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
	)	

ECONOMIC/LEGAL REPLY COMMENTS OF

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COMMON CAUSE, EDUCAUSE, PUBLIC KNOWLEDGE, U.S. PIRG,
CENTER FOR DIGITAL DEMOCRACY, NATIONAL HISPANIC MEDIA COALITION, WIRELESS INTERNET SERVICE PROVEDERS ASSOCIATION,
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March 2, 2007

TABLE OF CONTENTS

NAF, *et al.* filed extensive comments in this proceeding on January 31, including separate Technical Comments that appended the results of two engineering studies demonstrating that harmful interference to television reception can certainly be avoided. In these Reply Comments to the FCC's FNPRM, NAF, *et al.* focuses on two topics: 1) the incumbents' pleadings for additional free spectrum rights, which in each case would entail enormous opportunity costs with respect to spectrum efficiency and unlicensed innovation; and 2) arguments claiming superiority of licensed over unlicensed allocation of the TV white spaces, which are based in each case on false or contradictory assumptions. These Reply Comments are supplemented by a separate set of Technical Reply Comments, drafted by leading RF engineers and filed concurrently with this filing. We also incorporate and endorse those comments by reference.[1]

I. SPECIAL PLEADINGS BY INCUMBENT LICENSEES WOULD, CUMULATIVELY, DESTROY THE VALUE OF THE TV BAND FOR BROADBAND AND WIRELESS INNOVATION

The comments to this FNPRM represent a diverse array of incumbent interests and an even greater variety of arguments supporting those interests. Earlier comments have focused on the incumbent interests of the high power TV broadcasters, public safety, and wireless microphone licensees to the broadcast spectrum. This set of comments brought out the medical telemetry, cable operators, LPTV, and TV translator incumbents in greater force. Some of the comments are transparent efforts to leverage the proceeding to grab additional spectrum rights;[2] others are blatant attempts to stifle competition to their licensed offerings;[3] while still others are desperate bids to protect an inefficient and eroding status quo despite the enormous social and economic opportunity costs of continuing to warehouse TV band spectrum rather than redeploy it to facilitate wireless broadband and other innovation.[4]

One approach to responding to all the incumbents' arguments is to deal with each one individually. Many of the most consequential assertions of the spectrum incumbents are addressed in NAF, *et al.*'s separate Technical Reply Comments.[5] Yet even if NAF, *et al.* had the resources to file hundreds of pages of rebuttal backed by millions of dollars worth of experimental data, it wouldn't be possible to respond to all the hypothetical arguments the incumbents have raised. But that is surely the point of many of the arguments. Rarely do the incumbents come close to proving their arguments. But they are banking on the fact that they don't need to; that the burden of proof will be on non-incumbents who seek to use the white space. So all they have to do is sow doubt – and convince the FCC to prohibit unlicensed access to so many unused TV band channels that the potential market for wireless broadband and other new services will be deterred.

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[1] Technical Reply Comments, NAF, *et al.*, ET Docket 04-186, submitted March 2, 2007.
[2] *See* Comments of Motorola, Docket 04-186, January 31, 2007.
[3] *See* Comments of Qualcomm and, on behalf of Qualcomm, by the Brattle Group (Comments of Charles L. Jackson and Dorothy Robyn), Docket 04-186, January 31, 2007.
[4] *See* Comments of Shure, Inc., GE Healthcare, American Society for Healthcare Engineering (ASHE), Docket 04-186, January 31, 2007.
[5] *Supra* note 1.

NAF, *et al.*, is not going to respond to all those arguments. This is the sixth time NAF, *et al.* has filed comments on the use of the TV white spaces. Our previous comments, which did attempt to do so, run to more than 400 pages. Instead, NAF, *et al.* will focus on the heart of the matter.

The unstated assumption underlying the incumbents' arguments is that the long-term interests of the many should be sacrificed for the short-term interests of the few. They are saying, in essence, that to potentially protect the spectrum uses of a small fraction of the public, for a small fraction of the time, they are willing to sacrifice spectrum uses that could benefit the vast majority of the public in an abundance of different ways, including to facilitate broadband deployment, affordability, and ubiquity at a time when our nation has fallen to 16th in the world in broadband adoption (and with prices ten times higher, per Mbps, than other advanced economies). With rare exception, the spectrum incumbents have been completely unwilling to explicitly deal with this objection, implicitly asserting that if even a single *potential* user of their service would be inconvenienced, they have the right to absolute protection. Their arguments, therefore, are completely at odds with the FCC's mission to manage the public airwaves in the public interest, which, in economic terms, means to maximize social welfare, as well as to facilitate robust and diverse communication based on First Amendment principles.

This underlying assumption that the opportunity cost to the general public can be ignored was obscured when the incumbents framed their arguments as merely protecting their existing users. But in their FNPRM comments, the incumbents have now gone well beyond that convenient framing of the issue. With few exceptions, prominent representatives from each major incumbent interest group have made major new claims on the TV white space, seeking a vast enlargement of their spectrum rights. They continue to frame this spectrum grab as protecting their existing users. But no one should be fooled by this framing. Now that they know the FCC is serious about allocating the white space, they want to claim as much of it as possible for themselves. And since they cannot baldly ask for such a momentous giveaway of spectrum rights (the Communications Act bans spectrum "windfalls"), they are, for the most part, framing their spectrum grab as a ratification of the status quo rather than the radical departure from the status quo which it is.

Taken individually, each incumbent's spectrum grab may seem reasonable. But taken collectively, a much clearer perspective of what is going on becomes evident. For if all the incumbents get what they want, it is clear that there will be virtually no spectrum left for any market entrant or future innovator, whether unlicensed or licensed. Moreover, with so many underutilized channels inaccessible, any unlicensed devices that are allowed would be so expensive or otherwise crippled that an unlicensed allocation, to the extent there is any, could be pyrrhic.

What will be protected by killing off the possibility of a meaningful allocation of low frequency spectrum to unlicensed use? Remarkably little. The wireless microphone incumbents typify the special pleading endemic to this proceeding. Shure Inc., the most active wireless microphone incumbent in this proceeding and on Capitol Hill, wants to

exclude unlicensed from a minimum of six vacant TV channels per TV market and a maximum of close to at least 20. The larger number is not stated explicitly, but merely stated as a request that wireless microphone users (90% of whom are operating illegally and would be rewarded for thumbing their nose at the Commission's rules) have exclusive use of first adjacent channels.[6] In a market like New York City, that represents at least 20 channels. To protect wireless microphones, Shure is also quite willing to ban personal/portable unlicensed devices across the entire band and impose crippling costs on unlicensed devices to ensure that they couldn't possibly, in any scenario, interfere with an unlicensed microphone. And what is protected at such an immense public cost? Shure cites large venues such as the Grand Ole Opry, the Super Bowl, Broadway and touring shows, the Academy Awards and the Grammy Awards shows, and national political conventions. The idea that these privately and tightly controlled venues cannot take steps to ensure that a low-power personal/portable device is not operated close to their receivers is implausible on its face. But moreover, the notion that the nation should sacrifice tens of billions of dollars in potential economic activity so that these venues might not be inconvenienced is a sad commentary on the "culture" of FCC spectrum politics.

