BEFORE THE
FEDERAL COMMUNICATIONS COMMISSION

In the Matter of	)	
	)	
Unlicensed Operation in the TV Broadcast Bands	)	ET Docket No. 04-186
	)	
	)	
Additional Spectrum for Unlicensed Devices Below 900 MHZ and in the 3 GHz Band	)	ET Docket No. 02-380
	)	

COMMENTS OF

NEW AMERICA FOUNDATION
EDUCAUSE, FREE PRESS, CONSUMERS UNION,
CONSUMER FEDERATION OF AMERICA, COMMON CAUSE,
WIRELESS INTERNET SERVICE PROVIDERS ASSOCIATION (WISPA),
CHAMPAIGN-URBANA COMMUNITY WIRELESS NETWORK, CLOUD ALLIANCE,
TRIBAL DIGITAL VILLAGE, MOUNTAIN AREA INFORMATION NETWORK,
CTCNET, NATIONAL HISPANIC MEDIA COALITION, U.S. PIRG,
CENTER FOR DIGITAL DEMOCRACY, KNOWBILITY,
NEWBURYOPEN.NET, NYCWIRELESS,
ASSOCIATION FOR COMMUNITY NETWORKING, ETHOS GROUP,
ACORN ACTIVE MEDIA, FREENETWORKS.ORG,
UNITED CHURCH OF CHRIST, PROMETHEUS RADIO PROJECT

Michael Calabrese
J.H. Snider
New America Foundation
Wireless Future Program
1630 Connecticut Avenue, NW
7th Floor
Washington, DC 20006
(202) 986-2700

Harold Feld
Andrew Jay Schwartzman
Media Access Project
1625 K St., NW
Suite 1118
Washington, DC 20009
(202) 232-4300
Counsel for NAF, et al.

January 31, 2007

CONTENTS

SUMMARY

Media Access Project, on behalf of New America Foundation and other consumer groups, community technology and wireless broadband operators, educational and other nonprofit organizations, submits these comments in the above captioned proceeding.

NAF, *et al.*, applaud the Commission for definitively moving forward with a rulemaking designed to make productive use of extremely valuable, underutilized spectrum in the broadcast bands available. However, Commenters must express their concern and frustration that the Commission has chosen to reopen the question of whether to do so on a licensed or unlicensed basis. The Commission's determination in the first *Notice of Proposed Rulemaking* (*2004 NPRM*) to permit unlicensed use of the broadcast "white spaces" rested on a record built over two years which included a special Commission task force and a notice of inquiry. *See In re Spectrum for Unlicensed Devices Below 900 MHZ and in the 3 GHz Band*, 17 FCC Rec 25632, 25634 (2002) (*2002 NOI*); *Public Notice, Commission Seeks Public Comment On Spectrum Policy Task Force Report*, 17 FCC Rec 24316 (2002). Even so, knowing that others would oppose the possibility of unlicensed access, NAF and others extensively catalogued the benefits of unlicensed access in the broadcast white spaces. *Comments of NAF, et al.,* at 1-4.

Nevertheless, the instant *Further Notice* reopens the debate on this critical issue *de novo*. Worse, in recounting the perceived benefits and drawbacks, the Commission fails to consider the First Amendment and public policy framework provided by NAF, *et al.* in the previous proceeding. As these factors weigh heavily in favor of unlicensed spectrum, and on their own would foreclose arguments other than those based on a significant risk of harmful interference, the Commission cannot refuse to address them in this stage of the proceeding.

Even without consideration of the First Amendment, however, the evidence clearly demonstrates the superiority of unlicensed access to the broadcast bands. Whether it is the economic success of unlicensed access in such a "Swiss cheese" spectrum environment when contrasted with the continued failure of licensing in such environments (as demonstrated by the ongoing efforts to implement licensed services in the 900 MHz band and 700 MHz guard band), the lack of any "tragedy of the commons" in the intensively used existing bands, or the evidence that auctions for such limited spectrum licenses routinely fail to attract substantial bids, the evidence unequivocally supports unlicensed access for the white spaces.

With regard to the specific technologies, NAF, *et al.* again caution the Commission that it should not deviate from its traditional Part 15 approach. Rather than bless a single technology such as sensing or "control signals" or "geolocation," the Commission should instead state the necessary functionalities for devices. This prevents the lock-in of technologies in an early stage of development, promotes innovation, and encourages "new and innovative uses of radio." 47 U.S.C. §303(g). Nevertheless, to complete the record, NAF, *et al.* provide information and concerns about possible barriers to entry with regard to the three specific approaches discussed in the *First Report and Order and Further Notice of Proposed Rulemaking (2006 FNPRM).*

The *2006 FNPRM* also raises questions on whether to permit mobile uses, whether to permit operation on Channels 2-4, and whether to permit fixed (but not mobile) operation on Channels 14-20.[1] [*2006 FNPRM* at ¶¶56-57] In addressing all these decisions, the Commission should carefully weigh the benefit of permitting such services and use in such bands, subject to rigorous testing. History has demonstrated time and again that prohibiting a particular use and

[1] NAF and CUWiN filed a timely *Petition for Reconsideration* requesting the Commission reconsider its conclusion in the *First Report and Order* to prohibit use of mobile services on Channels 14-20.

requiring a full rulemaking to permit it at some future date when the technology has improved or the circumstances change is a death sentence to innovation and advancement of the technology in that space. No one will invest the needed resources given the uncertainty of any future approval.

Furthermore, the Commission must consider the importance of providing sufficient spectrum and sufficient uses to allow economies of scale. Although a few innovators used the existing unlicensed bands for networking prior to 1999, it was only the adoption of the 802.11 "Wi-Fi" standards and the economies of scale achieved by putting Wi-Fi enabled chips in every new computer that brought the price down sufficiently to make broadband via unlicensed spectrum an affordable solution. As a result, millions of homes and businesses use wireless LANs, roughly 5,000 commercial wireless ISPs (WISPs) provide broadband services to hundreds of thousands of mostly rural consumers, volunteers have brought wireless connectivity to thousands in poor urban neighborhoods, and more than 200 city and countywide wireless broadband networks are already in operation for public access, or are in the RFP or deployment process as of this month (*see* Appendix B).

This boom in business and citizen communication over unlicensed bands takes place ***despite*** the failure of the Commission to provide significant new spectrum for unlicensed use. In fact, the Commission has reduced the availability of unlicensed spectrum available for public access today in the high-penetration frequencies below 3 GHz since this proceeding was initiated in 2002.[2] Certainly, this lack of available spectrum has hampered the deployment of new, ubiquitous wireless services to all Americans. Nevertheless, that use and demand for unlicensed

[2] Since November 2002, the amount of "beachfront" spectrum (below 3 GHz) allocated to unlicensed use has actually declined by 10 MHz, while the amount of spectrum for flexible use licensed service has increased by 519 MHz. See J.H. Snider, "The Rhetoric and Reality of Progress in Allocating More Spectrum for Unlicensed Use," New America Foundation, Policy Backgrounder (February 2006).

spectrum continues to grow despite the artificial obstacles imposed by existing rules both demonstrates the power of innovation in the unlicensed bands and rebuts the continuous predictions of a commons "tragedy."

This success story also provides an important lesson. In setting the rules for unlicensed access in the white spaces, the Commission should take care to remember that one of the most attractive features of unlicensed access is its affordability and low barriers to entry. The Commission's rules should therefore reflect an interest in maintaining these attractive features. The Commission should recall the valuable contributions of open source developers, community volunteers, and thousands of WISPs, who have brought broadband to millions of urban users, rural users, and small businesses that would not otherwise have access. Only the low cost of equipment and low barriers to entry have made this quiet broadband revolution feasible. When setting rules for unlicensed access to the white spaces, the potential "rocket fuel" for unlicensed wireless broadband in these underserved communities, the Commission must not impose rules that needlessly drive up cost or that allow incumbents to create barriers to entry.

The Commission, in examining the technical submissions of commentors and in conducting its own tests, should likewise ensure that the process is transparent and open to all stakeholders. The Commission should give little, if any, weight to engineering studies that do not include sufficient explanation to allow interested parties or the Commission itself to replicate the results. To further assist the Commission, NAF, *et al.*, provide suggestions and guidelines on how the Commission can conduct its own testing in a way that includes all potential stakeholders. Such proceedings will have the salutary effect of eliminating future objections.

Finally, the Commission should resolve the question of use in the border areas by

concluding that coordination is not necessary. The purpose of the treaties mandating coordination is to prevent harmful interference in a neighboring country. This is reflected in the difference between the area of mandatory coordination for UHF and VHF. Here, the low-power signals will not penetrate any significant distance into either Mexico or Canada.

This approach is consistent with the Commission's interpretation of Section 301 adopted in the 2004 Ultra-Wideband Order. There, the Commission determined that the mandatory license requirement did not apply to low-power use of radio frequencies because such uses were incapable of causing harmful interference. *See In re Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, Second Report and Order and Second Memorandum Opinion and Order*, 19 FCCRcd 24558 (2004). Similarly, the need for cross-border coordination only applies if a signal will interfere with the operation of wireless services in Mexico or Canada.

To the extent the Commission does not wish to rely on this legal interpretation, it can and should rely upon the interference mitigation measures adopted in this proceeding generally. Whether they incorporate sensing, database, geolocation, or other means, the devices enabled in this proceeding will protect Mexican and Canadian broadcasters as thoroughly as they will protect U.S. broadcasters.

I. UNLICENSED REMAINS THE CLEAR CHOICE FOR USE OF THE WHITE SPACES.

The Commission does not start its examination with a blank slate, as the *2006 FNPRM* suggests. The decision to explore only unlicensed options in the *2004 NPRM* derived from an extensive record. To reverse course in the face of this record, without any explanation, would constitute an arbitrary exercise of Commission authority.

Even without this past history, however, the evidence clearly shows that unlicensed access will provide the best means to promote intensive and productive use of the white spaces without causing harmful interference to any licensed service. As set forth below, the interests of the First Amendment and public policy favor adoption of an unlicensed access regime.

A. The Commission Has Already Adequately Investigated This Question And Concluded That An Unlicensed Regime Best Serves the Public Interest.

The Commission first considered the question of whether to permit unlicensed operation in the broadcast bands as part of its reexamination of its Part 15 Rules in 1987, but declined to do so in 1989 for fear that an unlicensed underlay in the television broadcast bands would interfere with the anticipated change to analog high-definition television. *In re Revision of Part 15 of the Rules Regarding the Operation of Radio Frequency Devices Without Individual License, First Report & Order*, 4 FCCRcd 3493, 2501 (1989). Although no one has disturbed this essential finding of the Commission that licensed broadcasters may share the broadcast bands with low-power unlicensed devices, the television broadcast bands have remained closed to low-power unlicensed devices.

In 2002, the Commission created a Spectrum Policy Task Force (SPTF) for the express

purpose of conducting a comprehensive reexamination of all aspects of the Commission's spectrum policy. *See Public Notice, Spectrum Policy Task Force Seeks Public CommentOn Issues Related to Commission's Spectrum Policies*, 17 FCC Rec 10560 (2002). As part of this process, the SPTF compiled a substantial record in support of numerous new policy initiatives, including opening the broadcast white spaces to unlicensed use.[3] After a lengthy deliberative process involving written comments, public workshops, and public hearings, the Spectrum Policy Task Force delivered a set of reports and recommendations to the Commission. *See Public Notice, Commission Seeks Public Comment On Spectrum Policy Task Force Report*, 17 FCC Rec 24316 (2002). The Commission initiated a public comment period on the report and its recommendations, providing further opportunity for public comment. *Id.* Among the recommendations included finding new spectrum for unlicensed use, such as the broadcast white spaces.

The Commission immediately thereafter sought comment on this specific proposal. *In re Spectrum for Unlicensed Devices Below 900 MHZ and in the 3 GHz Band*, 17 FCC Rec 25632, 25634 (2002) (*2002 NOI*). The Commission, on examining the record compiled by the SPTF, concluded that the broadcast white spaces and the 3650-3700 MHZ band provided the best opportunities to open useful spectrum for unlicensed devices in a manner that would not cause harmful interference to licensees. *Id.* The Commission explicitly considered the benefits of unlicensed access against the possible harms. As the Commission explained, however, permitting unlicensed operation in the broadcast bands appeared both feasible and desirable as a means of facilitating numerous public interest benefits. *Id.* at 25637. Nevertheless, out of an abundance of

[3] For example, in his invited testimony at one of the public hearings empaneled by the SPTF, Michael Calabrese, director of NAF's Wireless Future Program, proposed that all unused TV channels in each of the nation's 210 TV

caution, the Commission chose to issue an initial notice of inquiry rather than proceed directly to a rulemaking.

In 2004, acting on the record built in the *2002 NOI*, the Commission commenced the pending rulemaking. *In Re Unlicensed Operation In the TV Broadcast Bands*, 19 FCC Rec 10018 (2004) (*2004 NPRM*). Once again, the Commission considered the objections raised against operation of unlicensed devices in the broadcast bands. Once again, the Commission concluded that the arguments raised in favor of unlicensed operation in the broadcast white spaces outweighed the interference risks or purported advantages of licensing use of the broadcast white spaces. *Id.* at 10022-25. Accordingly, the Commission adopted a "tentative conclusion" to allow unlicensed operation in the broadcast white spaces. *Id.*

An agency may, of course, refuse to adopt a proposal. But where the agency moves from a proposed rule to a complete change in direction, the agency must provide some compelling reason for its reversal. *See Fox Television Stations, Inc. v. FCC*, 280 F.3d 1027, 1044-45 (2002). Yet the *First Report and Order and Further Notice of Proposed Rulemaking* provides no explanation for the sudden change of course. Ignoring the two years spent investigating the question licensed v. unlicensed before issuing the *2004 NPRM* , the *FNPRM* observes that the *2004 NPRM* "did not address the possibility of instead providing for new low-power operations on a licensed basis." *2006 FNPRM* at ¶26.

Given the history of the proceeding, the Commission cannot seriously contend that the failure of the *2004 NPRM* to again solicit comment on the possibility of adopting a licensed as opposed to unlicensed justifies returning to the question a second time. Indeed, the Commission's discussion of the relative benefits of licensed versus unlicensed operation mirror the discussion in

---

markets be reallocated for shared access by low-power unlicensed devices.

the *2002 NOI*. *Compare FNPRM* ¶¶27-30 with *2002 NOI*, 17 FCC Rec at 25633-37. Similarly, the discussion of the comments favoring unlicensed operation and favoring licensed operation will read, to quote Yogi Berra, "like deja vu all over again." *Compare FNPRM* at ¶¶29-30 with *2004 NPRM,* 19 FCC Rec at 10023-24.

For the Commission to determine that something has caused it to change its mind about its tentative conclusion in 2004, but to fail to explain precisely what, is the essence of arbitrary decision making. For the Commission to provide sufficient notice, it must at least explain what prompts this reversal, so that parties can respond to the agency with the necessary specificity. *See Fox Television Stations, supra*. Accordingly, the attempt to reopen the question of licensed versus unlicensed at this late date must fail.

B. Further Evidence Since 2004 Continues to Support the Superiority of Unlicensed Spectrum for Productive Use of the TV White Spaces.

In response to the Commission's 2002 *Notice of Inquiry* and 2004 *Notice of Proposed Rule Making*, NAF *et al.* has filed four sets of comments making the economic case for unlicensed use of the vacant spectrum between TV channels 2 and 51.[4] Subsequently, the New America Foundation has published a series of working papers and fact sheets[5] expanding and elaborating

[4] NAF, *et al*. Comments, April 17, 2003, FCC Docket 02-380; NAF, *et al.* Reply Comments, May 16, 2003, FCC Docket 02-380; NAF, *et al*. Comments, November 30, 2004, FCC Docket 04-186; NAF, *et al.* Reply Comments, January 31, 2005, FCC Docket 04-186.

[5] *See* Pierre de Vries, "Populating the Vacant Channels: The Case for Allocating Unused Spectrum In the Digital TV Bands to Unlicensed Use for Broadband and Wireless Innovation," New America Foundation Working Paper, August 2006, available at: http://www.newamerica.net/publications/policy/populating_the_vacant_channels;
J.H. Snider, "Reclaiming the Vast Wasteland: The Economic Case for Re-Allocating the Unused Spectrum (White Space) Between TV Channels 2 and 51 to Unlicensed Service," New America Foundation Working Paper, updated February 2006, available at:
http://www.newamerica.net/publications/policy/the_economic_case_for_re_allocating_the_unused_spectrum_white_space_between_tv_channels_2_and_51_to_unlicens;
William Lehr, "The Economic Case for Dedicated Unlicensed Spectrum Below 3GHz," New America Foundation Working Paper, July 2004, available at:
http://www.newamerica.net/publications/policy/the_economic_case_for_dedicated_unlicensed_spectrum_below_3ghz;

on those arguments.

In the previous round of comments, the central debate centered on whether the white spaces should be retained for the exclusive benefit of the broadcasting industry or allocated to unlicensed use. Now, with the collapse of the broadcast industry's technical claims that any use of the white spaces would cause harmful interference to television viewers, the Commission has shifted the debate to whether the public interest would be better served by open public access or by auctions and exclusive licensed access.

The Commission initially determined that the "significant growth of and consumer demand for unlicensed wireless broadband applications" supported opening up the TV band white spaces for unlicensed use.[6] We believe the record supports the Commission's initial determination even more clearly than it did in 2004. Although the proven and rapidly growing economic value of unlicensed spectrum should by no means be the Commission's principle justification for facilitating the public's ability to communicate without the mediation of a government licensee in their homes, businesses, communities and even across entire cities and counties (see Section I.F. below), the economic case for expanding the supply of unlicensed spectrum is far stronger than it was in 2004. NAF, *et al*. does not intend to repeat in this proceeding its previous general economic arguments filed as part of the record. Rather, NAF, *et al*. seeks to update the record and respond to the arguments of those seeking licensed use of the white spaces.

J.H. Snider, "Myth vs. Fact: The Rhetoric and Reality of Progress in Allocating More Spectrum for Unlicensed Use," New America Foundation Fact Sheet, February 2006, available at: http://www.newamerica.net/publications/policy/myth_vs_fact_the_rhetoric_and_reality_of_progress_in_allocating_more_spectrum_for_unlicensed_use.

[6] *See Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, Notice of Proposed Rule Making, 19 FCC Rcd. 10018 (¶7) (2004).

1. The Use of the Existing Unlicensed Bands Continues to Increase Rapidly, Producing Positive Social and Economic Benefits, and with No Evidence of a "Tragedy of the Commons"

Each passing month, unlicensed devices are making a greater and greater impact across the economy and in the everyday lives of nearly every American. Indeed, unlicensed devices are now so embedded in our lives and so pervasive that, like the air we breathe, we rarely think of them as such. In this day and age, very few American adults go through a full day without using an unlicensed device—whether it is by wirelessly opening their garage door or car door, wirelessly playing a video game, wirelessly linking an ear piece to their cell phone or speaking on the cordless extension of their wired phone, wirelessly linking their MP3 player or satellite radio receiver to their car speakers, wirelessly restraining their dog within an "invisible dog fence" in their backyard, wirelessly paying a car toll, or wirelessly accessing the Internet over a notebook computer or PDA. More than 200 towns, cities and counties already are or will soon be completely covered with ubiquitous and free or reasonably-priced wireless Internet access over networks initiated by local governments (*see* Appendix B). If these meshed Wi-Fi deployments are given the spectrum access they need to scale and offer higher-bandwidth services, there can be little doubt that within five years, a majority of Americans will have an option to communicate and access the Internet—any time, from any location—through networks operating over unlicensed spectrum. The benefits for local economic development, education, government and personal productivity, and particularly for bridging the broadband deployment gap in rural and in low-income urban areas, are quite literally incalculable.

