# Sweeten the Deal

## Transfer of Federal Spectrum through Overlay Licenses

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**Abstract**

The largest challenge in wireless telecommunications policy is transferring spectrum from inefficient legacy operators such as the federal government to bandwidth-hungry wireless broadband operators. Delay results in annual consumer welfare losses totaling hundreds of billions of dollars. One solution would be to auction overlay licenses to commercial bidders and give spectrum incumbents a clearing deadline. Overlay licenses reorder property rights and give incumbents the ability to sell the possessory rights to their frequencies. An alternative reform proposal from a 2012 President's Council of Advisors on Science and Technology report recommends relying on complex spectrum-sharing technologies in order to avoid clearing agencies from their spectrum. Such a proposal would take decades to implement, would not encourage efficient government use of spectrum, and would likely degenerate into regulatory failure. In contrast, the PCS and AWS-1 auctions by the FCC show that overlay licenses permit commercial deployment of wireless technologies in encumbered spectrum within a few years.

*JEL* codes: D440, D450, H110, H540, K000, K230, L330

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**Sweeten the Deal**

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## I. Introduction

The explosion in consumer demand for wireless services that began in the 1990s caught policymakers off guard. Demand has only accelerated as new cellular wireless technologies—such as broadband Internet via 3G and 4G LTE—permit services such as web browsing, video streaming, the Internet of Things, and gaming, thus necessitating a steady influx of spectrum as an input. However, the traditional Federal Communications Commission (FCC) and National Telecommunications and Information Administration (NTIA) spectrum assignment processes, to nonfederal and federal users, respectively, strained to accommodate new demands and cutting-edge services. In traditional assignment, still widely used today, the rights to use certain frequencies are awarded by the FCC and NTIA for free to deserving users.[1] Figuring out who is deserving in the absence of the price system, however, is a time-consuming and politicized process. Rent-seeking and economic waste at the FCC became too obvious to ignore in the 1990s, however, and regulators today are increasingly relying on market allocation of nonfederal spectrum via spectrum auctions.[2]

The new challenge is transferring spectrum from inefficient legacy operators to bandwidth-hungry entrants. Almost no "greenfield" spectrum is left—commercial and government users occupy nearly all valuable spectrum—so policymakers are scouring existing wireless systems for surplus spectrum that can be auctioned. In the past 25 years, therefore,

[1] *See* 47 U.S.C. § 309(a) (the FCC "shall determine, in the case of each application filed with it . . . whether the public interest, convenience, and necessity will be served by the granting of such application."); US Department of Commerce, National Telecommunications and Information Administration, *Manual of Regulations and Procedures for Federal Radio Frequency Management* 8-1 (May 2013, rev. May 2014), http://www.ntia.doc.gov/files/ntia/publications/redbook/2014-05/8_14_5.pdf (describing NTIA's spectrum assignment procedures).

[2] Thomas W. Hazlett, *Assigning Property Rights to Radio Spectrum Users: Why Did FCC License Auctions Take 67 Years?*, 41 J.L. & ECON. 529 (1998).

various incumbent users, including television broadcasters,[3] public safety agencies,[4] aeronautical systems,[5] and utility companies,[6] have seen their spectrum transferred to new licensees and repurposed for consumer uses such as mobile broadband. Not only are inefficient commercial technologies locked in because of decades of top-down spectrum assignment, but the growing consensus among experts[7] is that spectrum assigned to federal agencies is lightly used and would therefore be better redeployed for consumer use.[8]

Slow repurposing of federal spectrum is a hidden public policy crisis with tremendous economic costs. Delayed reassignment of spectrum to efficient use is costly to society,[9] so streamlining the process of quickly transferring swaths of spectrum between users is a policy goal that would yield significant economic benefits. Economists estimate that spectrum in the hands of inefficient incumbents represents hundreds of billions of dollars of lost consumer

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[3] Robert M. Rast, *The Dawn of Digital TV*, IEEE SPECTRUM (Oct. 3 2005), http://spectrum.ieee.org/consumer-electronics/audiovideo/the-dawn-of-digital-tv (describing the clearing of analog broadcast television systems to allow for the 700 MHz auction).

[4] *See infra* description of the PCS auction.

[5] Gregory L. Rosston, *Increasing the Efficiency of Spectrum Allocation*, 45 REV. OF INDUS. ORG. 221, 231 (2014).

[6] *See infra* description of the PCS auction.

[7] Harvey J. Levin, *The Radio Spectrum Resource*, 11 J.L. & ECON. 433, 434 (1968) ("Most other users (like those in public safety and local or federal government radio) are not directly constrained in their use of spectrum by pressures in any 'markets' for their end products or services."); Jeffrey A. Eisenach, *Spectrum Reallocation and the National Broadband Plan*, 64 FED. COMM. L.J. 87, 130 (2011); THOMAS M. LENARD, LAWRENCE J. WHITE & JAMES L. RISO, INCREASING SPECTRUM FOR BROADBAND: WHAT ARE THE OPTIONS? 23 (2010) ("There appears to be a widespread consensus that spectrum in government hands is likely not being used efficiently."); James Losey & Sascha Meinrath, *Free the Radio Spectrum*, IEEE SPECTRUM (June 28, 2010), http://spectrum.ieee.org/telecom/wireless/free-the-radio-spectrum/0 (stating that "the 270,000 [assignments] held by government agencies . . . are woefully underutilized."); Martin Cave & Adrian Foster, *Solving Spectrum Gridlock: Reforms to Liberalize Radio Spectrum Management* 3 (C.D. Howe Inst., Commentary 303, 2010) ("To a significant degree, these [efficiency] improvements have not worked their way into spectrum use by public sector users, including the military, emergency services, or aeronautical or maritime transport.").

[8] President Barack Obama concurs with this assessment, and in June 2010, he issued a memorandum directing NTIA to identify federal spectrum that can be made available for wireless broadband by 2020. Unleashing the Wireless Broadband Revolution, 75 Fed. Reg. 38,387 (June 28, 2010).

[9] Coleman Bazelon & Giulia McHenry, *Staying on Track: Realizing the Benefits from the FCC's Incentive Auction without Delay*, in COMMENTS OF LOCUSPOINT NETWORKS, LLC, IN THE MATTER OF BROADCAST INCENTIVE AUCTION COMMENT PUBLIC NOTICE AUCTION 1000, 1001, AND 1002, AU DOCKET NO. 14-252, AND EXPANDING THE ECONOMIC AND INNOVATION OPPORTUNITIES OF SPECTRUM THROUGH INCENTIVE AUCTIONS, GN DOCKET NO. 12-268 (Feb. 20, 2015), http://apps.fcc.gov/ecfs/document/view;ECFSSESSION=Kk3QJpkhFvcQwklx1G3Rz6tF8p3LBhxBWph1ZmjDp4nkr60XTZRG!156529071!809722108?id=60001031918 (estimating that the social costs of delaying the "incentive auction" of TV bands by two or three years could approach $200 billion).

surplus annually.[10] Delayed deployment of new wireless services results chiefly because few incumbents offer to relinquish their valuable spectrum. Incumbents generally have two undesirable options: either (a) relocate to another band and purchase new, more efficient equipment or (b) mothball operations completely.

The spectrum shortage is not a market failure; rather, it is a regulatory failure that prevents spectrum from being quickly transferred to its highest-valued uses. First, although some commercial users pay market rates for spectrum through auctions and secondary markets, federal agencies do not pay market rates.[11] The negligible annual fee agencies pay for their frequencies means spectrum is treated as a free good, and agencies have little incentive to economize. Second, because federal agencies cannot sell or transfer their spectrum to commercial users, the resources are locked into inefficient federal systems.[12]

To paraphrase FCC Commissioner Jessica Rosenworcel, federal agencies need "carrots and sticks" for efficient use.[13] In the next 5 to 10 years, particularly with the hardest-to-reclaim

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[10] Harold Furchtgott-Roth, *Granting Licensed Spectrum Flexibility: How to Spur Economic Growth and Innovation in America* 6, ECON. POL'Y/BRIEFING PAPER (Hudson Inst.), Dec. 2012, http://www.hudson.org/content/research attachments/attachment/1084/hfr--spectrumflexibility--dec12.pdf; Thomas W. Hazlett & Roberto E. Muñoz, *A Welfare Analysis of Spectrum Allocation Policies*, 40 RAND J. ON ECON. 424, 425 (2009).

[11] Agencies pay only a small, annual fee for their spectrum—$122 for each frequency assignment. U.S. GOV'T ACCOUNTABILITY OFFICE (GAO), GAO-13-7, SPECTRUM MANAGEMENT: INCENTIVES, OPPORTUNITIES, AND TESTING NEEDED TO ENHANCE SPECTRUM SHARING 11, n.14 (Nov. 2012), *available at* http://www.gao.gov/assets /660/650019.pdf.