Moreover, there are excellent and affordable substitutes for the types of applications Shure wants protected at such an immense social cost. If they want high guaranteed quality of service, they can use licensed audio services provided by 3G, MSS, and WiMax providers. If they continue not to want to pay for spectrum, they can use an unlicensed audio service with widely deployed standards such as WiFi or Bluetooth. Alternatively, they could continue to provide audio service in the TV white spaces on an unlicensed basis with their existing wireless microphones. If corporate America is willing to incorporate WiFi into their PBXs for mission critical telephone communications, surely many of the local venues that use wireless microphones can do the same. All these arguments have already been presented in earlier NAF *et al.* comments but Shure and the other wireless mic advocates have yet to address them in a serious way.

For better or worse, these wireless microphone systems can continue to operate during a transition period with protection from unlicensed devices that incorporate sensing/DFS technology. Reply Comments filed by the joint high-technology company coalition (Dell, Microsoft, Intel, Google, AT&T, et al.) describe the parameters of the first prototype personal/portable device and its ability to detect and avoid interference with these wireless microphone systems.[7]

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[6] *See* Comments of Shure, Inc., Docket 04-186, January 31, 2007.
[7] *See* Reply Comments of AT&T, Dell, Google, *et al.*, ET Docket 04-186 (March 2, 2007).

II. THERE ARE CLOSE AND MORE EFFICIENT SUBSTITUTES FOR INCUMBENT APPEALS FOR EXPANDED PROTECTION ON THE TV BAND

Table 1 categorizes the incumbents' claims on the white space. Note that in every case there are close economic substitutes for the services the incumbents want to provide at a huge opportunity cost to society. The list is not comprehensive, but it highlights major issues. The list also ignores proposed restrictions on modes of unlicensed use (such as proposed bans on personal/portable) and simple devices not burdened with costly interference mitigation technologies. These omissions are not made because the uses are not important, nor because there are not excessive restrictions on unlicensed spectrum use. They are omitted only because they aren't necessary to explicate the basic economic logic of what the incumbents are seeking to do.

Table 1. Incumbents' White Space Spectrum Grab

Incumbent Interest	Spectrum Sought	Substitutes
Cable (NCTA)	Cable headends outside of the Grade B contour; Channels 2-13	Direct Broadcast Satellite TV, Cable TV, Telco TV, Internet TV, Commercial Satellite TV, point-to-point microwave links; Settop boxes;
Public Safety (Motorola)	Channels 14-20; two additional vacant channels each from 7-13 and 21-25.	700 MHz spectrum, 800 MHz spectrum, 4.9 GHz spectrum, federal interoperable spectrum
Wireless Microphones (Shure)	Six to at least 20 vacant channels	3G, MSS, WiMax, WiFi, Bluetooth
Medical Telemetry (GE Healthcare)	Channels 36, 38; delay white space use of Channels 33-35	Channel 37, Unlicensed rights with trespass laws
High Power Broadcasters (Joint Comments of Broadcasters, NAB/MSTV)	New spectrum rights between the Grade B and DMA contours; First Adjacent channels	Satellite TV, Cable TV, Telco TV, Internet TV
TV Translators and LPTV (Community Broadcasters Association and National Translator Association)	New spectrum rights between the Grade A contour and the farthest edge of a household that can receive a TV signal outside that contour by employing high antennas directed at the broadcast transmitter	Satellite TV, Cable TV, Telco TV, Internet TV

A. Cable

Spectrum Grab: NCTA observes that "portable devices have the potential to cause interference to headend reception," and concludes, "thus their operation should be restricted within the Grade B contour and coordinated with headends outside the Grade B contour."

Substitutes: Cable TV headends now have many substitutes for acquiring local broadcast TV channels. These substitutes include use of the fiber backbone connecting their broadband service to the World Wide Web (more than 90% of cable systems now provide broadband service), direct broadcast satellite TV (which now provides local TV service to more than 94% of the U.S. population), interconnection with adjacent cable TV networks within the Grade B contour, and direct microwave-to-microwave links from a site within the Grade B contour to a headend outside the Grade B contour (the cable industry has been allocated more than 1 GHz of spectrum to support their internal operations, including linking cable systems together into networks).[8]

Spectrum Warehousing: NCTA asks the FCC to "prohibit transmissions in the VHF channels given the high probability of direct pickup interference to TV receivers."

Substitutes: Let us assume merely for the sake of argument that NCTA's VHF shielding allegations are correct (a position that NAF, *et al.* has disputed in its technical comments[9]). This still leaves open the possibility that consumers can readily address any interference problem. They could do this in four ways: 1) purchase a TV with better shielding, 2) avoid using an unlicensed device in the immediate vicinity of their TV, 3) purchase a set top converter box (which converts all signals to channels 2-4), or 4) subscribe to satellite service.

How many consumers are affected by the poor shielding problem? NCTA acknowledges it doesn't have this information and requests that the Commission pick a representative sample of receivers to test. An upper bound is the percentage of U.S. households that rely on basic cable service, which is less than 50%. Of those affected, most could undoubtedly address the problem simply by having the unlicensed device switch to a non-interfering channel. For those where this might be impractical, such as an apartment complex with paper-thin walls, an option would be to acquire a converter box, which costs as little as $50 at retail and is often bundled for free as part of a cable subscription package.

B. Public Safety

Spectrum Grab: In previous comments, Motorola has sought to ban the use of personal/portable unlicensed devices on Channels 14-to-20 in all of the nation's 210 local

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[8] As an aside, if cable systems are unwilling to use spectrum allocated to them for point-to-point microwave links, they should give up that spectrum. Solving any existing rural cable headend problem could be an ideal use of the cable industry's high frequency spectrum allocation.

[9] Cite Marcus et al.

TV markets because in 13 of those TV markets, one or two of those channels are used by increasingly antiquated analog public safety radios.[10] The fear is that unlicensed devices purchased outside those 13 markets could be carried into those 13 markets, endangering their public safety communications.