Consider the list of devices in Figure 1, which illustrates the extraordinary diversity of devices operating on unlicensed spectrum.

Figure 1: *The Diversity of Unlicensed Products*

Asset and people tracker: Ekahau's real-time location systems allow health care professionals to quickly locate patients, caregivers and medical equipment.

Camera: The Nikon Coolpix P3 Wi-Fi Digital Camera allows photographers to wirelessly send pictures to a computer or upload them to the Internet.

Clothing: The Burton Audex Motorola Cargo Jacket lets skiers and snowboarders talk hands-free on their mobile phone through a microphone and speakers built into the jacket.

Internet phone: The Cisco Wireless IP Phone 7920 Version 3.0 allows people to make calls over the Internet through a wireless handset.

LCD picture frame: The Kodak Easyshare allows users to update photos wirelessly from their computer and also create slideshows.

Meter reader: The Neptune MRX920-950 Mobile Data Collector allows utility companies to remotely read meters while driving through neighborhoods.

Mobile media player: SanDisk's Sansa Connect MP3 player allows users to listen to songs via the Internet. Microsoft's Zune lets users share music with other Zune users.

Parking garage: A Helicomm parking management system uses wireless technology to track the number of available parking spaces in a garage and display the number on an electronic sign so drivers can see how many spaces are left.

Printer: The HP DeskJet 6980 allows laptops, PDAs and mobile phones connected to wireless home or enterprise networks to print from anywhere in the network's range.

Refrigerator: Samsung's Wireless ICE Refrigerator turns a kitchen into a media center thanks to a flat-panel LCD screen that is detachable and connects wirelessly with devices such as a stereo.

Security camera: The D-Link SECURICAM Network™ DCS-5300G Internet Security Camera is used in surveillance systems that use wireless technology to connect with broadband networks for remote, high-quality video and audio monitoring.

Shipping container tracking: Tracking systems from WhereNet use Radio Frequency Identification (RFID) technology to allow shipping companies to track movement of containers around ports, and sense when containers have been tampered with.

Smartphone: Apple's upcoming iPhone lets users access broadband, bypassing slower and more expensive web-surfing technology provided by a wireless carrier.

TV: The Samsung FP-T5894W plasma TV hangs on a wall without a tangle of wires; peripheral equipment, such as a DVD player, can sit on a rack up to 300 feet away.

Video game player: The Nintendo Wii wirelessly connects to the Internet so players living in different areas can challenge each other. Wii also has wireless controllers that allow players to manipulate the actions of characters on the TV screen, such as swinging a tennis racquet or tossing a football.

Wireless headset: The Motorola H605 drivers to keep both hands on the wheel while talking on their mobile phone.

Wireless sensor: A SmartMesh-based Tridium Niagara system from Dust Networks allows companies to make buildings more energy-efficient by sensing energy usage levels in different areas of the structures.

Although innovation on the unlicensed bands evolves more rapidly than the available data can document, what follows is a brief update on the most significant uses of unlicensed spectrum in six major market segments: rural broadband access, wireless device innovation, home networking, enterprise networking, education (campus to classroom), and community wireless networks.

a) *Rural Broadband Access*

Due to geography and low population density, rural areas are far more expensive to serve with wired telecommunications service than urban and suburban areas. Wireless technology, which can cover long distances at far less expense, is the most efficient way to serve the most rural areas in the U.S. Unlicensed wireless is one of the inexpensive and flexible technologies that rural carriers are increasingly turning to for the provision of voice and broadband. Thousands of WISPs and RLECs are currently using unlicensed spectrum to provide broadband connections to approximately one million homes, small businesses and schools across the country—whereas wireless broadband services relying on exclusively licensed spectrum are serving a trivial number of Americans, and most of those in cities like Jacksonville, Florida, where consumers already have access to one or two other broadband options.

According to Wireless Internet Service Providers Association (WISPA), there are at least 3,000 wireless Internet Service Providers (WISPs) in the U.S. serving about one million customers.[7] WISPs use primarily unlicensed spectrum to provide wireless broadband service in rural areas. One of the biggest obstacles WISPs face in reaching more rural households is the difficulty of passing their high-frequency unlicensed signals through trees. If they had more low-

[7] Interview with Marlon Schaefer, WISPA Board Member and FCC Committee Chair, January 26, 2007.

frequency unlicensed spectrum, these rural customers would be much easier to reach, with better quality coverage and at a lower cost of deployment. A 2004 study by Intel Corporation concluded that a wireless service with access to spectrum in the 700 MHz band "has significant capital advantages over a carrier operating at higher frequencies." Intel's study showed, for example, that "a 2.5 GHz MMDS licensee in a rural environment will incur capital expenditures over 4 times that incurred by a hypothetical 700 MHz operator."[8]

In addition to WISPs, there are approximately 1,200 small, independent local telephone companies in the U.S. These independent carriers, represented by the National Telecommunications Cooperative Association (NTCA), serve approximately 14 million customers, about seven percent of the nation's telephone subscribers. According to NTCA's 2006 Annual Wireless Report, 61 percent of its members use unlicensed spectrum to provide wireless service to their customers. This service includes both backhaul and end user telecommunication links. According to Brian O'Hara, until recently Government Affairs Representative for NTCA, the current unlicensed allocation has been a great help to rural carriers, but more low-frequency unlicensed spectrum—the type of spectrum most sought after by broadband providers—would be an even greater help.

> Unlicensed spectrum has been a great asset to rural carriers and the communities they serve by expanding the reach of broadband at a lower cost. Current spectrum assigned for unlicensed usage is in much higher frequencies than the frequencies in the TV band at issue here. The general rule is that the higher the frequency is in the spectrum band the less distance it can travel and less ability it has to penetrate buildings or through dense trees or foliage. This is especially important in rural areas where population is sparse and terrain can be rugged or heavily forested. **If opened to unlicensed usage, the low frequency of unused spectrum in the TV band would allow providers to reach more rural customers at even lower cost than with the current less optimum spectrum**.[9]

[8] Chris Knudsen and Masul Kibria, "Capital Expenditure Implications of Spectrum Assets in Semi-Rural Environments," Intel Corporation, unpublished study results, Oct. 30, 2004.

[9] Brian O'Hara, presentation before the New America Foundation Forum on the Benefits of Unlicensed Access to

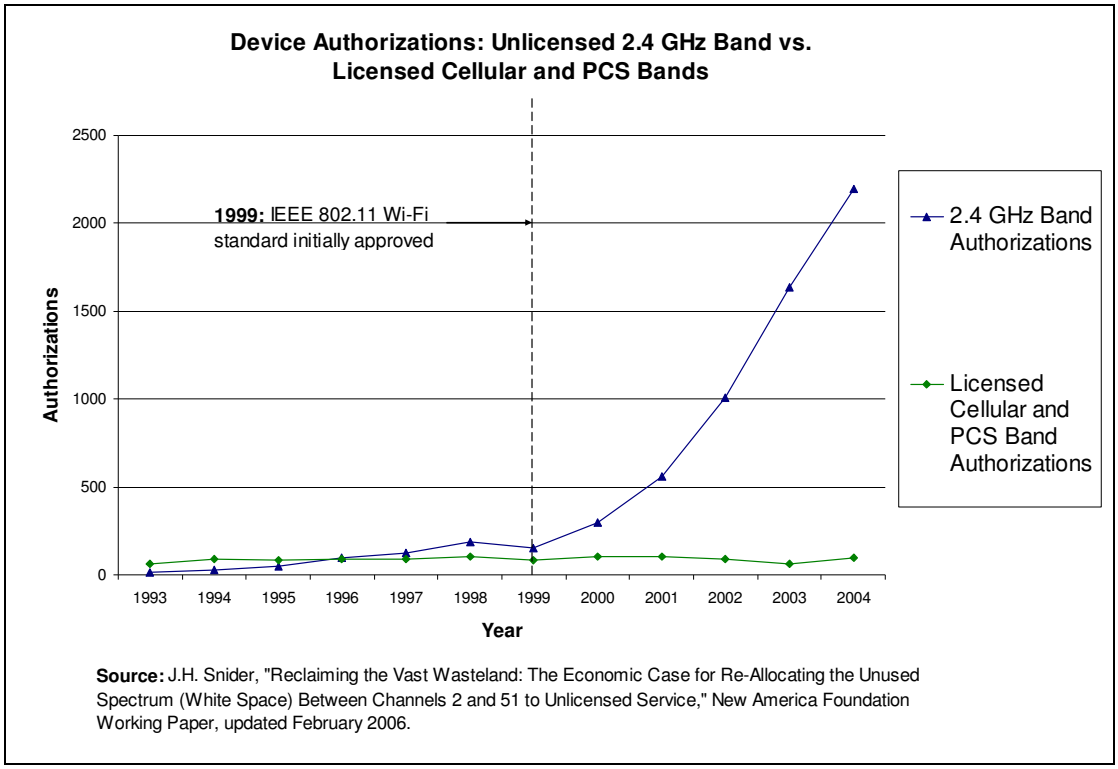
b) *Wireless Device Innovation*

Some commentors in this and other FCC proceedings have argued that unlicensed allocations are somehow inimical to investment and innovation in spectrum technology. The record strongly suggests otherwise. Consider that in the mobile telephone bands, occupying 170 MHz of spectrum, there are at most 25 manufacturers of equipment, whereas in the unlicensed 2.4 GHz band, occupying only 83.5 MHz of spectrum, there are at least 500 manufacturers (*see* Appendix C). Moreover, the mobile telephone bands occupy prime (low frequency) unencumbered spectrum, whereas the unlicensed band is known as the "junk band" because it is shared with hundreds of millions of devices, such as cordless phones and microwave ovens, that emit incidental radiation in this band as a byproduct of their operations.

Relative innovation in the unlicensed 2.4 GHz and mobile telephone bands is reflected in the number of FCC equipment authorizations. In recent years there have been more than 25 times as many equipment authorizations in the unlicensed 2.4 GHz band than in the mobile telephone bands (see Figure 2).

Vacant TV Spectrum, September 20, 2006, available at: http://www.newamerica.net/files/Brian_OHara_Remarks.pdf.

Figure 2



Source: J.H. Snider, "Reclaiming the Vast Wasteland: The Economic Case for Re-Allocating the Unused Spectrum (White Space) Between Channels 2 and 51 to Unlicensed Service," New America Foundation Working Paper, updated February 2006.

Another indicator of the relative level of competition and diversity in the unlicensed 2.4 GHz band is the number of devices certified by the Bluetooth and Wi-Fi trade associations, both of which certify equipment that use their unlicensed standards. Since the year 2000, the two associations have certified some 4000 unlicensed products, with the great majority in the last few years. Appendix D presents a list of these certified products. This list, however, is not comprehensive in documenting the breadth and volume of unlicensed innovation. In addition to the Bluetooth and Wi-Fi standards, there are at least a half dozen others, including ZigBee, Z-Wave, and WiMax (WiMax operates on both licensed and unlicensed bands), that operate in the 2.4 GHz band and are expected to witness explosive growth in coming years. This list also only covers unlicensed wireless *components*, which may be included in many different end products. For example, PC manufacturers such as Dell, HP, or Lenovo might include the same unlicensed

wireless card in hundreds of different desktops, workstations, and notebook computers, but such models wouldn't show up in the list of certified models. Perhaps one very narrow unlicensed category—notebook computers—has as much product variety as the entire mobile telephone handset market.

c) *Home Networking*

A January 2007 essay on "Radio Frequency Spectrum" published by the Consumers Electronics Association concludes with the following statement about the current value of unlicensed spectrum and the great potential increase in that value if more low-frequency spectrum is allocated for unlicensed use:

> The CE industry makes and sells millions of wireless products in the unlicensed areas of the RF spectrum. Cordless phones alone generated $943 million of revenue in 2005. Unlicensed CE products allow consumers to get the most out of a natural resource that belongs to everyone. One could argue that applying today's efficient radio technology to a recently vacated area of spectrum in the lower bands could provide consumers with the best of both worlds. A small parcel of unlicensed spectrum in the analog TV bands could lead to products that offer longer range and improved run-time at a lower cost. [10]

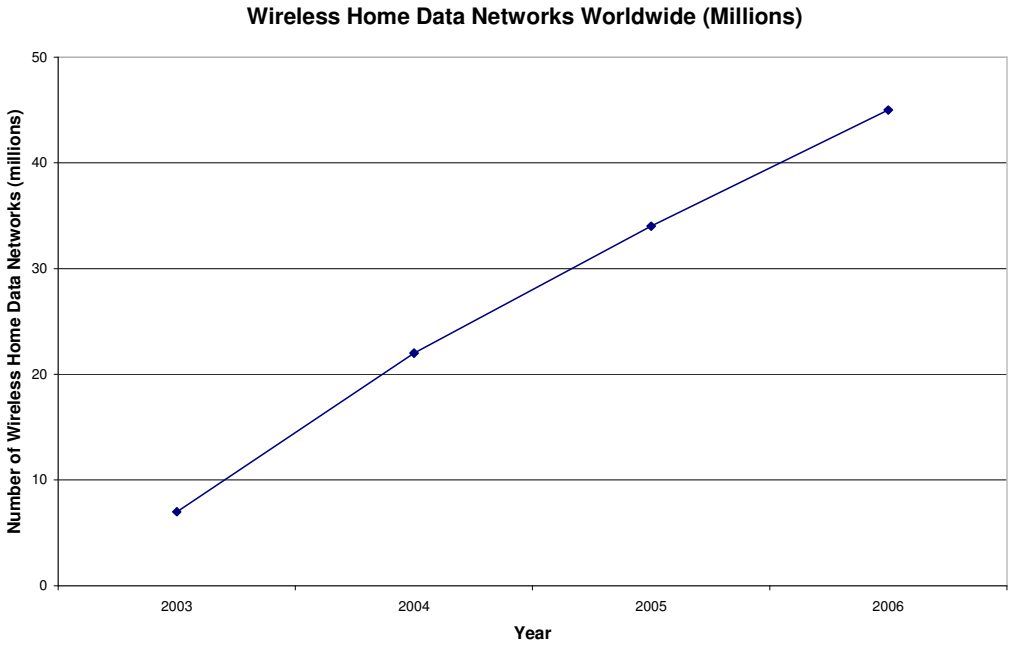
Illustrating the importance of unlicensed devices to the consumer electronics industry, as of June 2006 the installed base of unlicensed cordless phones (188.7 million) exceeded the installed base of licensed cellular phones (181.8 million). Many of the licensed cellular phones also include unlicensed service, usually Bluetooth but increasingly Wi-Fi as well. These unlicensed devices, in turn, spur demand for other unlicensed devices such as wireless headphones. And this is just the tip of the iceberg for the consumer electronics industry because cordless phones and cellular phones are only two of the hundreds of different product categories

[10] Consumer Electronics Association, "Radio Frequency Spectrum," *Special Supplement to Vision*, p. 32.

that use unlicensed spectrum.[11]

Perhaps the most publicized growth of an unlicensed device in the home is the wireless router. These routers connect to the wired Internet and feed wireless devices throughout the home. Many consumers purchase these routers as standalone devices at stores such as Best Buy, Circuit City, and Costco. Others acquire them from their local cable or telephone company, which provide wired broadband Internet service to the home and know that wireless access within the home can spur demand for their product. According to the Telecommunications Industry Association's *2006 Telecommunications Market Review and Forecast*, sales of wireless home networks increased from seven million units in 2003 to 45 million units in 2006, a three-year increase of 500 percent (see graph below).[12]

Figure 3



Source: TIA 2006 Telecommunications Market Review and Forecast

[11] Consumer Electronics Association, *June 2006 CE Ownership and Market Potential Survey*.
[12] Telecommunications Industry Association, *2006 Telecommunications Market Review and Forecast*, p. 189.

This critical mass of direct consumer access to the airwaves is fueling innovation and demand for new products. At the 2007 Consumer Electronics Association convention, there were more than 1,000 unlicensed devices on display. A CEA publication explained that "content is slowly breaking its physical tethers to make it more portable"[13] and that a trend to watch is the growth of wireless connections "between the PC and the various displays in a house to access video, music, and gaming content stored there."[14] While these tens of millions of LANs rely on unlicensed spectrum, they could also achieve better coverage and quality—and better avoid possible congestion—if they had access as well to a range of frequencies below 1 GHz. This will be particularly important when, as CEA and others expect, households begin to demand the ability to wirelessly stream video programming directly from their computers to video monitors elsewhere in their home.

d) ***Enterprise Networking***

From a base of essentially zero in 2000, an estimated 60 percent of U.S. corporations now provide some type of wireless networking using unlicensed spectrum.[15] An estimated 30 percent of corporations use voice-over-wireless LAN.[16] A driving force behind this growth is the desire of corporations to integrate wireless into their inter-office telephone exchange, also known as PBX (Personal Branch Exchange). Businesses with a highly mobile workforce, including hospitals, retail stores, and factories, have been the first to deploy this technology. Businesses like the enhanced security, control, quality of service, coverage, and lower costs that an on-premise

[13] *Supra* note 10, p. 45.
[14] *Id*., p. 41.
[15] *Supra* note 12, p. 188. For a larger estimate, *see* In-Stat, "In-Depth Analysis: Wireless Data in the Enterprise: The Hockey Stick Arrives," December 2006. *See also* ABI Research, "Enterprise IP Telephony," 2006.
[16] Infotech, "Mobile Communications in the U.S. Workplace" February 2006, cited in "Dual-Mode Cellular/WiFi

unlicensed wireless network can provide their employees.[17] Today, all the major corporate PBX providers, including Cisco, Nortel, Siemens, NEC, Avaya, and Alcatel, integrate Wi-Fi phones into their product offerings.

On May 25, 2006, in testimony before the Senate Commerce Committee, Roger Cochetti, federal policy director of the Computing Technology Industry Association (CompTIA), stated that reallocating the TV white spaces for unlicensed use "will be used by small business to improve their productivity, not least of which will be access to new wireless broadband services."[18] CompTIA's 20,000 members are predominantly among the nation's 32,000 so-called value-added resellers (VARs), a $43 billion industry that wires and now very commonly unwires IT networks for small- to medium-sized businesses and professional offices in every town and city across the country. VARs are the outsourced IT departments of America's small business sector. Cochetti testified:

> The use of radio spectrum for data services is an absolutely essential part of our industry today, Mr. Chairman…"White space" frequencies represent prime, largely unused wireless "real estate." With their excellent signal propagation characteristics, low-cost broadband deployment using this spectrum should be readily achieved, jumpstarting significant new business opportunities and improvements in the productivity and competitiveness of small businesses, urban and rural. Such wireless broadband services will enable small businesses to more easily and cost-effectively employ and network IT, especially in sparsely populated, underserved areas where the economics of broadband deployment sometimes make it impractical for providers to serve. In doing so, "white space" technology will give America's small businesses a better foot up in the globally competitive environment.[19]

Device Will Drive Enterprise VoWLAN Growth," *Business Wire*, February 8, 2006.

