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THE FATE OF THE 3500–3650 MHZ BAND

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I. INTRODUCTION

Spectrum policy, the regulation of electromagnetic frequencies used by everything from broadcast television to Wi-Fi to cellular phones, will define the shape of communication technology for years to come. Many commentators forecast that the existing frequencies allocated to the private sector are insufficient to meet the growing demand for wireless communications.[1] While the private sector clamors for more freedom to communicate, frequencies that were allocated for government and other uses when demand was low go underutilized. On June 28, 2010, President Obama announced his plan to evaluate underutilized spectrum and open up 500 MHz of spectrum for "everything from smartphones to wireless broadband connectivity for laptops to new forms of machine-to-machine communication within a decade."[2] The National Telecommunications and Information

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1. *See, e.g.*, Lowell C. McAdam, *Running Out of Bandwidth*, N.Y. TIMES, Oct. 22, 2011, at A17.

2. Press Release, The White House, President Obama Details Plan to Win the Future Through Expanded Wireless Access (Feb. 10, 2011), *available at* http://www.whitehouse.gov/the-press-office/2011/02/10/president-obama-details-plan-win-future-through-expanded-wireless-access [hereinafter The White House, Wireless Plan]; *see also* Press Release, The White House, Presidential Memorandum: Unleashing the Wireless Broadband Revolution (June 28, 2010), *available at* http://www.whitehouse.gov/the-press-

Administration ("NTIA"), which is charged with managing federal use of spectrum and carrying out President Obama's proposal, identified various bands — including the 3500–3650 MHz band — for possible release by moving the current user to a different band, splitting the band between the new user and the incumbent, or determining that the new and current users would share the band.[3] Although the President's plan focuses on the benefits of licensing spectrum, such as raising revenue through auctioning exclusive licenses to spectrum bands and providing spectrum for mobile use,[4] it would be a mistake to ignore the possible benefits that would accrue from allocating unlicensed spectrum to fixed wireless.

Unlicensed spectrum, as the name implies, does not require a license for use. However, there are usually restrictions attached as to how "loud" devices using these open frequencies can be to discourage one user from causing harmful interference with other uses of the spectrum.[5] Many popular consumer uses exist in unlicensed spectrum, including Wi-Fi and Bluetooth.[6] Wireless Internet service providers, or WISPs, are also largely dependent on this spectrum.[7] WISPs operate much like wired Internet service providers, but connect the end user through a wireless radio, rather than through a fixed line. Network architecture varies, ranging from a fixed model, which like satellite television requires that the wireless radio be pointed at a base station, to a broadcast model, which like a cell phone system simply requires that the wireless radio be somewhere in the broadcast range of the base tower.[8] Many WISPs provide service to rural areas where either no wired service exists, or the existing service is slow because it is uneconomical to deploy the necessary cables to connect residences

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office/presidential-memorandum-unleashing-wireless-broadband-revolution [hereinafter The White House, Presidential Memorandum].

3. *See* GARY LOCKE & LAWRENCE E. STRICKLING, U.S. DEP'T OF COMMERCE, AN ASSESSMENT OF THE NEAR-TERM VIABILITY OF ACCOMMODATING WIRELESS BROADBAND SYSTEMS IN THE 1675–1710 MHZ, 1755–1780 MHZ, 3500–3650 MHZ, AND 4200–4220 MHZ, 4380–4400 MHZ BANDS iv, 1-3 (Nov. 15, 2010), http://www.ntia.doc.gov/files/ntia/publications/fasttrackevaluation_11152010.pdf [hereinafter NTIA ASSESSMENT].

4. *See* The White House, Presidential Memorandum, *supra* note 2.

5. KENNETH R. CARTER, AHMED LAHJOUJI & NEAL MCNEIL, FCC OFFICE OF STRAT. PLANNING AND POLICY ANALYSIS, UNLICENSED AND UNSHACKLED: A JOINT OSP-OET WHITE PAPER ON UNLICENSED DEVICES AND THEIR REGULATORY ISSUES 4–6 (Working Paper No. 39, 2003), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1086626.

6. *Id.* at 28–30.

7. MATT LARSEN, WIRELESS INTERNET SERV. PROVIDERS ASS'N, AMERICA'S BROADBAND HEROES: FIXED WIRELESS BROADBAND PROVIDERS 7 (2011), http://www.wispa.org/sites/wispa/files/americas-broadband-heroes-fixed-wireless-2011.pdf; *see also* Christian Sandvig, *Spectrum Miscreants, Vigilantes, and Kangaroo Courts: The Return of the Wireless Wars*, 63 FED. COMM. L.J. 481, 488 (2011).

