MEMORANDUM

To: REFORM
From: Wendell Bartnick
RE: Spectrum Management Model Comparison: Licensed vs. Unlicensed Spectrum
Date: July 24, 2006

NOTE

This Draft Memo is unpublished and used only as an internal resource to the NTIA. The views expressed in this memo are those of Wendell Bartnick and not necessarily those of NTIA.

INTRODUCTION

Near the end of 2003, then FCC Chairman Michael K. Powell said, "Wireless broadband is increasingly a reality in the marketplace. [M]aking more spectrum available for this important application will foster facilities-based broadband competition and significantly advance the public interest. Moreover, additional unlicensed [radio] spectrum was a key recommendation of the Spectrum Policy Task Force." [1] That Spectrum Policy Task Force Report led to the FCC's choice to allocate more unlicensed radio spectrum, as opposed to licensed radio spectrum. [2] The Task Force and FCC relied on the "tremendous success" of Wi-Fi to support the premise that unlicensed spectrum prompts innovation and is the most efficient use of spectrum.[3] However, more unlicensed spectrum may not be the best use of limited spectrum.

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[1] *See* Roy Mark, *FCC Makes More Unlicensed Spectrum Available*, November 13, 2003, available at http://www.wi-fiplanet.com/news/article.php/3108961; Spectrum Policy Task Force, FCC, *Report 11-17* (2002), 54, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228542A1.pdf.
[2] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 601. Unlicensed bandwidth was granted both by giving unlicensed devices underlay rights to licensed spectrum and by creating bands dedicated exclusively to unlicensed devices.
[3] *Id.*

One must put Wi-Fi's success in context. With all of Wi-Fi's success, Wi-Fi adds less than $100 million to the U.S. economy.[4] In contrast, the mobile wireless industry, using licensed spectrum, adds billions in economic output.[5] With this difference in economic activity, and with few other unlicensed successes, giving scarce spectrum to unlicensed users rather than to licensed users like mobile wireless services may not make sense.

This memo argues that a fully licensed flexible-use spectrum management model best suits society's needs, not the unlicensed model the FCC currently contemplates. In Part I, this memo discusses Wi-Fi as the prime impetus for the FCC choosing to create more unlicensed spectrum bands. Then, Part II briefly outlines three potential spectrum management models. Part III analyzes the spectrum management models by looking at the crucial factors to consider when choosing a management scheme. Finally, the paper concludes that after looking at the factors, unlicensed spectrum is likely not the ideal model to meet the FCC's principles of supporting innovation and efficient spectrum use.[6] Instead, a fully licensed spectrum better meets society's needs.

I. WHAT PROMPTED THE EXPANSION OF UNLICENSED SPECTRUM POLICY?

Wi-Fi is a type of wireless network technology that allows computers to wirelessly connect to each other and the Internet. Wi-Fi has become increasingly widespread. Some predictions show there will be 707 million Wi-Fi users in the world

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[4] *Id* at 614.
[5] *Id*.
[6] "Regulatory policies must promote technological neutrality, competition, investment, and innovation to ensure that broadband service providers have sufficient incentive to develop and offer such products and services.", available at http://www.fcc.gov/broadband/; "Because there is a finite amount of spectrum and a growing demand for it, effectively managing the available spectrum is a strategic issue for the FCC", available at http://www.fcc.gov/spectrum/.

by 2008. [7] Market research shows that in the U.S., Wi-Fi is used in 8.4 percent of all households. [8] Virtually all laptops automatically come with Wi-Fi adapters. [9] Wi-Fi hotspots have popped up throughout the country and a few large cities have completed projects to build municipal Wi-Fi networks, and many more cities will follow. [10]

Wi-Fi has also become more important. Many businesses implemented an exclusively Wi-Fi solution in their office buildings due to the low cost of network roll-out versus wiring an office building. However, Wi-Fi is an unlicensed use of radio spectrum. This means that licensed users of radio spectrum or other unlicensed devices can interfere with Wi-Fi. This potential interference problem will only worsen as people build more Wi-Fi networks and use other unlicensed devices.

Wi-Fi uses the 2.4 GHz unlicensed band along with many other unlicensed devices including microwave ovens, cordless phones, and Bluetooth enabled devices. This crowded area of the spectrum can lead to interference between the devices. For example, if a cordless telephone is used in the same room as a Wi-Fi network, poor Wi-Fi performance results.[11] In addition, amateur radio and amateur TV broadcasters are licensed users of adjacent frequency bands to the 2.4 GHz unlicensed band. Both amateur radio and TV users have experienced interference with what they believe is Wi-Fi use. The American Radio Relay League (ARRL), the association for amateur radio

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[7] *See* Peter Judge, *Wi-Fi to overtake broadband*, TechWorld, July 22, 2003 (available at: http://www.techworld.com/news/index.cfm?fuseaction=displaynews&newsid=293).
[8] *Id.*
[9] Kenneth R. Carter, et. al., *Unlicensed and Unshackled: A Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues*, May 2003, at 36, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-234741A1.pdf.
[10] *See* Bob Gaby, *Break free: a user's guide to wireless technology today – and tomorrow.*, California CPA, May 2005, available at http://www.allbusiness.com/periodicals/article/575555-1.html; Eric Griffith, *Earthlink's First Muni Wi-Fi Launches*, June 29, 2006, available at http://www.wi-fiplanet.com/news/article.php/3617321.
[11] Jim Geier, *Minimizing 802.11 Interference Issues*, January 11, 2002, available at http://www.wi-fiplanet.com/tutorials/article.php/953511.

operators, has been involved with a case of nation-wide interference from wireless networks.[12] Amateur TV stations in San Francisco reported an increase in background interference from Wi-Fi.[13] These interference problems may only be the tip of the iceberg. Wi-Fi certainly significantly impacted wireless technology, but Wi-Fi is still far from use in even a majority of homes. If interference problems exist now, nation-wide Wi-Fi may not be possible. If that is true, should Wi-Fi be considered the tremendous success that FCC officials use as the foundation for their move to an unlicensed spectrum management model?