[12] The Miscellaneous Receipts Act requires "an official or agent of the Government receiving money for the Government from any source" to "deposit the money in the Treasury as soon as practicable without deduction for any charge or claim." 31 U.S.C. § 3302(b). Thus, under current law, any payment to agencies would have to be submitted to the Treasury rather than be retained by the agency receiving the payment for relocation purposes. Once revenue is submitted to the Treasury, it may only be disbursed pursuant to a specific congressional directive. COMMERCE SPECTRUM MGMT. ADVISORY COMM., RECOMMENDATIONS FOR IMPROVING THE PROCESS FOR IDENTIFYING SPECTRUM FOR FUTURE REALLOCATION OR SHARING 25 (Aug. 22, 2008), http://www.ntia.doc.gov /files/ntia/publications/081508_csmac_wg3_report_revised_clean_final.pdf.

[13] One meritorious "stick" proposal is to charge agencies approximately the opportunity cost of their spectrum, much like the United Kingdom does. Long-term spectrum fees should be budgeted for as an operating expense so that agencies can sensibly weigh the tradeoffs between acquiring spectrum and other inputs that further their agency mission. This proposal resembles a "GSA for spectrum." *See* LENARD, WHITE & RISO, *supra* note 7; Brent Skorup, *Reclaiming Federal Spectrum: Proposals and Recommendations*, 15 COLUM. SCI. & TECH. L. REV. 90, 110–12 (2013). For a thoughtful analysis on the merits of this proposal, *see* Dorothy Robyn, *Buildings and Bandwidth:*

spectrum (such as that of the Department of Defense), a "carrot" may be required. One carrot proposal would encourage efficient trades by giving agencies greater rights to the spectrum they possess—a system of transferable spectrum licenses[14]—so that agencies can trade and sell spectrum to commercial users and retain some of the proceeds.

Commissioner Rosenworcel proposed that to effect these transactions and to channel spectrum to its highest-valued uses, the FCC and NTIA could auction off "overlay" licenses to commercial users.[15] Overlay licenses here mean flexible-use licenses to use a particular band occupied by another licensee. Overlay licenses grant auction winners the right to use only unoccupied spectrum adjacent to an incumbent system in the band and exclusive rights to bargain with those existing users. These licenses can be accompanied by a deadline for incumbent users to move out of the band. Before that deadline, overlay licensees must protect existing users in the band, but they also reap the rewards (such as faster deployment of 4G LTE services) if they can convince the incumbents to move or repack to another band.

Purchasing an overlay license is akin to purchasing a city block of real property encumbered by a few tenants with unexpired leases. The existing tenants have a superior possessory right to occupy the property, but they may willingly abandon the property for a high enough cash payment or trade. The benefit of overlay licenses is that they create residual claimants and encourage voluntary settlements between the incumbent user—in this case, a federal agency—and the overlay auction winner. The FCC has previously executed successful

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*Lessons for Spectrum Policy from Federal Property Management*, ECON. STUDY (Brookings Inst.), Sept. 2014, *available at* http://www.brookings.edu/~/media/research/files/papers/2014/09/23_buildings_bandwidth_spectrum_property/23_buildings_bandwidth_spectrum_property.

[14] My thanks are extended to an anonymous reviewer for suggesting this term.

[15] Commissioner Rosenworcel does not use the term *overlay*, but she describes the same process. Jessica Rosenworcel, FCC commissioner, Remarks to CTIA at the Mobile Marketplace (May 22, 2013), http://www.fcc.gov/document/commissioner-rosenworcels-speech-ctia-2013 ("So I propose we auction 2155–2180 MHz along with an additional right . . . the exclusive right to negotiate with federal incumbents [in the 1755–1780 MHz band].").

overlay auctions on the nonfederal side, and Rosenworcel called such auctions an "elegant solution" for a band encumbered by federal users.[16]

There are several policy alternatives for repurposing federal spectrum. A White House–commissioned study focuses on the deficiencies of these proposals but largely avoids comparative institutional analysis.[17] The study, for instance, critiques the overlay auction process as "extremely slow and cumbersome."[18] The analysis cannot end there, however. The important questions to be answered include (1) are overlays slow and cumbersome compared to the available alternatives and (2) which process is more likely to improve social welfare?

Economist Ronald Coase pointed out that a proposed policy should, as much as possible, be compared with other real-world policy alternatives and their economic effects.[19] Here, as in many debates, all available policy choices are costly. Regulators must consider how their rules influence relocation decisions relative to other real-world alternatives. In this paper, I make the case that private ordering through overlay auctions performs admirably when compared to the regulation-intensive spectrum-sharing regime recommended in the President's Council of Advisors on Science and Technology (PCAST) report.[20] By examining how overlay auctions and sharing techniques have worked in practice, regulators have a better understanding of the costs and benefits associated with spectrum policy decisions.[21]

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[16] Rosenworcel, *supra* note 15.
[17] Karen D. Gordon et al., *A Review of Approaches to Sharing or Relinquishing Agency-Assigned Spectrum* (IDA Sci. & Tech. Inst., Paper P-5102, 2014), *available at* https://www.ida.org/upload/stpi/pdfs/p5102final.pdf.
[18] *Id.* at 54.
[19] Ronald Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1, 43 (1960) ("A better approach would seem to be to start our analysis with a situation approximating that which actually exists, to examine the effects of a proposed policy change and to attempt to decide whether the new situation would be, in total, better or worse than the original one.").
[20] PRESIDENT'S COUNCIL OF ADVISORS ON SCI. & TECH. (PCAST), REALIZING THE FULL POTENTIAL OF GOVERNMENT-HELD SPECTRUM TO SPUR ECONOMIC GROWTH ix (July 2012), *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf.
[21] Thomas Hazlett performed a similar analysis when discussing relocating television broadcasters. Thomas W. Hazlett, *Efficient Spectrum Reallocation with Hold-Ups and Without Nirvana* (Geo. Mason U. L. & Econ. Res. Paper 14-16, 2014), *available at* http://iep.gmu.edu/wp-content/uploads/2014/04/nirvana.pdf.

## II. Background

Command-and-control spectrum allocation methods prevailed at the FCC and NTIA for decades, drawing comparisons to the former Soviet Union's State Planning Committee, known as Gosplan, "which allocated scarce resources by administrative fiat among factories and other producers in the Soviet economy."[22] Economists such as Ronald Coase pointed out during this era that spectrum has many attributes of real property and that it might be more efficiently used by private users who (1) internalize the benefits and costs of deploying the input and (2) can sell it to parties who value it more.[23] Market-based spectrum reform, if not always practiced, has essentially won the day both on the commercial side and at the FCC since the early 1990s. Auctions are held for spectrum, secondary markets permit license transfers to profit-maximizing firms, and the FCC generally avoids prescribing what wireless services must be provided. Scholars therefore have increasingly focused on injecting market reform into the reordering of federal spectrum,[24] which is assigned to agencies by the NTIA through command and control.

The 3,200 MHz segment of spectrum spanning 300 MHz to 3,500 MHz is in high demand for both government and commercial users. This range of frequencies, or similar approximations to it,[25] represents the so-called beachfront spectrum because it has optimal propagation characteristics for many popular wireless services. Lower frequencies in this range

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[22] Gerald R. Faulhaber & David Farber, Spectrum Management: Property Rights, Gosplan, Markets, and the Commons, Presentation to the FCC, 1 (June 12, 2002).

[23] *See, e.g.*, Furchtgott-Roth, *supra* note 10, at 4; Yochai Benkler, *Some Economics of Wireless Communications*, 16 HARV. J.L. & TECH. 25, 29–30 (2002) (citing the property rights and auctions framework as "the standard economists' view"); Thomas W. Hazlett, *The Wireless Craze, the Unlimited Bandwidth Myth, the Spectrum Auction Faux Pas, and the Punchline to Ronald Coase's "Big Joke": An Essay on Airwave Allocation Policy*, 14 HARV. J.L. & TECH. 335, 449 (2001); Eli Noam, *Spectrum Auctions: Yesterday's Heresy, Today's Orthodoxy, Tomorrow's Anachronism, Taking the Next Step to Open Access Spectrum*, 41 J.L. & ECON. 765, 766 (1998).

[24] *See, e.g.*, Eisenach, *supra* note 7; LENARD, WHITE & RISO, *supra* note 7; Skorup, *supra* note 13; Robyn, *supra* note 13.

[25] Estimates of beachfront spectrum range from 225 MHz to 3,700 MHz.

permit transmissions over long distances, whereas higher frequencies transmit shorter distances but have higher capacity, for example, for transmitting web data and for streaming video. National mobile broadband carriers—the primary purchasers of available spectrum—such as Sprint and AT&T Mobility therefore take a diversified approach. They acquire low and high bands so that they can provide both good regional coverage (via low bands) and localized high capacity (via high bands).