8. *See* LARSEN, *supra* note 7, at 3–6.

in sparsely populated areas.[9] WISPs also provide service in suburban and urban areas[10] and thus compete directly with traditional wired ISPs. As explained in a letter sent in April 2011 to the FCC by the Wireless Internet Service Providers Association ("WISPA"), WISPs will need more spectrum to continue to provide broadband to the communities they serve due to growing demand.[11]

The 3500–3650 MHz range of spectrum is ideal for WISP use. Mobile carriers have expressed little interest in spectrum above 3000 MHz,[12] but new technologies will turn formerly difficult-to-use higher frequencies into prime spectrum "real estate." Use by WISPs under appropriate restrictions should be compatible with incumbent users, such as the Navy and fixed satellite operators. Opening the 3500 MHz band to unlicensed or lightly licensed use will best meet the directive President Obama gave when he declared:

> This new era in global technology leadership will only happen if there is adequate spectrum available to support the forthcoming myriad of wireless devices, networks, and applications that can drive the new economy. To do so, we can use our American ingenuity to wring abundance from scarcity, by finding ways to use spectrum more efficiently.[13]

This Note provides an overview of the technical characteristics of the 3500 MHz band as described in the literature, describes the possible wireless broadband system designs that can use the spectrum, and then addresses concerns from various stakeholders, including the incumbent users of the spectrum.

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9. *See* Jonathan S. Adelstein, Comm'r, FCC, WISPs: Providing Opportunities for Rural America Through Access to Broadband, Remarks at WISPCON VII (Mar. 21, 2005) (transcript available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-257737A1.pdf).

10. For a list of WISPs registered with the Wireless Internet Service Providers Association, see *Member Directory*, WISPA, http://www.wispa.org/member-directory (last updated Mar. 3, 2012).

11. *See* Comments of the Wireless Internet Service Providers Association, ET Docket No. 10-123, at 3 (FCC Apr. 22, 2011), *available at* http://fjallfoss.fcc.gov/ecfs2/document/view.action?id=7021240830.

12. *See* Comments of T-Mobile USA, Inc., ET Docket No. 10-123, at 3 (FCC Apr. 22, 2011), *available at* http://fjallfoss.fcc.gov/ecfs2/document/view.action?id=7021240877; Comments of AT&T Inc., ET Docket No. 10-123, at 7 (FCC Apr. 22, 2011), *available at* http://fjallfoss.fcc.gov/ecfs/document/view?id=7021240827.

13. The White House, Presidential Memorandum, *supra* note 2.

II. THE 3500 MHZ BAND

A. Incumbent Uses and Restrictions

Today, the 3500 MHz band is used for radiolocation (i.e., radar) and fixed satellite operations.[14] Radar is used in this band by military jets, fixed land stations, and naval ships off the coast.[15] The NTIA compiled a report analyzing the restrictions necessary on any new use of the spectrum to avoid interfering with the incumbent use and determined the various sizes of exclusion zones around the incumbent use that would suffice to allow continued operation of those systems.[16] The report, though detailed, is limited in that it only considers a mobile broadcast network called WiMAX, and only at high powers required for use by mobile devices.[17] With high-power broadcast comes correspondingly large exclusion zones, which the report found would need a radius of up to 570 kilometers, effectively eliminating nine out of ten of the major metropolitan areas in the United States from possible WiMAX coverage in this band.[18] High-powered broadcast models are best used when interference is not a concern, but they make little sense when trying to maximize geographic coverage without interfering with an incumbent. Fortunately, there are other wireless distribution models and parameters that, if examined by the NTIA, would yield much more usable geography without jeopardizing incumbent use.

The first model is to simply use a lower power standard, like the one used in the adjacent band, 3650–3700 MHz.[19] Users, usually WISPs, can employ those frequencies on a non-exclusive basis by registering with the FCC and obeying certain restrictions on power output and location.[20] When calculating the required restriction zones using power levels typical of WISPs and not of mobile carriers, the exclusion zone shrinks down to 73 kilometers instead of 300 or more kilometers.[21] Another technique is to use a directional antenna pointed away from the coast in exclusion zones. Like a flashlight, a directional