[17] *See* J.H. Snider, "Reclaiming the Vast Wasteland," *supra* note 5.

[18] Roger J. Cochetti, CompTIA Testimony before the Senate Committee on Commerce, Science and Transportation, May 25, 2006.

[19] *Id.Id.*.

e) ***Education: Campuses to Classrooms***

According to EDUCAUSE, which represents the nation's institutions of higher education on IT and technology issues, 45.8 percent of university classrooms have unlicensed wireless access.[20] The average number of hotspots at one of the 100 largest public colleges in the U.S. has increased from zero at the end of 2000 to 2,000 at the end of 2006, with Ohio State alone now having more than 10,000.[21] To put this in perspective, the approximately 200,000 wireless base stations at just these 100 colleges is about 200 times greater than the total number of broadcast TV towers in the U.S. and about the same number as the total number of cell towers in the U.S. If the approximately 3,000 colleges in the U.S. were surveyed, the total number of hotspots would surely be more than a million—perhaps more than all the licensed base stations that have ever been deployed in the U.S.

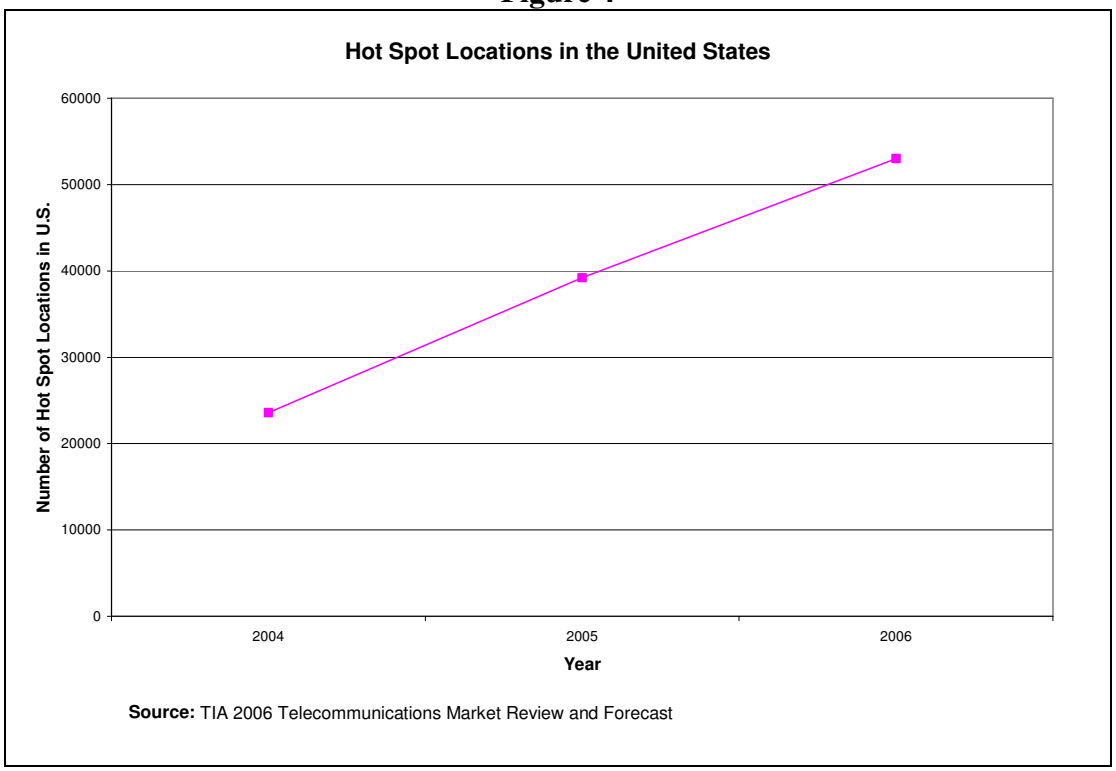
In the K-12 marketplace, the situation is much the same. As Bob Moore, executive director of information technology services for the Blue Valley Union School District 229 in Kansas, puts it, "Wireless Connectivity in schools is as basic a need today as was 'hard-wired' connectivity five years ago."[22] Indeed, the vision of every high school and middle-school student with an Internet-enabled notebook in a classroom will depend on access to more and better unlicensed spectrum.

[20] Brian L. Hawkins and Julia A. Rudy, *EDUCAUSE Core Data Service Fiscal Year 2005 Summary Report*, November 2006.
[21] Data provided by Wendy Wigen, EDUCAUSE Policy Analyst, January 2007.
[22] Cited by Justin Appel, "New Wireless Technologies Make Waves," *E-SchoolNews*, January 16, 2007.

f) ***Community Wireless Networking***

The number of public commercial hotspots in the U.S. has skyrocketed in recent years. These hotspots include airports, bus stations, truck stops, cafes, and hotels. According to the Telecommunications Industry Association, U.S. hotspots have increased in number from 23,600 in 2004 to 53,000 in 2006, serving millions of Americans with mobile Internet access (see Figure 4 below).[23]

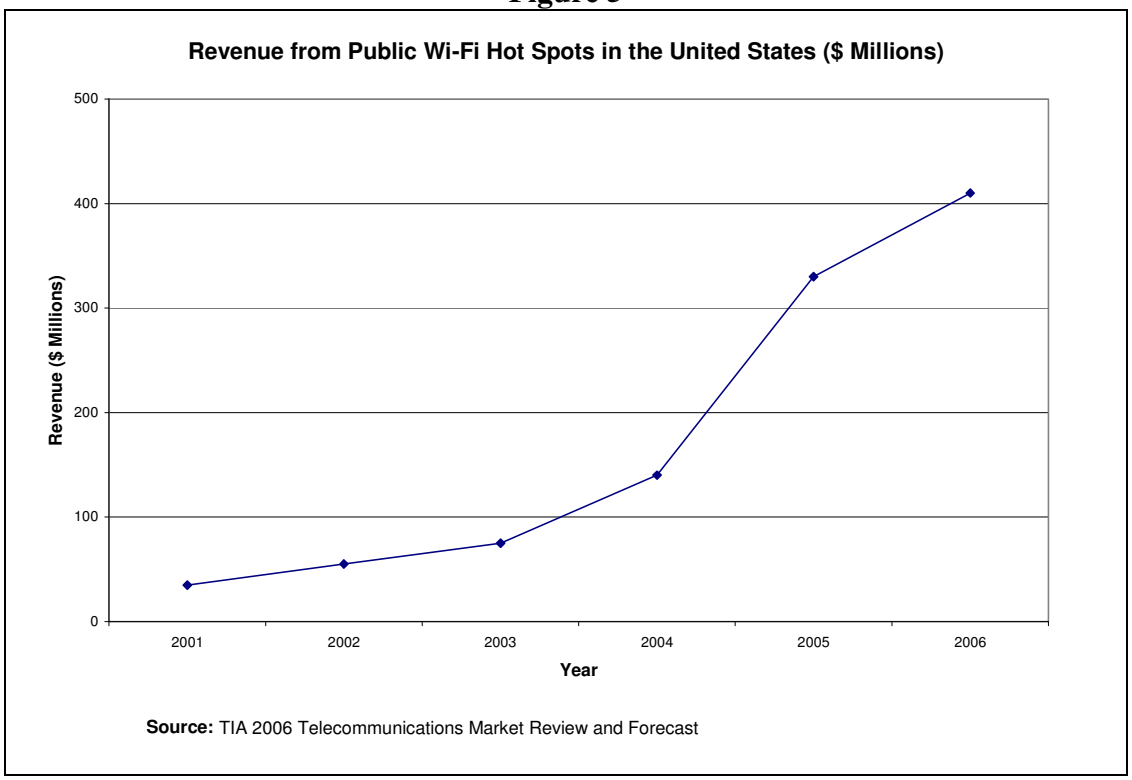
Figure 4



Similarly, U.S. spending on public hotspots has increased from $35 million in 2001 to $410 million in 2006 (See Figure 5).[24]

[23] *Supra* note 12, p. 190.
[24] *Supra* note 12, p. 160.

Figure 5



Source: TIA 2006 Telecommunications Market Review and Forecast

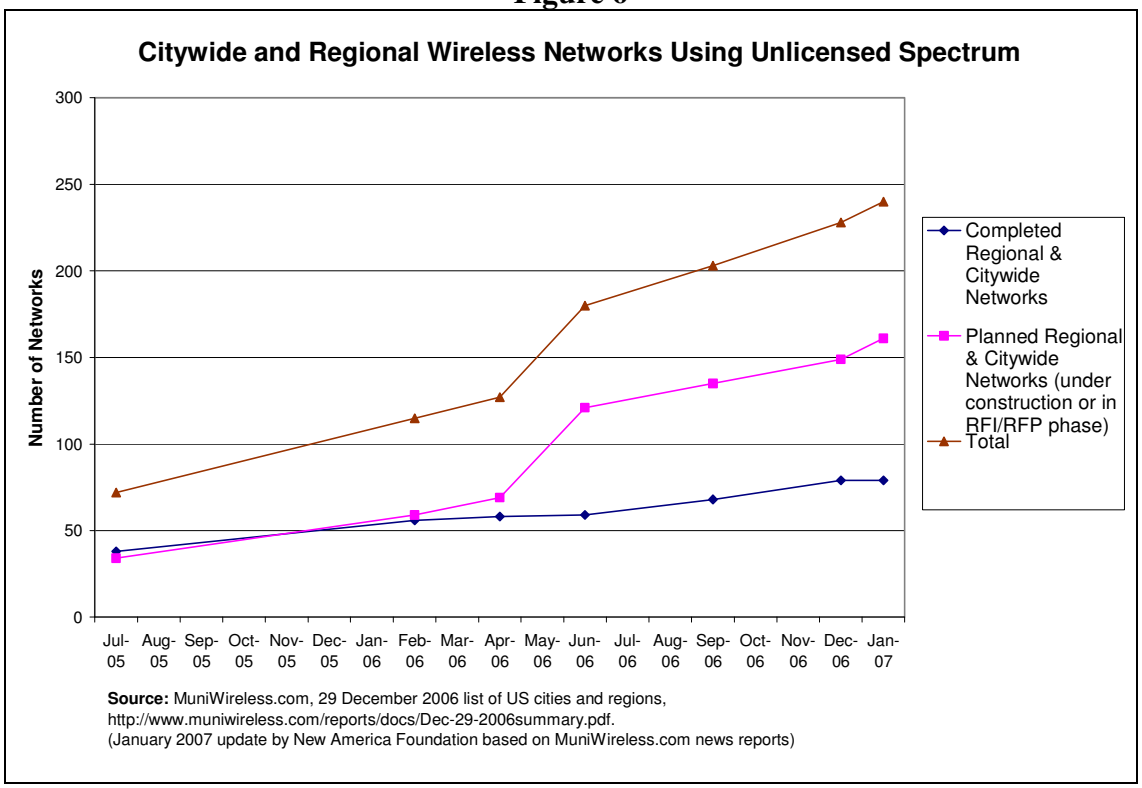
In general, commercial establishments are increasingly providing free Wi-Fi service or bundling it with other services. Thus, paradoxically, as consumer welfare from hotspots operating on unlicensed frequencies continues to grow, hotspot revenue is not expected to increase much in the future even as the number of hotspot locations continues to increase.

Public Wi-Fi outside business premises has also rapidly evolved since the 2004 NPRM in far more dramatic fashion. Starting as scattered hotspots in high demand areas such as libraries, schools, parks, and downtown business districts, the networks have increasingly evolved into comprehensive networks covering entire towns, cities, counties, multi-county regions (e.g., the seven-county Sacramento, CA, regional wireless project) and—beginning as early as next year—entire states, possibly beginning with Vermont.[25]

[25] In his "E-state" of the State Address, Vermont Governor James Douglas proposed a $40 million bond to leverage

As of December 2006, some 240 towns and cities within the U.S. were already operating or had announced plans to deploy wide area municipal, countywide and even multi-county (regional) Wi-Fi networks,[26] with many more offering Wi-Fi hotspots in libraries, schools, parks, downtown business districts, and other public spaces. This was an increase over the previous 18 months of more than 300 percent (See Figure 6). Another 36 municipalities or counties are already operating, or currently building, high-speed wireless data networks dedicated to public safety applications and/or local government services. These communities, along with the status of their wireless deployments, are listed in Appendix B.

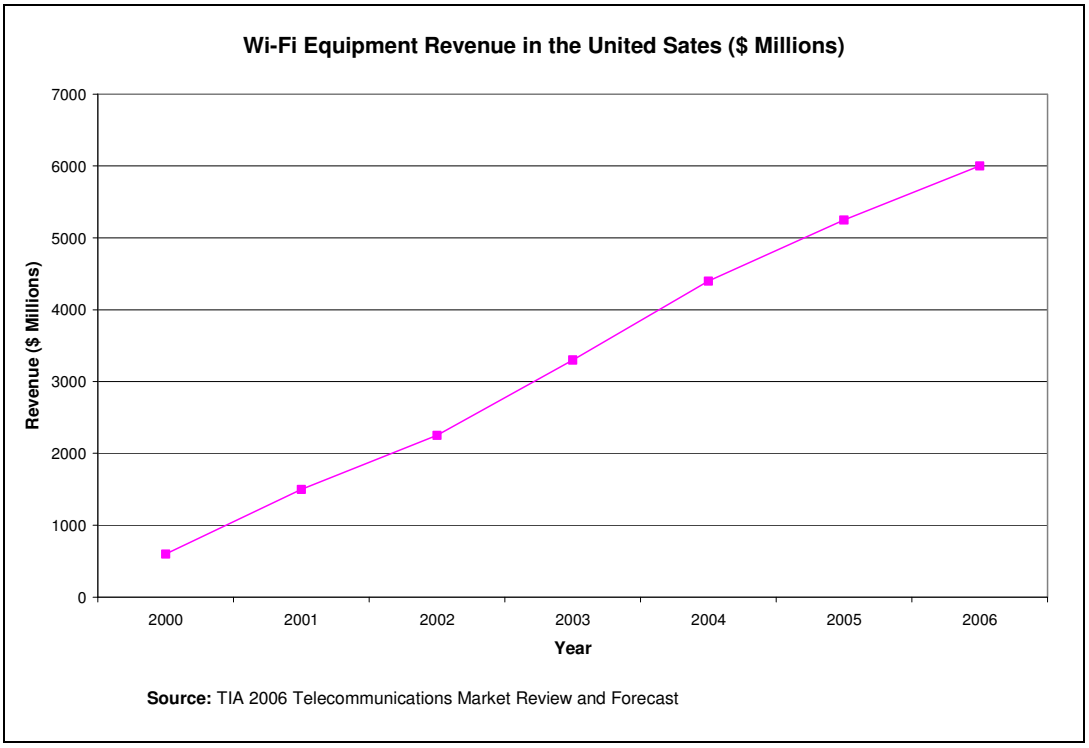
Figure 6



additional private investment in a statewide, universal wireless broadband network. *See* "Inaugural Address of Governor James H. Douglas: The Vermont Way Forward," January 4, 2007, available at: http://www.vermont.gov/tools/whatsnew2/index.php?topic=GovPressReleases&id=2230&v=Article, last visited Jan. 29, 2007.

According to the Telecommunications Industry Association, U.S. Wi-Fi infrastructure expenditures, covering all public Wi-Fi networks, increased from $600 million in 2000 to $6 billion in 2006 (see Figure 7 below).[27] Such investment in public infrastructure, which is dependent on adequate unlicensed spectrum, will continue to accelerate over the next several years as far larger jurisdictions begin to actually deploy networks now in the planning and RFP stages.

Figure 7



Source: TIA 2006 Telecommunications Market Review and Forecast

Indeed, it would be economically wasteful for a business—or a household—to pay a licensed intermediary for access to the airwaves for wireless networking. And indeed, virtually all

[26] *See* http://www.muniwireless.com/article/articleview/5495, last visited Jan. 29, 2007.
[27] *Supra* note 12, p. 193.

unwired homes, individuals seeking Internet access outside the home, and far more businesses get high-speed wireless broadband service via unlicensed spectrum than licensed spectrum because the cost is lower and the speed and reliability of the network is greater. For example, according to an October 2005 study by In-Stat, 71.7 percent of laptop users wirelessly access the Internet exclusively via an unlicensed Wi-Fi service, while only 5.3 percent access the Internet exclusively via a licensed cell phone network.[28]

Another vivid illustration of the potential consumer welfare of unlicensed spectrum is the fact that cellular carriers, with few exceptions, prevent their subscribers' cell phones or PDAs from working on unlicensed networks. Wi-Fi capabilities available in European versions of certain smartphones are stripped from devices authorized by carriers to operate on cellular networks in the U.S. Cellular carriers fear that up to 40 percent of their customers' voice minute usage could be transferred to unlicensed networks if WiFi capabilities allow customers to seamlessly transfer to an unlicensed network within range. They are especially fearful that unlicensed service will cut into their new and highly profitable data services because unlicensed networks are most common in places—such as homes, businesses, and hotels—where high-speed data services are most likely to be accessed.

The economic logic driving the carriers' fear is most vividly demonstrated by the carriers' incorporation of a crippled version of Bluetooth in their phones. The carriers recognize that Bluetooth is an excellent way to provide customers with hands-free access to their phones. Such hands-free access addresses important public safety concerns, including the dangers of driving while holding a cell phone and the dangers of holding a device emitting high power

[28] The study is cited in In-Stat, "Wireless Broadband Evolution: Technology Landscape and End-User Attitudes," 2006.

electromagnetic radiation directly next to the ear. On the other hand, the carriers have purposefully crippled Bluetooth to prevent customers from transferring video, audio, and other content directly to a computer or other device that would bypass their network and reduce their ability to control and charge for usage. If carriers didn't fear the great economic potential of unlicensed service, they would not have gone to such great lengths to cripple their own products.[29]

2. Efforts to Wedge Licensed Services Into Similar "Swiss Cheese" Spectrum Have Failed.

Permitting unlicensed access has proven a remarkably successful strategy for promoting spectrum use. By contrast, the efforts to use exclusive licensing and auctions in situations that parallel the broadcast white spaces have fallen far short of their goals. This should hardly prove surprising. As discussed in greater detail in Section I.D and I.E, the flexibility, low cost and low power of unlicensed make it ideal for spectrum bands where devices must operate at low power in the presence of sensitive licensed services. Because users of unlicensed services willingly accept interference from other sources in exchange for the low cost and ability to customize use, the limitations of a "Swiss cheese" spectrum environment that relies on opportunistic use of available frequencies does not conflict with user expectation or need.

By contrast, users of licensed services pay more—both in terms of the scarcity of providers and the limitations on use. They have an expectation of reliability not found among unlicensed users. As a consequence, the efforts to create a limited number of licensees in situations that would maximize the advantages of unlicensed spectrum have consistently failed to achieve anything remotely like the success of the unlicensed bands.