NTIA manages federal spectrum, and it estimated in 2012 that federal operations use about 40 percent of the in-demand spectrum.[26] Of the 3,200 MHz of beachfront spectrum, NTIA is currently analyzing close to 1,000 MHz to either share with or transfer to commercial users.[27] To that end, in late 2014, the FCC auctioned off federal spectrum in the AWS-3 auction.[28] The biggest bidders included AT&T Mobility, Verizon Wireless, Dish Network, and T-Mobile,[29] and the 50 MHz band of paired spectrum (25 MHz of federal spectrum was paired with another nonfederal 25 MHz block) raised more than $40 billion.[30] Several empirical studies show that the *annual* consumer surplus derived from wireless broadband approximates the auction value of the underlying spectrum.[31] Therefore, the $40 billion paired

[26] NTIA defined *high-value spectrum* as spanning 225 MHz to 3,700 MHz. *Spectrum Management: Federal Government's Use of Spectrum and Preliminary Information on Spectrum Sharing: Testimony before the Subcomm. on Comm'n and Tech. of the H. Comm. on Energy and Commerce*, 112th Cong. 3 (Sept. 13, 2012) (statement of Mark L. Goldstein, GAO), *available at* http://www.gao.gov/assets/650/648206.pdf.
[27] NTIA, FIFTH INTERIM PROGRESS REPORT ON THE TEN-YEAR PLAN AND TIMETABLE 6, table B-1 (Apr. 2015), http://www.ntia.doc.gov/files/ntia/publications/ntia_5th_interim_progress_report_on_ten-year_timetable_april_2015.pdf.
[28] AWS-3 included previously federal bands 1,695–710 MHz and 1,755–80 MHz. The latter band was paired with 2,155–80 MHz at auction, which contained nonfederal fixed microwave licensees and BRS licensees.
[29] Phil Goldstein, *AWS-3 Auction Results: AT&T Leads with $18.2B, Verizon at $10.4B, Dish at $10B and T-Mobile at $1.8B*, FIERCEWIRELESS (Jan. 30, 2015), http://www.fiercewireless.com/story/aws-3-auction-results-att-leads-182b-verizon-104b-dish-10b-and-t-mobile-18b/2015-01-30.
[30] The paired spectrum grossed $42.5 billion, and the unpaired 15 MHz of federal spectrum grossed $2.43 billion. *See* George S. Ford & Lawrence J. Spiwak, *Auction 97 and the Value of Spectrum* (Phoenix Center, Perspectives 15-02, 2015), at 2, *available at* http://www.phoenix-center.org/perspectives/Perspective15-02Final.pdf.
[31] Bazelon & McHenry, *supra* note 9.

block of AWS-3 spectrum, when deployed, will provide about $40 billion worth of consumer surplus annually.

Federal agencies are market participants for many indispensable inputs but not, anomalously, for spectrum. Agencies compete with private firms for supply of most inputs, such as labor, real estate, electricity, automotive fleets, and office supplies. Spectrum, however, is given to federal agencies for practically nothing,[32] and underused or excess spectrum cannot be sold to commercial operators. Agency spectrum is removed from market processes, and agencies have little economic incentive to use or manage spectrum efficiently.[33] With little sense of the opportunity costs of the spectrum they use, agencies are largely exempt from economic pressures to use more efficient radios, outsource wireless services to commercial operators, or substitute wireless communications with wired communications.

Market mechanisms for repurposing federal spectrum are currently unavailable, so members of Congress and the executive branch rely mostly on scrutiny from government audits and congressional hearings, which have limited effectiveness.[34] Policymakers understand the

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[32] Agencies pay only a small, annual fee for their spectrum—$122 for each frequency assignment. GAO, *supra* note 11.

[33] PCAST concluded that "federal users currently have no incentives to improve the efficiency with which they use their own spectrum allocation." PCAST, *supra* note 20. Some of the inefficiency is undoubtedly to be expected. Any large organization has bureaucratic friction, and federal agencies—particularly defense agencies—are especially risk averse. A lack of transparency regarding federal uses of spectrum and the fragmented authority over federal spectrum management certainly contribute to the government failure. Transparency in spectrum use is generally unrewarded and is therefore undersupplied. HAROLD FELD & GREGORY ROSE, BREAKING THE LOGJAM: SOME MODEST PROPOSALS FOR ENHANCING TRANSPARENCY, EFFICIENCY AND INNOVATION IN PUBLIC SPECTRUM MANAGEMENT 5 (2010), http://www.publicknowledge.org/pdf/pk-fed-spectrum-transparency-whitepaper.pdf. The fragmentation of authority over federal spectrum may unfortunately be intractable. A 1994 effort to consolidate Department of Defense spectrum management lasted only a year because the chiefs of Army, Navy, Air Force, and intelligence organizations all wanted to retain their own spectrum management office. GAO, GAO-NSIAD-97-131, DEFENSE COMMUNICATIONS: FEDERAL FREQUENCY SPECTRUM SALE COULD IMPAIR MILITARY OPERATIONS 15 (June 1997), *available at* http://www.gao.gov/archive/1997/ns97131.pdf.

[34] The slow relocation of government systems leads to verbal haranguing of federal administrators and to visible frustration. Carl Franzen, *Congress Blasts Military and National Telecom Agency for Not Sharing Wireless Spectrum Faster*, VERGE (June 27, 2013), http://www.theverge.com/2013/6/27/4470738/congress-house-wireless-spectrum-hearing-june-2013 ("Do you [NTIA and Department of Defense administrators] sit down and talk to each other? Why wouldn't the two of you sit down and talk about it. Why am I even having to ask this question again?") (quoting Rep. Eshoo).

urgency, but the Obama administration's June 2013 memorandum[35] to federal agencies, like the PCAST report that informed the memorandum, does little about the underlying problem. On the issue of efficient use of federal spectrum, the memorandum merely directs agencies to determine what spectrum could potentially be made available for sharing or clearing and requests that agencies "use the minimum spectrum reasonably necessary to most effectively meet mission requirements."[36]

These sorts of requests have been around for decades. The problem is not that a president has not asked for efficient use forcefully enough; rather, the problem is that federal agencies face few economic tradeoffs.[37] Agencies have acceded—slowly—to congressional mandates to clear spectrum for auction. However, agencies are increasingly resistant to relocating their operations.[38] For this reason, the White House is contemplating several spectrum-clearing and spectrum-sharing methods, though no alternative has emerged as the consensus.[39]

## III. Rival Approaches

Repurposing federal spectrum is a pressing economic problem that has received increasing attention, and several solutions have been proposed. As a 2014 study commissioned by the White House found, every federal spectrum-repurposing proposal, including overlays, faces

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[35] Presidential Memorandum, Office of the White House Press Secretary, Expanding American's Leadership in Wireless Innovation (June 14, 2013), *available at* http://www.whitehouse.gov/the-press-office/2013/06/14/presidential-memorandum-expanding-americas-leadership-wireless-innovatio.

[36] *Id.*

[37] *Federal Management of Radio Spectrum 4: Hearing Before the Subcomm. on Telecomm. & Fin. of the H. Comm. on Commerce*, 104th Cong. 10 (Sept. 7, 1995) (statement of James L. Gattuso, Citizens for a Sound Economy), *available at* http://www.ipmall.info/hosted_resources/lipa/Pub.%20L.%20No.%20104-104%20-%20Telecommunications%20Act%20Of%201996/Volume%2021/Federal%20Management%20of%20the%20Radio%20Spectrum%20-%20Hearing%20before%20the%20Subcommittee.pdf ("the root cause of the Federal problem [is] the lack of incentives to use spectrum efficiently.").

[38] PCAST and other experts believe relocating incumbent federal systems will be increasingly difficult. PCAST, *supra* note 20, at 9.

[39] Gordon et al., *supra* note 17.

implementation challenges.[40] Comparisons between policies are therefore necessary for informed policymaking. Below, the PCAST dynamic sharing proposal is analyzed and compared to recent overlay auctions and the clearing of federal users.

***PCAST's Dynamic Sharing Proposal***

The political difficulties in transferring a valuable resource from one group (federal agencies) to another (commercial wireless operators and consumer device makers) guided the PCAST recommendation to do away with traditional clearing and auctioning procedures such as overlays.[41] Instead, PCAST recommended simply changing the nature of the obligations of spectrum users—a do-no-harm standard—and relying on the future advancement of technologies that enable dynamic spectrum sharing.[42] With dynamic sharing, commercial devices such as smartphones, tablets, and small cells will detect and avoid—possibly in real time—interference with federal systems, such as radar and video surveillance, that use the same frequencies at the same time in the same geographic area. The benefit is that dynamic sharing eliminates the need to clear resistant federal users.