II. WHAT ARE THE SPECTRUM MANAGEMENT OPTIONS?

Traditionally, the FCC used a command-and-control spectrum management model to distribute licenses encumbered with restrictions on technology, services, coverage, and transferability. [14] Policy and industry experts agree that this management method resulted in under-utilization of spectrum resulting in increased industry costs, reduced incentive to innovate, slower deployment and adoption of new services, and the increase in spectrum scarcity. [15]

Most, if not all, spectrum experts agree that market-driven spectrum allocation is most efficient, but they disagree on the implementation model due to other factors. Many economists and existing licensees believe that the best solution is for the FCC to grant

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[12] ARRL, *FCC Part-15 Rules: Unlicensed RF Devices*, April 25, 2006, available at http://www.arrl.org/tis/info/part15.html#conclusion. ("The Phonex Corporation manufactured wireless modem jacks installed by TCI Cablevision to thousands of customers. The wireless jacks worked on a frequency that in some areas significantly interfered with the authorized use of that frequency for amateur radio hobbyists. Both companies extended immediate cooperation to resolve the interference, but problems still exist over a year later. See Wireless Modem and Telephone Jacks (http://www.arrl.org/tis/info/rfiteljx.html) for more.")

[13] Ed Sutherland, *Is Wi-Fi Heading Down the Wrong Track?*, May 9, 2002, available at http://www.wi-fiplanet.com/news/article.php/1107451.

[14] William Lehr, *Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz*, May 17, 2004, at 3, available at http://itc.mit.edu/itel/docs/2004/wlehr_unlicensed_doc.pdf.

[15] *Id* at 3.

perpetual, exclusive, flexible-use licenses – the Fully Licensed Spectrum Model. Others believe that granting exclusive use licenses will create private monopolies and that unlicensed under- and over-lays on licensed spectrum are necessary for innovation – the Unlicensed Spectrum Easement Model. Still others, including many at the FCC, believe that the FCC should assign more dedicated unlicensed spectrum bands – the Dedicated Unlicensed-use Spectrum Model. This model provides both licensed and unlicensed bands allowing innovators to choose which band-type fits their use best. Each of these spectrum management models is described in greater detail below.

A. *Fully Licensed Spectrum Model*

Today, for the most part, the FCC grants spectrum to those that complete the licensing process, including the payment of a hefty fee, and agree to strict limitations on the spectrum use. Those without an FCC license are prohibited from transmitting signals over much of the radio spectrum. This spectrum management model helps prevent interference among spectrum users. For example, companies in the mobile wireless services industry gained access to the licensed radio spectrum by participating in spectrum auctions. Once a wireless telephone company has a license, the company can use that bandwidth according to the FCC restrictions (i.e. geographical, timing, and service-type, etc.) to the exclusion of all others to prevent interference. [16]

Many economists believe that for a market to allocate spectrum efficiently and to prevent interference, the FCC must liberalize the existing licensing process and spectrum use restrictions so that spectrum rights are flexible, exclusive, and exhaustively

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[16] Kenneth R. Carter, et. al., *Unlicensed and Unshackled: A Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues*, May 2003, at 4, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-234741A1.pdf.

assigned.[17] The underlying economic rationale is that licensees that have exclusive rights must internalize both the costs and benefits of particular spectrum uses leading the licensee to make the most efficient decisions. [18] The licensee bears both the expense and captures the gain from creating valuable services which make the licensee conserve spectrum and invest in infrastructure. [19] Plus, the licensee has a spectrum right to exclude others from interfering with its use of the spectrum band which can be court enforced.

Along with liberalizing the licensing regulations, economists believe that the FCC should allow license transfer, creating an effective secondary spectrum market. [20] Currently, transfers occur, but they are very limited and still subject to the same FCC restrictions under the original license. [21] This limitation results in highly valued spectrum trapped in low value uses since the spectrum cannot be redeployed to a better use. [22] With rapid technical progress in the industry this lack of transfer flexibility needlessly increases the costs and reduces the efficiency of spectrum utilization.

Implementing the fully licensed spectrum model also removes much of the rigorous, time-consuming, and expensive process of acquiring a license from the FCC. Potential innovators that desire spectrum would simply go to the current licensee of the desired spectrum and negotiate for its purchase.

In addition, government agencies must have the authority to budget for and participate in spectrum transactions. Currently, most federal agencies may not "augment

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[17] Evan Kwerel & John Williams, *A Proposal for a Rapid Transition to Market Allocation of Spectrum*, November 2002, at 8, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228552A1.pdf.
[18] *Id* at 5.
[19] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 626.
[20] *Id* at 619-20.
[21] *Id* at 619-20.
[22] William Lehr & Lee W. McKnight, *Wireless Internet Access: 3G vs. WiFi?*, August 23, 2002, at 12, available at http://itc.mit.edu/itel/Docs/2002/LehrMcKnight_WiFi_vs_3G.pdf.

their operating budgets by undertaking activities to raise money." [23] While most federal agencies do not have the express power to raise money, some agencies may have a generic authorization that would allow spectrum transactions as long as any income is reinvested in spectrum related activity. [24] For those agencies that do not have express or implied permission, Congress must change the law to authorize agencies to participate in spectrum transactions.

B. *Unlicensed Spectrum Easement Model*

The FCC allows unlicensed devices to use a number of frequencies that also have licensed users. This unlicensed use is commonly called a frequency underlay or overlay easement on a licensed spectrum band. An example is the 380 MHz band where garage door openers were an unlicensed device that worked in the same frequency band as licensed radio use by the Department of Defense. [25]

The FCC created rules to govern the manufacture and use of unlicensed devices which are contained in the Federal Register ("Part 15"). The rules ensure that unlicensed devices do not interfere with licensed users, especially important when an underlay or overlay easement exists on a licensed band. [26] Part 15 contains two important general restrictions. First, unlicensed devices must conform to maximum power levels and

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[23] Adele Morris, *Getting the Best out of Public Sector Spectrum* (Department of the Treasury, September 8, 2005) (draft), at 10, available at: http://web.si.umich.edu/tprc/papers/2005/497/Morris%20Cave%20public%20sector%20spectrum%209%209%202005.pdf.