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14. NTIA ASSESSMENT, *supra* note 3, at vi, 3-33.
15. *See id.* at vi.
16. *See id.* at 1-6 to 1-7.
17. *See id.* at 2-5.
18. *See id.* at 4-72 to 4-77.
19. *See* Wireless Telecommunications Bureau Announces Start Date for Licensing and Registration Process for the 3650–3700 MHz Band, 72 Fed. Reg. 74,283, 74,285 (Dec. 31, 2007).
20. *See id.* at 74,284–85.
21. *See* Clem Fisher, Motorola Solutions, Operation of Wireless Broadband Services in the Band 3550–3650 MHz Identified Under the NTIA Fast-Track Evaluation 4–5 (July 29, 2011) (presentation slides available at http://www.its.bldrdoc.gov/isart/art11/slides/FisherMotorola3.5GHzOpportunityISART2011.pdf) (stating that 43 dBm, or 1W/MHz is the appropriate power, not 61 dBm, or about 60W/MHz).

antenna points the bulk of a signal in a particular direction and leaves other areas largely unaffected.[22] Unintended spread from the antenna and reflections off objects make perfect directionality a practical impossibility, but even moderate directionality will expand the usable geography.[23] The drawback is that service will be unavailable to anyone who is between the base antenna and the coast. Having more base towers would be costly but would increase the probability that a connection would not produce interfering signals and would thus increase the number of people served.

A slight modification on the directional model allows an even tighter pattern. If each customer's receiver is paired with a transmitter, each customer essentially becomes another connection point for other customers.[24] This means that as the number of subscribers grows, the number of possible connection points grows as well, increasing the chances of the availability of a connection point that will not direct interference toward the coast. Furthermore, with many more connection points, power can be further reduced to prevent interference.

B. Garbage Spectrum?

Historically, spectrum above 3000 MHz was viewed as less attractive because of its propensity to scatter rather than pass through objects like trees and walls.[25] Scattering causes two problems: First, the signal is deflected from its intended course and takes longer to arrive and thus attenuates. Second, a scattered signal can overlap and interfere with itself, causing dead spots and increased signal noise.[26] However, Multiple-Input Multiple-Output ("MIMO"), a recent technology, has the potential to use these scattering properties to economically increase the quality of the signal.[27] Briefly, MIMO uses multiple antennas to transmit the same signal, which is then received by multiple antennas. Signals arriving at different times are analyzed

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22. *See* LARSEN, *supra* note 7, at 4.

23. *See* CISCO, OMNI ANTENNA VS. DIRECTIONAL ANTENNA, http://www.cisco.com/en/US/tech/tk722/tk809/technologies_tech_note09186a00807f34d3.shtml (last updated Feb. 27, 2007) (offering a basic explanation of directional antennas).

24. *See, e.g.*, *How netBlazr Works*, NETBLAZR, http://netblazr.com/dev/services/how-netblazr-works (last visited May 3, 2012).

25. Scattering is a function of the frequency in use and the material it passes through. *See Tech Topic 17: Propagation Characterization*, FCC PUB. SAFETY AND HOMELAND SEC. BUREAU, http://transition.fcc.gov/pshs/techtopics/techtopics17.html (last visited May 3, 2012).

26. *See Multipath and Diversity*, CISCO, http://www.cisco.com/en/US/tech/tk722/tk809/technologies_tech_note09186a008019f646.shtml (last updated Jan. 21, 2008) (offering a basic explanation of this phenomenon, aptly called "multipath distortion").

27. *See* Jacob Sharony, Director, Network Technologies Division, Center of Excellence in Wireless & IT, Stony Brook University, Introduction to Wireless MIMO — Theory and Applications, presented at the IEEE Long Island 7–8, 13 (Nov. 15, 2006) (presentation slides available at http://www.ieee.li/pdf/viewgraphs/wireless_mimo.pdf).

and compared, allowing the device to derive the original signal from the collection of distorted ones.[28] The beneficial property of MIMO is largely determined by signal processing capacity, which, if history is any guide, will continue to increase even as prices drop.[29] Because computing power improves signal quality, the utilization of the spectrum will increase as processing power increases.

For fixed systems, MIMO raises another interesting possibility: beamforming, which allows for narrower beams and increases the ability of a system to reuse spectrum by limiting the geographic area a signal occupies.[30] Signals can be packed closer together, freeing spectrum to support additional users or faster speeds.[31]

Finally, higher frequencies have an aesthetic advantage: because higher frequencies allow smaller antennas and shorter antenna spacing for MIMO devices, devices mounted on homes or in windows will be less conspicuous and less likely to deter customers from using the service.[32]

Because of current and potential advancements in technology, the 3500–3650 MHz band has the potential to yield more efficient communication than was historically possible. Thus, what once was thought to be barely useable "garbage" spectrum can now become a fruitful frequency.