The PCAST recommendations are modeled on the FCC's TV white spaces proceeding,[43] which permitted unlicensed devices and cognitive radios in the unused "white spaces" that comprise about 240 MHz of the 294 MHz allocated to television broadcasters.[44] Like federal users, television broadcasters are legacy users that, generally speaking, cannot sell their spectrum

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[40] *Id.*
[41] PCAST, *supra* note 20, at 1 ("Clearing and reallocation of Federal spectrum for exclusive use is not a sustainable basis for spectrum policy.").
[42] *Id.* at 11 ("The key to the new architecture is to create very wide bands and implement dynamic, real-time, spectrum sharing.").
[43] *Id.* at 24 ("We envisage that access to large Federal bands authorized for shared use can be coordinated primarily by registering and communicating with a management database, similar in concept to the White Space Databases certified by the FCC to provide permission to transmit in the TV Bands."). *See also id.* at 31, 82–84, 105.
[44] Thomas W. Hazlett & Evan T. Leo, *The Case for Liberal Spectrum Licenses: A Technical and Economic Perspective*, 26 BERKELEY TECH. L.J. 1037, 1049 n.50 (2011). The strict rules for unlicensed devices mean much of the available frequencies cannot be exploited. *Id.*

to mobile carriers. After a 2002 staff recommendation for this type of spectrum sharing, the FCC issued a 2008 order allocating spectrum for white space devices' use, and the first device was approved in 2012.[45] White space devices must protect incumbent broadcasters but can transmit and receive signals in geographic areas and on frequencies that do not contain TV broadcasters.

The device specifications formulated by the FCC have strict power limits and are quite complex because of interference concerns.[46] White space–sharing techniques rely on accurate geolocation information, yet those crucial databases of registered devices contain hundreds of errors.[47] Seven years after the 2008 order, white space–sharing technology has been used only marginally. As of this writing, only about 600 devices are in use,[48] providing data services (e.g., connecting municipal water-monitoring systems) and Wi-Fi–like Internet access (at a handful of libraries and schools).[49]

### *Auction of Overlay Licenses*

An alternative proposal for spectrum reform, resembling Commissioner Rosenworcel's proposal, is to auction overlay licenses which permit the commercial use of spectrum currently encumbered by federal users.[50] These licenses are called *overlays* because they geographically

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[45] PCAST, *supra* note 20.
[46] *See* FCC, OFFICE OF ENGINEERING AND TECHNOLOGY, FCC/OET 08-TR-1005, EVALUATION OF THE PERFORMANCE OF PROTOTYPE TV-BAND WHITE SPACE DEVICES PHASE II iv (Oct. 2008), *available at* http://apps.fcc.gov/ecfs/document/view;jsessionid=7qp3P1VbdnpcVyFWySl2N52n318pmkvNznfvhcyWdnPhqGTpyhzP!1471562840!-321460796?id=6520183093.
[47] Robert McDowell, *The FCC Should Fight for Our Right to TV White Spaces*, WIRED (Apr. 7, 2015), *available at* http://www.wired.com/2015/04/fcc-white-spaces-database/; Mike Dano, *FCC Promises to Clean Up Error-Ridden TV White Spaces Databases*, FIERCEWIRELESS (Mar. 20, 2015), *available at* http://www.fiercewireless.com/tech/story/fcc-promises-clean-error-ridden-tv-white-space-databases/2015-03-20.
[48] McDowell, *supra* note 47.
[49] Lyndsey Gilpin, *White Space Broadband: 10 Communities Doing Big Projects*, TECHREPUBLIC (Mar. 19, 2014), http://www.techrepublic.com/article/white-space-broadband-10-communities-doing-big-projects/.
[50] *See* Richard M. Nunno, *Radiofrequency Spectrum Management* (Congressional Research Service, CRS-13, No. 97-218 SPR, Apr. 23, 1998). A wireless industry association opposed this proposal in the AWS-3 auction, but the crux of its opposition was that the federal users were not required to relocate by a certain date. COMMENTS OF 4G

surround an existing spectrum assignment. Overlays have enabled the relocation and clearing of state government systems and public safety systems from a few hundred MHz of spectrum. Overlays have not been used for federal spectrum because agencies cannot directly receive consideration from commercial users.

As noted earlier, overlay licenses grant auction winners (1) primary rights to any unused spectrum in the band, (2) secondary rights to spectrum in the band that is being used by an incumbent, and (3) exclusive rights to bargain directly with existing users occupying portions of the band. In the case of auctioning spectrum occupied by federal users, the winning overlay licensee is required to protect the incumbent federal users but can negotiate directly with them. Overlay licensees might induce incumbents to use more efficient devices (thereby freeing up spectrum for new uses), to tolerate certain amounts of interference, to move to a different band entirely, or to cease operations altogether.[51]

The policy innovation lies in combining transferable federal spectrum rights with the overlay auction framework. These rights would give agencies the ability to bargain with potential suitors and to be directly compensated for vacating or otherwise reducing their use of a band. Federal agencies are not profit-maximizing firms, but they do face budget constraints, and tradeoffs are more transparent when agencies are faced with priced assets. If permitted, agencies will improve their input mix by selling unused assets and reinvesting the revenue. For instance, as described *infra*, several agencies have transferable real property rights—that is, they have the authority to lease and sell federal real estate and buildings to private developers and to retain

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AMERICAS IN THE MATTER OF AMENDMENT OF THE COMMISSION'S RULES WITH REGARD TO COMMERCIAL OPERATIONS IN THE 1695-1710 MHZ, 1755-1780 MHZ, AND 2155-2180 MHZ BANDS 8, GN DOCKET NO. 13-185 (2013), *available at* http://www.hwglaw.com/siteFiles/News/3C0FD0FD14FA23AEC2FC7013E082AEB5.pdf. As stated *infra*, a deadline is critical in successful overlay auctions of federal spectrum.

[51] Theoretically, overlay licensees could also bargain with incumbents to share spectrum by the millisecond or by the hour, but it is unlikely, at present, that the economics of spectrum sharing permit such agreements in practice.

some of the proceeds.[52] Transferable spectrum rights make agencies residual claimants in a similar fashion. Overlay auctions give regulators a process to induce spectrum incumbents to sell their underused assets quickly.

Although the compensation should be negotiated, successful overlay auctions have featured a command-and-control element. As explained *infra*, it is likely necessary for federal incumbents to have a deadline to vacate their bands.[53]

*Case study of the PCS auction.* Overlays have been used a few times to repurpose encumbered nonfederal spectrum, such as in major auctions like the PCS auction and AWS-1 auction. Congress first authorized the FCC to conduct spectrum auctions in 1993 to avoid wasteful command-and-control prescriptions and to permit more spectrum for the nascent cellular phone industry. With that authority, the FCC used overlay auctions for the new Broadband Personal Communications Service (PCS), a type of cellular phone technology, in the mid-1990s.[54] The FCC auctioned 120 MHz of encumbered beachfront spectrum, and cellular phone companies were the major bidders. Incumbent users were mostly public utilities, railroads, and local governments operating thousands of microwave communication links, but they also included state public safety operations such as firefighters, police, and other emergency responders.[55] The auction and clearing proposals faced resistance and, echoing today's objections from federal agencies, public safety incumbents warned that the FCC's auction would disrupt their communications reliability and could "have a devastating

[52] *See* GAO, GAO-11-574, DEFENSE INFRASTRUCTURE: THE ENHANCED USE LEASE PROGRAM REQUIRES MANAGEMENT ATTENTION (June 2011), http://www.gao.gov/assets/330/320465.pdf.
[53] Peter Cramton, Evan Kwerel & John Williams, *Efficient Relocation of Spectrum Incumbents*, 41 J.L. & ECON. 647, 649 (1998). Overlays, then, may not be appropriate for bands where shutdown deadlines are especially unpredictable or long term.
[54] Nunno, *supra* note 50 at CRS-13 ("Overlay licenses were auctioned in the PCS auctions since there were already incumbent licensees . . . using that spectrum."). The auctioned spectrum was 1850–1910 MHz and 1930–1990 MHz.
[55] Cramton, Kwerel & Williams, *supra* note 53, at, 661, 669.

effect on . . . millions of inhabitants" relying on their services.[56] Nevertheless, the auctions for this encumbered spectrum commenced in 1995.[57] The auction winners could deploy services where there were no incumbents and had secondary rights to the spectrum where incumbents operated.