Now, Motorola is acknowledging that it is very wasteful to prevent 197 U.S. communities from using extremely valuable spectrum just because 13 might need use of that spectrum in an emergency. But Motorola's remedy is not to relocate the public safety users to one of the existing or new public safety bands; or even to restrict those channels to unlicensed devices relying on the geolocate/database means of ensuring that they do not operate in one of the 13 legacy metro markets. Instead, Motorola wants to leverage a legitimate interference concern to allocate all of white space between channels 14-20 for the exclusive use of "public safety low powered devices" – sold, on a proprietary and thus far more expensive basis, by none other than Motorola.[11] It also seeks to grant public safety "unconditional priority access" to two vacant VHF channels from Channels 7-to-13 and two vacant UHF channels from 21-to-25.[12] Lastly, it states that "public safety and other critical users should have the ability to preempt users on other channels within this range (TV channels 7-to-25) if necessary to meet critical communications requirements."[13]

Substitutes: Motorola is to be applauded for at least acknowledging the huge waste if the Commission were to allow the white space to lie fallow between TV channels 14-to-20 in 197 markets. But its appeal to acquire all that white space for public safety, plus other immense priority-of-use rights, would also come at a huge social cost. Congress and the FCC have in recent years allocated large new swaths of dedicated spectrum on a national basis to local public safety. This includes the 700 MHz band, a cleaned up 800 MHz band, and the 4.9 GHz band. A major justification for allocating the vacant TV channels to unlicensed was that the channels vary market by market and thus are not as useful for public safety as the national 700 MHz, 800 MHz, and 4.9 GHz bands. Nowhere does Motorola address this question. Nor does Motorola address the question whether, if public safety got this band, it would be willing to give up on its proposed new 30 MHz allocation in the 700 MHz band and its current 24 MHz allocation in that band. Surely there would be no rational justification for the Commission to grant exclusive rights to 42 MHz below 700 MHz on top of the existing 700 band allocation.

Already, more than 50% of all frequencies suitable for communications are used for the government's internal operations and for the provision of public safety. In an era when spectrum is the lifeblood of the economy, the first priority should be to get federal and local governments to use their existing spectrum more efficiently. That includes creating interoperable public safety systems that include both federal and local governments, where federal and local frequencies are viewed as close substitutes.

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[10] *See* Comments of Motorola, Docket 04-186, January 31, 2007, p. 3.
[11] *Ibid.,* p. ii, 15.
[12] *Ibid.,* p. 13.
[13] *Ibid.*

C. Medical Telemetry

Spectrum Grab: GE Healthcare "proposes that the use of television channels 36 and 38 by unlicensed devices not be permitted,"[14] that, at a minimum, "a one-year delay in the availability of channels 33-36 for unlicensed device use is needed to protect legacy medical telemetry devices,"[15] and that, on channels 7-to-46, "unlicensed fixed/access devices in the TV bands be required to notify nearby hospitals before they begin operations." The American Society for Healthcare Engineering (ASHE) goes one step further by arguing that *all* unlicensed devices should have built-in geolocation/database functionality to facilitate avoidance of interference with hospital medical telemetry equipment.[16]

Substitutes: In 1997, the FCC approved granting each incumbent TV licensee a second TV channel to accommodate its DTV transition. It also gave notice that the TV band would be radically reduced in size after the DTV transition in 2006 (the original deadline), thus restricting the ability of medical telemetry devices to operate in the vacant channels.

In 2000, the FCC responded to the concerns of the medical telemetry community by granting it 14 MHz of spectrum, including TV Channel 37, on a primary basis. Prior to this time, all medical telemetry devices operated on a secondary, unlicensed basis. As part of this deal, the FCC barred any new authorizations of medical telemetry devices on any TV channel other than Channel 37. However, the FCC grandfathered incumbent authorizations within the TV band, with the clear understanding that they were secondary users and could be prevented at any time from using their spectrum by a TV broadcaster which was a primary user.

The medical telemetry community has now known for ten years that it would have to vacate much of its spectrum within the TV band. In 1997, the FCC set that deadline to 2006. In 2005, Congress extended the deadline to 2009. In other words, by 2009, the medical telemetry community will have had 12 years of notice that it would have to substantially vacate the TV band and seek out an affordable substitute. NAF, *et al.* believe that 12 years of general notice and nine years with specific notice has been quite adequate notice, and the medical telemetry community should be given no additional delays.

In addition, since 2000, the medical telemetry community has been provided with a compelling substitute free-of-charge: 14 MHz of spectrum to which it has primary interference protection rights. It is long past time for the medical telemetry community to take advantage of that substitute.

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[14] *See* Comments of GE Healthcare, Docket 04-186, January 31, 2007, at p. 9.
[15] *Ibid* at p. 3.
[16] *See* Comments of American Society for Healthcare Engineering, Docket 04-186, January 31, 2007, at p. 5.

NAF, *et al.* also contends that the unlicensed status of medical telemetry devices on TV channels 7-36 and 38-46 should not be changed. If medical telemetry devices want additional protection, they should migrate to the 14 MHz the FCC allocated for that purpose.

Underlying the requests for delay and notification is an economic argument: the FCC can save the healthcare industry money "by protecting a significant portion of healthcare providers' existing investments in legacy equipment."[17] No financial calculations are provided to quantify the magnitude of this claim. Essentially, what the hospital community is asking is that to protect narrowly restricted services covering less than one thousandth of one percent of the U.S. landmass and with close and affordable substitutes, hundreds of millions of spectrum users in the rest of the United States must wait yet another year to share use of that spectrum and, to avoid interference with incumbent medical telemetry devices, also pay an equipment premium on every unlicensed product they purchase.

On TV Channels 36 and 38, GE Healthcare argues that unlicensed devices present a greater threat of interference than other devices, such as TV stations and wireless mics, with "fundamental emissions" near in frequency to Channel 37. It worries that "if unlicensed devices were to operate on either channel 36 or 38 within only a few meters of a WMTS receive antenna at 26 dBM EIRP, as proposed for personal/portable devices, significant receiver desensitization could be expected."[18] Let's assume that GE Healthcare's technical analysis is correct. There would nevertheless be other ways to address the problem that are far less costly to society. For example, hospitals already have to manage a lot of unlicensed interference within their own premises. That is because any medical telemetry device in a hospital can potentially interfere with any other one. With hundreds of medical telemetry devices in some hospitals (one per bed), that's a lot of unlicensed interference management. Those hospitals have for decades also had to manage potential interference with wireless mics and other portable devices that use the same TV channels. An extension of those interference avoidance methods can also be used to deal with personal/portable unlicensed devices.