III. POTENTIAL USE OF THE 3500–3650 MHZ BAND

WISPs are an important part of the nation's broadband infrastructure and can provide service to many households and businesses that traditional ISPs find uneconomical to serve. There are at least three reasons to promote the growth of WISPs. First, WISPs have a different cost structure than traditional ISPs. Traditional ISPs will build out their network until the marginal cost to connect another customer exceeds the average revenue received from customers.[33] The cost of serving some customers will exceed the average revenue, and they will go without service. In rural areas, this can mean that whole towns are unconnected, providing part of the impetus for President Obama's spectrum reallocation initiative.[34] Additionally, while urban areas will typically have one or more providers, not all areas are equally ser-

28. *See id.* at 7–8.
29. *See id.* at 11.
30. *See* FUJITSU, BEAMFORMING BOOSTS THE RANGE AND CAPACITY OF WIMAX NETWORKS 1–3, 5 (2008), http://www.fujitsu.com/downloads/MICRO/fma/formpdf/WiMAXbeamform.pdf.
31. *See id.*
32. *See* Sharony, *supra* note 27, at 29–30.
33. *See* Daniel F. Spulber & Christopher S. Yoo, *Rethinking Broadband Internet Access*, 22 HARV. J.L. & TECH. 1, 23–30 (2008).
34. *See* The White House, Presidential Memorandum, *supra* note 2.

viceable — some buildings might be too expensive to connect or have connections that suffer from defects too expensive to fix, thus providing degraded service.[35] Unlike a traditional ISP, WISPs' costs are not determined by digging and laying down the wire to create a conduit. Instead, the cost to a WISP is largely determined by the base antenna and user wireless equipment, the installation of a base station close enough to connect the customer, and the opportunity costs associated with displacing potential customers from lack of spectrum.[36] Where it is too expensive for wired ISPs to dig trenches and lay wires or install or repair connections in an old building, wireless transmission might be more economical. A household too expensive for a traditional ISP to connect for infrastructural reasons may be within the cost range of a WISP. As a result, households currently lacking wired service or with poor connectivity rely on over-the-air solutions to receive service. WISPs require more spectrum to meet that demand.[37] Thus, the government should allocate enough spectrum to accommodate multiple WISPs to ensure that competition keeps prices down. If given sufficient spectrum to work with, WISPs will increase both the number of households with available broadband service, as well as the average quality and speed of those connections.

Second, given sufficient bandwidth in which to operate, WISPs can compete with traditional ISPs, particularly cable, which in turn should lower prices and spur traditional ISPs to invest more heavily in infrastructure and technology. Because average costs drop with customers served, the wired ISP market will tend to consolidate into a single dominant provider with the possibility of a few minor competitors.[38] This arguably supports conditions of an unregulated natural monopoly.[39] When the same conditions existed in telephony, the FCC opted to regulate the dominant player, Bell, as a government-sanctioned monopoly. With time, however, the United States abandoned the strategy and broke Bell into many different companies.[40] With ISPs, the government has relied on intermodal competition rather than regulation.[41] Ideally, different modes of Internet service —

35. *See* LARSEN*, supra* note 7, at 21.

36. *See* LARSEN, *supra* note 7, at 12; Adelstein, *supra* note 9, at 1–2 (demonstrating WISP lowering cost by avoiding the digging usually incurred in ISP setup).

37. *See* LARSEN*, supra* note 7, at 21; Jeffery Rosen, *The Future of Spectrum*, ISSUES IN TECH. INNOVATION, Aug. 2011, at 3, http://www.brookings.edu/~/media/Files/rc/papers/2011/08_spectrum_rosen/08_spectrum_rosen.pdf.

38. Richard S. Whitt, *Evolving Broadband Policy: Taking Adaptive Stances to Foster Optimal Internet Platforms*, 17 COMMLAW CONSPECTUS 417, 433–34 (2009).

39. *See* William D. Rahm, *Watching over the Web: A Substantive Equality Regime for Broadband Applications*, 24 YALE J. ON REG. 1, 11 (2007). *But see* Spulber & Yoo*, supra* note 33, at 26.

40. *See* BERKMAN CTR. FOR INTERNET AND SOC'Y, NEXT GENERATION CONNECTIVITY REPORT 89 (2010), http://cyber.law.harvard.edu/sites/cyber.law.harvard.edu/files/Berkman_Center_Broadband_Final_Report_15Feb2010.pdf [hereinafter BERKMAN CTR.].