[24] *Id.*

[25] Paul L. Francis, *Potential Spectrum Interference Associated with Military Land Mobile Radios*, December 1, 2005, at 1, available at http://www.gao.gov/new.items/d06172r.pdf.

[26] 47 C.F.R. §15; Jim Wagner, *FCC To Approve Wi-Fi Rule Revamp*, May 13, 2002, available at http://www.isp-planet.com/news/2002/fcc_020513.html.

timing restrictions.[27] To enforce conformance, the FCC must certify manufacturers' unlicensed devices before manufacturers can sell the devices to the public.[28]

Second, unlicensed device owners have very little right to spectrum.[29] The unlicensed device must not interfere with any licensed devices on that frequency and the unlicensed device must accept interference from any licensed device.[30] This means that a licensed user takes precedence over an unlicensed device even if that causes undesirable operation of the unlicensed device.[31] The owner of the unlicensed device must turn off the device if interference occurs, and the user cannot resume operation until the harmful interference is corrected.[32]

For the purposes of this memo, this spectrum management model's important features are so similar to the following model, the Dedicated Unlicensed-use Spectrum Model, that both models will be discussed as one. Most remaining discussion will simply alternate between discussion of licensed and unlicensed spectrum. Therefore, for the purposes of this paper, unlicensed spectrum refers to both the Unlicensed Spectrum Easement Model and the Dedicated Unlicensed-use Spectrum Model, unless otherwise stated.

C. *Dedicated Unlicensed-use Spectrum Model*

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[27] 47 C.F.R. §15.247; Jim Geier, *EIRP Limitations for 802.11 WLANs*, July 18, 2002, available at http://www.wi-fiplanet.com/news/article.php/1428941; William Lehr, *Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz*, May 17, 2004, at 25, available at http://itc.mit.edu/itel/docs/2004/wlehr_unlicensed_doc.pdf.

[28] 47 C.F.R. §15.101, .201, .305, .607; Kenneth R. Carter, et. al., *Unlicensed and Unshackled: A Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues*, May 2003, at 12-13, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-234741A1.pdf.

[29] 47 C.F.R. §15.5 (a).

[30] 47 C.F.R. §15.5 (b).

[31] 47 C.F.R. §15.5 (b).

[32] 47 C.F.R. §15.5 (c).

The FCC dedicated a few spectrum bands entirely for unlicensed device use, not limiting unlicensed use to an under- or over-lay on a licensed band. The most familiar example is the 2.4 GHz unlicensed band used by Wi-Fi, microwave ovens, cordless telephones, and Bluetooth enabled devices. Dedicated unlicensed spectrum bands also exist for ISM, U-NII, and hearing aid devices. [33]

The FCC manages dedicated unlicensed bands with Part 15 rules, similar to the Unlicensed Spectrum Easement Model described above. Therefore, power level and interference rules exist. However, under the Dedicated Unlicensed-use Spectrum Model the Part 15 rules affect spectrum use a bit differently. For the most part these rules affect unlicensed devices interacting among themselves, not interference between licensed and unlicensed devices. The reason should be apparent, only unlicensed devices exist on the frequency band. Interference with licensed use will occur only when unlicensed devices cause interference with users on adjacent licensed bands.

Some experts believe that the current number of unlicensed bands is not enough and that licensed users should migrate to unused or even occupied portions of the spectrum to accommodate the growing need for wireless connectivity. [34] An FCC task force suggested the FCC create more spectrum opportunities for unlicensed devices by creating new "unlicensed bands" by band clearing. [35] Most experts do not suggest that all spectrum should be unlicensed, only portions.

III. FACTORS FOR CHOOSING A SPECTRUM MANAGEMENT MODEL

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[33] FCC, *Memorandum Order and Opinion ET Docket No. 03-122*, June 30, 2006, at 1, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-06-96A1.pdf.
[34] Kenneth R. Carter, et. al., *Unlicensed and Unshackled: A Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues*, May 2003, at 45, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-234741A1.pdf.
[35] *Id* at 49.

This section discusses some of the main factors economists, the FCC, and other analysts consider when analyzing which spectrum management model should be implemented. The factors include: 1) using spectrum efficiently, 2) managing interference, 3) prompting innovation and investment, 4) assessing overall social gains, 5) managing legal ambiguities, and 6) assessing the implemented model's success. These factors will be analyzed by contrasting the fully licensed spectrum model with the unlicensed spectrum models. The analysis proceeds to the conclusion that the fully licensed spectrum management likely makes the most sense.

A. *Using Spectrum Efficiently*

Currently FCC licenses limit spectrum use by geographic locations, timing requirements, services allowed, frequency bands, and in other ways. However, even with these limitations, licensees may not fully use their spectrum. Some licensees may only sporadically use the spectrum, leaving large chunks of time available for other use. Other licensees may only use the spectrum in certain geographic areas leaving others unused. Still other licensees may only use part of the band they have licensed. From an outsider's perspective, the previous three scenarios indicate that spectrum is not efficiently used because there are locations, times, or frequencies that are unused. Therefore, a goal of any spectrum management model must be to efficiently increase the density of spectrum use by adding users in locations, times, or frequencies that are under-utilized without creating interference problems.