Hospitals, and especially Intensive Care Units, tightly control their premises. For example, notice could be given that unlicensed use of TV channels 36 and 38 on hospital premises is not permitted and that anyone who violates such an edict will be evicted from hospital premises. If that wasn't enough protection, spectrum analyzers could be placed in sensitive locations to alert hospital staff of violations of the rule. As a reference point for how low prices can go for this type of functionality in a widely used unlicensed band, a Wi-Fi access point can now be purchased for less than $30. With freeware software, that chip can be turned into a sophisticated spectrum analyzer. With multiple analyzers and geolocation/GPS built into each device, the source of an unlicensed violation could be easily identified at an affordable price.

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[17] *Ibid.*, p. 5.
[18] *Supra* note 14, p. 9.

Moreover, the hospital community has provided no compelling evidence that several minutes of passing interference from an unlicensed device would be life threatening. In the late 1990s, when high powered TV stations turned on their very high power DTV channels and medical telemetry devices were temporarily disabled across thousands of square miles, there were no reported incidents of death. A low power unlicensed device passing by a hospital room for a few minutes before a problem is identified, or before the person carrying the device moves on, is much less intrusive than the massive shutdown caused by the advent of DTV service. Also noteworthy is that, despite decades of shared use, there have been no reported deaths from higher powered wireless mics or other wireless devices that have shared the same bands with medical telemetry.

Where the highest levels of public safety are needed, there are licensed substitutes in addition to the 14 MHz the FCC has set aside, including leasing use of the vast amounts of licensed spectrum the FCC has allocated to general service providers including those providing 3G, MSS, or WiMax service.

D. Broadcasters, High Power

Spectrum Grab: The Joint Comments of Broadcasters request all "available TV spectrum be licensed by DMAs" rather than Grade B contour.[19] By the word "available" they mean "white space" – spectrum outside their license area that is currently not being used. In other words, the spectrum rights conveyed by a broadcast license would be expanded from a Grade B contour line, which corresponds to the local community TV market, to the entire DMA, which is often a far larger geographic area not receiving free over-the-air TV service by that broadcast station. Since the area covered by a DMA is often more than 5 times larger than a Grade B, this is a huge increase in spectrum rights. The broadcasters go on to explain that "technological advances are emerging that would permit broadcasters to avoid the technical constraints of their site-based service areas."[20]

Alternative: NAF, *et al.* certainly agree that there is in many areas a large amount of unused spectrum (white space) at the same frequency licensed to local stations, but outside of the viewing area covered by the stations' current licenses (that is, outside the Grade B contour). Technological advances, such as Wi-Fi type technology, allow those white spaces to be put to productive use. NAF, *et al.* has therefore argued, in its Comments and Reply Comments last year in the proceeding on Digital Television Distributed Transmission System Technologies, Docket 05-312,[21] that incumbent broadcasters should not be granted this huge windfall of spectrum rights, particularly where there is no direct link between their expanded spectrum rights (awarded upfront) and any substantial increase in the number of households receiving television content they wouldn't receive in any case.

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[19] *See* Joint Comments of Broadcasters, Docket 04-186, January 31, 2007, p.6.
[20] *Ibid.*, pp. 7-8.
[21] Comments of New America Foundation, *et al.*, In the Matter of Digital Television Distributed Transmission System Technologies, MB Docket 05-312, Feb. 6, 2006.

NAF, *et al.* do not dispute, as a general matter, that it serves the public interest to expand broadcast programming available to viewers, particularly in areas with few channels or where geography has long prevented viewers from benefiting from the availability of free over-the-air programming. But the Commission must weigh this modest general benefit against the potential for a greater harm in cutting off public access to spectrum that would otherwise become available at the conclusion of Docket No. 04-186. Expanding the spectrum footprint of a service on which fewer and fewer households rely is an extremely inefficient use of this spectrum resource.

Spectrum Warehousing: NAB and MSTV argue that "Any operation of a TV Band device on a television station's First Adjacent channel will harm reception."[22] From this they conclude that "the Commission must exclude all TV band devices from operating within the contour of the first adjacent channel."[23]

Substitutes: NAF, *et al*. and other commentators have shown in prior technical comments that unlicensed devices can be used in the first adjacent TV channels without harmful interference to incumbents.[24] But let us assume for argument's sake that some harm to TV reception would inevitably ensue from *any* unlicensed use of the first adjacent channel, even if the unlicensed device operated 3 MHz away from the licensed channel, or at very low power levels, which are two among many alternatives for using the first adjacent channels *to at least some degree* for useful communications on an unlicensed basis. (NAB and MSTV want to assume an unlicensed service must operate over the entire 6 MHz or at a maximum Part 15 power level, but this is clearly not the case.)

But even assuming that current technology creates some risk of interference in some circumstances, it does not necessarily follow that, from a social welfare perspective, warehousing the first adjacent channel is optimal. When there are two adjacent building lots and one is already built and the other is not, building on the second lot may cause economic harm to the first lot builder (due to blocked views, more congestion, bad neighbors, etc.). But from this it does not follow that it is socially harmful to ban the building of any structure at all on all lots adjacent to pre-existing homes. This principle is well established at the FCC. For example, when the radio broadcasters sought to transition to digital radio, they did so by asking for permission to use the first half of each licensee's first adjacent channel. The FCC estimated that this could cause harmful interference to 2.6% of eligible receivers within an FM stations' service area,[25] but the broadcasters applauded this use of first adjacent channels, and the FCC allowed them to be used despite the harmful interference.

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[22] *See* Comments of NAB/MSTV, January 31, 2007, p.16.
[23] *Ibid.*, p.17.
[24] Daniel DePardo, Joseph B. Evans, James A. Roberts, Victor R. Petty, Alexander M. Wyglinski, Paul Kolodzy, and Michael Marcus, "Quantifying the Impact of Unlicensed Devices on Digital TV Receivers" (Washington, DC: New America Foundation, January 31, 2007); Comments of Dell, Google, Hewelett-Packard, Intel, Microsoft, and Philips Corp., Docket 04-186, January 31, 2007.
[25] Further Notice of Proposed Rulemaking and Notice of Inquiry in the Matter of Digital Audio Broadcasting Systems and their Impact on the Terrestrial Radio Broadcast Service, FCC Docket 99-325, April 20, 2004, para. 28.

What is the difference between the use of the first adjacent channels in the TV and radio bands? One difference is that far more people are adversely impacted by use of the first adjacent channels in the radio band.