[29] For a detailed discussion of this crippling, *see* Tim Wu, "A Proposal for Wireless Network Neutrality," New

Two ongoing rulemakings, the 700 MHz guard band proceeding, In re Former Nextel Communications, Inc. Upper 700 MHz Guard Band Licenses and Revisions to Part 27 of the Commission's Rules, 21 FCCRcd 10413 (2006) (700 MHz Guard Band NPRM) and the effort to improve deployment in the 900 MHz mobile Location and Monitoring Service (M-MLS), In re Amendment of the Commission's Part 90 Rules in the 904-909.75 and 919.75-928 MHz Bands 21 FCCRcd 2809 (2006) (M-LMS NPRM), illustrate the pitfalls of attempting to implement a licensing regime in an environment best suited for unlicensed. Both proceedings involve efforts by the Commission to promote licensed services under conditions nearly identical to those found in the broadcast white spaces. Both have failed to produce the predicted benefits, and have instead resulted in endless petitions by licensees to readjust the rules to favor this or that business model of a particular licensee or set of licensees. The Commission should consider this real world experience carefully in the face of claims that licensing offers a better means of promoting productive use of the white spaces.

i. The 700 MHz Guard Band Proceeding

In 2000 and 2001, the Commission engaged in multiple proceedings to develop rules for a new licensed service to utilize the "guard bands" in the 700 MHz bands allocated to public safety as a consequence of the DTV transition. *700 MHz Guard Band NPRM* at ¶¶ 6-10. Nevertheless, the Commission has found it necessary to issue a new *Notice of Proposed Rulemaking* in an effort to stimulate productive use of the band. *Id.* at ¶¶13-16. The recent *NPRM* observes that, despite efforts to accommodate the conflicting needs of guard band managers, guard band licensees, and public safety licensees, "there are few systems operating in the Guard Bands." ¶13.

America Foundation Working Paper, forthcoming February 2007.

Guard band operators and other interested parties have proposed numerous explanations for why so few systems have deployed in this extremely valuable band. They point to the limits on architecture designed to avoid interference, the high transactional costs associated with guard band management, and the uncertainty over the future of the band. *Id.* Further, there is little unity among stakeholders for how to fix the problems, and the time pressure associated with the DTV and accompanying public safety transitions has added additional difficulties for the Commission to craft a worthwhile solution. *Id.* ¶¶13-16.

All of the issues that have made creating a useful licensed service in the public safety "white spaces" apply with equal force to the broadcast white spaces. Like the public safety "white spaces," the broadcast white spaces remain equally subject to the concerns of existing users, the dynamic and uncertain nature of the DTV transition, and the high transactional costs licensing imposes. Yet despite the intensive efforts of the Commission in 2000-01 to develop rules that meet the needs of all potential stakeholders, the use of the public safety white spaces remains stalled for the foreseeable future.

This hardly provides an inspiring tale of success for the Commission to emulate in the broadcast white spaces. Yet, as the *2006 FNPRM* for the broadcast white spaces acknowledges, a decision to adopt a licensed service here would require the Commission to recapitulate exactly the same process that proved so unsuccessful for promoting use of the public safety guard bands. *2006 FNPRM* at ¶31. This stands in marked contrast to speed with which deployment took place in the 5.8 GHz band after the Commission opened that band for use in 1997, *Amendment of the Commission's Rules to Provide for Operation of Unlicensed NII Devices in the 5 GHz Range*, 12 FCC Rcd 1576, or the manner in which industry stakeholders have cooperated with government

agencies to resolve interference issues in the 5 GHz band. *In Re Revision of Parts 2 and 15 of the Commission's Rules to Permit U-NII Devices in the 5 GHz Band*, 18 FCCRcd 24484 (2003) Does the Commission really wish to engage in yet another round of rulemaking to set licensing rules, only to return to the regulatory bargaining table again years later when the spectrum remains underutilized?

The *2006 FNPRM* cites the financial interest of licensed parties to operate and deploy systems that do not interfere with adjacent licensed users. *2006 FNPRM* at ¶30. The experience with the public safety white spaces demonstrates the fallacy of this assumption. Licensees made a combined initial bidding investment of nearly $550 million,[30] as well as the cost of creating a system of band managers and other associated costs. Yet all this "incentive" to deploy profitable systems that minimize interference has produced is a handful of spectrum user agreements and a cottage industry for telecommunications lawyers lobbying the Commission for further changes.

Certainly, the pending *700 MHz Guard Band NPRM* may open the door to increased utilization of the public safety white space—but only after years of false starts and wasted investment. Rather than repeat this experiment—which even now has no guarantee of success—in the broadcast white spaces, the Commission should adopt unlicensed rules that better suit the nature of this band.

ii. The 900 MHz M-MLS Proceeding

The Commission's other attempt to use licensing to promote intensive use of a band shared by licensees and other users, the M-MLS service created and auctioned by the Commission in the late 1990s, provides an even starker contrast between the ability of licensed services and unlicensed services to thrive in a difficult and dynamic spectrum environment. As the

Commission recently acknowledged, the M-LMS service has proven a dismal disappointment. *M-MLS NPRM*, 21 FCCRcd at 2810. The majority of licensees that won their licenses at auction have yet to even begin building out their systems. Nor can the licensees, despite their theoretically shared incentive, agree on how to modify the rules to enhance the viability of the service—or even whether they should do so. To date, the effort to set rules for licensing in the band and auction these licenses has produced only a set of spectrum speculators that have repeatedly returned to the Commission for an endless series of rule changes that they promise will prove the "silver bullet" for facilitating deployment and intensive use of the M-LMS portion of the band.

This stands in stark contrast to the widespread deployment and intense use of the band by operators using unlicensed technology. As the Commission recognized, unlicensed operation in the 900 MHz band has created a "proliferation of important public, private, and consumer applications, and for amateur operators." *Id.* Despite sharing the band with federal users, licensed non-federal users, and amateur users, intense use of unlicensed devices has produced neither destructive interference to licensed users nor a "tragedy of the commons" rendering the band useless.[31] To the contrary, millions of unlicensed devices coexist in the band with licensed users, providing a wealth of services without harmful interference. *Id.* at 2811.

These real world examples should provide more than adequate rebuttal to the wholly theoretical argument cited by the Commission that licensing somehow provides a greater incentive to create and deploy non-interfering systems. To the contrary, as both the public safety

---

[30] *700 MHz Guard Band NPRM* at ¶11.

[31] Certainly the removal of artificial regulatory barriers could improve the ability of unlicensed operators to use the band. But there is rather a broad chasm between "the band could be used more efficiently" and "non-exclusive unlicensed use has made the band unusuable."

"white spaces" experiment and the *M-MLS NPRM* clearly show, licensing simply does not work for services trying to co-exist in dynamic, intensely used bands. Rather than guaranteeing efficiency, the high transactional costs and divergent economic interests of the licensees — to say nothing of other stakeholders — makes deployment and use of licensed systems in such bands extremely difficult and time consuming, if not impossible. By contrast, the low cost of unlicensed deployment, coupled with the ability of unlicensed operators to take advantage of the dynamic opportunities offered in such bands, makes unlicensed spectrum the clear choice for success in the broadcast white spaces.

C. Licensing Offers No Inherent Advantage For Minimizing The Possibility of Harmful Interference.

The *FNPRM* also suggests that licensing provides superiority to unlicensed spectrum in controlling interference in bands shared with others because licensing will enhance accountability for interference. Combined with the incentive to deploy usable systems, proponents of licensing maintain that licensing will prove inherently superior to unlicensed use in preventing harmful interference to licensed broadcast services. The lengthy, inefficient, expensive and interminable process of rebanding the 800 MHz public safety band more than adequately refutes this assertion, especially when contrasted with the success of unlicensed co-existence in the 900 MHz band.

The 800 MHz band enjoyed use by two competing licensed services: commercial mobile radio service (CMRS) and public safety. Under the logic suggested by the *FNPRM* in favor of licensed use, the situation should have proven ideal for co-existence. The commercial users, given their financial incentives, the restrictions of licensing, and the critical public safety uses of

the non-commercial licenses, should have enjoyed a prosperous and harmonious existence. The fact that the CMRS system belonged to a single commercial user, making accountability easier, should have made co-existence even easier.

By contrast, under the logic put forward by proponents of licensing, the 900 MHz band should be an unmanageable ocean of interference. Certainly it should not support anything as critical as licensed public safety use and unlicensed broadband networks.

Reality, however, has provided a definitive rebuttal to the proponents of licensing. The 800 MHz band, with its co-existing public safety licensees and CMRS licensees, became dangerously unusable. Only after years of intense negotiation among stakeholders did the Commission arrive at a solution to extricate the licensed public safety users from the single and supposedly accountable licensed commercial user. The solution itself has required a complete transformation of the band plan, a swap of spectrum, a payment of billions of dollars to the public to compensate for the additional spectrum rights given to Sprint-Nextel, and further billions invested in migrating and resupplying licensees. And yet, more than two years after the Commission adopted a way forward out of the 800 MHZ spectrum quagmire and with the deadline for DTV transition approaching, the rebanding continues to drag on.

By contrast with the "tragedy of the exclusive licensees" that took place in the 800 MHz band, the millions of devices in the 900 MHz band continue to co-exist with a variety of licensed services. The ever-increasing intensity of unlicensed use has not raised the overall "noise floor" or produced an army of unaccountable phantoms interfering with critical licensed services. As the Commission discovered when it recently proposed to modify the relationship between unlicensed services and the licensed M-LMS licensees, power companies and other "critical infrastructure"

users have sufficient confidence in unlicensed spectrum to invest huge sums in deployment and imbed the devices into critical systems. It is this "triumph of the commons" that the Commission should seek to replicate in the broadcast white spaces, rather than the "tragedy" of the 800 MHz licensing.

D. The Economic Case In Favor of Unlicensed Remains Unrefuted

In purely economic terms, an unlicensed allocation of the discontinuous white space in the TV band is the best option, since it encourages innovation, promotes broadband competition and deployment, complements the licensed allocation of the 700 MHz spectrum, and encourages regulatory and market diversity. Improving the balance between licensed and unlicensed options for wireless device makers, service providers and ordinary citizens by adding a substantial unlicensed band below 1 GHz will improve overall spectrum efficiency and consumer welfare.

1. Innovation Flourishes in Unlicensed Bands[32]

Experience in the 2.4 GHz ISM band proves the benefits of an unlicensed allocation. Almost every laptop computer on sale today includes Wi-Fi technology that uses this band.

Technology innovation has been dramatic. Maximum network-throughput speed has increased almost fivefold.[33] The 802.11e standard that facilitates multimedia applications has contributed to the rapid growth and positive outlook for networks that support voice and video streams. The draft 802.11n standard promises data-throughput rates up to 540 Mbps, ten times

[32] For a more detailed discussion of the innovation and broader economic advantages of designating the TV white spaces for unlicensed access, *see* de Vries, *supra* note 5, from which this section and the next are adapted.
[33] From a maximum of 11 Mbps for 802.11b to 54 Mbps for 802.11g and 802.11a.

faster than today's best devices.[34] Products based on this specification are expected to make up about 15 percent of all the home wireless LAN routers shipped worldwide in 2006.[35]

This has all happened very quickly: the first 802.11 standards underlying Wi-Fi were only ratified in 1999/2000.[36] The worldwide market for wireless local area networks had grown to $2.5 billion by 2005. By 2009, only a decade after its inception, overall Wi-Fi market revenues are forecast to reach $4.8 billion.[37]

Unlicensed allocations encourage new players to enter the market, leading to innovation and competition. Usage scenarios are decentralized, leading to rapid industry growth. Wi-Fi enabled devices now include cameras (Kodak, Canon, Nikon), freestanding 'radios' that tune to Internet stations over Wi-Fi (Kerbango, Roku) and even a rabbit: the Nabaztag[38] desktop toy provides weather forecasts and wake-up calls, and waggles its ears when your loved one moves the ears of their toy.

New applications continue to emerge. Commercial networks of wireless hotspots emerged in 2003 (Boingo, Wayport, iPass, T-Mobile, and others), metro mesh[39] networks started to appear in large numbers in 2005, and Internet voice services over wireless networks are now being created, particularly in enterprises.

---

[34] "Faster Wi-Fi Standard Moves Forward," *PCWorld*, January 19, 2006, available at: http://www.pcworld.com/news/article/0,aid,124413,00.asp.

[35] Dell'Oro Group, cited in "Faster Gear to Drive Wi-Fi Market" *PCWorld* Jan 24, 2006, available at: http://www.pcworld.com/news/article/0,aid,124478,00.asp.

[36] *The Economist* (2004): The basic 802.11 standard was published in 1997. 802.11b was ratified in December 1999, and 802.11a in January 2000. Apple introduced Wi-Fi as an option on its new iBook computers in July 1999.

[37] Dell'Oro Group Inc, reported in "Dell'Oro: faster gear to drive Wi-Fi market," *Infoworld*, 24 January 2006. Figures do not include Wi-Fi capabilities embedded in DSL and cable modems. (http://www.infoworld.com/article/06/01/24/74752_HNdellorowifi_1.html?WIRELESS%20LANS%20-%20WLAN)

[38] *See* http://www.nabaztag.com/

[39] A mesh network has two or more paths to any node; nodes act as traffic relays for each other. Information can move between two nodes that are not directly connected by "hopping" across intermediate nodes. A mesh can be contrasted with the point-to-multipoint networks used in cellular systems, where all nodes communicate directly with one central node, usually on a tower.

There has also been dramatic business model innovation, from rural entrepreneurs offering broadband Internet access to their communities for the first time, to hotspot access packages from mobile-telephone companies. Few would argue that Wi-Fi networking and all the social and economic benefits outlined for the six industry sectors above would have materialized had licenses to operate in this band been auctioned off.

2. Unlicensed Spectrum as 'Regulatory Insurance'

In addition to its intrinsic advantages outlined above, having sizeable and spectrally diverse unlicensed allocations also offers hedges against non-scarcity of spectrum, and government greed.[40]

If it turns out that spectrum becomes relatively more abundant due to (say) advances in technology, license holders acting in concert would be able to charge customers excess fees based on the initial presumed scarcity that motivated a market in licenses. There are anti-trust remedies for such behavior, but they take a long time to catch up with the market. The availability of unlicensed allocations, by contrast, provides an immediate outlet for entrepreneurs that is unencumbered by licensee control.

On the other hand, if spectrum becomes very scarce, say because usage scenarios and demand outstrip spectrum utilization technologies, then unlicensed will become congested and licensed bands will be an outlet for entrepreneurs who initially built their business in unlicensed bands.

There is no agreed way to decide the degree of scarcity for all spectrum, even at a single moment in time, let alone in a dynamic situation where technology and usage feed off each other.

[40] Lehr, *supra* note 5.

Hence, one cannot make an *a priori* determination of which scenario is the most suitable. As long as both regulatory models exist, each provides a market test, and a check on potential inefficiencies, for the other.[41] Whether government decides to license or allow open, shared access to a band, it partly determines the business models, uses and competitive entrants. Hence, the AWS auctions have been—necessarily—a recipe for predominantly large, incumbent and well-capitalized companies to invest in a business model for broadband based on centralized infrastructure. In contrast, the unlicensed bands—particularly 2.4 GHz—facilitate competitive entry by a far larger number of smaller entrepreneurs with business models premised on decentralized capital spending, most of it by consumers who buy and connect their own interoperable consumer devices to the edge of the network.

Modern regulatory theory tends to presume that the least regulated option is the optimal starting point, because it offers the most economic options and opportunities. However, it would be difficult to recover unlicensed allocations once one has devoted all spectrum to flexible licenses. Spectrum property advocates might counter that a band manager might choose to institute the equivalent of unlicensed in a market system, or the government might buy spectrum and re-allocate it to unlicensed. However, there has been no interest in a band manager model, due to the difficulty of excluding non-payers; and also the reality that the large device, chip, and software manufacturers with a hypothetical self-interest in facilitating such a "private park" are adamant that they are not in that business and would not enter it. Indeed, public policy should prefer to see devices and services compete on a level spectrum playing field—open access to free spectrum—rather than a market where competition is limited to the one or two well-capitalized manufacturers that can literally purchase the airwaves! Moreover, the notion of local governments

[41] *Id.Id.*.

or individual citizens required by the FCC to buy back access to spectrum is based on the debatable premise that the public doesn't "own" it already.

There is also risk to good policy when government extracts scarcity rents in spectrum through auctions. In order to get the highest possible price, government may be tempted to auction off as little spectrum as possible, perpetuating the current inefficient "command and control" allocation regime. Unlicensed provides a hedge against government delay in auctioning spectrum; if the price of spectrum licenses rises too high due to artificial scarcity, entrepreneurs willing to trade off the cost of spectrum against the cost of dealing with interference from other users will move to unlicensed.[42]

3. A Spectrally Diverse Mix of Licensed and Unlicensed Access to the Airwaves is the Best Overall Policy Solution.

In November 2002, the FCC's Spectrum Policy Task Force released a report calling for shifting large amounts of spectrum from the current command and control allocation system to both unlicensed and licensed flexible-use spectrum. Since then, the Commission has started numerous proceedings to follow through on these recommendations. But whereas the proceedings granting flexible use to incumbent license holders and others have been fast-tracked and completed, the proceedings, such as this one, seeking to allocate more unlicensed spectrum below 5 GHz have all been sidetracked. Indeed, since the Spectrum Policy Task Force Report was released, the amount of dedicated unlicensed spectrum below 5 GHz has actually decreased by 10 MHz whereas the amount of licensed, flexible use spectrum has increased by at least 519 MHz.[43] Despite this gross imbalance, the advocates for more licensed spectrum have been insatiable in

[42] de Vries, *supra* note 5.

their demands. The Commission should step back and recall this larger picture and its earlier promise to allocate more unlicensed spectrum.

In fact, the two regulatory models complement each other, and as the Spectrum Policy Task Force concluded, a robust combination of the two spectrum access models is superior to either one alone. Markets facilitate the interaction of diverse groups, and such diversity is essential to efficient operation. Markets are remarkably efficient at solving all sorts of problems, provided diversity, interaction and incentives are in place.[44] It is important not only to have diversity of participants within a given market structure, but also to have different kinds of markets. Anti-trust legislation and rules on auction participation seek to avoid unhealthy concentration and to increase diversity of operators in markets for spectrum licenses. However, licenses are just one kind of spectrum-related market; an unlicensed allocation creates a market in device technologies in which manufacturers compete with each other to provide affordable innovation directly to end-users.

In many spheres, society maintains a mix of public and private goods. Parks and private property are the paradigmatic example. A recent survey for the National Recreation and Park Association found that open spaces have substantial positive impacts on surrounding property values.[45] As Pierre De Vries argues:

> [A] combination of spectrum-title and unlicensed spectrum allocations will result in a greater social benefit than each individually, in the same way that a public park enhances the market value of surrounding properties, and the use by surrounding residents increases

---

[43] *See* Snider, "Myth vs. Fact," *supra* note 5.

[44] *See* e.g., James Surowiecki, *The Wisdom of Crowds: Why the Many Are Smarter Than the Few and How Collective Wisdom Shapes Business, Economies, Societies and Nations*, 2004.

[45], *See* Sarah Nicholls, "Measuring the Impact of Parks on Property Values," 2006, http://www.nrpa.org/content/default.aspx?documentId=1013., Sarah Nicholls and John L Crompton, "Impacts of Regional Parks on Property Values in Texas," *Journal of Park and Recreation Administration*, Summer 2005, Vol. 23, No. 2, pp. 87-108; Sarah Nicholls and John L Crompton, "The impact of greenways on property values: Evidence from Austin, Texas," *Journal of Leisure Research*, 2005, Vol. 37, No. 3, pp. 321-341.