The FCC began to move to unlicensed spectrum because it believed unlicensed spectrum results in efficient spectrum use. However, opponents of the unlicensed spectrum models [hereinafter "opponents"] conclude that the fully licensed spectrum

model creates incentives for licensees to invest in bandwidth conservation because licensees can resell what they do not use. In addition, licensees will adopt innovations expected to produce consumer benefits exceeding their costs and will reject profitless projects which means spectrum is put to it highest-valued use. [36]

Proponents of the unlicensed spectrum models [hereinafter "proponents"] argue that many licensees will hoard and waste their spectrum by not actively using all of it. Therefore, licensees should be relocated to other spectrum bands to open up more spectrum for unlicensed use. [37] However, a fully licensed spectrum model will correct for this inefficiency. Once licensees own flexible spectrum use and transfer rights, licensees will put that spectrum to use or sell unused spectrum on the secondary market. If the spectrum still goes unused, the licensee has not received an offer from a prospective licensee higher than the value the current licensee gains by leaving the spectrum unused. Thus, there will be cases when unused spectrum is at its highest valued use, and onlookers should not conclude that unused spectrum is wasted. In fact, licensees will use the least amount of spectrum possible so the licensee can put more on the secondary market.

Proponents of unlicensed spectrum argue that exclusively-assigned property rights over the spectrum can result in excluding potential entrants. [38] If a licensee gains so much spectrum that other potential licensees are unable to fairly compete with the licensee in the product marketplace, the nation's antitrust laws apply. Plus, congestion

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[36] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 617.

[37] Kenneth R. Carter, et. al., *Unlicensed and Unshackled: A Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues*, May 2003, at 48-49, 45-footnote 88, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-234741A1.pdf.

[38] William Lehr, *Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz*, May 17, 2004, at 37, available at http://itc.mit.edu/itel/docs/2004/wlehr_unlicensed_doc.pdf.

and interference concerns in unlicensed spectrum can be just as effective in limiting competition and innovation because potential licensees will not find spectrum where they can be assured of interference free spectrum. [39]

Proponents also argue that a spectrum secondary market will fail to efficiently determine a market price for two reasons. First, since most spectrum needs are localized, low spectrum demand will fail to create a valid license price point. [40] This logic does not make sense when dealing with a scarce resource like radio spectrum. By definition a scarce resource has less supply than demand and a price reflects that relationship. A low price simply means demand is less than supply, not that the market is broken. If, as many people believe, spectrum demand is extremely high and increasing, a lack of demand will not be a problem. Instead a vibrant market will exist.

Second, proponents argue that the license price in a fully licensed spectrum model will not include the cost of externalities (e.g. interference, network effects). [41] Instead, non-market mechanisms like regulation and sharing-protocols can manage these externalities. [42] However, proponents must realize that the enforcement of these non-market mechanisms will occur within the courts, just as the fully licensed spectrum model will require court action if licensees are "polluting" others' spectrum with interference. [43] Both models end at the same place when externalities occur. Additionally a licensee in the fully licensed spectrum model can negotiate with an

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[39] William Lehr & Lee W. McKnight, *Wireless Internet Access: 3G vs. WiFi?*, August 23, 2002, at 16, available at http://itc.mit.edu/itel/Docs/2002/LehrMcKnight_WiFi_vs_3G.pdf.
[40] William Lehr, *Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz*, May 17, 2004, at 31, available at http://itc.mit.edu/itel/docs/2004/wlehr_unlicensed_doc.pdf.
[41] *Id.*
[42] *Id* at 32.
[43] If an unlicensed spectrum user agrees to conform to industry or other non-market created rules, interference problems will need to be resolved in court because other enforcement methods will not exist. Similarly, if a licensee experiences interference, that licensee can go to court for an injunction and damages against the interference creator.

interference creator for an easement, a process any normal property owner follows. Strict regulations of unlicensed spectrum may foreclose an unlicensed spectrum user from private negotiation to solve the interference problem. Each spectrum management model allows possible externalities and mechanisms to deal with it. While a spectrum market may not include every possible externality in its prices, few markets do successfully include every externality its prices. See below for more discussion of interference issues. [44]

Another possible problem with fully licensed spectrum is the hold-out problem. The hold-out problem occurs when one entity attempts to acquire a large, contiguous amount of property to complete a large project. A property owner, located in that area and knowing that his property is necessary to complete the large project, holds-out for an incredibly high price, thereby threatening the entire project.[45] The hold-out problem could force a licensee to create devices that work on multiple frequencies to avoid paying hold-outs. The cost of producing the more advanced devices will increase consumer prices. If dedicated, nation-wide, unlicensed spectrum bands exist with room for more users, this hold-out problem will not exist. A potential spectrum user can create a nation-wide service in an unlicensed band.

Proponents seek to gain efficient spectrum use through unlicensed spectrum. They believe that with fully licensed spectrum, licensees will not fully use their spectrum,

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[44] *See* Part III.B.

[45] A common example of the hold-out problem occurs when the government builds interstate highways. When the government declares that a highway will be built in a given location, owners of property in that location will have an incentive to hold-out for a price much higher than fair market value. Generally the government can get around this problem by using their eminent domain power. The spectrum market can potentially have the same problem. If a potential licensee seeks to acquire all licenses in one nation-wide frequency band to roll-out a nation-wide service, incumbent licensees have an incentive to hold-out for high prices. Unlike in the highway example, a potential licensee will not have the power of eminent domain.

they will hoard spectrum to bar access by prospective licensees, and the market will fail to determine a valid market price due to externalities and low demand. One other efficiency concern is the hold-out problem. Opponents respond with the stronger argument that the development of a secondary market will assure efficient spectrum use. If monopolies occur, the courts are available to implement change. Plus, because supply is low and demand is high, a valid market price will exist. Finally, all models allow potential externalities; however, a fully licensed spectrum may allow for more solutions. However, a fully licensed spectrum model could make building nation-wide systems difficult, making products and services more expensive to the consumer.

B. *Managing Interference*

Interference between unlicensed devices and licensed users has already begun. For example, in 2001 in San Francisco, amateur television stations broadcasting on adjacent bands to the 2.4 GHz unlicensed band reported an increase in background interference from Wi-Fi devices.[46] Also in 2001, in Dallas, an amateur television station reported a Wireless Internet Service Provider ("WISP") was interfering with its station. The FCC forced the WISP to eliminate the interference.[47] In 2002, Sirius Satellite Radio Inc. complained to the FCC that in-car Wi-Fi and Bluetooth gadgets could cost the satellite radio industry $3 billion in lost signal strength due to interference.[48] Wi-Fi is in its infant stages of adoption, yet interference problems already exist.