One reason is that far more people listen to radio over-the-air than TV over-the-air. Radio is still a killer application because it is mobile and faces fewer substitute goods. During drive time, for example, it overwhelmingly dominates the listening audience. Over-the-air TV, in contrast, is a fixed service and faces close cable TV, telco TV, and satellite TV substitutes. Consequently, it only serves a small fragment of the TV audience (less than 10% in certain urban areas such as New York City).

Another reason is that radio is a high power service whereas unlicensed is a low power service, and the potential for harmful interference increases with power levels.

A third reason is that the radio broadcasters wanted to make immediate use of the first adjacent channels. In the TV band, in contrast, the request is only to grant the FCC the *option* to authorize devices in the first adjacent channels if those devices satisfy certain performance criteria designed to minimize potential harm to incumbent broadcasters. This leaves open the possibility that unlicensed use of the first adjacent channels could be phased in gradually as technology improves and allows the specified performance criteria to be met.

However, the biggest difference between the radio and TV bands is that in the radio bands the FCC allowed the incumbent radio broadcasters to reap the windfall from the use of the first adjacent channel. What did the incumbent broadcasters care if they lost up to 5% of their existing audience, measured on a MHz per population basis, when the second channel (the first half of each of their first adjacent channels) allowed them to double their MHz per population coverage and, by granting them rights to convert to digital service, which facilitates audio compression, allow them to provide up to 20 times the standard definition audio service on their licensed spectrum. In other words, the potential gains from the use of the first adjacent--when adjusted for both the increase in spectrum coverage and the increase of service facilitated by digital technology--was more than 40:1.

In the TV band, in contrast, the broadcasters are not being allowed to internalize the social windfall by ending the warehousing of the first adjacent channels. Therefore, they oppose it and harp endlessly on the few Americans who might hypothetically lose over-the-air reception as a result of use of the first adjacent TV channels. Consider the New York City TV market, which has at least 20 first adjacent TV channels and where less than 10% of the public even relies on over-the-air reception. Anybody who might lose reception quality as a result of the use of the first adjacent channels has the option of using close substitutes in the form of cable TV, telco TV, internet TV, or satellite TV. Indeed, from a net social welfare perspective, society might be better off subsidizing anybody who lost TV reception so that this vast treasure trove of spectrum can come into productive use. This might even include subsidizing those whose lost TV reception only

consisted of a single TV channel, for a few minutes a week, broadcasting home shopping information.

However, doing so would be contrary to many precedents in dealing with improvements to other public rights-of-way. For example, should society have forsaken the paving over of dirt roads because dirt roads are hard on horse's feet and thus harm horse rider interests, despite the fact that society overwhelmingly benefits by creating conditions that allow automobile and truck transportation to thrive? Most people who used the horses eventually realized they were better off using the more advanced and flexible modes of transportation. And, in any case, the social gains from upgrading the roads were too great to allow the horse owners to hold the rest of society hostage to their short-term interests. The same public interest logic should apply to the use of the first adjacent channels.

To be fair, the TV broadcasters have not yet sought use of the first adjacent TV channels for themselves. Their sole goal right now appears to keep the first adjacent channels warehoused. But surely, as they are doing with the unused co-channel spectrum in their bid to increase their protected contours from a Grade B to DMA contour, they will one day come back to the FCC and ask for use of the first adjacent channels, just as the radio broadcasters have already paved the way in the radio band. Indeed, their privileged access to the first adjacent channels for wireless microphones, video assist devices, and broadcast auxiliary service, already represents substantial control of the first adjacent channels. Given the huge social cost of allowing the first adjacent channels to continue to be warehoused, the FCC may ultimately accede to the incumbent broadcasters' wishes if third parties are not allowed use of the spectrum. But instead of warehousing the spectrum for many more years and eventually allowing the incumbent broadcasters to reap a spectrum windfall, the FCC should use this proceeding to make sure the first adjacent TV channels come as rapidly as possible into socially productive use. This may be a phased transition, conditioned on the development of advanced technology. But the principle that the first adjacent channels should not simply be granted to the incumbent broadcasters as a default matter needs to be established in law.

E. Broadcasters, Translators and LPTV

Spectrum: The Community Broadcasters Association, which represents LPTV, and the National Translator Association, which represents translators, both seek to expand their protected contour lines. In the words of the Community Broadcasters Association:

> The threshold signal to which a signal sensing system must detect is at least a Grade B signal, because Class A and LPTV stations have significant audiences at those levels, even though the stations are protected only to their Grade A contour. To truly protect Class A and LPTV stations, the signal sensing systems must detect signals weaker than Grade B to take account the variances of television signal propagation.[26]

[26] *See* Comments of Community Broadcasters Association, Docket 04-186, January 31, 2007, p.5.

With more than 5,000 TV translator stations in rural areas, the LP would eat up a huge amount of the rural white space. It would do in the rural areas what the full-power broadcasters propose to do by expanding their licensed spectrum rights out beyond their current service areas to cover the entire DMA.

Alternative: LPTV licensees were given free, site-based spectrum rights to serve local communities, under principles of localism, and it was never intended that they should have expansive, exhaustive geographic spectrum rights akin to an Advanced Wireless Service license (which, in addition, are auctioned). Thus, why give it to them? LPTV licensees are making no promises to serve a substantial population currently lacking access to their local TV stations. Virtually 100% of Americans have access to satellite TV, including network broadcast TV coverage. Currently, 94% also have access to local-into-local broadcast TV service, a figure that, as noted above, is expected to rise to 100% as all 210 local TV markets are covered by the next generation of spot beam satellites.[27] The cable TV industry also claims to pass more than 95% of American homes – and subscribers have access to all local channels under must-carry rules. Most importantly, the rural spectrum that translators want to reallocate for more broadcast service is best used to provide more broadband Internet service. Just as satellite is the low cost and efficient way to provide broadcast TV service to rural areas, low frequency spectrum is the low cost and efficient way to provide broadband to rural areas.

F. Wireless Microphones

Spectrum Grab: Shure, Inc. seeks to have the FCC allocate a minimum of six vacant TV channels in every TV market for use by wireless mics and exempt from use by unlicensed devices. But it argues that even this is not enough.