To relocate those incumbents and to free up spectrum for PCS, the FCC mandated that the PCS license winners pay the incumbents' relocation costs. But the FCC also did something novel: it gave the incumbent users transferable spectrum rights. That is, the FCC permitted the incumbent users to bargain with the overlay auction winners and, in exchange for an additional payment or in-kind benefit, move before a relocation deadline.[58]

The FCC gave non–public safety users a two-year voluntary negotiation period during which they were not required to negotiate with the PCS overlay winners.[59] This period was followed by a one-year mandatory negotiation period during which the PCS licensee and the incumbent were required to bargain in good faith.[60] After that deadline, three years from commencement, PCS licensees could force the incumbent to move (while compensating it for relocation costs). Public safety users had a three-year voluntary negotiation period followed by a two-year mandatory negotiation period.[61]

This PCS auction grossed $7.7 billion in bids.[62] There are no public records of the payments made for early relocation, but good-faith negotiations were reportedly the norm.[63]

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[56] REPLY COMMENTS OF THE LOS ANGELES COUNTY SHERIFF'S DEPT. IN THE MATTER OF REDEVELOPMENT OF SPECTRUM TO ENCOURAGE INNOVATION IN THE USE OF NEW TELECOMMUNICATIONS TECHNOLOGIES, ET DOCKET NO. 92-9 (1994), at 2, *available at* http://apps.fcc.gov/ecfs/document/view?id=1320380001.
[57] FCC rulemaking for the auction commenced in 1993, and the PCS auctions were carried out in 1995, 1996, and 1997. Cramton, Kwerel & Williams, *supra* note 53, at 660–61.
[58] *Id.* at 658, 669 ("[T]here have been reports of incumbents demanding premiums of several times actual relocation costs to relocate before the involuntary relocation period.").
[59] In 1997, this voluntary period was shortened to one year. *Id.* at 665–66.
[60] *Id.*
[61] *Id.* at 666. These negotiation periods and conditions were occasionally fine-tuned by the FCC. *Id.*
[62] Evan R. Kwerel & Gregory L. Rosston, *An Insiders' View of FCC Spectrum Auctions*, 17 J. REG. ECON. 253, 275 (2008).
[63] Cramton, Kwerel & Williams, *supra* note 53, at 669.

By January 1998, more than half of the microwave links had been moved out of the band,[64] and the spectrum was deployed for cellular service. Most incumbent microwave links were upgraded to work on new frequencies, but about 10% shifted to wired connections or ceased operation.[65] Today PCS spectrum supplies about 20% of all licensed spectrum used for mobile broadband and is a major part of each national carrier's spectrum holdings.[66] In hindsight, the concerns about widespread public safety communications disruption never materialized.

*Case study of AWS-1.* The 2006 Advanced Wireless Services (AWS-1) auction was an auction of 90 MHz of paired (45 MHz) spectrum that contained nonfederal and federal users.[67] The nonfederal spectrum was auctioned off via overlay licenses; the federal spectrum wasn't. Post auction, 12 federal agencies in the 1.7 GHz band[68] relocated to other bands and several nonfederal users in the 2.1 GHz band relocated. The nonfederal users included various state and commercial microwave systems, as well as Broadband Radio Service systems, which provided services like two-way broadband and public safety communications.[69]

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[64] *Id.* at 668.
[65] *Id.*
[66] FCC, SEVENTEENTH REPORT IN THE MATTER OF ANNUAL REPORT AND ANALYSIS OF COMPETITIVE MARKET CONDITIONS WITH RESPECT TO MOBILE WIRELESS, INCLUDING COMMERCIAL MOBILE SERVICES, WT DOCKET NO. 13-135 (2014), at 50, https://apps.fcc.gov/edocs_public/attachmatch/DA-14-1862A1.pdf (estimating there is about 580 MHz of spectrum used for mobile broadband). Note that 120 MHz (PCS spectrum) out of 580 MHz is a little over 20%.
[67] Rosston, *supra* note 5, at 235–36 ("The Commission adopted procedures by which new AWS licensees may relocate incumbent [nonfederal] BRS and fixed microwave service operations in a manner similar to that developed for clearing the PCS band."). Hazlett & Leo, *supra* note 44, at 1072.
[68] Those agencies are the Department of Agriculture, the Department of Defense, the Department of Energy, the Department of Homeland Security, the Department of Housing and Urban Development, the Department of the Interior, the Department of Justice, the Department of Transportation, the Department of the Treasury, the National Aeronautics and Space Administration, the Tennessee Valley Authority, and the United States Postal Service. *See* NTIA, RELOCATION OF FEDERAL RADIO SYSTEMS FROM THE 1710–1755 MHZ SPECTRUM BAND, SECOND ANNUAL PROGRESS REPORT (Mar. 2009), *available at* http://www.ntia.doc.gov/legacy/osmhome/reports/Final2ndAnnual RelocationReport20090416.pdf.
[69] FCC, NINTH REPORT AND ORDER IN THE MATTER OF SERVICE RULES FOR ADVANCED WIRELESS SERVICES IN THE 1.7 GHZ AND 2.1 GHZ BANDS 2–5, WT DOCKET NO. 02-352 (Apr. 21, 2006), *available at* https://apps.fcc.gov/edocs_public/attachmatch/FCC-06-45A1.pdf.

The federal users had a clearing deadline with no direct compensation from winning bidders. However, federal users received some indirect compensation. AWS-1 was the first band auctioned under the 2004 Commercial Spectrum Enhancement Act, a law giving federal agencies a limited share of pooled auction proceeds—compensation for their relocation costs.[70] The 45 MHz occupied by nonfederal users, on the other hand, was assigned via an overlay license. The FCC permitted the nonfederal incumbents—much as the incumbents in the PCS bands—to enter into private cost-sharing agreements with the new AWS-1 licensees.[71] Despite the encumbrances, the 2.1 GHz band grossed almost $7 billion.[72] Like the agreements between overlay licensees and incumbents in the PCS auction, the post-auction cost-sharing agreements relocating the nonfederal incumbents in the 2.1 GHz band are unavailable.

The federal users did not have overlay licensees to bargain with and merely faced relocation deadlines. NTIA tracked the relocation costs of federal systems in the 1.7 GHz band so that agencies could be reimbursed through the relocation fund created by the Commercial Spectrum Enhancement Act. The Government Accountability Office (GAO) estimated that the encumbered 1.7 GHz band grossed almost $7 billion.[73] Relocation costs of federal users totaled around $1.5 billion[74] ($1 billion

[70] 47 U.S.C. 928.
[71] 47 C.F.R. 27.1160; 27.1176.
[72] GAO, GAO-13-472 (2013), FEDERAL RELOCATION COSTS AND AUCTION REVENUES 16, *available at* http://www.gao.gov/assets/660/654794.pdf.
[73] *Id.*
[74] Estimates for relocation costs and for upgrading technologies like outdated analog surveillance systems varied widely before the auction. On the low end, NTIA projected in a report that the cost of 2,240 frequency assignments across 12 agencies would be $936 million. In 2005, the Congressional Budget Office estimated that costs could run as high as $2.5 billion. Agencies included the Department of Defense (mostly the Navy), Department of Energy, Department of Homeland Security, and Federal Aviation Administration. The Forestry Service had 579 assignments and the Department of Energy had 596. Howard Buskirk, *NTIA Says Cost of Clearing AWS Spectrum Will Be Below $1 Billion*, COMMUNICATIONS DAILY, Dec. 29, 2005.

less than a Congressional Budget Office estimate but exceeding NTIA's original estimates by about 50 percent),[75] for net revenue of $5.5 billion.

Once the auction was completed, even though little financial incentive was provided beyond the benefit of upgraded wireless systems, the clearing of agencies happened fairly rapidly. By December 2008, two years after the auction, dozens of federal wireless systems had been moved from the 1.7 GHz band, and licensees had deployed mobile broadband in some cities.[76] Four agencies—the Department of the Treasury, the Department of Homeland Security, the US Postal Service, and the Department of Housing and Urban Development—had vacated the band completely.[77] By late 2010, four years after the completion of the auction, seven agencies representing 81% of eligible systems had been relocated.[78] By 2011, 95% of systems were relocated,[79] and by 2012, six years after the auction, NTIA reported that all 12 agencies had ceased operations in the band.[80]

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[75] GAO, *supra* note 72, at 11–12; NTIA, RELOCATION OF FEDERAL RADIO SYSTEMS FROM THE 1710–1755 MHZ SPECTRUM BAND, SIXTH ANNUAL PROGRESS REPORT 2–3 (Mar. 2013), *available at* http://www.ntia.doc.gov/files/ntia/publications/sixth_annual_report_1710-1755_mhz_04042013.pdf.

[76] NTIA, *supra* note 68.

[77] *Id.*

[78] NTIA, RELOCATION OF FEDERAL RADIO SYSTEMS FROM THE 1710–1755 MHZ SPECTRUM BAND, FOURTH ANNUAL PROGRESS REPORT 2 (Mar. 2011), *available at* http://www.ntia.doc.gov/files/ntia/publications/1710-1755mhz_cseareport_03302011.pdf.

[79] NTIA, RELOCATION OF FEDERAL RADIO SYSTEMS FROM THE 1710–1755 MHZ SPECTRUM BAND, FIFTH ANNUAL PROGRESS REPORT 2 (Mar. 2012), *available at* http://www.ntia.doc.gov/files/ntia/publications/fifth_annual_report_1710-1755mhz_03302012.pdf.