41. *Id.* at 137.

DSL, cable, and fiber — will compete for customers.[42] However, DSL's technological limitations have forestalled it from being a next-generation broadband solution capable of competing with high-speed cable offerings.[43] Furthermore, fiber connections to the home are expensive to build and will therefore be competitive only in the long term.[44] As a result, cable is left without a viable competitor for high-speed broadband in many parts of the country, a potential reason that broadband availability, speed, and pricing in the United States lags behind that of other OECD nations.[45] Some commentators hope that mobile networks will eventually be able to compete with cable, but given the recent pattern of establishing tight data transfer limits on mobile connections and the relatively high price for high capacity service, it does not appear that mobile will be competing directly with fixed service in the foreseeable future.[46]

On the other hand, in many instances WISPs have lower capital requirements than wired services and are limited primarily by the range of available frequencies and processing power.[47] The amount of spectrum available directly affects the amount of data throughput.[48] The more spectrum made available for use by WISPs, the more users a WISP network can sustain and the more speed the WISP network can provide.[49] A wireless signal can provide speeds comparable to fiber but without the requirement to rebuild trenches. It therefore might be economical to build fiber out to neighborhoods and then rely on wireless to link the users to the fiber connection.[50] Bringing the fiber connection closer to the user reduces the power necessary to provide a wireless connection, also limiting inadvertent interference.[51] This is still less costly than building out a fiber connection to each residence.

Installing both transmitters and receivers in each home adds the possibility of creating a mesh network, where a user connected to the

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42. Spulber & Yoo, *supra* note 33, at 23–26.

43. *See* FCC, CONNECTING AMERICA: THE NATIONAL BROADBAND PLAN 42 (2010), http://download.broadband.gov/plan/national-broadband-plan.pdf; BERKMAN CTR., *supra* note 40, at 9.

44. *See* FCC, *supra* note 43, at 42; BERKMAN CTR., *supra* note 40, at 9.

45. *See* BERKMAN CTR., *supra* note 40, at 12, 137–38.

46. *See* LARSEN, *supra* note 7, at 5; Stacey Higginbotham, *Why Verizon Killed Its Unlimited Plans*, GIGAOM.COM (July 7, 2011), http://gigaom.com/broadband/why-verizon-killed-its-unlimited-plans.

47. *See* LARSEN, *supra* note 7, at 8.

48. *See generally* Claude E. Shannon, *A Mathematical Theory of Communication* (pts. 1 & 2), 27 BELL SYSTEM TECH. J. 379, 623 (1948).

49. *See* LARSEN, *supra* note 7, at 8–9.

50. *See* MARK MACCARTHY, ASPEN INST., RETHINKING SPECTRUM POLICY: A FIBER INTENSIVE WIRELESS ARCHITECTURE 1, 36–37 (2010), http://www.community-wealth.org/_pdfs/articles-publications/municipal/paper-maccarthy.pdf.

51. *Id.* at 35–36.

base can serve as a signal source for other units further away.[52] The system would be analogous to the type described by Yochai Benkler as a model that makes better use of spectrum.[53] By making each user a part of the communications infrastructure as well, each new user adds to the capacity of the network to offset, at least in part, the reduced capacity due to its own communications.[54] In contrast to a broadcast model, wherein each new user reduces capacity, the user-infrastructure model scales well and allows spectrum to be used more efficiently.[55] Furthermore, this model eliminates the expense of building multiple base towers and can increase reliability by giving users multiple ways to connect to the network. As the technology develops, it may provide a useful test of Benkler's proposal, which if successful could lead to further increases in efficient use of spectrum.

Finally, with load balancing capability that is becoming more common in end-user routers, a WISP connection can be added to the existing connection, raising the possibility that a WISP connection can be combined with DSL or a slow cable connection to increase the speed and compete with cable's high-speed services.[56] WISPs are quick and inexpensive to deploy, lending them a flexibility to work around the limitations of wired connections. While WISPs may not be capable of shouldering the entire load, they should help fill in the gaps left by traditional ISPs.

The 3500–3650 MHz band is adjacent to the 3650–3700 MHz band currently used by many WISPs, allowing equipment manufactured for the latter band to be easily modified to service the former as well.[57] Furthermore, the 3500–3650 MHz band is currently used for wireless broadband in many countries, meaning that devices designed to use these frequencies will have a larger market over which to spread research and development costs.[58] Although the technology is not yet mature, it has already had time to come out of its infancy and will almost certainly accelerate in its development if opened up for use in the United States.