> Designating six (6) exempt channels for wireless microphone operation is not sufficient to preserve the wide range of important wireless microphone applications and uses. Additional interference solutions are necessary for the many large scale events or venues like the Grand Ole Opry, the Super Bowl, Broadway and touring show, the Academy Awards and the Grammy Awards shows, and National political conventions. Large scale events use as many as 300 channels and require more open RF spectrum than is available today. These events cannot be produced using just six (6) exempt channels.[28]

Accordingly, Shure argues that "unlicensed devices should not be permitted to operate on first adjacent channels."[29] In a city such as New York, with 20 broadcast TV channels, this would make at least 20 channels exempt.[30] In other words, Shure is seeking to

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[27] Memorandum Opinion and Order in the Matter of General Moters Corporation and Hughes Electronics Corporation, Transferers, FCC, MB Docket 03-124, January 14, 2004, para 332.
[28] *See* Comments of Shure, Inc., Docket 04-186, January 31, 2007, pp.13-14.
[29] *Ibid*., p.11.
[30] Slightly less in practice because the broadcast band is divided into segments such that not all TV channels are surrounded by two adjacent channels. For example, there is only one TV channel adjacent to channel 2 because there is no channel 1.

exempt unlicensed use of between 6 to at least 20 vacant TV channels between channels 2-to-51, excluding 37.

Shure also wants to ensure that unlicensed devices include costly interference mitigation technologies such as beacons to avoid any risk that an unlicensed device would operate on one of the exempt channels allocated for wireless mic service.[31]

Substitutes: As noted above, there are many close substitutes to wireless mics that use spectrum much more efficiently.

III. THE MERITS OF LICENSED VS. UNLICENSED ALLOCATIONS

The arguments in the comments that favor allocating the white spaces on a licensed rather than unlicensed basis mostly repeat generic arguments (some might even say theological arguments) that NAF, *et al.* has responded to in earlier comments in this docket, as well as in published papers.[32]

One of the key arguments in favor of unlicensed is that there is a lot of uncertainty associated with the final spectrum assignments of incumbents in the TV band. The consequence of this uncertainty would either be to dramatically depress the value of the white spaces sold at auction or postpone the use of the white spaces for many years as the future license areas of the incumbent license holders were clarified in a host of different FCC proceedings. NAF, *et al.* articulated this argument in its comments, and was happy to see that several days later **FCC Chairman Kevin Martin made essentially the same argument before the Senate Commerce Committee** when Senator John Sununu asked him about the relative merits of licensed vs. unlicensed use of the TV white spaces. In Chairman Martin's words:

> It would be more difficult and potentially actually even delay a little bit the full utilization of the white spaces to try to actually license off the white spaces, because it would first require us, from a technical standpoint, to identify exactly what all the white space was. Whereas, if we could adopt general rules which said, "We think you can operate under these parameters without causing interference, and then you can do so as long as you're not causing interference," it would be more easily able to allow the technological innovations that are occurring in unlicensed to more fully utilize that spectrum.[33]

The comments by Charles L. Jackson and Dorothy Robin (the "Brattle/Qualcomm" comments)[34] do provide a new wrinkle in the auction/licensing case. NAF, *et al*. wants to

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[31] *Ibid.*, p.14.

[32] *See, e.g.,* Pierre de Vries, "Populating the Vacant Channels: The Case for Allocating Unused TV Band Spectrum for Broadband and Wireless Innovation," New America Foundation, Working Paper #14 (August 2006).

[33] February 1st Senate Commerce, Science, and Transportation Committee hearing, "Assessing the Communications Marketplace: A View from the FCC."

[34] *Supra* note 3.

call attention to the unreasonably high valuation they come up with for the value of the white spaces if sold via auction.

According to Dr. Gregory Rose, an economist and auction analyst, a more realistic revenue estimate obtainable from auctioning the white space is in the range of $1.6 billion to $3.73 billion—not the $3.7 billion to $6 billion estimated by Jackson and Robyn.[35] Dr. Rose's analysis is attached as Appendix B.

NAF, *et al.* would also like to call the Commission's attention to a prior spectrum valuation that Chuck Jackson did on behalf of the National Association of Broadcasters in 1995. His findings in that study are important because of the great inconsistency they reveal in his methodology. When the National Association of Broadcasters wanted to refute the high value that FCC economists placed on the second channel the broadcasters sought as part of the Telecommunications Act of 1996 (an estimate made at the request of Sen. John McCain), they hired Charles Jackson and John Haring and widely distributed their report to key decision makers on Capitol Hill. While the FCC's Robert Pepper valued the broadcasters' spectrum windfall at up to $70 billion, Jackson estimated it was a maximum of $3 billion. In his words: "Under the best of circumstances, auctions of reversion channels could raise between $2-3 billion dollars by 2002."[36] But here are the interesting discrepancies: The amount of spectrum that was being valued was approximately nine times the amount in this study (200 MHz vs. 24 MHz), and it was national, contiguous, and cleared spectrum (like the post-DTV transition spectrum occupied currently by TV channels 52-to-69), not the Swiss cheese and heavily encumbered spectrum that constitutes the TV white spaces between TV channels 2 and 51. What explains these utterly breathtaking discrepancies? The simplest explanation may be that in 1995, the National Association of Broadcasters paid Jackson to come up with a low number, and in 2007, Qualcomm paid him to come up with a high number. In any case, this track record suggests – as does the analysis in Appendix B – that the Brattle/Qualcomm estimate should be viewed with some considerable skepticism.

IV. CONCLUSION

To date, the incumbents' comments in this proceeding have not dealt with the social opportunity costs of granting the incumbents all the spectrum protections and enhancements that they seek to acquire. Their most recent set of comments, by baldly laying claim to virtually all the TV white space, vividly lays bare their almost complete indifference to those opportunity costs. NAF, *et al.*'s reply comments have sought to draw out this underlying economic logic from the morass of the incumbent special pleadings elicited in this rulemaking. NAF, *et al.* have also put into the record of this rulemaking Chairman Martin's Comments to the U.S. Senate Commerce Committee on the advantages of unlicensed over licensed allocation of this band. Finally, it has questioned the inconsistent and questionable methodology used by Jackson/Robyn to value the white space if auctioned.

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[35] *Ibid.*, p. 55.
[36] Cited in J.H. Snider, *Speak Softly and Carry a Big Stick* (iUniverse, 2005), p. 301.