[80] NTIA, *supra* note 75, at 2. The types of federal wireless systems varied widely in terms of services and relocation costs. The Department of Housing and Urban Development had only five systems, for instance, that transmitted video and communications. The total relocation costs were around $21,000. NTIA, *supra* note 68, at B-11. The Department of Justice's Bureau of Alcohol, Tobacco, Firearms and Explosives likewise had five systems (mostly for video communications), but it had many more components, and the estimated relocation outlays totaled over $65 million. *Id.* at B-13. The Drug Enforcement Agency had a single system, identified only as "video surveillance," that was estimated to take three years and $88 million to relocate. *Id.* at B-15. The US Postal Service also had a single video surveillance system consisting of about 500 devices that took one year and $1.8 million to relocate. *Id.* at B-20.

Representatives from industry expressed publicly that they were satisfied with the relocation process, but some systems and agencies were more difficult.[81] Representatives from MetroPCS, the fourth-biggest bidder in the auction, with licenses mostly in the West and the Northeast, stated that the relocation process "worked relatively well."[82] Carriers' discussions with agencies about information like channel bandwidth, antenna power, and height for each system to be relocated expedited the process.[83] Steve Sharkey, T-Mobile's chief of engineering and technology policy, said that these technical discussions with federal users "resulted in T-Mobile being able to deploy services years earlier than originally anticipated."[84]

Clearing federal agencies and allowing nonfederal incumbents to bargain with the overlay licensees allowed productive use of much of the encumbered AWS-1 bands within a few years. T-Mobile was the top bidder, paying over $4 billion for AWS-1 licenses covering nearly

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[81] Some regions were difficult to clear. In 2009, T-Mobile representatives noted to NTIA that "T-Mobile's launch of service in the AWS band was delayed by several months, if not longer, in many markets. Indeed, even today—nearly three years after Auction No. 66—there are certain parts of the country such as the southeast w[h]ere no wireless carrier has been given access to AWS frequencies. Such delays jeopardize investment, hinder broadband deployment, and harm consumers." COMMENTS OF T-MOBILE IN THE MATTER OF RELOCATION OF FEDERAL SYSTEMS IN THE 1710–1755 MHZ FREQUENCY BAND: REVIEW OF THE INITIAL IMPLEMENTATION OF THE COMMERCIAL SPECTRUM ENHANCEMENT ACT 5, DOCKET NO. 0906231085-91085-01 (Aug. 21, 2009), *available at* http://www.ntia.doc.gov/files/ntia/t-mobile_csea_noi_comments_8-21-09_0.pdf.

[82] COMMENTS OF METROPCS, IN THE MATTER OF RELOCATION OF FEDERAL SYSTEMS OF 1710–1755 MHZ FREQUENCY BAND: REVIEW OF THE INITIAL IMPLEMENTATION OF THE COMMERCIAL SPECTRUM ENHANCEMENT ACT 2, DOCKET NO. 0906231085-91085-01 (Aug. 21, 2009), *available at* http://www.ntia.doc.gov/files/ntia/metropcs_-_comments_on_ntia_csea_notice84803305_5_0.doc.

[83] COMMENTS OF T-MOBILE, *supra* note 81.

[84] *Hearing on Creating Opportunities through Improved Government Spectrum Efficiency before the Subcomm. on Comm'n & Tech., H. Comm. on Energy & Commerce*, 112th Cong. 6 (Sept. 13, 2012) (statement of Steve Sharkey, T-Mobile), *available at* http://energycommerce.house.gov/sites/republicans.energycommerce.house.gov/files/Hearings/CT/20120913/HHRG-112-IF16-WState-SharkeyS-20120913.pdf. *Communications Daily* reported Sharkey saying,

> "I think we're at the point of let's get engineers into a room to figure out and solve the problems," he said. "Neither side has a complete understanding of the way each other's systems work and operate." During AWS-1 clearance when industry first tried to clear spectrum on the West Coast, the immediate reaction of government users was "no way, it's all redlined out and it'll be a long time," he said. "But we gave them more information about how our systems really operate and the power levels that they would expect—it cleared up practically a whole coast almost immediately."

Howard Buskirk, *Spectrum Shortfall Tops Concerns at CTIA, But Signs Growing Carriers Might Embrace Sharing*, COMMUNICATIONS DAILY, May 11, 2012.

the entire United States.[85] A mere two years after the auction, after federal users had cleared their spectrum and T-Mobile had negotiated with nonfederal incumbents, T-Mobile launched 3G service in 27 markets covering over 100 million people,[86] including the lucrative San Francisco[87] and New York City[88] markets. By 2010, it completed most of its nationwide mobile broadband network using AWS-1 spectrum. Auction winners like MetroPCS and Leap Wireless covered millions more after clearing their AWS-1 spectrum.[89] Today that 90 MHz of AWS-1 spectrum, now cleared of incumbents, supplies about 15% of licensed mobile broadband spectrum and is used by more than 200 million Americans through technologies such as 4G LTE.[90]

## IV. Comparison of Dynamic Sharing and Overlay Auctions

Decades of assigning spectrum to agencies for free has locked valuable frequencies into inefficient wireless uses. Choosing the superior set of policies for repurposing federal spectrum in a timely manner means capturing tens of billions of dollars annually—from consumer welfare gains, industry investment, and jobs—that would otherwise evaporate.[91] The experiences described suggest that clearing and relocating federal systems through a system of overlay auctions yield greater economic benefit than do dynamic sharing proposals like the one contemplated by PCAST.

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[85] Press Release, T-Mobile, T-Mobile USA Statement on the Conclusion of Bidding in the FCC Auction of Advanced Wireless Services (Sept. 18, 2006), *available at* http://newsroom.t-mobile.com/phoenix.zhtml?c=251624&p=irol-newsArticle&ID=1809478&highlight=.
[86] GLOBAL VIEW PARTNERS, MOBILE BROADBAND IN THE AMERICAS: MOMENTUM BUILDING IN THE AWS BAND 14 (2009), *available at* http://www.gsma.com/latinamerica/wp-content/uploads/2012/06/momentumbuildingintheawsbandreport.pdf.
[87] COMMENTS OF T-MOBILE, *supra* note 81.
[88] Katherine Noyes, *T-Mobile's 3G Network Touches Down in NYC*, TECHNEWSWORLD, May 5, 2008, *available at* http://www.technewsworld.com/story/62876.html.
[89] GLOBAL VIEW PARTNERS, *supra* note 86, at 14-15.
[90] FCC, *supra* note 66.
[91] For a discussion of the economic costs of delay in the TV broadcaster incentive auction, *see* Bazelon & McHenry, *supra* note 9.

Direct comparison of unlicensed dynamic sharing with overlays is difficult because, as mentioned, dynamic sharing technologies do not have widespread deployment. This is a red flag given the substantial costs for every year that implementation is delayed. NTIA has proposed the use of dynamic sharing strategies since at least 1991,[92] but to date these technologies have permitted very little sharing between commercial and government users.[93] The PCAST authors are aware of some of these difficulties and therefore predict that its proposed overhaul of policy would take "perhaps two to three decades."[94]

That prediction is a best-case scenario. It would likely take longer to implement a widespread, complex sharing regime. Even if it becomes technically feasible to share spectrum across a wide band of frequencies in real time, the regulatory process either halts or substantially delays interorganization sharing.[95] The unlicensed sharing approach shifts the tasks of devising certifications and regulating spectrum-sharing etiquette from market actors to regulators.[96] Nearly all wireless operators, including government agencies and commercial licensees, vigorously resist sharing spectrum with other users and technologies. There have been costly episodes of agencies and licensees fiercely objecting to even minute possibilities of interference to their own wireless operations.[97]

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[92] NTIA, US SPECTRUM MANAGEMENT POLICY: AGENDA FOR THE FUTURE (Sept. 3, 1998), *available at* http://www.ntia.doc.gov/report/1998/us-spectrum-management-policy-agenda-future#ch3.
[93] Gerald R. Faulhaber, *Commentary on "The Spectrum Opportunity: Sharing as the Solution to the Wireless Crunch,"* 8 INT'L J. COMM. 119 (2014).
[94] PCAST, *supra* note 20, at ix.
[95] Thomas W. Hazlett & Brent Skorup, *Tragedy of the Regulatory Commons: LightSquared and the Missing Spectrum Rights*, 13 DUKE L. & TECH. REV. 1 (2014).
[96] Jerry Brito, *The Spectrum Commons in Theory and Practice*, 2007 STANFORD TECH. L. REV. 1 (2007).
[97] GAO, *supra* note 11, at 12–13. *See, e.g.*, the LightSquared-GPS dispute. Hazlett & Skorup, *supra* note 95. Ultrawideband (UWB) users struggled for more than a decade to coordinate with federal users, NTIA, and the FCC to share spectrum. *See The FCC's UWB Proceeding: An Examination of the Government's Spectrum Management Process: Hearing Before the Subcomm. on Telecomm. and the Internet of the Comm. on Energy and Commerce*, 107th Cong. 42–43 (2002), *available at* http://www.gpo.gov/fdsys/pkg/CHRG-107hhrg80674/pdf/CHRG-107hhrg80674.pdf ("It took 13 years, including three and one half years of intensive efforts, to gain regulatory approval for

The multitude of federal systems with vastly different performance characteristics—radar, satellite communications, air-to-ground communications, video surveillance, unmanned aircraft systems, to name a few—means that the complex challenges for consumer device makers are multiplied. No amount of engineering ingenuity can tell regulators what the "correct" probability of harmful radio interference is. In sharing disputes, the incumbents invariably commission technical analyses that highlight remote, worst-case interference scenarios. The entrants respond with their own studies showing "typical" scenarios in which their systems pose little interference threat to existing users. Regulators are caught in the middle of a tug-of-war of competing technical papers and have no propensity to make a decision that optimizes wireless output between the systems. Even after a decision is made to allow shared use, a federal system technology upgrade or a change in federal supplier could simply restart the process anew (at best) or stymie necessary and life-saving agency upgrades (at worst).