> the utility of the park. A combined allocation nurtures new deployments. Unlicensed bands allow entrepreneurs to enter a market without incurring the cash drain of obtaining a license. If a business is so successful that it attracts competitors that increase interference, it would have the option of relocating to a nearby spectrum-title band where it can buy the right to avoid interference. The spectrum-title allocation gains value because unlicensed acts as a demand generator.
>
> Conversely, because unlicensed bands are open to all, licensed operators can also enhance their services, or increase their spectrum capacity, by routing certain traffic over unlicensed frequencies. For example, cellular operators are combining unlicensed hotspot data service with wide-area service in spectrum-title bands. When customers access a cellular company's data network from a hotspot they do not burden the spectrum-title band, enabling the network to support more customers without buying more spectrum. Devices that combine spectrum-title [licensed] and Wi-Fi operation are emerging, and will soon be common. Licensees have also benefited from other unlicensed technologies like Bluetooth headsets and other mobile phone add-ons. [46]

The Commission has allocated huge swaths of new spectrum for flexible licensed use that have yet to be deployed. The FCC should focus its efforts on speeding up those deployments rather than creating new flexible use licenses under conditions much less favorable to licensing. For example, the incumbents using the 195 MHz in the MMDS/ITFS band have argued since the late 1990s that if they were given spectrum flexibility worth tens of billions of dollars, they would quickly deploy advanced telecommunications service. They got much of what they wanted from the FCC in 2000 and got the balance in 2004, promising once again that their delivery of wireless broadband service would be imminent if only the FCC gave them the spectrum. But it is now 2007 and the confident promises have not been fulfilled. Only six of the 450 U.S. market areas for the MMDS/ITFS band have been cleared for broadband; the incumbents are asking for yet additional delays in their FCC mandated build out requirements; and service in this huge swatch of spectrum is serving only approximately a tenth of one percent of U.S. households and

[46] de Vries, *supra* note 5, p. 18.

businesses.[47]

Similar delays and similar arguments apply to broadband use of the 2.3 GHz WCS band, where the incumbents who got their licensees in 1997 have failed to meet their ten year build out requirement and have now requested and received from the Commission a delay in the implementation of that requirement.

Most recently, the FCC auctioned 90 MHz of spectrum in the 1.7 GHz and 2.1 GHz bands, so-called "AWS" spectrum. The use of this spectrum for licensed service is being significantly delayed by the need to clear off government incumbents with more than 2,000 spectrum assignment in the acquired licensed areas. The FCC can serve to help prod the incumbents to vacate their spectrum in a timely way.

Today there are now far more devices per MHz using the 2.4 GHz unlicensed band than using any other band, including the much-touted mobile telephone bands but especially the more newly allocated bands such as MMDS/ITFS, WCS, and AWS. Consider a historical comparison of the use of the 2.4 GHz unlicensed and 2.5 GHz MMDS/ITFS bands. In 2000, both bands had minimal use. But today the situation is quite different. Definitive data are not available but a back-of-the-envelope estimate suggests that the number of households now making use of the 2.4 GHz unlicensed band is a factor approximately 1,000 times greater than the number of U.S. households making use of the 2.5 GHz band[48] If the unit of comparison is devices rather than

[47] Clearwire and Sprint/Nextel control the majority of the MMDS/ITFS spectrum. According to SEC filings, as of September 30, 2006 Clearwire had 144,000 subscribers in the U.S. As of early January 2007 Sprint had announced deployments in four markets but had not yet launched them. There are more than 110 million households in the U.S

[48] There are more than 110 million households in the U.S., of which more than 50 percent have Bluetooth-enabled mobile phones. Many others have Wi-Fi, ZigBee, analog, or other Bluetooth devices, all of which utilize the 2.4 GHz band. For example, all three major video game platforms now have built-in WiFi as does virtually every computer laptop now sold in the U.S. A large fraction of households also have analog cordless phones that use the 2.4 GHz band. In addition, there are many non-communications devices, such as microwave ovens, that emit energy in the 2.4 GHz band (hence the historical designation of the 2.4 GHz band as a "junk" band).

households, the ratio would probably be at least 5,000 to 1. And all this is despite the fact that the amount of spectrum in the 2.5 GHz band for licensed use is more than twice the amount of spectrum in the adjacent 2.4 GHz band for unlicensed use.

E. Exclusively Licensing the TV White Spaces Would Have Many Disadvantages.

The point of the examples recounted in Parts I.B.2 and I.C is not that unlicensed spectrum will inherently prove superior to licensed spectrum at every opportunity. Rather, NAF, *et al.*, provide the above sections to demonstrate the fallacy of the arguments from proponents of licensing that licensing is ***inherently*** superior to unlicensed in the critical aspects of interference mitigation and enhancing deployment of wireless services. As the previous sections demonstrate, unlicensed access has proven superior to licensed services in environments similar to that confronted by the Commission in the broadcast white spaces.

It is no coincidence that unlicensed access has thrived and coexisted with other users in environments where licensed services have failed to prosper or proven inimical to co-existence. The superiority of unlicensed access for bands marked by a need for co-existence with an abundance of licensed users, severe restrictions on power levels, and dynamically shifting geographic and spectral environments has its roots in sound economics. Just as the success of licensed bands operating in different environments provides little of value for setting rules for deployment, the theoretical models developed without regard to the specifics of the broadcast white spaces provide little of value in developing an economic case for licensing.

In raising the licensing issue in Section IV.A of the FNPRM, the Commission states that it:

> has tried to strike a balance between the licensed model and the unlicensed model, determining which model to use based on all of the relevant circumstances. Both models have been successful. The licensed model is more efficient in many cases, and tends to work best *when spectrum rights are (1) clearly defined, (2) exclusive, (3) flexible, and (4) transferable.* When spectrum rights lack these attributes, potential licensees face uncertainty and may lack incentive to invest in a license or offer service.[49] (Emphasis added.)

Clearly, the geographically discontinuous and unsettled nature of licensing on TV Channel 2 to 51 spectrum—referred to appropriately as "Swiss cheese spectrum"—is not easily definable, almost necessarily non-exclusive and contingent on incumbents, and certain to be restricted in terms of power and interference-avoiding technologies to a degree that makes it far less valuable and productive than other bands auctioned for Advanced Wireless Services. Even if the obstacles to defining the relative rights of new and incumbent licensees can be surmounted, the delay will be substantial—and measured in years—compared to opening the band immediately for unlicensed access. The result will be less broadband deployment, less competition, less innovation, and less progress in bringing both affordable and ubiquitous broadband service to rural, remote and low-income areas lacking it today.

1. Auctioning the TV White Spaces Will Create Substantial Delays and Uncertainty Likely to Deter Investment, Innovation and Broadband Deployment.

In paragraph 28 of the *FNPRM*, the FCC makes a crucial (and understated) observation regarding the potential extensive delays, inherent uncertainty and unusual restrictions on licensees that an auction of this "Swiss cheese spectrum" would entail:

> 28. As an initial matter, we note that the frequencies and amount of unused television spectrum in the TV band will vary from location to location and, depending on the approach we ultimately adopt, could change over time as additional television stations are licensed or change frequency. For example, the assignment of low power television

[49] FNPRM at ¶27.

> stations is not scheduled to be complete by the end of the DTV transition in February 2009. Also, under existing rules, currently authorized DTV stations would be permitted to seek to change frequencies after that date, which could complicate licensing of the white spaces spectrum, particularly if the Commission were to license the spectrum pursuant to auction. For example, if licensed wireless operations are required to protect other types of licensees in the TV bands, then wireless licensees in the TV bands could potentially lose their ability to operate on some, or even all, of their authorized frequencies when new operations with higher allocation status are authorized to operate in the same area. We also observe that, if protection of incumbents is required, devices operating in the TV bands would need to operate at lower power levels than are typical of many licensed services.[50]

The full implications of these observations are quite striking because uncertainty about rights and licensing don't mix well, and the extent of uncertainty in this band for a bidder is huge. For example, there are more than 5,000 low power TV stations and TV translator stations in the United States. Unlike the high power TV stations, they currently have no post-DTV transition spectrum allotment table. The final allotment table will have to await a proceeding that has yet to be written or released and, if it is anything like the process to arrive at the final allotment for high power TV stations, could take many years to complete.

Similarly, the high power TV broadcasters are currently seeking to expand their interference protection rights in a host of proceedings, most dramatically in the proceeding on Digital Television Distributed Transmission System Technologies, where they are seeking to expand into the white space both within and outside their Grade B contours.[51] Broadcasters are also expected to seek a new round of "minor modifications" after the final DTV allotment table is finalized. Since the current purpose of the broadcast band is to provide broadcast service, if new technology allows incumbent broadcasters to modify their licenses in a way that doesn't harm another incumbent high power TV licensee, the Commission is obliged to accept the "minor modification." It is unclear what impact a decision to auction the white space would have on

[50] FNPRM at ¶28.
[51] *See* NAF, *et al*. Comments, Docket 04-186, November 30, 2004.

these other proceedings and the Commission's longstanding rules regarding minor modification requests by incumbent broadcasters.

Consequently, any potential bidder for the white spaces won't know if the spectrum up for bid is encumbered or not, and, if it is encumbered, when it will become unencumbered. That means, in turn, that a successful bidder, despite having purchased spectrum at auction, could have a business plan and even capital investment rendered worthless (or held up for a payoff to the broadcast station). Indeed, the Commission would be creating an intrinsically inefficient—and potentially corruption inducing—moral hazard.

The Commission could decide simply to subordinate the rights of LPTV and translator licensees to the auction winners, forcing the low power broadcasters (who never paid for their licenses) to negotiate and pay for an arrangement that allows them to remain on the air after their current license period expires (or to accept a buyout). However, it seems unlikely the Commission will define the auction rights for license in a manner that will result in many, mostly rural communities losing over-the-air TV service. The more likely result would be such a severe reduction in auction receipts that the FCC would surely face great pressure to postpone an auction—and the productive use of this spectrum—for an indefinite period. Potential bidders would face great uncertainty and the prospect of negotiating with potential holdouts with legacy license rights.

In contrast, unlicensed devices and services would be required to simply work around whatever broadcasters are occupying any channel now or in the future. For example, the sensing and Dynamic Frequency Selection method used by unlicensed devices to avoid interference with military radar in the upper 5 GHz band would work just as well if Channel 43, for example, were

unoccupied this year and licensed to a broadcast entity next year. The unlicensed device would simply sense the DTV signal and switch to an unoccupied channel.

Of course, auctions would necessarily entail the complete subordination of one category of currently "licensed" users of unused TV channels: In addition to the TV broadcasting facilities licensed under Part 73 of the Commission's Rules, this band contains other, less well-known "low power (broadcast) auxiliary stations" used by broadcasters and certain other narrowly defined classes of users for support of their operations. These uses, which do not involve direct broadcast to the general public, are authorized under Part 74 Subpart H of the Commission's Rules. Eligible uses include wireless microphone systems and "wireless video assistance devices," although only a specified list of broadcast, cable, news and entertainment industry applicants are eligible for a license under Subpart H.

All of these eligibles and all of the permitted uses clearly only use a tiny fraction of the total whitespace when one considers it in terms of bandwidth, total time used, and the fraction of the surface are of the U.S. covered by all of these short-range devices. These economic minnows are swimming in a vast sea of wasted bandwidth. Yet under present Commission policies, only these specifically enumerated users and uses are allowed and no other access to this white space is permitted. While the opponents of this rulemaking have repeatedly pointed to the "licensed" status, these Part 74 licenses differ significantly from the usual licenses as they do not specify either transmitter location or frequency.

As explained in greater depth in the separate Technical Comments filed by NAF, *et al.* filed simultaneously in this docket, while these uses are "licensed," the licenses have little in common with most FCC licenses such as Part 90 (land mobile) or Part 73 (broadcast) licenses that

specify location and frequency and are more closely related to Part 95 Personal Radio Service/ "Citizen's Band" with their lack of a frequency assignment and location. *If* the Commission were to decide to license all TV band frequencies and create some kind of band manager license, as the licensing proponents in this proceeding advocate, entities planning to bid for the licenses would be faced with an intractable problem: While they know precisely, in terms of frequency and transmitter location, what Part 73 TV signals must be protected, they have no idea what frequency Part 74 Subpart H may be on and they only know "the usual area of operations" of the transmitter locations. And this does not even address the issue that the vast majority of wireless microphones in this band are operating illegally—that is, they are used by parties not eligible for licensing in Part 74 and hence no licensing records exist—even though their advocates in this proceeding feel they are entitled to "protection." Such new spectrum should—consistent with the spectrum policies of the past decade that call for marketplace forces to determine the best use for various frequencies—force at least all secondary users of the TV band to bid in the auction to retain their rights.

By allocating the white space to licensed service, the FCC will both put the spectrum to use most quickly and prevent spectrum best suited for broadband service from being allocated to a dying, economically inefficient service. Alternatively, if the FCC rushed an auction, not only would receipts likely be significantly reduced, but also the resulting investment uncertainty would likely delay deployment of service.

2. Transaction and Coordination Costs Will Be Particularly High on This Band for Licensed Compared to Unlicensed Acccess.

Some arguments for a market in spectrum licenses are based on the Coase Theorem.[52] Coase showed that in a world of zero transaction costs, the initial distribution of entitlements (e.g., property rights or liability rules) has no effect on the ultimate allocation of resources. If the players are left to bargain among themselves, an efficient outcome will be arrived at regardless of how initial property rights are assigned.

The result holds provided that (1) the costs of transactions is zero; and (2) the parties to a dispute are able to negotiate, to strike bargains, and to be confident that their bargains are enforceable. Transaction costs for access to wireless communication include finding suitable spectrum, negotiating for access, and policing and enforcement. These cannot be neglected, particularly in socially important applications with low user density such as rural or disadvantaged urban areas. Finding providers will be difficult for people with poor access to information; negotiation will be expensive since it is an occasional activity; and enforcement will be tricky since there are few players in a large area. If spectrum is spread over many owners, simply establishing who owns what will be costly. Obtaining permission to operate, once owners are known, may also be costly. If there is low or intermittent interest from buyers, providers are unlikely to set up a streamlined process for obtaining sub-licenses.

It will be particularly tricky to define rights in the white spaces, since operating parameters will be different everywhere. The most likely auction will not be national overlays, but will divide assignments geographically in order to meet the needs of rural political interests. Interference-avoiding frequencies will vary from place to place, particularly in the borderlands between broadcast towers. Thus, someone seeking to license spectrum access will need to petition a variety

[52] Ronald H. Coase, "The Problem of Social Cost," *J. Law & Econ*. 3, 1960, p. 1, available at: http://www.sfu.ca/~allen/CoaseJLE1960.pdf.

of providers. Market concentration may emerge, but will take time. It currently seems likely that licenses will go to existing big spectrum players, since the FCC has decided that it will require buyers to actually use their spectrum purchases themselves.[53] Markets will probably be inefficient since spectrum scarcity will vary so much depending on locale that it will be difficult to support a liquid market to trade in the appropriate rights.

The application of the Coase Theorem should also be tempered by non-economic considerations. Assuming all the assumptions hold, the outcome after negotiations will be efficient only in technical economic terms. However, an "efficient" allocation may not meet other social criteria. For example, if the global efficiency of the system is achieved by a transfer of $100k from A to B, economics doesn't care whether A is a pauper and B is a plutocrat, or vice versa; society at large may have a different opinion.[54]

F. Even If The Economic Case For Licensing Were Valid, Other Public Interest Considerations Mandate Selection of Licensing.

The Commission has found that use of the broadcast white spaces is technologically feasible. The real world examples provided above demonstrate clearly that licensing provides no inherent advantage over unlicensed use to facilitating co-existence without harmful interference. To the contrary, as the Sprint-Nextel 800 MHz rebanding experience clearly demonstrates, co-existing licensed services have a considerable capacity to interfere with one another as intensity of use increases.

What remains then is the purely economic question of which set of rules will best serve the

[53] Chris Kraeuter, "Speculating On Spectrum," *Forbes On-line*, May 25, 2006, available at: http://www.forbes.com/2006/05/25/wireless-auction-fcc_cx_ck_0526spectrum.html?partner=alerts

public interest by facilitating deployment of wireless services to all Americans in a timely and affordable manner. But even if the Commission remains unpersuaded by the economic arguments in favor of unlicensed access, the First Amendment and the Communications Act would compel the Commission to adopt unlicensed access rules.

1. The First Amendment Prohibits Exclusive Licensing Except to Avoid Harmful Interference or Where Exclusive Licensing Is the Least Restrictive Means of Achieving A Compelling Government Interest.

As a general rule, discretionary licenses for the right to communicate are repugnant to the First Amendment.[55] Only because unregulated use of the electromagnetic spectrum by *everyone* would make the ineffective use of the spectrum by *anyone* has the Supreme Court permitted the Federal Government to restrict access to spectrum to a handful of government-selected licensees.[56] In other words, because far more people wish to use the electromagnetic spectrum for various purposes than the medium can support, the government must limit the number of licenses available to the public. The need to manage the use of spectrum to avoid harmful interference among all would-be users has become known as the "scarcity rationale."[57]

The scarcity rationale does not give the government unlimited authority to curtail speech. To the contrary, because the government must suppress rights of the vast majority of Americans to speak directly through the electromagnetic spectrum, the scarcity rationale imposes on the

---

[54] *See* de Vries, *supra* note 5, from which this section is adapted.
[55] *See* Watchtower Bible & Tract Society of New York, Inc. v. Village of Stratton, 536 U.S. 150, 161–64 (2002) (holding that a requirement of registration to make a public speech is incompatible with the First Amendment guarantees of free speech and assembly).
[56] *See* NBC v. United States, 319 U.S. 190, 226 (1943); Fed. Radio Comm'n v. Nelson Bros., 289 U.S. 266, 285–86 (1933).
[57] *See* Red Lion Broad. Co. v. FCC, 395 U.S. 367, 390 (1969) ("Because of the scarcity of radio frequencies, the Government is permitted to put restraints on licensees in favor of others whose views should be expressed on this

government a fundamental responsibility to protect the public's "collective right to have the medium function consistently with the ends and purposes of the First Amendment."[58] The Supreme Court has found that the public interest standard underlying the Communications Act "necessarily invites reference to First Amendment principles, and, in particular, to the First Amendment goal of achieving 'the widest possible dissemination of information from diverse and antagonistic sources.'"[59]

It should be noted that few doctrines in the annals of First Amendment jurisprudence have attracted so many critics and predictors of its imminent demise.[60] The courts and Congress, however, have consistently rejected attacks on the scarcity rationale.[61] As long as the government maintains that interference creates a need to award exclusive rights to use radio frequencies, it confers an obligation to protect the speech rights of those excluded from use of these frequencies under the general requirement that issuance of any license serve the public interest.[62] At the same time, however, striking the proper balance on how to protect these rights remains in the hands of the FCC, subject to the direction of Congress.[63]

As explained by *Red Lion* and other cases, the scarcity doctrine imposes a responsibility on the Commission to regulate those holding exclusive licenses so as to protect the "paramount" First Amendment right of the public to receive access to a diversity of views in the electronic media. *Red Lion*, 395 U.S. at 390-391. This responsibility remains unaffected by the decision to

---

unique medium.").
[58] *Id*.
[59] FCC v. Nat'l Citizens Comm. for Broad., 436 U.S. 775, 795 (1978) (internal citations omitted).
[60] *See, e.g.,* Jim Chen, *Liberating Red Lion From the Glass Menagerie of Free Speech Jurisprudence*, 1 J. TELECOMM. & HIGH TECH L. 293 (2002); Glen O. Robinson, *The Electronic First Amendment: An Essay for the New Age*, 47 DUKE L.J. 899 (1998); Christopher S. Yoo, The Rise and Demise of the Technology-Specific Approach to the First Amendment, 91 GEO L.J. 245 (2003).
[61] *See, e.g.,* Turner v. FCC, 512 U.S. 622, 637–38 (1994).
[62] Ashbacker Radio Corporation v. FCC, 326 U.S. 327 (1945).

open more spectrum for unlicensed use. The responsibility to regulate broadcasters to preserve diversity flows from the scarcity of high power *broadcast* licenses. *Id.* at 400-401; *Prometheus Radio Project v. FCC*, 373 F.3d 372, 401-402 (3rd Cir. 2004). At the same time, however, the Commission has an equal duty to promote access by the public to spectrum for communication generally.