Proponents of the unlicensed spectrum model argue that technology like "intelligent radios" will alleviate the need for other interference management solutions

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[46] Ed Sutherland, *Is Wi-Fi Heading Down the Wrong Track?*, May 9, 2002, available at http://www.wi-fiplanet.com/news/article.php/1107451.
[47] *Id.*
[48] *Id.*

making unlicensed bandwidth more attractive.[49] However, these same technology improvements also offer potential value with fully licensed spectrum.[50] Technology helps both solutions. Some people believe that implementing "intelligent radios" in a licensed band would be easier than in an unlicensed band anyway.[51] In addition, finding a technical solution to prevent interference under the unlicensed spectrum easement model has been difficult with no credible solution in sight.[52]

Proponents also argue that social norms and technical sharing protocols can effectively address any interference problems.[53] For example, some manufacturers of unlicensed devices on the 2.4 GHz band contacted the American Radio Relay League (ARRL) which represents amateur radio users on the adjacent spectrum band. The manufacturers asked for amateur radio information to help avoid building products that cause harmful interference.[54] Opponents of unlicensed spectrum believe that the fully licensed model is necessary to manage spectrum interference. Exclusive rights require spectrum users to coordinate frequency use because any interference constitutes a trespass.[55] On an unlicensed spectrum band, interference resolution among unlicensed devices is unclear. Plus, successful solutions for interference require experts that a

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[49] William Lehr, *Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz*, May 17, 2004, at 10, available at http://itc.mit.edu/itel/docs/2004/wlehr_unlicensed_doc.pdf.
[50] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 603.
[51] William Lehr & Lee W. McKnight, *Wireless Internet Access: 3G vs. WiFi?*, August 23, 2002, at 19, available at http://itc.mit.edu/itel/Docs/2002/LehrMcKnight_WiFi_vs_3G.pdf.
[52] William Lehr, *Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz*, May 17, 2004, at 25-26, available at http://itc.mit.edu/itel/docs/2004/wlehr_unlicensed_doc.pdf.
[53] *Id* at 19, 35 Tragedy of the Commons is caused by users who over-use a common resource (i.e. using unnecessarily high transmit powers relative to need) which is individually optimal in the sense of increase peak performance for the user but is collectively sub-optimal (degrades aggregate network performance. *Id.*
[54] ARRL, *FCC Part-15 Rules: Unlicensed RF Devices*, April 25, 2006, available at http://www.arrl.org/tis/info/part15.html#conclusion.
[55] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 603. Unlicensed bandwidth was granted both by giving unlicensed devices underlay rights to licensed spectrum and by creating bands dedicated exclusively to unlicensed devices.

licensee will usually employ as opposed to, for example, the normally relatively unskilled Wi-Fi user.

Generally, fixing interference problems on a dedicated unlicensed band is a local problem (since these devices must be low powered and have small broadcast ranges). The device owner can fix interference problems by moving the conflicting devices apart. [56] However, this is not a scalable solution to interference problems, because coordination between devices breaks down when many users are involved. [57] Therefore, interference problems will only increase as multiple and overlapping wireless service providers enter the market. [58] With licensed spectrum, the licensee is legally protected from interference. A licensee can adopt the spectrum interference management strategy that is most appropriate for the licensee's situation without worrying about other spectrum users. [59]

Proponents also say that licensees should not fear interference from adjacent unlicensed spectrum bands any more than from adjacent licensed bands. [60] However, by its very nature, many unknown devices and device owners fill an unlicensed spectrum band. Licensees will find the hunt for the interfering device difficult, even assuming

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[56] *See* Pierre De Vries & Amer Hassan, *Spectrum Sharing Rules for New Unlicensed Bands*, December 11, 2003, at 2, available at http://www.wi-fi.org/files/uploaded_files/kc_32_Spectrum%20Sharing%20Rules%20for%20New%20Unlicensed%20Brands.pdf.

[57] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 634.

[58] William Lehr & Lee W. McKnight, *Wireless Internet Access: 3G vs. WiFi?*, August 23, 2002, at 12-13, available at http://itc.mit.edu/itel/Docs/2002/LehrMcKnight_WiFi_vs_3G.pdf; Jim Wagner, *When the FCC Knocks on Your Door*, May 16, 2002, available at http://www.wi-fiplanet.com/news/article.php/1135751. (For example, while a Wi-Fi user can fix the problem of spectrum interference created at the Wi-Fi location, the user cannot control potential interference from other Wi-Fi service providers or other devices that are sharing the unlicensed spectrum over whom the user experiencing interference has no control. This problem arises in part because many new wireless service providers are unaware of the complexities of the FCC regulations that call for separate certification of both equipment and the overall Wi-Fi network. The Wi-Fi network in its entirety must be certified.)

[59] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 603.

[60] William Lehr, *Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz*, May 17, 2004, at 26, available at http://itc.mit.edu/itel/docs/2004/wlehr_unlicensed_doc.pdf.

there is only one. To make matters worse, unlicensed devices together create an increased aggregate level of interference for which no one device is directly accountable. In that case, deciding which unlicensed devices must be turned off to comply with interference regulations is difficult.

The FCC is investigating a "frequency temperature" method for setting unlicensed device usage rules by setting a maximum cap on the aggregate level of unlicensed transmissions on each spectrum band. [61] The "frequency temperature" of each band will be based on current spectrum usage levels. [62] The FCC believes this solution may solve the interference problems licensees fear, especially interference from underlay easement use. While this idea is intriguing, there are a number of problems with it.

