

Reclaiming the 'Vast Wasteland'

UNLICENSED SHARING OF BROADCAST SPECTRUM

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Introduction

Each day, from morning to night, nearly every American makes use of an incredible variety of unlicensed wireless devices. From controlling the garage door and monitoring the baby, to microwaving breakfast and speaking on a cordless phone, to using wireless Internet access at an office or public 'hotspot', to turning off the television via remote control, our interactions with unlicensed devices have become second nature. And each day, whether most of us realize it or not, we go to bed not having to ask permission or pay a cent to anyone for the right to do these things.

What makes all of these conveniences possible? Open and shared citizen access to a small portion of the spectrum by multiple users at low power, subject to light-handed technical restrictions. The benefits of this freedom to innovate within the unlicensed bands are seen daily in the numerous devices and conveniences we take for granted. Additional unlicensed spectrum at low frequencies would create opportunities for greater competition and innovation, more affordable high-speed Internet access, and other new wireless services.

Unlicensed Notice of Inquiry

On December 20, 2003, the Federal Communications Commission released a Notice of Inquiry¹ in the matter of allocating additional spectrum above 3GHz and below 900MHz for general use on a license-exempt basis. While opening up additional unlicensed spectrum above 3GHz is beneficial, the physical characteristics of spectrum below one gigahertz offer the unique ability to penetrate foliage, walls, and other natural obstacles faced by radio signals.² These frequencies have increased economic value derived from their beneficial technical characteristics. Therefore, the means by which unlicensed devices are given the opportunity to utilize unused spectrum in the bands allocated to television broadcasting is the focus here.

At the heart of the FCC's inquiry was a request for comment on the ability of unlicensed devices to operate in a secondary fashion to licensed high-power services in the broadcast bands. In response, a broad range of individuals,

incumbent licensees, public interest groups, and technology companies filed over one hundred comments and reply comments.

Not surprisingly, the majority of responses leaned toward an incumbent "not in my backyard" argument (also known as the "NIMBY Syndrome"). While the bulk of the Commenters expressed general support for opening up more spectrum to unlicensed use, their support was predicated on the assumption that their spectrum should remain untouched. The logical consequence of this NIMBY Syndrome is that every frequency band, once assigned to a licensed service, tends to remain so, leaving no spectrum capacity available for unlicensed access by newer, more spectrally efficient technologies.

During the past three years, the rapid deployment of unlicensed wireless devices — particularly Wi-Fi networks — has become one of the few examples of growth and profitability in the telecom sector. While most of the equipment deployed has utilized frequencies above one gigahertz, more requests have been made for access to lower frequencies due to propagation characteristics that offer greater flexibility and cost-effectiveness. Yet, rather than give these unlicensed devices more spectrum breathing room, the FCC has decided that they would rather risk suffocating this nascent industry.

As personal communication and Internet access goes wireless, the demand for spectrum continues to explode. Something, or rather someone, has to give. Due to the command and control allocation regime currently in place, even though the vast majority of spectrum in the broadcast bands is grossly underutilized, it has been impossible for new, novel, and more efficient technologies to be rapidly deployed.

The New America Foundation, in formal comments to the FCC, proposed three distinct methods of allocating unlicensed access to the broadcast spectrum:³

1. **Dedicated** unlicensed access would allocate a band of frequencies solely on a shared basis to devices operating without interference protection. An example of dedicated

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unlicensed use is the 2.4 GHz band, where Wi-Fi, Bluetooth, and other unlicensed services are booming. Currently, over 90% of the spectrum used by TV channels 52-69 are guard bands, or “whitespace” not assigned to full power TV stations. Since these are due under current law to be returned to the public, they should be allocated for shared access immediately and become unlicensed after the digital television transition.

2. **Underlay** access would allow license-exempt devices to operate alongside licensed services on a localized and low-power basis without causing harmful interference. Garage door openers are an example of such use, as they share the 225-400 MHz band with the United States Air Force with little incident. A low power unlicensed underlay could be allocated across all broadcast bands.
3. **Opportunistic** unlicensed access would give “smart” radio devices the right to transmit on licensed or government bands where primary services do not fully utilize the information-carrying capacity of their spectrum allocations. Emerging smart radio technologies incorporating sharing protocols can be used by unlicensed devices without harmful interference to incumbent services.