The precise dimensions of this later obligation, and the limitations it imposes on Congress and the FCC's ability to exclude non-interfering uses of spectrum remain largely unexamined.[64] On the one hand, determining how many licenses to grant for a particular service in a particular geographic area is a quintessential "expert agency" question that Congress intended to entrust to the FCC. On the other hand, the Constitution does not permit Congress (or its delegees) to override the First Amendment rights of would-be speakers purely in the name of economic efficiency. This suggests that the power to regulate under the scarcity rationale solely to exclude would-be speakers has limits.

Stuart Minor Benjamin argues that government restriction on the use of radio frequencies should be subject to an "intermediate scrutiny" standard of review.[65] Under this standard, Congress and the FCC must justify their decisions to restrict the speech rights of individuals to use spectrum with a substantial government purpose; suppression of speech must be incidental to the government's goal and the regulation must burden no more speech than necessary.[66]

Application of this principle to the FCC's licensing regime argues for a rather simple rule:

---

[63] FCC v. WNCN Listeners Guild, 450 U.S. 582 (1981).
[64] *See generally*, Stuart Minor Benjamin, *The Logic of Scarcity: Idle Spectrum As First Amendment Violation*, 52 DUKE L. J. 1 (2002) [hereinafter *Idle Spectrum*]; *see also* Stuart Minor Benjamin, *Spectrum Abundance and the Choice Between Public and Private Control*, 78 N.Y.U. LAW. REV. 2007 (2003) [hereinafter *Spectrum Abundance*].
[65] Benjamin, *Id.*, at 6.
[66] *See id.*

where technology allows users to speak through the electromagnetic spectrum without interference to the productive uses of higher powered licensed services, the FCC has no right preventing them from speaking. Economic grounds alone are not a substantial government interest, and thus cannot support exclusive licensing where the threat of interference does not exist.

The Supreme Court has explicitly found that the First Amendment prohibits the government from granting exclusive rights in communications media unless the physical characteristics of the medium require exclusivity as a precondition of productive use. In *City of Los Angeles v. Preferred Communications*, Preferred Communications did not take part in an auction for an exclusive cable franchise.[67] Nevertheless, it applied for a franchise in competition with the winner of the auction, and the City of Los Angeles denied the application.[68] The district court upheld the power of the city to award an exclusive license, but the Ninth Circuit Court of Appeals reversed on First Amendment grounds.[69] The Supreme Court remanded for further fact-finding on the question of whether physical limitations required the city to limit the number of franchises.[70] Finally, the Court explicitly held that the desire of the city to maximize revenue or maximize economic efficiency did not permit limiting the ability of citizens to speak through the new medium any more than the city could limit, in the name of economic efficiency, the number of newspapers circulated.[71] In other words, where the laws of physics no longer require exclusivity, exclusivity cannot be justified on economic or efficiency grounds alone.

It is not suggested that technology has advanced to the point where the spectrum may

[67] City of Los Angeles v. Preferred Commc'ns, 476 U.S. 488, 490 (1986).
[68] *Id*. at 490 and n.1.
[69] *Id.* at 492.
[70] *Id*

accommodate all who wish to use it such that the days of exclusive licensing have passed.[72] Indeed, many users, particularly those in the public safety sector, will continue to demand exclusivity for the foreseeable future. Those applications will still require that the FCC impose necessary public interest obligations and service rules in order to ensure that these exclusive licenses serve the "public interest, convenience and necessity" as required by Section 307 and Section 310(d) of the Communications Act.[73]

The ability of technology to provide unlicensed access to all citizens under some conditions does not render the underlying basis of *Federal Radio Commission v. Nelson Bros.* or *NBC v. United States* obsolete.[74] At the same time, however, the fact that some high-power applications require exclusive licensing does not eliminate the First Amendment rights of citizens to use electromagnetic spectrum in a non-interfering way.

To analogize, the government may impose reasonable time and place restrictions on First Amendment activities on public property, but the government may not exclude more speakers than necessary. The Constitution would not tolerate an auction for rights to protest in a town square on the grounds that an auction would increase government revenue, or to ensure that only those who "most value" the right to speak publicly have the opportunity to do so. Such a scheme could not circumvent the First Amendment by arguing that winners at auction would resell or rent

---

[71] *Id.* at 494–95.

[72] *Cf.* FCC v. League of Women's Voters of California, 468 U.S. 364, 376 n.11 (1984) (observing that technological advances might someday render exclusive licensing obsolete).

[73] *See* 47 U.S.C. §§ 307, 310(d) (2000). Furthermore, even if scarcity were eliminated as a matter of law, the Commission would still be required to impose public interest obligations on broadcasters and others, as licensed entities owe their superior position to government exclusivity. *See* Red Lion Broad. Co., Inc. v. FCC, 395 U.S. 367, 400 (1969).

[74] Federal Radio Comm'n v. Nelson Bros., 289 U.S. 266 (1933) (holding that national regulation of broadcasting is not only appropriate but essential to the efficient use of radio); NBC v. United States, 319 U.S. 190 (1943) (finding that government control of spectrum and the rules it implemented pursuant to that control were justified by the scarcity of the spectrum). Where unlicensed access reaches the point of scarcity, the scarcity rationale prevails.

to other speakers if it were genuinely more efficient to allow just anyone to speak.[75] To the contrary, in the real world context, where genuine physical limitations and well understood principles of private ownership are present, the Supreme Court has found a state interest and authority to open private property to public speech.[76]

It makes no sense as a matter of First Amendment jurisprudence, therefore, to posit that the First Amendment rights of the vast majority of citizens to speak directly to one another, rather than through a government-licensed intermediary, can arbitrarily be circumscribed in the name of economic efficiency. Even under the rational basis level of scrutiny applied by courts reviewing decisions by Congress and the FCC, the Supreme Court has found that "[t]he 'public interest' standard necessarily invites reference to First Amendment principles."[77] Indeed, the FCC has a fundamental responsibility to protect the public's "collective right to have the medium function consistently with the ends and purposes of the First Amendment."[78]

2. Unlicensed use generally furthers the interests of the First Amendment and Furthers the Public Interest As Defined By the Communications Act.

First Amendment principles alone, therefore, would impose upon the FCC an obligation to promote more unlicensed access to spectrum. Significantly, however, adopting an unlicensed regime for the white spaces serves the public interest policies identified by the Communications Act and the FCC.[79]

---

[75] *Cf.* United States Postal Service v. Council of Greenburgh Civic Ass'n., 453 U.S. 114, 141–42 (1981) (White, J., concurring) (stating that a user fee is legitimate, even if it cuts off access to public forum, provided the fee is used for recovery of costs).
[76] *See* Pruneyard Shopping Center v. Robins, 447 U.S. 74, 88 (1980).
[77] FCC v. National Citizens Committee for Broad., 436 U.S. 775, 795 (1978) (internal citations omitted).
[78] *See* Red Lion Broad. Co., Inc. v. FCC, 395 U.S. 367, 390 (1969). *See also*, *Idle Spectrum*, *supra* note 64, at 110–11.
[79] *See, e.g.*, *In re* Principles for Promoting the Efficient Use of Spectrum by Encouraging the Development of

The Communications Act contains a number of competing goals that cumulatively serve the public interest.[80] Traditionally, these have included promoting increased media diversity and heightened competition.[81] Recently, Congress amended the Act to eliminate discrimination in the deployment of communications service and to promote the deployment of broadband services to all Americans.[82] Section 257 of the Communications Act, which requires the FCC to review barriers to entry by small businesses into the telecommunications industry every three years, and to use its regulatory powers to reduce or eliminate these barriers, contains a concise summary of these public interest goals to guide the FCC in its Trienniel Review: "in carrying out subsection (a) of this subsection, the Commission shall seek to promote the policies and purposes of this [Act] favoring diversity of media voices, vigorous economic competition, technological advancement, and promotion of the public interest, convenience and necessity."[83] The FCC has repeatedly found that expanding Part 15 rules furthers the goals of encouraging new technologies and services to the public.[84]

The paucity of service and lack of ownership opportunities for minority communities

---

Secondary Markets, *Policy Statement*, 15 F.C.C.R. 24,178 (Nov. 9, 2000). In its spectrum *Policy Statement*, the Commission enunciated a public policy of promoting the public interest by "permit[ting] spectrum to flow more freely among users and uses in response to economic demand." *Id.* ¶ 1.

[80] *See, e.g.*, 47 U.S.C. §§ 157, 158, 160, 161, 201 (2000).

[81] FCC v. Nat'l Citizens Comm. for Better Broad., 436 U.S. 775, 780 (1978).

[82] Telecomm. Act of 1996 §§ 104, 706, Pub. L. No. 104–104 (codified as amended at 47 U.S.C. §§ 151–157); *In re* Appropriate Framework for Broadband Access to the Internet over Wireline Facilities; Review of Regulatory Requirements for Incumbent LEC Broadband Telecommunications Services; Computer III Further Remand Proceedings: Bell Operating Company Provision of Enhanced Services; 1998 Biennial Regulatory Review – Review of Computer III and ONA Safeguards and Requirements; Inquiry Concerning High-Speed Access to the Internet Over Cable and Other Facilities; Internet Over Cable Declaratory Ruling; Appropriate Regulatory Treatment for Broadband Access to the Internet Over Cable Facilities, *Policy Statement*, 20 F.C.C.R. 14,986 (Aug. 5, 2005).

[83] 47 U.S.C. §257(b).

[84] *See, e.g.,* Amendment of the Commission's Rules to Provide for Operation of Unlicensed NII Devices in the 5 GHz Range¸ *Report and Order*, 12 F.C.C.R. 1576, ¶¶ 8–18 (Jan. 9, 1997) (finding that expanding unlicensed access furthered interest of developing new technologies, new services, new competitors, deployment of advanced telecommunications capabilities to all Americans—with an emphasis on rural and educational uses—and helped fulfill the Commission's obligations under Section 257 to promote entry by small businesses and to enhance diversity of information sources); *In re* Section 257 Proceeding to Identify and Eliminate Market Entry Barriers for Small

further highlights the importance of unlicensed access. Providers of broadband and other advanced telecommunications services generally focus their attention on the wealthiest markets.[85] Furthermore, although the Communications Act directs the Commission to use auctions to promote "economic opportunity and competition . . . by avoiding excessive concentration of licenses and by disseminating licenses among a wide variety of applicants, including small businesses, rural telephone companies, and businesses owned by members of minority groups and women,"[86] ownership of telecommunications facilities remains excessively concentrated in the hands of a few, large corporations.[87]

Despite the Commission's consistent efforts to develop bidding criteria that will promote minority and small business ownership, spectrum auctions continue to fail at these goals. A recent Center for American Progress publication analyzing ten years of FCC auction data concluded that spectrum auctions increasingly serve to entrench incumbent interests and discourage disruptive new entrants and ownership by minority-owned businesses.[88] The results of the FCC's most recent spectrum auction proved consistent with these empirical studies of past auctions. In the 2006 Advanced Wireless Services Auction, the FCC offered for bid the largest block of licenses in desirable frequencies below 2 GHz in years.[89] Incumbent wireless carriers, as well as a consortium consisting of the two largest incumbent cable operators and one of the largest

---

Businesses, *Report*, 12 F.C.C.R. 16,802, ¶¶ 202–05 (May 8, 1997).

[85] *See* Leonard M. Baynes, *Deregulatory Injustice and Electronic Redlining: The Color of Access to Telecommunications*, 56 ADMIN. L. REV. 263, 268(2004).

[86] 47 U.S.C. §309(j)(3)(C).

[87] *See, e.g.*, Eli M. Noam, *Deregulation and Market Concentration: An Analysis of Post-1996 Consolidation*, 58 FED. COMM. L. J. 539, 541–43(2006)(outlining empirical evidence of the concentration of ownership in the telecommunications field).

[88] Gregory F. Rose & Mark Lloyd, "The Failure of FCC Spectrum Auctions," Center for American Progress (2006), available at: http://www.americanprogress.org/atf/cf/%7BE9245FE4-9A2B-43C7-A521-5D6FF2E06E03%7D/SPECTRUM_AUCTIONS_MAY06.PDF. *See also* Leonard M. Banes & C. Anthony Bush, *The Other Digital Divide: Disparity In the Auction of Wireless Telecommunications*, 52 CATH. U. L. REV. 351 (2003).

incumbent wireless carriers, won the vast majority of licenses.[90]

Empirical evidence to date, therefore, suggests that spectrum auctions of the kind that the Commission would use to distribute licenses for use of the white spaces do little to create competition or provide opportunities for minority ownership. To the contrary, the existing state of the wireless market and the last ten years of auction data indicate that spectrum auctions are inimical to promoting competition and diversity of ownership. This should raise grave concerns for the FCC, as promoting competition and diversity of ownership are core public interest goals of the Communications Act.

By contrast, granting unlicensed access would create immediate opportunities for deployment in any community by any entity, particularly communities economically unattractive to incumbents. These communities will be able to deploy needed systems themselves. The FCC has observed how unlicensed access removes regulatory barriers to minority and small business ownership of telecommunications facilities.[91] The Commission also recognizes that expanding unlicensed access benefits Americans in both urban and rural areas.[92] Others, including the New America Foundation, have extensively documented the benefits of unlicensed access.[93]

---

[89] *See* Auction of Advanced Wireless Services Licenses Scheduled for June 29, 2006, *Public Notice*, 21 F.C.C.R. 794 (Jan. 31, 2006).

[90] Paul Davidson, *Wireless Carriers Snap Up Federal Airwaves Licenses*, USA TODAY Sep. 14, 2006 at 2B, *available at* http://www.usatoday.com/tech/wireless/2006-09-14-spectrum-usat_x.htm?POE=TECISVA.

[91] *See In re* Section 257 Triennial Report To Congress, Identifying and Eliminating Market Entry Barriers For Entrepreneurs and Other Small Businesses, *Report*, 19 F.C.C.R. 3034, ¶¶ 140–44 (Dec. 31, 2003); *In re* Section 257 Triennial Report To Congress, Identifying and Eliminating Market Entry Barriers For Entrepreneurs and Other Small Businesses, *Report*, 15 F.C.C.R. 15,376, ¶ 139 (July 28, 2002).

[92] *See, e.g.*, Comm'r Kathleen Q. Abernathy, FCC, The Harvest: Keynote Remarks at the Wireless Communications Association International Annual Conference (June 2, 2004); Comm'r Jonathon S. Adelstein, FCC, WISP Forum, S.D. School of Mines and Tech. (May 25, 2004).

[93] *See, e.g.,* Matt Barranca, *Unlicensed Wireless Broadband Profiles: Community, Municipal and Commercial Success Stories* (New Am. Found. Spectrum Policy Program, Washington, D.C., Apr. 2004); William Lehr, *Dedicated Lower Frequency Unlicensed Spectrum: The Economic Case for Dedicated Unlicensed Spectrum Below 3 Ghz* (New Am. Found., Spectrum Series Working Paper No. 9, 2004); J.H. Snider, *Reclaiming the Vast Wasteland: the Economic Case for Reallocating the Unused Spectrum (White Space) Between Channel 2 and 51 to Unlicensed*

Unlicensed access has become a mainstay of cities' and counties' efforts to provide affordable and ubiquitous broadband services, so-called "muniwireless" or "unwired" cities.[94] Unlicensed spectrum also plays an increasing role in public safety. Unlicensed devices provide interoperable voice, video and data systems for a rapidly increasing number of public safety entities,[95] and proved highly flexible and useful as a "force multiplier" in the aftermath of Hurricane Katrina.[96]

II. TECHNICAL ISSUES RAISED BY THE *FNPRM*

There are a variety of technical methods – including technologies not yet invented – that unlicensed devices can use to avoid interference with television reception in the TV band. The three basic technologies highlighted by the FCC in this proceeding are control signals, position determination, and cognitive radio with spectrum sensing and dynamic frequency selection (DFS). Can unlicensed devices use interference avoidance technology to completely protect licensed broadcast TV services? This is, fundamentally, an empirical issue. Since the *2004 NPRM* comment period concluded, broadcast industry interests have released studies and videos claiming to demonstrate the potential for unlicensed devices of the type contemplated in the *NPRM* to cause

---

Service (New Am. Found., Working Paper No. 13, 2006). *See also In re* Establishment of and Interference Temperature Metric to Quantify and Manage Interference and to Expand Available Unlicensed Operation in Certain Fexed, Mobile and Satellite Frequency Bands, *Ex Parte Comments of Prometheus Radio Project, Consumer Federation of America, Public Knowledge, Champaign-Urbana Community Wireless Project, Benton Foundation, Electronic Frontier Foundation, New America Foundation, The Dandin Group, Wireless Tech Radio and NYCWireless,* ET Docket No. 03-237, at 37 (June 18, 2004) (accessible via FCC Electronic Comment Filing System).

[94] Barranca, *supra* note 93, at 4–10, 19. For more information on "municipal wireless broadband projects worldwide that are funded or supported by cities and towns," including many with dedicated public safety applications over unlicensed spectrum, see the MuniWireless website at http://muniwireless.com (last visited Jan. 28, 2007).

[95] *See* Naveen Lakshmipathy, "Wireless Public Safety Data Networks Operating on Unlicensed Spectrum," New America Foundation Policy Paper (Feb. 21, 2006), available at http://www.newamerica.net/publications/policy/wireless_public_safety_data_networks_operating_on_unlicensed_airwaves (last visited Jan. 28, 2007).

[96] *See* Jeff R. Allen, *Radio Response's Activities Following Hurricane Katrina*, Feb. 24, 2006, at 24–25, *available at* http://www.nella.org/jra/dr/katrina/katrina-final-report.html (follow "Incident Command System" hyperlink under "Table of Contents").

harmful interference with TV reception.[97] NAF, *et al.*, as well as prominent high-tech corporations, have consistently argued in filings to the Commission that the interference avoidance mechanisms proposed by the *NPRM*, combined with further technical parameters to be developed by the Commission, can indeed protect the consumers of licensed TV broadcast services.[98] NAF, *et al.* have again filed a separate set of Technical Comments in this proceeding, addressing new issues and developments arising in the *FNPRM*. Additionally, NAF has commissioned two engineering studies, which are filed concurrently in the record of this proceeding, that in a rigorous and highly replicable fashion demonstrate that unlicensed operations can completely protect licensees.[99]

A. The Commission Should Not Select A Specific Technology, But Should Follow Its Traditional Part 15 Approach And Simply State What Functionalities Are Required.