Technical and regulatory problems make the idea seem less feasible. [63] Negative economic impacts also exist. First, some economists believe that the "frequency temperature" cap will artificially increase the amount of unlicensed bandwidth to the detriment of licensed users and society. Unlicensed technology will get access to any spectrum that appears empty or unused by the licensee, rather than giving the access to the licensed users who may already be making efficient use of that spectrum in their own way. [64] Second, by choosing the "frequency temperature" solution, the FCC is implicitly choosing some technologies over others. The FCC will in essence determine how "agile radios, smart antennas, software-defined radios, and other 'opportunistic devices' share

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[61] Roy Mark, *FCC Makes More Unlicensed Spectrum Available*, November 13, 2003, available at: http://www.wi-fiplanet.com/news/article.php/3108961.
[62] *Id.*
[63] William Lehr, *Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz*, May 17, 2004, at 26, available at http://itc.mit.edu/itel/docs/2004/wlehr_unlicensed_doc.pdf.
[64] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 609.

spectrum to implement the frequency temperature solution.[65] If this is the case, then government regulation rather than the market chose a spectrum sharing solution, which is invariably less efficient than the market.[66] Third, capping aggregate unlicensed device transmission levels by regulation means the caps cannot change over time to accommodate true usage needs and technical improvements.

Managing interference is a prime concern for spectrum users. Proponents of unlicensed spectrum believe that technical innovations will remove interference concerns and where technology fails, industry and social sharing protocols can manage any problems. Further, the nature of unlicensed devices makes fixing interference problems a local issue that a device owner can easily fix. To fix interference problems caused by aggregate unlicensed device transmissions, a "frequency temperature" method for managing interference can be implemented. However, technical advances improve licensed spectrum interference prevention as well as unlicensed, so technical advances do not necessarily point in favor of unlicensed spectrum. Additionally, industry and social sharing protocols only work on a small scale. When there are many devices and many device owners, without clear spectrum ownership, sharing protocols break-down. Wireless service overlap and the sheer number of devices could also make tracking down the interfering device impossible. Finally, the adoption of a "frequency temperature" method for capping aggregate unlicensed device transmission levels will allow the FCC to choose technology winners and losers and play a large role in the future of wireless, rather than letting the market efficiently determine the appropriate distribution of resources.

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[65] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 609.
[66] *Id* at 612.

C. *Prompting Innovation and Investment*

1. Barrier to Entry

Proponents of the unlicensed spectrum models believe that unlicensed spectrum naturally promotes investment and innovation in wireless services due to the lower entry cost into the wireless market, because innovators need not purchase expensive spectrum licenses.[67] Innovators will find it cheaper and faster to market products.[68] Consumers will gain the benefits of lower product costs, products that fill unique needs, less hassle, and more rapid innovator development cycles.[69] Contrastingly, innovators forced to acquire a license will need to show market viability before they can get funding and they won't be able to show market viability because they won't have spectrum.[70] Therefore, a fully licensed spectrum management model will affect which technologies are funded.[71]

Proponents support their belief in the unlicensed spectrum by using Wi-Fi as the prototype. They believe that Wi-Fi use exploded precisely because Wi-Fi users rather than wireless service providers purchase and develop the Wi-Fi infrastructure when users buy inexpensive Wi-Fi devices.[72] Wi-Fi users do not need to go through the cost and hassle of acquiring licenses, so the barriers of entry into the technology are low.

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[67] William Lehr, *Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz*, May 17, 2004, at 6, available at http://itc.mit.edu/itel/docs/2004/wlehr_unlicensed_doc.pdf.
[68] Kenneth R. Carter, et. al., *Unlicensed and Unshackled: A Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues*, May 2003, at 46-47, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-234741A1.pdf.
[69] *Id* at 4.
[70] William Lehr, *Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz*, May 17, 2004, at 37, available at http://itc.mit.edu/itel/docs/2004/wlehr_unlicensed_doc.pdf.
[71] *Id* at 5.
[72] William Lehr & Lee W. McKnight, *Wireless Internet Access: 3G vs. WiFi?*, August 23, 2002, at 4, available at http://itc.mit.edu/itel/Docs/2002/LehrMcKnight_WiFi_vs_3G.pdf.

Simply because unlicensed spectrum does not impose licensing costs on users does not mean unlicensed spectrum is the best solution for driving innovation and investment. Increased flexibility in spectrum licensing rules and the emergence of secondary markets will make licenses much cheaper and easier for innovators to acquire. [73] Under the current model, licensees have no incentive to conserve spectrum because they are unable to resell unused spectrum. With fully licensed spectrum and more liberalized license rules, licensees will more efficiently use spectrum and attempt to resell unused spectrum. Licensees adding their unused spectrum to the market will drive down the price.

Innovators will be able to get funding for innovative technologies. The dot-com boom displayed investors' eagerness to fund good ideas with little or no proven market viability.

Licensees will likely try to keep new competitors out of the market, but this activity exists in all industries. [74] Monopolistic practices generally fail, but should one occur, legal antitrust solutions are available to assure competition exists.

Also, if the government, including the FCC, decides that unlicensed bands of spectrum are crucial to innovation, the government may acquire a license and manage the spectrum as an unlicensed band. [75] The government currently acquires (or doesn't sell) land for state parks, a similar process can work with spectrum. [76] Forcing the

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[73] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 629; William Lehr & Lee W. McKnight, *Wireless Internet Access: 3G vs. WiFi?*, August 23, 2002, at 4, available at http://itc.mit.edu/itel/Docs/2002/LehrMcKnight_WiFi_vs_3G.pdf.
[74] William Lehr, *Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz*, May 17, 2004, at 37, available at http://itc.mit.edu/itel/docs/2004/wlehr_unlicensed_doc.pdf.
[75] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 631.
[76] Evan Kwerel & John Williams, *A Proposal for a Rapid Transition to Market Allocation of Spectrum*, November 2002, at 7, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228552A1.pdf.

government to purchase licenses will require it to face the opportunity cost of limiting licensed spectrum.

Companies working in unlicensed wireless spectrum aren't mom-and-pop establishments that need protection. The strongest proponents of dedicated unlicensed bands include Intel, Microsoft, Apple, and Cisco, technical giants who want to sell equipment and let consumers worry about the interference issues.[77] These companies can actively participate in a spectrum market.