52. KEVIN WERBACH, NEW AMERICA FOUND., RADIO REVOLUTION: THE COMING AGE OF UNLICENSED WIRELESS 18–19, http://werbach.com/docs/RadioRevolution.pdf.

53. *See* Yochai Benkler, *Some Economics of Wireless Communications*, 16 HARV. J.L. & TECH. 25, 44–45 (2002).

54. *Id.* at 45; WERBACH, *supra* note 52, at 18–19.

55. Benkler, *supra* note 53, at 45.

56. For an explanation of load balancing, see *Internet Load Balancing*, PEPLINK, http://www.peplink.com/solutions/internet-load-balancing (last visited May 3, 2012); *Routers — CNET Reviews*, CNET, http://reviews.cnet.com/routers/?filter=500563_5152540 (last visited May 3, 2012) (listing products that contain load balancing capability).

57. Fisher, *supra* note 21, at 6; *see also* 47 C.F.R. § 2.106 (2010) (FCC Table of Frequency Allocations).

58. *See Top WiMAX Operators by Number of Subscribers Q3 2011*, 4GCOUNTS, http://www.4gcounts.com/images/Top%20WiMAX%20Operators%20Q3%202011.png (last visited May 3, 2012).

IV. ADDRESSING THE CONCERNS OF THE VARIOUS STAKEHOLDERS

To accommodate incumbent users, a new service that shares the frequencies must show that it will not interfere with incumbent use. The new service must also be resistant to interference from the incumbent use. This is important partly for political reasons; incumbents fear that if their use degrades the new, popular use, the resulting public ire will create pressure on them to relinquish their use.

To alleviate both concerns, rules should be made regarding both the permissible levels of interference new devices are allowed to cause and resiliency to the incumbent use. Rules currently in use in the adjacent 3650–3700 MHz band achieve those ends and should be emulated in the 3500–3650 MHz band. The business models described above are a few examples of creative ways to accommodate the restrictions, and if the additional spectrum is allotted, there will certainly be more parties interested in developing other creative ways to work around the constraints.

While the President's memo emphasizes auctions and revenue generation, this band of frequency is unlikely to generate sufficient revenue from an auction to justify turning down the opportunity to allow WISPs to use it to create value. Mobile telephone carriers have requested spectrum below 3 GHz, and have not pursued anything above.[59] Furthermore, the FCC has been exploring options for sharing the spectrum and does not seem to be entertaining the option of relocating the incumbent users to new spectrum.[60] Mobile telephone carriers have expressed disinterest in sharing a band that is limited by exclusion zones.[61] Therefore, it is doubtful that an auction would raise much revenue. Furthermore, many commentators doubt the efficacy of using auctions as a panacea for broadband shortage.[62] Opening spectrum for unlicensed use has inadvertently led to much value before, and unlicensed spectrum continues to be a vehicle for innovation and a workhorse in data communication.[63]

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59. *See supra* note 13 and accompanying text.

60. *See* NTIA ASSESSMENT, *supra* note 3, at 1-6 to 1-7.

61. *See* Comments of AT&T Inc., *supra* note 12, at 7.

62. *See* MICHAEL A. CALABRESE, NEW AMERICA FOUND., USE IT OR SHARE IT: UNLOCKING THE VAST WASTELAND OF FALLOW SPECTRUM 32–33 (Sept. 2011), http://ssrn.com/abstract=1992421 (discussing the limitations of auctions in this band); *see also* LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD 76–82 (2001) (discussing the advantages of unlicensed spectrum).

63. *See* Yochai Benkler, *Open Wireless vs. Licensed Spectrum: Evidence from Market Adoption*, 26 HARV. J.L. & TECH. (forthcoming fall 2012) (manuscript available at http://cyber.law.harvard.edu/node/7211).

V. CONCLUSION

The FCC and the NTIA have an opportunity to convert some sparsely used spectrum into a key component of the United States' broadband infrastructure. By opening up the 3500–3650 MHz spectrum for unlicensed or lightly licensed use and combining it with the existing 3650–3700 MHz range, the administration would give WISPs the bandwidth necessary to provide a high-speed connection to many unserved and underserved rural areas and provide an additional competitor in urban areas. The NTIA should reevaluate the potential for sharing based on the lower power levels used by WISPs and provide rules flexible enough to allow for additional technological solutions to avoid interfering with incumbent uses.