NAF, *et al.* favor performance-based standards that are technologically neutral with respect to the methods designated for enabling non-interfering spectrum access to the TV band white space by unlicensed devices. Performance-based standards are standards for equipment approval that do not specify the design of equipment but rather specify an objective readily

---

[97] *See*, e.g., Comments of Association for Maximum Service Television (MSTV), Docket 04-186.
"Your Neighbor's Static," video available at: http://www.mstv.org/static.html.

[98] *See,* e.g., Comments of Microsoft, Intel, and Shared Spectrum, FCC Docket 04-186;
NAF, *et al.* Technical Reply Comments, January 31, 2005, Docket 04-186;
Michael Marcus *et al.*, "Why Unlicensed Use of Vacant TV Spectrum Will Not Interfere With Television Reception," New America Foundation Issue Brief; January 31, 2007.

[99] *See,* e.g., Technical Comments of NAF *et al.*, Docket 04-186, January 31, 2007;
*NPRM*Mark A. Sturza and Farzad Ghazvinian, "White Space Technical Study: Can Cognitive Radio Operating in the TV White Spaces Completely Protect Licensed TV Broadcasting?" New America Foundation Working Paper, January 29, 2007 (submitted attached to NAF, *et al.* Technical Comments), available at: http://www.newamerica.net/publications/policy/can_cognitive_radio_operating_in_the_tv_white_spaces_completely_protect_licensed_tv_broadcasting
See also NAF, *et al.* Receiver Desensitization Interference Study, Docket 04-186, January 31, 2007.*et al.*

reproducible test that the equipment must pass for approval. The Section 15.407 standards for 5 GHz U-NII band frequency sharing with Federal Government radars, using cognitive radios employing dynamic frequency selection (DFS) and total power control, are performance-based standards in that a reproducible test is used to show whether the equipment complies. Technical neutrality is a more general concept that deals with regulations avoiding details that relate to the physical design of devices or the choice of basic, underlying technology. Thus US cellular radio telephone regulation has technical neutrality as it permits use of multiple cell phone standards, e.g. GSM and CDMA.

The Commission should determine in general, and considering the opportunity costs, what protection is reasonable to protect the 14 percent of American households who actually rely on over-the-air reception of TV signals, and use this policy determination to derive performance parameters for TV band devices that can be objectively measured in the Commission's Equipment Authorization Program. Objective and technologically-neutral equipment authorization standards are both necessary for administrative certainty, transparency and capital formation for technology development and are a long-standing tradition at the Commission.

For example, the previous authorization for unlicensed 5 GHz U-NII devices to share spectrum using a related DFS technique with Federal Government radar systems, including national security-related systems, is codified in §15.407. The specific equipment requirements for sharing are enumerated in terms of specific technical performance requirements that can be directly and objectively tested during equipment authorization, *not* overall performance such as "no interference to any radar within *x* km." If this approach is good enough to protect national security-related radar systems, it should be adequate to protect TV receivers. Other Part 15

standards for equipment sharing licensed spectrum are all based on specific technical performance standards that can be directly tested.

When the Commission authorized the U-NII sharing with Government radars in §15.407(h)(2), it did not have definitive proof that devices could be built to detect the radar signals at a sufficiently low level. Rather, it set the threshold at what was needed to protect the radars and gave industry the challenge to meet that goal if it wanted to sell equipment. If equipment didn't meet the goal, it couldn't be sold. This has been the Commission's historical approach to technical standards. The opponents of this rulemaking have implicitly raised a higher and unprecedented barrier of proving feasibility before the rule is adopted.

B. Of the Approaches Explicitly Discussed In the *FNPRM*, Each Has Achieved Sufficient Advances Since 2004 To Ensure That At Least One Approach Will Work.

NAF, *et al.* believe that each of the interference avoidance methods—when implemented with appropriate safeguards—is sufficient to protect licensed broadcast TV services with overwhelming certainty in all but the most contrived worst-case scenarios. In our technical filings to be submitted simultaneously in this proceeding, NAF, *et al.* have argued—and provided engineering evidence—of these claims.

1. Spectrum Sensing Shows Great Promise And Would Be More Cost-Effective and Efficient to Implement

The cognitive radio approach, incorporating spectrum sensing and dynamic frequency selection (DFS), can adequately protect licensees in the TV band. Taken cumulatively, the NAF,

et al. technical filings address the two key elements of the spectrum sensing/DFS equation: the ability of TV band devices to *detect* signals that need protection, and the ability of those devices to *transmit* signals without causing desensitization interference with neighboring, licensed channels.

In its Technical Comments, NAF, *et al.* have addressed the broadcast industry's repeated use of the "hidden node" problem to discredit the sensing/DFS approach, arguing that detectors in TV band devices are, through current technologies, capable of high degrees of detection sensitivity—a fact that incumbent licensees have repeatedly failed to acknowledge in their comments. NAF, *et al.* have also established an engineering case for the feasibility of unlicensed use of the TV white space by low-power personal/portable devices using sensing/DFS technology. In recent months, NAF has commissioned two engineering studies to establish an empirical record on the questions of signal detection/DFS and desensitization interference. The first study, submitted as an attachment to the NAF, *et al.* Technical Comments, demonstrates definitively that unlicensed devices are capable of detecting (and avoiding) even broadcast signals that have undergone a high degree (37 dB) of attenuation due to the "hidden node" problem.[100] The study leaves little doubt that sensing/DFS will be an adequate means by which unlicensed devices can avoid channels in use by licensed services.

DFS technology can also be used in a synergistic way with transmitter power control (TPC), a more traditional technology that assures that the minimum power is used for each transmission. The combination of DFS and TPS will be able to reduce the risk of TV receiver

[100] Mark A. Sturza and Farzad Gazvinhian, "Can Cognitive Radio Operating in the TV White Spaces Completely Protect Licensed TV Broadcasting?" New America Foundation, Working Paper #16 (January 2007), available at http://www.newamerica.net/publications/policy/can_cognitive_radio_operating_in_the_tv_white_spaces_completely_protect_licensed_tv_broadcasting. This paper, reporting on the study conducted by Sturza's 3C Sytem Company, is filed as an attachment to the separate and concurrent Technical Comments of NAF *et al.*

interference to a negligible level in the 14% of American household that depend on over-the-air reception of TV signals. While the other two options for enabling TV band devices require infrastructure development before they can be used in a given area, the DFS/TPS combination can be deployed as soon as developers can demonstrate to the Commission in its Equipment Authorization Program that they have met the relevant technical performance standards. This should be a great incentive for capital formation and technical development of final products.

In a separate filing today in this docket, NAF, *et al.* have also submitted the results of a second study,based on testing conducted over the past several months – and still ongoing – at the University of Kansas Information & Telecommunication Technology Center (the KU Study) which addresses the transmission side of the equation. The study, entitled "Quantifying the Impact of Unlicensed Devices on Digital TV Receivers," quantifies the desensitization phenomenon caused by primary emissions and out-of-band emissions (OOBE) in order to recommend an emission limit for proposed TV band unlicensed devices that will give protection to TV receivers comparable to existing precedents. The KU study demonstrates that unlicensed TV band devices can operate (at up to at least 100 mW) without risk of interference to the reception of very weak over-the-air on neighboring DTV channels. These power levels are equivalent to current WiFi units, such as 802.11g routers, that are commonly used in the home. Indeed, the experimental results support the claim that properly implemented secondary transmission in the television band is possible without significant impact upon DTV reception.

2. Geolocation/Database and Various "Countrol Signal" Approaches are Workable, Although they Could Create Barriers to Entry, Delay, Conflicts of Interest and Unnecessarily High Costs Relative to the Sensing Approach

The separate NAF, *et al.* Technical Comments similarly argue the feasibility of the geolocation/database option, observing that today's assisted GPS (A-GPS) technology *does* work indoors, contrary to claims made by incumbents. Indeed, other geolocation technologies that also work both indoors and outdoors will likely be available in the future. The Technical Comments recommend that the Commission set a maximum time interval within which any TV band device must produce a valid geolocation reading before transmission is allowed.

NAF, *et al.* Technical Comments similarly concur in the potential for "control signal" approaches to work effectively with respect to protection of TV licensees. We note that this is the same approach the Commission has used to protect very sensitive satellite earth stations from similar unlicensed equipment in the 3650 MHz proceeding, Docket 04-151.[101] The new rules for the 3650 MHz contain the following provision:

> **§ 90.1333 Restrictions on the operation of mobile and portable stations.**
> (a) Mobile and portable stations may operate only if they can positively receive and decode an enabling signal transmitted by a base station.
> (b) Any mobile/portable stations may communicate with any other mobile/portable stations so long as each mobile/portable can positively receive and decode an enabling signal transmitted by a base station.

While there are pending controversies in this band and pending reconsideration requests in Docket 04-151, there is no controversy in the record over this specific §90.1333 rule. Satellite earth station operators, who both have receivers much more sensitive to interference than TV receivers and have much more direct financial interest at stake in the case of interference than the

101 *See Report and Order and Memorandum Opinion and Order*, Docket 04-151, March 16, 2005.

opponents of this rulemaking, have not objected to this solution to the potential interference problem. Yet this provision is essentially the same as the control signal approach in the instant proceeding, which has nevertheless been the subject of attack by the opponents of this rulemaking.

In taking these approaches into consideration, the Commission must also take into account critical policy implications. While NAF, *et al.* recommend technological neutrality with respect to both device requirements and interference avoidance mechanisms, should the Commission choose to endorse certain interference avoidance methods over others, NAF, *et al.* recommend that the Commission does not approve ONLY a geolocation approach and/or a control signal approach. Due to a reliance on geographically specific information, the geolocation approach would unnecessarily increase the cost of equipment and would also rely on the accuracy of database information that could be out of the control of device manufacturers and users. As in the geo-located/database option, implementation of the control signal approach will involve delay and infrastructure development. In both cases affected parties must reach consensus on a map showing what channels may be used by TV band devices in which areas. In addition, control signal formats must be developed and transmission facilities procured. The control signal approach also is susceptible to a single point of failure: if a beacon is down, licensees cannot be protected. While some operators may decide to use the control signal approach in combination with geolocation – for example, in a mesh network, base stations with geolocation could send a permission-to-transmit control signal to the mobile devices authorized for access to the network – these methods generally require greater infrastructure investment and are not well suited to true mobility, or to the consumer mass market that could boom on this band, as WiFi has at 2.4 GHz.

The sensing/DFS approach, however, is the one approach which could stand by itself. It is the method most favorable to mobility, to community mesh network broadband deployment, to a mass consumer market for devices – and is therefore the method the Commission should ensure can be certified if, now or in the near future, manufacturers can produce devices to the Commission's performance-based criteria. Sensing has several advantages over the other methods. It does not require extra infrastructure deployment to be implemented and is not susceptible to undue control or manipulation by incumbent licensees. For example, if geolocation and/or control signal technologies require the cooperation of incumbent licensees, unlicensed device manufacturers, service providers and users could be vulnerable to the incumbents' self-interest in demonstrating that non-interfering use of the band is unworkable. The sensing method is also not susceptible to a single point of failure, such as inaccurate or outdated database information, or a beacon signal that might temporarily go down. Furthermore, sensing enables both personal/portable as well as fixed device operation, and ensures the protection of secondary licensed users such as wireless microphones without extra coordination.

Finally, and critically, the sensing/DFS method will allow an expansion of what is perhaps most unique and valuable about unlicensed WiFi devices in the current unlicensed bands: Individual households and citizens can purchase a mass market, off-the-shelf wireless laptop, router or modem, and use it to connect directly to the Internet without the need to go through an intermediary network operator. As noted above, the data show that the vast majority of mobile Internet connections are made by individual consumers over public hotspots – in schools, parks, hotels, coffee shops, downtown business districts and so on. Devices equipped with wireless modems can interoperate with any open network – they do not necessarily need to be paid

subscribers or clients of the network. Similarly, millions of home and small business wireless Internet routers simply connect directly to a wired ISP (e.g., to a DSL or cable Internet service). Both of these very common and productive consumer broadband devices – mobile devices and household WLANs – should be allowed, if technologically feasible, to use sensing and DFS rather than to be limited by some stationary or more expensive method that simply appears "safer" because it is based on a command-and-control technology.

C. Commission Testing and Evaluation of Data Must Be Open, Transparent, and Comply With Scientific Rigor.

At the heart of the debate over the necessary service rules sits the question of harmful interference. NAF, *et al.*, as much so as other proponents of unlicensed and as much so as the incumbents, do not wish to see the Commission approve service rules that ultimately create problems of harmful interference. It serves no one's interest to create service rules that ultimately require mass recalls and lengthy new proceedings to correct. Accordingly, NAF, *et al.*, favor a process of testing that fully engages all stakeholders in an open and transparent manner. This will ensure that the Commission addresses legitimate questions and concerns as they arise, either by its own tests or by requesting further tests from others.

Television broadcasters and others, however, have demonstrated via their comments and conduct that their understanding of the proper threshold for interference protection differs from the standard the Commission generally applies. The Commission has long established that it measures the possibility of "harmful interference" with reference to **user** expectations (here, the viewers) and the nature of the service. Where users routinely experience modest "noise" as a

consequence of weather or physical environment, the Commission has taken these user expectations into account. *First Report and Order*, *Creation of Low Power Radio Service*, 14 FCC Rcd 2471 (1999).

Specifically, incumbents have no right to demand that the Commission only certify devices if the Commission can categorically conclude that no device will ever cause any interference under any conditions at any time. To the contrary, even where the Commission has found that permitting a new service almost certainly ***will*** cause some increase in interference risk, that risk does not rise to the level of "harmful" unless it notably degrades the ability of users to enjoy the licensed service. *Amendment of Parts 2 and 25 of the Commission's Rules to Authorize Subsidiary Terrestrial Use of the 12.2-12.7 GHz Band*, 17 FCCRcd 9614, 9641-42 (2002). The courts have explicitly endorsed this definition of "harmful interference." *Northpoint Technology, Ltd, v. FCC*¸ 414 F.3d 61 (D.C. Cir. 2005). By contrast, the courts have remanded where the Commission only when it has departed from this standard and failed to explain its reasoning. *AT&T Wireless Services, Inc. v. FCC*, 270 F.3d 959 (D.C. Cir. 2001).

Further, as the Commission is aware, licensed incumbents – and terrestrial broadcasters in particular – have a lengthy history of using interference claims to forestall the entry of new services even in the face of overwhelming evidence to the contrary. In response to this history, Congress enacted Section 7 of the Communications Act. 47 U.S.C. §157. Section 7 shifts the burden of proving harmful interference to those opposing a new service, and requires the Commission to conclude its evaluations within one year. *Id.* The Commission itself has encountered this phenomena in numerous proceedings. Understandably then, while the Commission must conduct its studies in a manner that engages all stakeholders, the Commission

must also recognize that incumbents will always raise new objections with the hope of delaying or preventing a successful conclusion of this proceeding.

For the same reason, the Commission must carefully evaluate all evidence submitted by interested parties, and permit interested parties to test the validity of technical comments and objections. For example, in response to the *2004 NPRM*, MSTV submitted what it claimed were experimental results that demonstrated that unlicensed devices that would conform to the rules then proposed by the Commission would desensitize digital TV tuners. MSTV failed to provide sufficient data on its methodology to allow NAF to evaluate MSTV's evidence. As a consequence, NAF spent considerable time, money and effort to reverse engineer the MSTV experiment in order to refute it.[102]

Requiring the Commission and interested parties to invest time and resources to validate the supposedly scientific studies submitted into the record wastes time and impermissibly delays this proceeding. The Commission should make it abundantly clear that it will refuse to consider studies or other evidence presented by interested parties that fail to provide sufficient evidence to allow the Commission or other interested parties to replicate the experiments and thus test the validity of the results.

[102] In a separate, concurrent filing, NAF, *et al.* has filed in this docket a preliminary study, entitled "Quantifying the Impact of Unlicensed Devices on Digital TV Receivers," conducted at the University of Kansas, that quantifies the desensitization phenomenon caused by primary emissions and out-of-band emissions (OOBE) in order to recommend an emission limit for proposed TV band unlicensed devices that will give protection to TV receivers comparable to existing precedents. Among the practical implications of that study, for example, is the finding that if TV receivers were to be protected from an unlicensed device operating just 10 meters or more away, then these receivers can operate with a 100 mW transmitter power (at least) without risking a degraded picture

1. Ensuring The Commission's Own Testing Processes Resolve Possible Objections And Include All Stakeholders In the Planing Phase.

NAF, *et al.*, applaud the Commission's decision to conduct independent tests, and its *Public Notice* soliciting prototypes for testing. In order to avoid future objections about testing, and to facilitate buy in by interested stakeholders via collaboration in the testing process which will prove so valuable for developing service rules, NAF, *et al.*, recommends the Commission undertake the following procedures.

First, OET should issue a public notice soliciting comment on what experiments and studies it should conduct, and allow reply comments by interested parties. This notice should likewise include OET's own proposed experiments and procedures. Ideally, OET would also conduct one or more meetings with stakeholders to solicit suggestions and other feedback. Unfortunately, the tight deadlines needed for successful conclusion of this proceeding on the schedule proposed by OET this fall will necessitate short turn around time for comments and reply comments.

Discussion of proper procedures should include the handling of potentially proprietary data in a manner that balances legitimate concerns with the need for openness. As a general rule, however, OET should seek to prevent the use of proprietary data in technical testing here. Submission of proprietary data creates barriers to scrutiny and verification by stakeholders and makes testing needlessly complicated. It also raises the concern that parties will deliberately seek to introduce proprietary data as a means of forestalling scrutiny and verification by other stakeholders. Accordingly, OET should permit the use of proprietary data sparingly, if at all, and should ensure that the procedures used to protect proprietary data still permit other interested

parties to verify experimental results.

With regard to the conduct of the experiments themselves, OET should consider a mechanism by which interested stakeholders can request access to the facilities and, if possible, observe. Such a procedure must not disrupt OET's work or introduce significant delay.

NAF, *et al.*, stress that OET must, at all times, remain in control of the testing and the process. Commentors here do not suggest that OET should conduct its experiments with the same formality and need to respond to every filing and objection that governs rulemaking. NAF, *et al.*, also recognize that these suggestions will involve an increase in cost and resources. But this modest investment in enhanced transparency will pay huge dividends in the final result. Such transparency will increase the effectiveness of the testing and reinforce its validity by eliminating possible objections.

2. The Commission Should Give No Weight To Studies That Fail To Include Sufficient Data To Allow Replication and Evaluation.

Because the Commission has limited resources, it relies on the efforts of interested parties both to conduct independent research and to "peer review" evidence submitted by others. This approach also has the advantage of multiplying the expertise available to the Commission. At the same time, however, the Commission must recognize that parties acting from self-interest will have every incentive to construct studies and submit evidence most favorable to their own case, while seeking to suppress or discredit results less favorable.

Accordingly, the Commission must ensure that studies and other evidence submitted into the record accord with the rigorous standards necessary to establish appropriate rules. The easiest

means of accomplishing this end is to require what the scientific world generally requires: that anyone submitting evidence provide sufficient description so that others can replicate the results. This will not only ensure validity, it will also allow the Commission and interested parties to determine whether a particular study or experiment is relevant to the real world conditions devices will encounter.