2. Investment

Opponents of unlicensed spectrum say that companies will not invest in costly infrastructure to support innovation because they fear interference.[78] For example, in the mobile wireless industry, a mobile wireless service provider must cover a large contiguous geographic area. To do so, the service provider must build and own an end-to-end network which includes significant infrastructure.[79] Companies like Cingular, Sprint-Nextel, and Verizon Wireless are completing billion-dollar upgrades to their systems. Overall, U.S. mobile wireless service providers spend about $20 billion annually on capital infrastructure.[80] These numbers show the importance companies place on exclusive licenses and assured interference protection. In addition, significant innovation occurs within the licensed bands, perhaps more in quantity and more socially beneficial innovations than in unlicensed bands.[81]

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[77] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 621.
[78] William Lehr, *Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz*, May 17, 2004, at 6, available at http://itc.mit.edu/itel/docs/2004/wlehr_unlicensed_doc.pdf.
[79] William Lehr & Lee W. McKnight, *Wireless Internet Access: 3G vs. WiFi?*, August 23, 2002, at 4, available at http://itc.mit.edu/itel/Docs/2002/LehrMcKnight_WiFi_vs_3G.pdf.
[80] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 659.
[81] *Id* at 615.

In contrast to the money pouring into licensed spectrum infrastructure, not much infrastructure building or use has occurred in the new dedicated unlicensed bands. Likely, the same interference fears that keep licensees from supporting unlicensed spectrum also keep companies from heavily investing in unlicensed bands. Investors fear that large numbers of future users will access the spectrum and create significant interference problems. [82]

3. Regulation stifles Innovation

Monopolistic activity or high costs of entry into a market are not the only possible chilling effects on innovation. Despite the implication that unlicensed bands allow innovators to work freely, the FCC strictly regulates unlicensed devices in both power level and interference effects. Over-regulation can stifle innovation, but finding a good level of regulation is difficult.[83] For example, the FCC restrictions have proven insurmountable for innovators in the unlicensed PCS band. The FCC did not approve a single device for use on the band and now the FCC is taking some of that spectrum away. [84] Managing spectrum via regulations has other problems as well. A regulatory body like the FCC will in general will be slower to react than the market to changes in technology which can stunt innovation. Also, the FCC must make decisions to support the public interest even when the public interest is not apparent or the area is politically charged. Good decisions made in that environment may be uncommon. Finally, policy

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[82] *Id* at 646-49.
[83] *See* Pierre De Vries & Amer Hassan, *Spectrum Sharing Rules for New Unlicensed Bands*, December 11, 2003, at 2, available at http://www.wi-fi.org/files/uploaded_files/kc_32_Spectrum%20Sharing%20Rules%20for%20New%20Unlicensed%20Brands.pdf.
[84] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 655-56.

making is even more difficult without data to value alternatives which is what the market provides. [85]

Prompting innovation and investment is a crucial role of any spectrum management model. Proponents of unlicensed spectrum point to the high cost of acquiring a license as preventing innovation and investment. However, new flexible-use rules and a secondary spectrum market will enable licensees to put spectrum to its most efficient use and to resell unused spectrum, driving the license cost down. Innovators will find many willing venture capitalists to support their projects and acquire a necessary license. Wi-Fi may be a rare success story since many of the unlicensed bands are unused due to the strict regulations and the fear of future interference. Licensed spectrum alleviates the interference fears of interference and prompts significant investment as shown in the mobile wireless industry.

D. *Assessing Public Gains*

Proponents of unlicensed spectrum argue that requiring companies to purchase licenses at auctions could hurt society because auctions take money that would otherwise be used for capital investment to provide better and more products and services. [86] In essence, the auctions act as a tax on those who want to build a better wireless infrastructure. [87]

Opponents of unlicensed spectrum disagree. First, auction money goes into the federal treasury. Second, after the initial auctions, the secondary markets will take over. The secondary markets will make spectrum available at the going market rate.

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[85] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 630-31.
[86] William Lehr, *Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz*, May 17, 2004, at 23, available at http://itc.mit.edu/itel/docs/2004/wlehr_unlicensed_doc.pdf.
[87] *Id* at 37.

Innovators who value the spectrum most will get access to the spectrum. This is better for society than leaving spectrum in low-valued use. As stated above, the market will be efficient and will not keep innovators from innovating. In fact, licensing likely promotes innovation resulting in better products and services. The public will gain from more products and services in a fully licensed spectrum.

E. *Managing Legal Ambiguities*

Ambiguous property rights make enforcement of interference regulations difficult. When clear property rights do not exist, something else must takes its place to determine how spectrum rights are distributed. With spectrum, the FCC enforces interference regulations based on their assessment of the public good. This means that politics can get involved and result in less efficient solutions. [88]

A prime example of a problem ambiguous property rights creates with an unlicensed underlay of a licensed band occurred in 2004. At that time, the Department of Defense ("DOD") implemented a new radio using its licensed spectrum. The DOD was unaware garage-door openers under-layed that same frequency. The new DOD radios caused the garage-door openers to malfunction. Because the DOD licensed the spectrum, it had every right to use the spectrum as it did. Garage-door openers are unlicensed devices and have no rights to the spectrum relative to the DOD and must accept all interference. [89] Even if the DOD wanted to check for possible interference problems, no documentation existed on which unlicensed devices operated on that frequency. [90] Garage door opener owners pressured their government representatives to fix the

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[88] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 630-31.
[89] Paul L. Francis, *Potential Spectrum Interference Associated with Military Land Mobile Radios*, December 1, 2005, at 1, available at http://www.gao.gov/new.items/d06172r.pdf.
[90] *Id* at 3-4.

problem. The political pressure caused the DOD to work with the garage door opener manufacturers to figure out a solution. Manufacturers sold expensive kits to fix the problem and the DOD completed a series of community outreach programs to counteract the negative press it received from the incident. The DOD also plans to proactively inform communities near military stations of potential interference problems. [91]

