, interoperability with other local, state, and federal public safety systems, etc.) that are considered appropriate by the state government officials. The winning contractor would then have the appropriate incentives to use the spectrum efficiently and to lease any unused spectrum for private -sector uses. The price paid by the state to the contractor may end up being positive or negative, once the value of the spectrum is taken into account. In essence, more efficient use of the spectrum that has been designated for public safety uses may well come from the public safety agencies' purchasing the necessary spectrum services from the private sector rather than managing the resources themselves. [29]

6. Generally, encourage purchase of communications services in place of grants of spectrum. Government generally need not—and often does not—purchase primary inputs and attempt to combine inputs into the goods and services that it needs; instead, it directly purchases intermediate and final goods and services.[30] With respect to wireless communications services, greater efficiency would surely be achieved by having governments purchase those services from communications providers rather than trying to produce those services themselves by purchasing the inputs separately—i.e., the spectrum and the equipment—and putting those inputs together to produce the services. Moreover, private sector providers may be able to achieve economies of scale and scope in the provision of wireless services for public safety and other government functions that cannot be achieved through direct government provision.

[29] We note as a parallel that the Department of Defense (DOD) has contracted with airlines and with ocean shipping companies.

[30] For example, police departments do not attempt to manufacture their own cars, school lunch programs are not expected to grow their own food, the DOD does not manufacture its own airplanes, etc.

IX. The Legal Standard for Enforcement of Spectrum Property Rights

In a property rights regime for spectrum, the property owners need to be able to have legal recourse in the event that someone breaches their property right—in essence, if someone "trespasses" on their spectrum property. It is also critical that the property rights be as clearly defined and unambiguous—and that the adjudication process be as simple —as possible.

These considerations (and the real estate analogy that we have found useful throughout this document) suggest that the appropriate legal framework should be the law of trespass. In the event of an emissions trespass, the spectrum owner can legally obtain an injunction against future such trespasses and sue for damages from past trespasses. There is a strong analogy here to the concept of "strict liability" in the area of tort liability. Though the responsibility in the first instance is on the potential emitter to avoid trespassing on the spectrum owner's property, negotiations between the owner and the emitter ought to be able to find mutually beneficial ways to reduce costs in such situations —e.g., it may be less costly (in return for a payment from the emitter) for the spectrum property owner to improve (tighten) the reception characteristics of her receivers and then allow some trespassing emissions than for the emitter to avoid all trespasses.

Due to the physical properties of spectrum, the detection and measurement of emissions is not always straightforward. In the quasi-property-rights regime that currently governs the PCS bands, interference is controlled by regulating output at the transmitter. The maximum emissions levels at the frequency and geographic boundaries (the basic parameters of the property right) are fed into a radiation propagation model that calculates the maximum transmitter output consistent with those levels. This method seems to be working well.

There are also arguments that favor using actual measurements of radiation power strengths at the boundaries (geographic and frequency) as the basis for enforcing the spectrum property right. Under this method, the power strength standard could be expressed as a simple maximum level, the exceeding of which would constitute trespass. Or, it could be expressed in a way that explicitly accounts for the stochastic variations in power strengths at any measurement point due to environmental conditions.

The best way to measure whether emissions limits have been exceeded is likely to be fact-specific, depending on such factors as the activities and frequencies involved. We therefore think it is probably not appropriate to set out in advance a global rule for how property rights will be enforced. The courts (whether administrative or judicial) are in a better position to work out these issues based on a fuller set of facts. This new area of property law can develop efficiently by following such a common-law approach.

X. The Forum for Adjudication of Spectrum Property Rights

In disputes with respect to their property rights, spectrum property holders will need a forum for legal adjudication. There are two obvious alternatives, each with advantages and disadvantages. Property disputes could be decided in adjudicatory proceedings in a reformed FCC (see the forthcoming report of the DACA Institutional Reform Working Group). FCC administrative law judges would presumably become knowledgeable about the technical aspects of these issues. There is some concern that FCC judges or commissioners might be more prone than court judges to use these adjudications as a policy-making opportunity. However, a reformed FCC might develop a more objective adjudicatory process.

The other alternative is to give the federal court system jurisdiction over these disputes. Perhaps the best argument for this is that we use the courts for property disputes generally. Moreover, the federal courts might be less prone to "make policy". On the other hand, they may also have less specialized expertise and may not welcome this expansion of their jurisdiction.

In either event, a good argument could be for appeals being channeled to the Court of Appeals for the Federal Circuit, since many of that appellate court's decisions involve copyright and trademark disputes and thus involve property rights issues.

XI. International Obligations

The property rights regime that we have outlined in this document can be consistent with the international obligations of the U.S. In essence, all spectrum property rights should be subject to any relevant U.S. international obligations. As an easy example, the borders of the U.S. with Canada and Mexico would also constitute the geographical boundaries for any spectrum property rights that would encompass territories that would be adjacent to the boundaries and the power limits at those borders would have to be consistent with U.S. obligations and understandings with respect to those two countries and their spectrum usage.

XII. The Role of the FCC

The FCC would have at least one and possibly two additional important roles in the property rights regime advocated in this document. First, the FCC would be responsible for the initial implementation of the property rights regime—the auctions, the specification of power limits at geographic and spectrum wavelength boundaries, the specification of the boundaries themselves, etc.—under any of the options presented above (see Sec. IV.A above). Second, the FCC could be the agency that maintains the national spectrum registry (see Sec. V.A). Third, the FCC could be the initial forum for the adjudication of spectrum property disputes (see Sec. X).

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