APPENDIX A. COMMENTING PARTIES

Common Cause is a non-partisan non-profit dedicated to holding power accountable and encouraging citizen participation in democracy. Common Cause has nearly 300,000 members and supporters throughout the country, and state organizations in 38 states. www.commoncause.org

EDUCAUSE is a nonprofit association whose mission is to advance higher education by promoting the intelligent use of information technology. Membership is open to institutions of higher education, corporations serving the higher education information technology market, and other related associations and organizations. The current membership comprises more than 2,000 colleges, universities, and educational organizations, including 200 corporations, with 15,000 active members. www.educause.edu

NYCwireless is a non-profit organization that advocates and enables the growth of free, public wireless Internet access in New York City and surrounding areas. NYCwireless, founded in 2001, is an all-volunteer organization with seven board members, five special interest working groups and serves thousands of individuals throughout the New York City metro area. www.nycwireless.net

U.S. PIRG was founded in 1983 as the association of all state public interest research groups (PIRGs). U.S. PIRG works to promote the public interest and consumer protection in the nation's capital in the same way its member organizations work to promote these goals in state capitals. www.uspirg.org

NewburyOpen.net, Boston's largest free WiFi Community, is a movement that promotes the use of free WiFi for public access and social justice in Boston and throughout the nation. It strives to set an example of how local businesses, residents, and community members can work with innovative wireless technology to provide high-speed Internet access to everyone, regardless of social status or physical location. www.newburyopen.net

Association For Community Networking (AFCN) is an educational nonprofit corporation dedicated to fostering and supporting "Community Networking" -- community-based creation & provision of appropriate technology services of the highest quality with a broad range of uses. AFCN's mission is to improve the visibility, viability and vitality of Community Networking by assisting and connecting people and organizations, building public awareness, identifying best practices, encouraging research, influencing policy, and developing products & services. www.afcn.org

Acorn Active Media is a consulting firm that engages in software, website and technical development in service of the global justice movement. http://acornactivemedia.com

Community Technology Centers' Network (CTCNet) is a national membership network of community technology centers (CTCs) and other non-profits, united in their commitment to provide technology access and education to underserved communities. CTCNet works through the CTC Network to provide resources and advocacy to improve the quality and sustainability of CTCs. http://ctcnet.org

The **Champaign-Urbana Community Wireless Network** (CUWiN), a project of the Urbana-Champaign Independent Media Center Foundation, has deployed an extensive mesh network using Part 15 spectrum in the Champaign-Urbana metro area. Its three part mission is to (a) connect more people to Internet and broadband services; (b) develop open-source hardware and software for use by wireless projects world-wide; and, (c) build and support community-owned, not-for-profit broadband networks in cities and towns around the globe. www.cuwireless.net

The **Ethos Group** is a telecommunications consulting firm focusing on the community benefits of wireless technology. www.ethoswireless.com

FreeNetworks.org is a volunteer cooperative association dedicated to education, collaboration, and advocacy for the creation of FreeNetworks. A FreeNetwork is any computer network that allows free local transit. FreeNetworkers have been meeting since 2000 to organize, share information, and pool resources to find the best way to build community networks. Members include community advocates, system administrators, RF engineers, writers, lawyers, programmers, business owners, and many others who want to help build FreeNetworks in their local communities. www.freenetworks.org

Media Access Project (MAP) is a 30 year-old non-profit tax exempt public interest telecommunications law firm which promotes the public's First Amendment right to hear and be heard on the electronic media of today and tomorrow. MAP's work is in the courts, the FCC, and in active outreach as a coalition builder among other public interest organizations. MAP is the only Washington-based organization devoted to representing listeners' and speakers' interests in electronic media and telecommunications issues before the Federal Communications Commission, other policy-making bodies, and in the courts. www.mediaaccess.org (*Counsel for NAF, et al.*)

National Hispanic Media Coalition (NHMC) is a coalition of Hispanic-American organizations that have joined together to address a variety of media related issues that affect the Hispanic-American community across the nation. www.nhmc.org

New America Foundation (NAF) is a nonpartisan, non-profit public policy institute based in Washington, DC, which, through its Wireless Future Program, studies and advocates reforms to improve our nation's management of publicly-owned assets, particularly the public airwaves. www.newamerica.net

The **Center for Digital Democracy** (CDD) is committed to preserving the openness and diversity of the Internet in the broadband era, and to realizing the full potential of digital

communications through the development and encouragement of noncommercial, public interest programming. www.democraticmedia.org/index.html

Public Knowledge is a group of lawyers, technologists, lobbyists, academics, volunteers and activists dedicated to fortifying and defending a vibrant information commons. www.publicknowledge.org

Tribal Digital Village (TDV) connects and serves more than 7,600 Native Americans living on reservations in isolated and scattered rural communities stretching from the California-Mexico border into Riverside County—an area that encompasses 150 miles and takes 4 ½ hours to visit by car. Nearly 30 percent of the tribal community's population lives below the poverty line, and 50 percent are unemployed. Tribal Digital Village's work, enabled by a grant from Hewlett-Packard, connects the 18 American Indian reservations in southern California to a high-speed, wireless Internet backbone and uses the Internet to build communities of interest among tribal members in ways that resemble family and community networks. www.sctdv.net

Wireless Internet Service Providers Association (WISPA) is dedicated to promoting and improving the WISP industry. WISPA serves as a liaison between the membership and the FCC to promote efficient spectrum use and help formulate new spectrum policy to assist our member organizations deliver broadband in a cost-effective manner. www.wispa.org

APPENDIX B. A CRITIQUE OF THE CHARLES L. JACKSON AND DOROTHY ROBYN SPECTRUM VALUATION SUBMITTED IN DOCKET 04-186

By Dr. Gregory Rose[37]

Jackson and Robyn develop five scenarios estimating potential DTV white space on an MTA and national basis[38] and present a market comparables argument for the valuation of that white space on which their revenue estimations are based.[39] Specifically, they argue that the closest comparable to the majority of DTV white space is the 2.5 GHz BRS/EBS band, which they value at $0.15 MHz-pop, based on secondary market transactions of 2.5 GHz BRS/EBS licenses and comparison to secondary market valuations of PCS and AWS licenses. Additionally they estimate the value of a hypothesized 24 MHz nationwide license of white space as $0.50 MHz-pop, based on the mean value of spectrum allocated in the AWS-1 auction, $0.54 MHz-pop. On this basis they present revenue estimates under one of their scenarios, involving all DTV and Class A stations and TV translators with adjacent channel protection, for a hypothesized auction. Their estimates range from $3.7 billion to $6.0 billion.