By creating distinctions in unlicensed access types, spectrum regulators would have greater flexibility and legal granularity to accommodate multiple simultaneous users within a set of frequencies. The benefits of this approach would enable users to use spectrum to its fullest capacity, while lowering the costs of spectrum access by mitigating its artificial scarcity. This Issue Brief will focus primarily on allocating additional dedicated unlicensed bands while also building a case for the rethinking of access policies that govern unused portions of the prime spectrum currently allocated for TV broadcasting. (For more details, please consult New America’s Comments and Reply Comments.⁴)

Channels 52-69: A Vast Wasteland

The broadcast band is famously underutilized. In the memorable phrase of Mark Lewyn: “Television is a wasteland of wasted spectrum.”⁵ Currently, there are 402 MHz of prime spectrum allocated for local TV broadcasting. This 402 MHz is scattered between the frequencies of 54 to 806 MHz and is divided into 67 channels, each 6 MHz wide. After the digital TV transition, a total of 294 MHz and 49 channels will remain allocated to TV broadcasting.

Although there are 67 useable channels, the average American television market only receives at present slightly more than seven channels, leaving on average close to 90

percent of the broadcast spectrum empty.⁶ Most of this empty space was designed to provide interference protection (“guard bands”), while the remainder is unassigned, especially outside the very largest cities. In addition, the allocation of television stations is skewed toward lower frequency channels, which offer superior reception. As the average viewer creeps up the television dial, stations become fewer and far between, particularly beyond the core channels 2-to-51.

High Power Broadcast Spectrum Utilization Rate As a Share of 210 U.S. TV Markets		
Channel	(%) Allocation	(%) Viewing Households
52	11.0	28.7
53	11.9	28.1
54	9.1	19.0
55	11.9	20.6
56	12.9	32.6
57	12.9	25.0
58	11.9	20.0
59	9.1	20.6
60	3.3	15.6
61	6.2	24.0
62	5.2	20.5
63	1.9	3.7
64	3.8	7.5
65	3.3	12.7
66	5.2	18.6
67	4.3	15.3
68	4.8	21.1
69	1.9	5.1
Average	7.3	18.8

Figure 1. Channels 52-69: A Vast Wasteland

To demonstrate the immediate availability of broadcast band spectrum above channel 52, a tally was made of licensed television stations operating in each of the nation’s 210 Designated Market Areas.⁷ Figure 1 illustrates the low spectrum utilization rate of the Lower and Upper 700 MHz bands. The column labeled “(%) Allocation” shows the percentage of stations operating on a particular channel (across all 210 market areas) and is not affected by the size of the population within those markets. The column labeled “(%) Viewing Households” shows the percentage of viewing households out of the total number of viewing households (from all 210 market areas) that can receive a particular channel. By its nature, this second column weights television coverage depending on the size of the market.

These utilization numbers indicate that there is on average a 1 in 14 chance that a high-powered station is operating on one of channels 52-69 in a viewing area, and a 1 in 5 chance that the station is actually receivable by a viewing household.