Nothing illustrates the need for such a requirement better than the "desensitization study" submitted by MSTV and its subsequent video release, *Your Neighbor's Static.* As part of the record in this docket, MSTV submitted a study purporting to find that unlicensed devices operating under the rules proposed in the *2004 NPRM* would render DTV tuners unusable due to desensitization. *See* Comments of NAB and MSTV, 04-186 (filed November 30, 2004). In August 2005, MSTV released a video called *Your Neighbors Static*, which claimed that use of unlicensed devices in the white spaces would render DTV sets unusable. *See* Michael J Marcus, Paul Kolodzy, and Andrew Lippman, "Why Unlicensed Use of Vacant TV Spectrum Will Not Cause Interferance With Television Reception," New America Foundation (2006).[103]

In neither case, however, did MSTV explain how it came to its dramatic conclusion that unlicensed operation in the white spaces was "unsafe at any speed." Through considerable effort and expense, a team of engineers commissioned by the New America Foundation "reverse engineered" the experiments. Using generally accepted engineering techniques, the NAF team demonstrated that the MSTV study had achieved their results by concocting such an implausible set of circumstances as to have virtually no bearing on the real world. Further, even this minimal risk could be eliminated by a simple modification of the Commission's rules. *Id.* Similarly, the

[103] This Issue Brief is available at http://www.newamerica.net/publications/policy/why_unlicensed_use_of_vacant_tv_spectrum_will_not_interfere_with

best efforts by the NAF Team to reconstruct the events supposedly chronicled in *Your Neighbors Static* demonstrate conclusively that the scenarios depicted could not happen in the real world. *Id.* Although MSTV continues to insist on the validity and relevance of its studies, it has still failed to provide sufficient description of its methods to permit a reasonable evaluation of its claims by means other than that employed by NAF.[104]

The Commission must not allow opponents of unlicensed to transform the serious business of interference testing into an elaborate "gotcha" exercise or an expensive and time consuming scavenger hunt. The Commission has no obligation to investigate claims of interference based on home movies and studies that do not conform to generally accepted engineering standards. Nor should the Commission exhaust its own resources or require others to exhaust their own resources, to disprove studies that fail to provide sufficient information to determine relevance or validity. Considering the enormous social and economic opportunity costs associated with allowing this "vast wasteland" of TV band spectrum to remain fallow, the focus needs to be narrowly on protecting the dwindling number of over-the-air TV consumers from truly "harmful interference," not merely from hypothetical static concocted under extraordinary circumstances. The Commission should therefore refuse to consider studies that lack the information necessary for replication of the results.

---

television reception (last accessed Jan. 31, 2007).

[104] For a more complete discussion of this issue, see the separate, concurrent Technical Comments filed in this docket by NAF, *et al.* and the engineers who designed the Kansas University tests, Paul Kolodzy, former director of the FCC's Spectrum Policy Task Force, and Michael Marcus, a spectrum engineer now retired from the FCC's Office of

3. The Commission Should Conduct Independent Tests on Possible Interference in Channels 14-20 and Channels 2-4.

The Commission has deferred to this proceeding whether to permit non-mobile operation on bands 14-20, or any operation on Channels 2-4.[105] *2006 FNPRM* at ¶¶56-57. The Commission expressed concern for operations in these channels due to the unique set of circumstances in each channel. Channels 14-20 are used in 13 metropolitan areas around the country. Channels 2-4 are used for numerous consumer device interfaces, such as VCRs. Because of the additional operations on these channels, the Commission sought further evidence that use of unlicensed devices in broadcast white spaces will not interfere with either public safety operation or use of consumer devices.

In Section III, NAF, *et al.*, address why the Commission should permit operation on these channels/bands, even if it requires more rigorous testing. For purposes of technical testing, NAF, *et al.*, urge the Commission to conduct separate tests for these bands rather than rely merely on data developed as part of the overall testing to determine the general standards for devices authorized for other bands. Given that the concern arises from the unique conditions on these channels, the Commission should conduct experiments that will expressly address these concerns. If indeed any interference-avoiding technology – such as sensing/DFS, or a combination of the geolocation and control signal approaches – can avoid interference on these channels, the Commission should make this determination and consider opening access to unlicensed devices to

---

Engineering and Technology.

[105] NAF, *et al.* have pending a petition for reconsideration concerning these issues. *See* Petition for Reconsideration of the New America Foundation and the Champaign Urbana Wireless Network in the Matter of Unlicensed Operation in the TV Broadcast Bands, FCC Docket 04-186, and Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band, FCC Docket 02-380 (December 18, 2006).

the extent that is practically feasible.

III. THE COMMISSION SHOULD PERMIT THE BROADEST POSSIBLE SET OF USES CONSISTENT WITH MANAGING HARMFUL INTERFERENCE RISK.

Economies of scale and flexibility of use have provided the ingredients for the tremendous success of unlicensed devices. The use of unlicensed spectrum as a broadband solution – whether by small business WISPs, volunteer and non-commercial community wireless organizations, or government deployments providing hundreds of thousands of connections over hundreds of square miles – is possible only because the flexibility of unlicensed and the low cost of equipment make it possible. Restricting the flexibility of unlicensed spectrum does not merely reduce its utility to an individual user. Without sufficient spectrum or sufficient flexibility of use to make unlicensed use in the white spaces attractive, manufactures will never achieve the economies of scale necessary to make widespread deployment feasible.

Unsurprisingly, those opposed to the use of the white spaces have urged the Commission to limit the uses to the greatest extent possible. These appeals generally take the form of urging "an abundance of caution," arguing that the Commission can subsequently relax rules if it finds them no longer necessary. This argument amounts to a "death by a thousand cuts" for unlicensed devices in the band. Each channel eliminated, each use foreclosed, makes it that much harder to reach the "tipping point" necessary for mass-market use.

The Commission should therefore resist the urge to impose limitation by rule unless absolutely necessary. To the contrary, the Commission should seek to maximize the potential spectrum available and the potential flexibility of use. In particular, the Commission should

authorize mobile use as a key driver of innovation and economies of scale. To the extent that technology has not yet advanced to the point where devices can coexist with uses on particular bands or mobility remains a concern, the Commission should adopt the approach it took when it authorized unlicensed devices in the 5 GHz bands shared with military radar. There, the Commission wisely authorized service under the rules, but required industry to work with NTIA to develop technologies that could meet the standards adopted by the Commission. The government set a standard, gave technologists and industry the challenge to meet it, and worked with companies to eventually certify devices that met that standard.

Here as well, the Commission should state what specifications it requires for devices to provide mobile services and to operate on Channels 2-4 and Channels 14-20. Deferring the matter to a future rulemaking provides no incentive to develop new technology, given the lengthy and difficult process that initiating a new rulemaking will entail. By contrast, establishing a clearly defined set of requirements for devices will, as it did in the 5 GHz band, spur industry to develop new technologies that address real interference concerns.

A. The Need for Economies of Scale and for Flexibility.

The Commission has observed first hand the dramatic differences economies of scale and flexibility can make in the cost and utility of devices. In 2003, the National Public Safety Telecommunications Council petitioned the Commission to permit it to use "commercially available off the shelf" technology designed for unlicensed operation in the 5.4 GHz band in the 4.9 GHz band allocated by the federal government for public safety. *See In Re 4.9 GHz Band Transferred From Federal Government Use*, 19 FCCRcd 22325 (2004). The Commission

granted the petition, in no small part because of the huge savings it would provide for public safety entities. *Id.* at 22329 & n.38. As the Commission noted, the fact that the consumer market is "orders of magnitude" bigger than the public safety market could drastically reduce the costs associated with designing and manufacturing equipment.

The same economic realities hold true in unlicensed. The use of unlicensed spectrum as a broadband solution became possible because adoption of the IEEE 802.11 "wifi" standards created a massive market for "wifi enabled" consumer devices. *See, e.g.,* Yochai Benkler, "Some Economics of Wireless Communication," 16 Harv. J. L. & Tech. 25, 30 (2002). The availability of this low cost equipment made manufacture of wireless equipment optimized for broadband use affordable by small businesses, universities and local governments.

Indeed, the ubiquitous availability of equipment capable of transmitting signals in the unlicensed band birthed the "community wireless movement." Using only recycled equipment and open source software, community-minded volunteers can "unwire" buildings and neighborhoods to provide free or low-cost wireless connectivity for those who would otherwise remain disconnected.

Without the ubiquitous availability of this wireless equipment, and without the flexibility to use the equipment in any manner desired by the end user, the development of unlicensed wireless broadband could not have happened. If the Commission hopes to see the same success story in the broadcast white spaces, it must ensure that these same two factors define the unlicensed environment. To achieve this goal, the Commission must ensure that developers have incentive and ability to build consumer devices. Only the consumer market provides sufficient size to ensure the necessary economies of scale and the ubiquity needed to ensure that all

Americans enjoy the potential benefits that opening the broadcast white spaces can bring.

As a general rule, the Commission must not impose artificial and expensive limitations on the band. For this reason, the continuous mantra of incumbents to layer endless restrictions "in an abundance of caution" must be resisted. The market for consumer devices is often highly price sensitive; often the jump from "early adopters" to "widespread adoption" does not occur until price drops significantly as economies of scale kick in. The shift this past holiday season of digital televisions from a high-tech luxury to a "must have" gift illustrates this trend.

Two factors require particular attention, however. First, the ability to create mobile devices constitutes a key driver for the consumer market. Second, the Commission must ensure sufficient availability of spectrum to guarantee to manufacturers a national market.

1. Potential Mobile Uses As a Key Driver for Deployment and Economies of Scale

In considering rules for wireless services, the Commission has consistently recognized the value and demand for mobile services as an important element in ensuring the success of wireless services. For example, the Commission cited the ever growing demand for new mobile services as a significant reason for approving the rebanding of the Broadband Radio Service. 19 FCCRcd 14165, 14168 (2004). The Commission likewise permitted mobile services as part of the AWS service rules, and will permit mobile services in the returned 700 MHz spectrum.

With regard to the history of unlicensed use, the desire for mobile connectivity led directly to the inclusion of "wifi enabled" chips in laptops and an endless array of consumer devices. Without this freedom of movement, it is impossible to imagine that the culture of "hotspots" and

public access points could have emerged, with its concomitant benefits for travelers, telecommuters, and society generally. Likewise, mobility is also a key driver and benefit behind the efforts by municipalities and counties to generalize wide area "hotspots" into citywide and even regional community wireless networks.

Given this history, it is obvious that mobility will provide a key driver for economies of scale. Without mobility, it is difficult to see what will prompt the production of millions of units necessary to create cheap devices for consumers. Fixed wireless equipment fit only for backhaul, the vision promoted by IEEE and others, offers little hope for the sort of economies of scale needed to produce genuinely affordable equipment.

2. Co-Existence on Channels 14-20 and Channels 2-4.

These channels represent a large swath of potentially useful spectrum. Because Channels 2-4 are the least desirable for full power digital broadcasters, they are likely to become the largest contiguous block of unassigned frequency after the digital transition. Further, as NAF, *et al.*, argued in their initial comments, consumer devices usually connect to each other using shielded cables, reducing the risk of possible interference.[106]

With regard to channels 14-20, these are only used by public safety entities in 13 markets. Especially in light of the Commission's decision to prohibit mobile uses on these channels, prohibiting operation in these bands nationally makes no sense. If high power television stations can operate safely in these bands, they can certainly accommodate the low power fixed devices the Commission proposes to permit on these channels in this proceeding. For example, as NAF, *et al.*

[106] This argument is developed more fully in the separate, concurrent Technical Comments filed by NAF, *et al.* in this proceeding.

explain in separate Technical Comments, it seems quite likely that an operator could use a combination of geolocation and control signal technologies to operate on both a fixed and mobile basis on Channels 14 to 20, even if this requires special and stricter device certification standards.

Importantly, if one tallies up the number of channels the Commission proposes prohibiting, it would significantly reduce the available spectrum for productive use, particularly in crowded urban markets. Even if the Commission envisions primary use in rural areas, the economics of equipment manufacture and deployment will alter radically if the Commission does not leave adequate spectrum for at lest some use in more developed areas. Unless equipment manufacturers can hope to achieve economies of scale, equipment for use in the band will remain expensive, limiting the ability of WISPs (and utterly foreclosing non-commercial community wireless networks) to exploit the spectrum the Commission would make available explicitly to promote broadband use.

The Commission should also remain cognizant of the amount of spectrum "soaked up" in other proceedings, such as the pending Digital Television Distributed Transmission Systems technology proceeding. MB Docket No. 05-312. By extending the transmission rights of incumbent licensees, dockets such as DTS reduce the available white spaces for productive unlicensed use. If the Commission unnecessarily limits the available white spaces spectrum further in the name of "prudence," it risks dropping the usable spectrum below the necessary threshold to ensure significant production and economies of scale.

B. It Is Better For The Commission To Permit The Broadest Possible Set of Uses At The Rule Stage and Control Interference Risk At the Certification Stage.

The Commission may conclude that technology does not yet permit the operation of unlicensed devices on certain channels or permit mobile uses. In such case, however, the Commission should not ban the use of such devices. The Commission took that approach in 1989, when it prohibited an unlicensed underlay in the television broadcast bands because it feared that such action would delay the roll out of analog high-definition TV. More than 25 years later, the Commission initiated a rulemaking to reconsider this decision. This hardly inspires confidence that the Commission will reopen a decision once it has "gained more experience" with the technology.

Nor does this proceeding stand alone. The lengthy and contentious proceedings that surrounded the introduction of new services such as MMVDS and ultra-wideband demonstrates the difficulty in pressing for the introduction or expansion of a new service fiercely resisted by incumbents. It is difficult to imagine that anyone will invest the money or resources necessary to develop whatever new technologies the Commission might require to permit operation on new channels, or introducing mobility or other flexible uses, if the Commission prohibits them at this stage, subject to a future rulemaking.

Instead, should the Commission decide that it cannot at this time formulate rules for operation on specific channels or for specific uses, it should nevertheless adopt technical specifications for devices that ***would*** address the Commission's concerns. It should then develop a suitable testing procedure that will permit manufacturers to develop these devices with the hope of bringing them to market once they comply with the technical specifications.

The Commission adopted this approach in its proceeding opening new space in the 5 GHz band for shared operation between low power unlicensed devices and military radar. *In Re*

Revision of Parts 2 and 15 of the Commission's Rules to Permit U-NII Devices in the 5 GHz Band, 18 FCCRcd 24484 (2003). To avoid potential interference with sensitive military operations, the Commission mandated that devices operating in the bands must employ dynamic frequency selection (DFS) and transmit power control. *In Re Revision of Parts 2 and 15 of the Commission's Rules to Permit U-NII Devices in the 5 GHz Band*, 21 FCCRcd 1816 (2006). The Commission created a two-year transition period, requiring industry to work with the federal government to create adequate testing procedures to protect military radar operations. *Id.* at 1817. While more complex than originally envisioned, the working group ultimately succeeded in developing tests and technology that satisfied the requirements mandated by the Commission. *See* Letter from Fredrick R. Wentland, Associate Administrator, NTIA, to Julius Knapp, Deputy Chief, OET, March 30, 2006 (available as part of ET Docket No. 03-122).

Industry participants had incentive to invest money and years in development because the Commission provided a clear road to approval of the new technology. The Commission can accomplish the same result in this proceeding by authorizing devices in its rules, but setting rigorous standards for testing and certification. Even without an interim certification process, the combination of a clear set of requirements and a realistic path to market will provide incentive to developers to address whatever reservations the Commission may harbor at the end of this rulemaking proceeding. On the other hand, without a clear and realistic path to market, the Commission should not imagine that developers will invest money and resources on the hopes that the Commission might "someday" revisit decision to prohibit certain channels or uses.

IV. OPERATION IN BORDER AREAS.

As described in the comments of NAF, *et al.*, in response to the *2004 NPRM*, Commentor Tribal Digital Village (TDV) provides the only available broadband network for a federation of 13 Native American tribes in San Diego County. This wireless network, using only unlicensed spectrum, covers an area of over 100 sq miles.

Access to unlicensed spectrum in the border areas will provide enormous benefits to TDV and the communities they service. If the Commission adopts exclusion zones in the border region, however, substantial portions of the TDV network will need to forgo use of this spectrum opportunity.

The purpose of the coordination agreements is to limit the risk of interference between the United States and Canada, and the United States and Mexico, and clearly address full power stations. *See* Canadian Working Arrangement Letter, available at http://www.fcc.gov/ib/sand/agree/files/can-bc/can-tv.pdf at 1 (agreement is "in order to prevent undue interference between stations" of respective countries). Given the low power and sensing capabilities proposed in this proceeding, there is no risk of interference to either Mexican or Canadian television operation. If the Commission certifies devices that can sense protected DTV signals originating within the U.S., it can be equally confident the devices can detect the comparable signals originating within Mexico or Canada. The geolocation approach should be another reliable option, for both fixed access devices and the handsets to which those base stations can transmit a control signal (i.e., permission to transmit).

The Commission adopted a similar approach in its interpretation of the Section 301 licensing requirement in its *2004 Ultra-Wideband Order*. *See In re Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, Second Report and Order*

and Second Memorandum Opinion and Order, 19 FCCRcd 24558 (2004). Addressing the argument that Section 301 required that all transmissions of energy required an exclusive license, the Commission determined that Section 301 applied only to transmissions of energy with sufficient power to cause interference to licensed services. *Id.* at ¶68.

Similarly, the Commission should interpret the legal requirements for coordination as existing only where a device can potentially interfere. This appears consistent with past practice, as there is no evidence that the Commission sought coordination from Mexico or Canada in the wake of the 1989 changes to the Commission's Part 15 rules which authorized an unlicensed underlay in the FM band.

V. ISSUES RAISED BY NAF, ET AL. IN PETITION FOR RECONSIDERATION.

On December 18, 2006, New America Foundation and the Champaign-Urbana Wireless Network submitted a timely *Petition for Reconsideration* addressing three issues. In addition to challenging the Commission's decision to reopen the question of licensed v. unlicensed as arbitrary, the *Petition* also asked the Commission to reconsider the determination to prohibit mobile uses on channels 14-20 and to prohibit marketing of unlicensed devices in the band until after the statutory date for the end of analog broadcasting. To the extent not already discussed in these comments, NAF, *et al.*, hereby incorporate the *Petition* and the arguments made therein.

CONCLUSION

This proceeding has tremendous opportunity to benefit the American people by making ubiquitous, affordable broadband available to all Americans via unlicensed devices. Indeed, given

the history of innovation in the unlicensed space, broadband may only prove to be the beginning of the wireless technologies that emerge from opening this particularly useful band to unlicensed use. The Commission should seize this opportunity to maximize productive use of all underutilized spectrum on the band, rather than frittering it away through misplaced caution.

Respectfully submitted,

J.H. Snider
Michael Calabrese
New America Foundation
Wireless Future Program
1630 Connecticut Avenue, NW
7th Floor
Washington, DC 20006
(202) 986-2700

Harold Feld
Andrew Jay Schwartzman
Media Access Project
1625 K St., NW
Suite 1118
Washington, DC 20009
(202) 232-4300
Counsel for NAF, et al.

APPENDICES

(Please see separate attachment)