This is a clear example of interference negatively affecting unlicensed device owners. Device owners were forced to either buy a new garage door opener or the fix-it kit. Plus, the DOD, the rightful licensee of the spectrum, faced a negative backlash from the community. The Department was forced to add expensive steps to their development process to help prevent interference problems with unlicensed devices in the future, even though the legal regulations indicated the DOD was under no obligation to identify or mitigate potential interference with unlicensed devices. [92]

F. *Assessing the Implemented Model*

Proponents of the unlicensed spectrum model do not recommend all spectrum should be completely unlicensed. They want enough unlicensed spectrum for innovators to develop products. Having a portion of the spectrum remain unlicensed will allow the market to determine which spectrum model is more appropriate for supporting innovation and market growth. [93] Unlicensed spectrum may be most useful as a test-bed for experimenting with new products and services. Once the technology matures an innovator may need to migrate to licensed spectrum to benefit from an exclusive license.

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[91] *Id* at 4-5.
[92] *Id* at 3.
[93] William Lehr, *Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz*, May 17, 2004, at 6-7, available at http://itc.mit.edu/itel/docs/2004/wlehr_unlicensed_doc.pdf.

[94] Opponents do not disagree with the concept of open spectrum. However, unlicensed spectrum should be part of a fully licensed market-based spectrum management model where unlicensed spectrum results from market demand, not from the FCC's choices based on perceived public need. If the FCC wants a spectrum management model test, it can purchase a license on the open market and manage the band as unlicensed. [95]

CONCLUSION

Bills introduced in February 2006 would allow unlicensed devices on the unused spectrum between TV channels.[96] As discussed above, there is a very real threat of interference between unlicensed users and the licensed TV broadcasters. Therefore the FCC must soon choose a spectrum management model that will provide society with the most benefit and prevent interference.

As discussed, there are a number of factors to consider when choosing a spectrum management model. First, the FCC must consider which model distributes spectrum most efficiently. Unlicensed spectrum proponents believe that the market will fail to efficiently allocate spectrum; however, liberalizing the licensing process including making spectrum flexible-use and allowing a secondary market are significant changes to the current model and will result in efficient allocation of spectrum.

Second, proponents believe that interference problems are best managed by improvements in technology and through sharing protocols among users, including the implementation of a "frequency temperature" interference measurement process.

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[94] *Id* at 27.
[95] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 631; Evan Kwerel & John Williams, *A Proposal for a Rapid Transition to Market Allocation of Spectrum*, November 2002, at 7, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228552A1.pdf.
[96] Anne Broache, *Bills would boost unlicensed Wi-Fi*, February 21, 2006, available at http://news.com.com/bills+would+boost+unlicensed+Wi-Fi/2100-7351_3-6041585.html; In re Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band, 17 F.C.C.R. 25,632 (2002).

However, technical improvements are not a reason to choose an unlicensed spectrum management model because technical improvements help licensed users as well. Also, sharing protocols will fail once the number of users and devices becomes too large to effectively manage that way. The "frequency temperature" method for capping aggregate unlicensed device transmissions is a bad idea because it allows the FCC, rather than the market, to choose technology rather than the market, which will likely result in inefficient results.

Third, proponents believe that unlicensed spectrum is the best way to encourage innovation and investment because licensed spectrum raises the cost of entry into the industry substantially, thereby hurting innovation. Opponents say that just the opposite is true. Significant changes including the change to flexible-use spectrum and the development of a secondary market will significantly lower spectrum license prices. In addition, good ideas will be funded just as they always have in the past. Only licensed spectrum will allow industries to invest in costly infrastructure. Licensees spend billions of dollars and unlicensed users spend relatively little as shown by the nearly complete lack of investment in some of the recently dedicated unlicensed spectrum bands. Finally, the necessary regulations to keep unlicensed spectrum viable will stifle innovation just as it has in some unlicensed bands already.

Fourth, proponents believe that society loses when innovators must pay steep licensing fees to enter the market. These innovators may no longer have the money to make capital investments to successfully build their products and services. However, once the initial allocation is complete, the market will take over the pricing which will likely drive down prices since now licensees will benefit from conserving and reselling

unused spectrum. Plus, the high license costs at auctions reflect the value of licensed spectrum and provide another cautionary note against more unlicensed spectrum.

Fifth, proponents argue that fully licensed spectrum can allow licensees to exclude potential entrants into the market if they choose. However, a congested unlicensed spectrum band can be just as exclusionary. At least in a fully licensed spectrum model, recourse through the courts is possible to fix market problems. In addition, in an unlicensed spectrum model, the FCC will manage the spectrum which could result in decisions based on political choices for the public good even though these choices will not be clear. These regulations also could quickly become antiquated from technology advances and the FCC will need to constantly play catch-up, stunting innovation.

Sixth, proponents suggest that allowing unlicensed spectrum bands will provide a check on the licensed spectrum market. Allowing both types of spectrum will allow innovators to choose which allocation method makes the most sense for their product. Opponents of an unlicensed spectrum model aren't against unlicensed spectrum per se. However, they are against distributing unlicensed spectrum without knowing its true cost (including opportunity costs). Therefore, a better solution requires the FCC to purchase a license on the market just like everyone else to create unlicensed bands.

Given these arguments, it appears that allowing the FCC to distribute additional unlicensed spectrum bands is a mistake. Even those in the industry seem to agree. A survey of the National Telecommunications Cooperative Association's ("NTCA") members say that interference is increasing already and they believe that unlicensed spectrum is not a reliable method of providing wireless service to the nation. Despite the

costs of licensed spectrum (the costs from the old model), NTCA members indicated that they would prefer more licensed spectrum to more unlicensed spectrum by a 71% to 29% margin. [97] Licensed flexible-use spectrum is the path to follow.

[97] Thomas W. Hazlett & Matthew L. Spitzer, *Advanced Wireless Technologies and Public Policy*, 79 S. Cal. L. Rev. 595, 638.