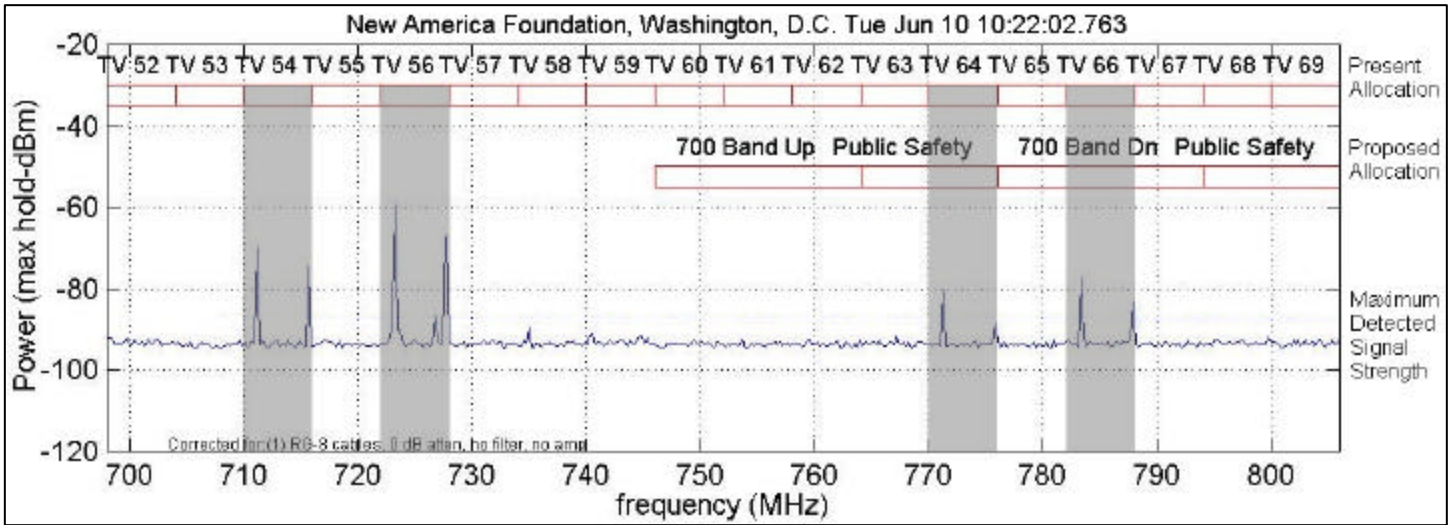


Figure 2. Whitespace Measurements of Channels 52 to 69, Downtown Washington, D.C., June 10, 2003.

Experimental Support

To demonstrate the emptiness of the broadcast band spectrum from channel 52 to 69, New America – in concert with the Shared Spectrum Company – took direct measurements of the spectrum within the vicinity of the Foundation’s headquarters, in downtown Washington, D.C., one mile north of the White House.⁸ Figure 2 shows the maximum signal strengths received over a two-hour monitoring period. It is evident that only 4 channels are active out of 18, and that only one of these channels barely meets the minimum standard for protection from interference according to the FCC-defined Grade B service contour. Put simply, the 108 MHz of spectrum allocated to television channels 52-69 is measurably underutilized and could very easily be put to better use by many other services.

Turn Whitespace into Dedicated Unlicensed Bands

A number of transitional steps will be necessary to allow for the gradual introduction of unlicensed devices on unused broadcast frequencies. The first step would allow unlicensed devices to operate on the guard bands and unassigned channels in the bands associated with TV channels 52-69. Since these channels have been designated for relocation early in the DTV transition, and since there are very few stations operating on these channels, a significant amount of spectrum should be made available for immediate sharing.

Next, as current licensed users vacate the band, unlicensed devices should then be granted the full frequency range for dedicated unlicensed use while avoiding interference to the public safety operations in the Upper 700 MHz band. Finally, as the DTV transition enters its final stages, former analog guard bands in the range of channels 2-to-51 (excluding Channel 37), should be made available for unlicensed use. However, even before the end of the DTV transition, an effort should be made to allow greater opportunistic use of unused broadcast spectrum.

There is nothing new about the sharing of broadcast spectrum by low-powered, limited-range devices: Production studio devices

and wireless microphones already have shared access to broadcast spectrum, with no apparent harmful interference to off-premise TV reception. For example, content and television producers use tools known as Wireless Assist Video Devices to coordinate scenes being shot by film crews. WAVDs are allowed to operate as broadcast auxiliary devices on unused spectrum provided they do not interfere with nearby television receivers. The proposal here merely extends this access to the public.

Other examples include low-powered wireless microphones produced by established companies such as Shure⁹ and Audio-Technica that operate in unused broadcast spectrum, and are used at sports venues, churches, and thousands of other locations. Since these devices operate on the broadcast band today with little incident, there is strong reason to doubt the assertion made by the National Association of Broadcasters that allowing unlicensed use would necessarily cause harmful interference to broadcast receivers.¹⁰

Opportunistic Sharing of Unused Capacity

Spectrum is not a depletable asset. Unlike, tangible resources like oil, its supply does not diminish with time and use. Any spectrum capacity not used at a particular moment is forever lost. If this otherwise unused spectrum could have been used for communication, a pure loss results when it remains fallow. To the extent unlicensed use of this spectrum is possible without materially harming broadcasters, it should be allowed.

It is known that the broadcast bands are mostly underutilized and that older technologies such as wireless microphones are capable of opportunistically sharing such spectrum. However, wireless microphones are primitive when compared to emerging cognitive radio technologies, which are capable of detecting their spectrum environment and adjusting to avoid interference. A double standard is evident in the fact that wireless microphones, which have no inherent spectrum etiquette, are allowed to operate freely in the broadcast spectrum while smarter devices, such as Wi-Fi equipment, are excluded.

Most broadcast spectrum, even channels licensed for use within a particular market, remains unused. In addition to guard bands and unassigned channels, noted above, many broadcasters do not transmit signals around the clock, making these channels available during some portion of the day or night. Also, not all broadcasters transmit their signals at full power, meaning that they needlessly block additional communications in unreached service areas.

If the broadcasters aren't fully using the spectrum on licensed channels, citizens should be able to use that spectrum on a listen-before-transmit basis, using smart radios and other intelligent wireless devices. Only approximately ten percent of Americans receive their television signals exclusively via terrestrial broadcast frequencies ("over-the-air"),¹¹ while the overwhelming majority of the population receives television signals via satellite or cable. In some areas, such as rural or mountainous regions, very few people actually receive over-the-air television. Where spectrum can be shared without causing harmful interference, other uses should be allowed.