Delay and resistance from incumbents will be present in any scheme. However, overlays and clearing have an established history of delivering spectrum to private markets, where millions of subscribers can use it productively in a few years' time. It is too early to say, as the PCAST report intimates, that clearing federal users is impractical. As the PCS and AWS-1 examples show, much of the spectrum cleared by overlay auctions and clearing deadlines is typically redeployed commercially in under five years.

By giving agencies greater rights to their spectrum and a mechanism—overlay auctions—that allows the agencies to transfer those rights and to retain revenues, federal spectrum could be repurposed for consumer uses. Overlay auctions have been completed before and represent an off-the-shelf technique that FCC staff members have experience

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UWB."); Brito, *supra* note 96, at 15 (describing how satellite incumbents objected to the FCC's exclusion zone sizes when permitting unlicensed devices).

implementing.[98] Overlays present great flexibility in auction design because licenses can be nationwide or regional or can cover narrow geographic locations.[99] Importantly, overlays rationalize band usage by creating residual claimants who internalize the gain from spectrum investments.[100] When an overlay licensee moves an agency to another band or medium, its spectrum is more valuable. It is this increase in value that gives the parties room to negotiate.

After 25 years of forecasts that dynamic sharing is right around the corner, dynamic sharing is still largely in the research and development stage.[101] Dynamic sharing depends on complex cognitive radios or central database look-up functions that may never be deployed en masse. Despite access to some 240 MHz of prime spectrum, only 600 or so unlicensed devices in the market use white space technology. I am not aware of any reliable estimates, but the total investment in the white space ecosystem seven years after its 2008 allocation likely totals only a few million dollars and a few thousand users.

In contrast, clearing incumbents with overlays in similar swaths of spectrum leads to investment and consumer welfare gains orders of magnitude larger, sometimes within months of auction. Hazlett et al. estimated in 2004 that the repurposing of 120 MHz of spectrum for PCS induced over $45 billion of network investment in the five-year period following the auction, from

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[98] Overlay auctions include the PCS and AWS-1 auctions described *supra*, as well as smaller auctions like the BRS auction.

[99] Louis Trager, *FCC Economist Spells Out Three Ways TV Spectrum Could Be Auctioned*, COMMUNICATIONS DAILY, June 11, 2010.

[100] As economist Thomas Hazlett says, overlays empower private "decision agents," who internalize gains from spectrum reassignment. "These actors not only have superior information and incentives to those of government administrators . . . but bring a different tool kit to the task at hand. In particular, private firms can write contracts and access capital markets." Hazlett, *supra* note 21, at 18.

[101] GAO, *supra* note 11, at 24; Paul Barbagallo, *For TV "White Spaces," the Global Outlook Is Hopeful but Cautious*, BLOOMBERG BNA, July 16, 2014, *available at* http://www.bna.com/tv-white-spaces-n17179892333/ (noting that "spectrum sensing, is still nascent"). The skepticism about the feasibility of spectrum sharing was captured by technologist Richard Bennett, who said, "if the DOD and the IRS and the Justice Department can share spectrum with each other, then I'll be pretty well convinced that they can share it with T-Mobile and Softbank." Richard Bennett, Presentation at the Spectrum Beyond Incentive Auctions Conference, Information Economy Project at the George Mason University School of Law: Blueprint for a Federal Spectrum Service (Apr. 25, 2014), *available at* http://iep.gmu.edu/conference-spectrum-beyond-incentive-auctions/.

1994 to 1998.[102] The 210 MHz of spectrum freed by the combined broadband PCS and AWS-1 auctions supplies about one-third of spectrum holdings of mobile carriers,[103] an essential input for an industry that in 2014 had revenues of nearly $188 billion and capital investment of $32 billion.[104]

Dynamic sharing technology simply will not enable similar economic benefits in the next several years. Given the tremendous opportunity costs of inaction in the interim, waiting for dynamic technology to be widespread is a speculative and costly option relative to clearing alternatives.[105]

## V. Final Notes

### *Response to the Counter that Federal Agencies May Not Respond to Financial Incentives*

Some scholars argue that giving agencies self-funding ability through transferable spectrum rights would be ineffective.[106] They counter that any gain in revenue from spectrum sales would be viewed by Congress as a windfall and would be offset in subsequent rounds of appropriations, thereby diminishing the incentive of agencies to sell their spectrum.[107]

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[102] THOMAS W. HAZLETT ET AL., SENDING THE RIGHT SIGNALS: PROMOTING COMPETITION THROUGH TELECOMMUNICATIONS REFORM: REPORT TO THE U.S. CHAMBER OF COMMERCE, 103 (Sept. 2004), *available at* http://www.rutledgecapital.com/pdf_files/20041006_telecom_dereg_complete_study.pdf.

[103] FCC, *supra* note 66 (estimating that there is about 580 MHz of spectrum used for mobile broadband).

[104] CTIA, *Annual Wireless Industry Survey*, CTIA.ORG, http://www.ctia.org/your-wireless-life/how-wireless-works/annual-wireless-industry-survey.

[105] Regulators in the recent past ignored the huge consumer welfare losses that delay inflicts. Jerry A. Hausman, *Valuing the Effect of Regulation on New Services in Telecommunications*, 28 BROOKINGS PAPERS ECON. ACTIVITY, MICROECONOMICS 1, 24 (1997) ("It appears that delay in cellular service was the commission's way to avoid confronting a very difficult decision. Potential losses in consumer welfare did not appear to figure into the FCC's regulatory approach.").

[106] *See, e.g.*, THOMAS LENARD & LAWRENCE WHITE, DIGITAL AGE COMMUNICATIONS ACT: REPORT FROM THE NEW SPECTRUM POLICY WORKING GROUP 20 (Mar. 2006), *available at* http://www.techpolicyinstitute.org/files/9.pdf; DOROTHY ROBYN, MAKING WAVES: ALTERNATIVE PATHS TO FLEXIBLE USE SPECTRUM 36 (2015), *available at* http://www.aspeninstitute.org/sites/default/files/content/docs/pubs/Making-Waves.pdf ("[T]he [argument against transferable federal spectrum rights] that has gotten the most traction in the spectrum community—is that the ability to retain the proceeds will not motivate federal agencies to transfer their spectrum because of the nature of the budget process . . . . In anticipation of this zero-sum dynamic, agencies would forego the opportunity to trade spectrum for money.").

[107] *Id.*

The logic is sensible, but existing evidence appears to undermine that theory. Admittedly, the literature on agency self-funding is limited,[108] and literature on the incentive effects from agency self-funding through asset sales is even scarcer. Therefore, predictions about how Congress and agencies will respond to the vestment of additional spectrum rights are largely conjectural. However, existing programs indicate that agencies (1) do not generally believe they will be penalized in the appropriations process for perceived windfalls from asset sales and (2) can be incentivized to relinquish property if they can pocket some of the gains.

The examples where agencies self-fund indicate that agencies favor such arrangements, provided that they have significant control over distributing the revenue.[109] For instance, GAO analysis of financial regulatory agencies that self-fund through examination fees and the like indicates that self-funded agencies generally *prefer* self-funding to funding through the appropriations process.[110]

More to the point, in responding to the notion that Congress will penalize agencies for monetary windfalls provided by asset sales, Dorothy Robyn, who was in an excellent position to view such dynamics while at the General Services Administration and the Department of Defense, concluded in her influential spectrum policy paper, "that has emphatically not been my experience."[111] Robyn points out that it was the agencies themselves that lobbied Congress for agency retention of revenue from land sales during a round of painful military base closures.[112] These sales can occasionally be quite large. The Navy, for instance, sold two Marine Corps bases

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[108] Charles Kruly, *Self-Funding and Agency Independence*, 81 GEO. WASH. L. REV. 1733, 1737 (2013).
[109] GAO, GAO-02-864, SEC OPERATIONS: IMPLICATIONS OF ALTERNATIVE FUNDING STRUCTURES 11–12, (July 2002), *available at* http://www.gao.gov/new.items/d02864.pdf.
[110] *Id.* at 12–13. Furthermore, if self-funding agencies in fact do receive more punitive scrutiny from Congress, the drawbacks are likely diminished in the case of spectrum sales, where agencies are merely supplementing their budgets. Presumably, Congress is more likely to scrutinize totally self-funded agencies than partially self-funded agencies.
[111] Robyn, *supra* note 13, at 14.
[112] *Id.*

for $850 million[113]—likely substantial enough to receive congressional notice—but there is no evidence the Navy saw decreased appropriations as a result.