Broadcasters' Limited License Rights

Although Congress granted the broadcast industry access to a disproportionate share of the most valuable low-frequency spectrum in return for providing "free" over-the-air television service, the terms of these licenses do not confer full property rights over all the possible uses of that spectrum.

Since broadcasters do not own the spectrum they operate on, any right not specifically contained in their license belongs to the public.¹² Their license is primarily restricted to the provision of local, ad-supported television programming.¹³ Allowing license-exempt users to provide a service on a non-interfering basis does not infringe on assigned license rights. In the recent Ultra-Wideband Report and Order¹⁴, the FCC affirmed this doctrine, rejecting attempts by Sprint to expand the scope of its PCS license rights, which would have prevented any license-exempt services from operating in the PCS frequencies. The FCC responded by explicitly stating that the right to operate a service on PCS spectrum "is not, and has never been, exclusive to Sprint or to any other licensee or user."¹⁵ In other words, while licensees are granted access to provide a service, the public retains the right to use the band for additional non-interfering communication. Since the public reserves all unenumerated spectrum rights, the public should apply these rights toward the provision of maximal additional wireless services.

Conclusion

Access to additional unlicensed spectrum, particularly in frequencies below one gigahertz, would offer a unique opportunity for innovators to capitalize on significant advances in digital and cognitive radio technologies to provide new services, including more affordable last-mile broadband connections for rural and low-income areas. Emerging technologies such as cognitive radios, directional antennas,

spectrum sharing protocols, and others will ultimately allow more users to capture the value of unused spectrum.

Wherever new technologies enable unlicensed services to utilize broadcast spectrum in a non-interfering manner, the government should allow the use of those technologies. As demonstrated above, large portions of the broadcast spectrum lie fallow. Allowing opportunistic, underlay, and dedicated license-exempt access to the grossly underutilized TV broadcast bands would create the regulatory environment necessary for fresh development in advanced wireless communications.

Endnotes

¹ Federal Communications Commission, Notice of Inquiry, "In the Matter of Additional Spectrum for Unlicensed Devices Below 900MHz and in the 3GHz Band," ET Docket No. 02-380, December 20, 2002.

² J. H. Snider, *The Explanation to the Citizen's Guide to the Airwaves*, Washington, DC: New America Foundation, May 2003.

³ A fourth type of allocation, derived from Robert Matheson's Electrospace Model, will be discussed in a forthcoming New America Foundation Working Paper, "The Technology, Economics, and Public Policy of Whitespace." The Electrospace Model, which assumes ideal radio devices, specifies a more fine-grained model of spectrum capacity and rights than the current FCC model. The Electrospace Model implies, for example, that the current broadcast service, restricted to one high power transmitter, not only could co-exist with other services without interference, but also use frequency bands that could simultaneously transmit more than a million times the current information transmitted within the broadcast band.

⁴ See Comments and Reply Comments, New America Foundation, et al., in ET Docket No. 02-380, April 17, 2003 and May 16, 2003.

⁵ Mark Lewyn, "Airwave Wars," *Business Week*, July 23, 1990.

⁶ Thomas Hazlett, "The U.S. Digital TV Transition: Time to Toss the Negroponte Switch," Working Paper 01-15, Brookings-AEI Joint Center for Regulatory Studies, November 2001.

⁷ See 100000 Watts: US Radio and TV Directory, <http://www.100000watts.com/>

⁸ For more details about the broadcast spectrum measurements, see Max Vilimpc and Mark McHenry, "Dupont Circle Spectrum Utilization During Peak Hours," New America Foundation and Shared Spectrum Company, June 10, 2003. Available at: http://www.newamerica.net/Download_Docs/pdfs/Doc_File_183_1.pdf

⁹ See Comments of Shure, Inc. in ET Docket No. 01-75, August 7, 2001.

¹⁰ See Comments of the National Association of Broadcasters in ET Docket No. 02-380, April 17, 2003.

¹¹ *Supra*, note 6, Hazlett, at p.7.

¹² Communications Act of 1934, Title III, Section 301.

¹³ The Telecommunications Act of 1996 grants broadcasters the right to offer "ancillary services," providing they pay a five percent royalty to the public for this right. However, types of ancillary service are limited; broadcasters cannot, for example, offer mobile telephone service under their license.

¹⁴ Federal Communications Commission, "Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems," First Report and Order, ET Docket No. 98-153.

¹⁵ *Ibid.*, at ¶ 271.