Further, Congress authorizes the secretaries of the military departments to lease underused real property and personal property that the department controls in exchange for cash and in-kind consideration.[114] The military has used that authority to enter into complex leases, called *enhanced use leases*, which might grant, for example, a 50-year lease of military land to a private developer.[115] A 2011 GAO report noted that there were 17 enhanced use leases in place, with in-kind consideration valued at hundreds of millions of dollars, and dozens more were either under review or in negotiation.[116] On the basis of agency use of these programs, Robyn concluded that "the ability to retain the proceeds from the disposal of property is a key motivator for federal agencies."[117]

There are risks, such as improper incentives and decreased accountability to Congress and to the president, when agencies self-fund.[118] Self-funding programs should be monitored and perhaps have mandatory sunsets, but there is some real-world evidence that allowing agencies to retain some proceeds of asset sales motivates the types of behaviors intended—namely, disposition of underused public assets into private markets, where the assets can be used more productively.

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[113] ROBYN, *supra* note 106, at 37.
[114] 10 U.S.C. 2667. Leasing spectrum has been proposed, but the government's inefficient management of spectrum leads scholars to conclude that it is preferable for agencies to sell spectrum rather than to lease it. *See* T. Randolph Beard et al., *Market Mechanisms and the Efficient Use and Management of Scarce Spectrum Resources*, 66 FED. COMM. L.J. 263, 291 (2013).
[115] GAO, *supra* note 52, at 2. These leases often include revenue sharing between the private developer and the agency. *Id.* at 8.
[116] *Id.* at 2.
[117] Robyn, *supra* note 13, at 14.
[118] *See* Kruly, *supra* note 108.

***Need for Mandatory Clearing Deadlines for Federal Users After an Overlay Auction***

One lesson from the PCS overlay auction, identified by Cramton, Kwerel, and Williams, was that relocating state government systems was significantly slowed when the agencies were permitted to stay indefinitely.[119] Such delays led the scholars to conclude that, in fact, government agencies may need weaker rights to stay than do nongovernment incumbents "because they [government users] may be too likely to stay when they should terminate or relocate."[120]

Absent a deadline, economically efficient improvements tend to be underproduced or substantially delayed because incumbents have an incentive to reject the bidder's offers indefinitely.[121] Incumbents know that their consent is required and that they can extract a portion of the producer surplus in excess of their opportunity costs—the so-called holdout problem. This problem is likely exacerbated when public agencies are involved. Furthermore, for an appreciating asset like spectrum, hoarding may be a lucrative strategy.[122]

The benefit of a deadline to move wireless systems is that negotiations focus on the relocation costs (with a premium paid for speedy relocation) and not on the value to the entrant of clearing the spectrum.[123] Incumbent users thus have an incentive to settle early.[124] In the broadband PCS and AWS-1 auctions involving federal and nonfederal incumbents, deadlines helped make relocations largely successful in encouraging positive-sum settlements.[125]

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[119] Cramton, Kwerel & Williams, *supra* note 53, at 664–65.
[120] *Id.* at 665.
[121] *See* Lloyd Cohen, *Holdouts and Free Riders*, 20 J. LEGAL STUD. 351 (1991).
[122] ROBYN, *supra* note 106, at 35.
[123] Cramton, Kwerel & Williams, *supra* note 53, at 649.
[124] *Id.* at 658.
[125] *Id.* at 649.

***Role of Political Entrepreneurship in Spectrum Reallocation***

Overlay licenses of encumbered federal spectrum would represent uncertain investments with substantial risk discounting, so economic modeling is challenging. Information about many defense and law enforcement systems is difficult to acquire and stymies bargaining between commercial bidders and agencies. Hence, knowledgeable former federal officials will likely need to use their expertise to make deals possible between agencies and commercial bidders.

Such political entrepreneurship has a storied history in spectrum allocation. In the 1980s and 1990s, Morgan O'Brien, a former wireless regulator at the FCC, acquired wireless licenses held by taxi and pizza delivery dispatchers.[126] The FCC agreed to waive rules regarding the licenses, and O'Brien aggregated the new, flexible licenses that enabled cellular phone technology.[127] His actions increased the economic value of those fragmented licenses and led to the creation of Nextel, which was one of the nation's largest mobile phone companies when it was acquired by Sprint.[128]

Since 2000, following the financial failures of several satellite communications operators, the FCC has waived rules requiring satellite communications in certain bands so that the same spectrum can be used instead for ground-based cellular mobile broadband. Though they were less successful at navigating the regulatory issues than was O'Brien, financier Phil Falcone and his business partners acquired spectrum licensed to satellite communications firms SkyTerra and Inmarsat, and they devoted billions of dollars to developing a new wireless network. The company, LightSquared, petitioned the government for waivers, and the FCC agreed to loosen its rules to permit traditional mobile phone service in that spectrum. Likewise, in 2011 Dish

[126] Thomas W. Hazlett, *Inching Toward Wireless Capitalism*, WALL STREET JOURNAL EUROPE, Jan. 12, 2004, *available at* http://mason.gmu.edu/~thazlett/opeds/Inching%20Toward%20Wireless%20Capitalism.pdf.
[127] *Id.*
[128] *Id.*

Network acquired 40 MHz of satellite spectrum through a fire sale purchase of two bankrupt satellite communications companies.[129] The FCC again waived most of its satellite rules and permitted traditional mobile broadband services.

Finally, most relevantly, in the AWS-1 auction, T-Mobile hired defense experts, including a former general and former director of the Defense Information Systems agency, to assist in negotiating with federal agency heads.[130] Successful political entrepreneurship requires institutional knowledge of federal systems and of the idiosyncratic personalities and hierarchies that may otherwise confound successful transactions.[131] Political entrepreneurship is difficult to identify and to model formally, but it will likely play an important role if agencies are vested with spectrum rights that they can transfer for payment.

## VI. Conclusion

Overlay auctions are one of several tools policymakers should consider for repurposing federal spectrum. There are several plans for approaching the problem of inefficient government use, but many are more time consuming and socially costly. If overlays and clearing deadlines are time consuming because relocations typically take two to six years, what does that imply for PCAST-style unlicensed dynamic sharing that take decades to fully implement? No other reform proposal

[129] FCC, REPORT AND ORDER AND ORDER OF PROPOSED MODIFICATION IN THE MATTER OF SERVICE RULES FOR ADVANCED WIRELESS SERVICES IN THE 2000–2020 MHZ AND 2180–2200 MHZ BANDS, WT DOCKET NO. 12-70, 8 (Dec. 17, 2012), http://transition.fcc.gov/Daily_Releases/Daily_Business/2012/db1218/FCC-12-151A1.pdf.
[130] Associated Press, *T-Mobile Lobbies on Wireless Airwaves*, Dec. 12, 2007, http://web.archive.org/web/20071217213319/http://biz.yahoo.com/ap/071212/t_mobile_lobbying.html?.v=1. T-Mobile's lobbyists included those at the Cohen Group, headed by former Clinton defense secretary William Cohen. *Id.*
[131] Political entrepreneurship admittedly resembles and likely overlaps with the notorious revolving door phenomenon in politics. It is beyond the purposes of this paper to distinguish between damaging rent-seeking and socially beneficial deal-making. Suffice it to say that in some circumstances former insiders, possessing a depth of knowledge that disinterested outsiders cannot reasonably attain, can effect Pareto improvements in regulated industries. The analysis presented *supra* suggests that Pareto improvements here are fairly easy to identify—it is likely that any transfers of spectrum from agencies to the private sector result in substantial social welfare gains. *See also* Bazelon & McHenry, *supra* note 9 (citing economics research that suggests the consumer benefits generated by spectrum deployed for wireless broadband are 10 to 20 times the value of the spectrum to producers).

has enabled widespread consumer use and economic investment as rapidly as have overlay auctions combined with clearing deadlines. Federal agencies lack some of the incentives that private firms have to use resources efficiently. Nevertheless, when spectrum users have the ability to sell their rights and overlay auctions are used, experience suggests that spectrum can be repurposed from legacy government systems to high-value commercial uses within a few years.