Jackson and Robyn reject the two principal prior studies estimating DTV white space. The methodologically sophisticated effort of the Association of Maximum Service Television, Inc., (MSTV) to estimate available DTV white space[40] was rejected on the grounds that it assumes an excessive interference protection rule,[41] despite the fact that the MSTV study used a rule consistent with the FCC's own interference policy. However, the principal objection appears to be that the MSTV study found too little DTV white space. The Free Press/New America Foundation study was rejected on various methodological grounds for both undercounting and overcounting such white space.[42] Using their own estimation method,[43] Jackson and Robyn arrive at estimates of potential DTV white space which differ from the MSTV study primarily in finding more white space in potentially lucrative urban markets. It is possible to criticize Jackson and Robyn on technical grounds for potentially overestimating the amount of available white space, but there is no reason not to accept their white space estimates for purposes of argument. What is objectionable is their selection of a scenario which appears to maximize estimation of white space in a way which is calculated simply to maximize estimation of auction revenue. Under two scenarios which Jackson and Robyn dismiss as requiring

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[37] Dr. Gregory Rose is an independent consultant working with both the New America Foundation and Media Access Project.
[38] *Ibid*., 12-21.
[39] *Ibid*., 55-58.
[40] Exhibit A in "Joint Comments of the Association for Maximum Service Television, Inc., and the National Association of Broadcasters," ET Docket Nos. 04-186 and 02-380, November 30, 2004. The study is incorrectly cited by Jackson and Robyn.
[41] "Comments of Charles L. Jackson and Dorothy Robyn," ET Docket Nos. 04-186 and 02-380, January 31, 2007, 12.
[42] *Idem*.
[43] The method is summarized in "Appendix A: Calculation of White Space in the TV Core Following the DTV Transition" in *ibid*.

excessive interference protection because they assume unlicensed utilization of white space, but which, in fact, correspond more closely to the interference protection rules the FCC is likely to eventually adopt, auction revenue estimates would be sharply lower. Revenue estimates based on these scenarios are provided below.

The market comparables analysis put forward by Jackson and Robyn is questionable on several grounds. While they reference the fourteen previous FCC auctions of analogous white space,[44] they take none of the data from those auctions into consideration. Table 2 (see next page) shows relevant data from the previous white space auction and the PCS and AWS-1 auctions cited by Jackson and Robyn:

[44] *Ibid*., 45.

Table 2.
Comparison of Previous White Space, PCS, and AWS Auctions

									$/MHz/Pop.		Rate of Convergence to PWB (Rnds)	
Auction No.	Spectrum/Service Type	Net Revenue ($millions)	MHz	License Plan	No. of Licenses	No. of Licenses PWB	No.of Bidders	No. of Rounds	Mean	St. Dev.	Mean	St. Dev.
6	Multipoint/ Multichannel Distribution Services	216.24	6	493 BTAs; 1 license each	493	493	155	181	0.24	0.27	95.95	37.05
7	900 MHz Specialized Mobile Radio Service	204.27	0.25	51 MTAs; 20licenses each	1020	1020	123	168	0.93	1.53	77.19	42.92
16	800 MHz Specialized Mobile Radio Service (SMR)	96.23	1 (A) 3 (B) 6 (C)	175 EAs; 3 licenses each	525	535	62	235	0.07	0.14	86.83	61.63
26	929 and 931 MHz Paging Service	4.12	0.02	51 MEAs; 12 929 MHz and 37 931 MHZ licenses in each MEA	2499	985	81	28	0	0	1.14	3.01

34	800 MHz SMR General Category Service	319.45	1.25 (GC) 1 (A) 3 (B) 6 (C)	1,050 licenses for 800 MHz General Category: 6 contiguous 25 channel blocks in 175 EAs; 3 licenses for selected EAs 800 MHz Upper Band: 1 20 channel block (A); 1 60 channel block (B), and 1 120 channel block (C).	1053	1030	26	76	0.19	0.28	29.66	14.71
36	800 MHz SMR Lower 80 Channels Service	28.98	0.25	16 non-contiguous 5 channel blocks in 175 Eas	2800	2800	28	151	0.01	0.04	28.77	44.43
40	Paging	12.9	2.12	14,000 lower bands paging licenses in 175 Eas; 1,514 upper bands paging licenses in 51 MEAs	15514	5323	193	140	####	####	14.33	23.51
42	Multiple Address Systems Spectrum	1.2	.025 (AA-BB) .1 (BC)	5,104 licenses in 176 Eas	5104	878	13	36	0.06	0.08	4.08	6.43
53	Multichannel Video Distribution & Data Service (MVDDS)	118.72	500	214 DMAs; 1 license each	214	192	14	49	0.14	0.17	17.45	11.1

55	900 MHz Specialized Mobile Radio Service	4.86	0.25	55 licenses in 31 MTAs	55	55	17	76	0.02	0.02	23.91	21.96
57	Automated Maritime Telecommunications System	1.06	1	20 AMTS Areas; 1 license each	20	10	4	3	0	0	1.1	0.32
59	Multiple Address Systems Spectrum	3.87	0.03	4,226 MAS licenses in 176 EAs	4226	2223	32	126	0.25	1.64	23.28	32.52
61	Automated Maritime Telecommunications System	7.09	1	10 AMTS Areas; 1 license each	10	10	7	116	0.04	0.03	89.5	19.92
63	Multichannel Video Distribution & Data Service (MVDDS)	0.13	500	22 DV--MVD Areas; 1 license each	22	22	3	3	0.1	0.09	1.91	0.29
5	Broadband PCS C Block	#######	30	493 BTAs; 1 license each	493	493	255	184	0.78	0.52	89.29	15.52
11	Broadband PCS D, E, & F Block	2,517.44	10	493 BTAs; 3 blocks each	1472	1472	153	276	0.27	0.46	117	67.68
66	AdvancedWireless Services	#######	20 (A,B) 10 (C,D,E) 20 (F)	734 CMAs, 1 license each (A); 176 EAs, 1 license each (B,C); 12 REAGs, 1 license each (D,E,F),	1122	1087	168	161	0.19	0.21	58.86	29.79

Several things are immediately apparent from examination of this data. First, valuation of spectrum in the previous white space auctions varies radically, depending on the use of that spectrum specified for the auctioned licenses, the bandwidth plan, and regional allocation of licenses. Additionally, spectrum value is highly positively correlated to population of license area in a handful of the white space auctions, but weakly negatively correlated in the majority of cases. Furthermore, the auctions themselves exhibited considerable variation in strategic dynamics (measured by the variation in mean rates of convergence to PWB) and willingness of bidders to bid (evidenced by the large number of licenses not PWB in some auctions because the FCC reserve price was never met), both of which had substantial impact on clearing prices. In light of the existence of empirical evidence of market valuation of white space in previous auctions, the selection of the value of 2.5 GHz BRS/EBS spectrum as the basis for valuing DTV white space seems almost completely arbitrary, particularly given Jackson and Robyn's repeated citing of uncertainty as to the FCC's ultimate determinations of spectrum use, bandwidth plan, and interference protection. A more sensible approach would have been either (1) to note the extreme variation in spectrum valuation in these auctions and attempt to make a more detailed assessment of the comparability of this spectrum and behavior of actors in these previous auctions to the hypothesized DTV white space spectrum and auction or (2) to take a weighted mean of the dollar per MHz-pop of those auctions involving unpaired spectrum and use that as the estimator of the dollar per MHz-pop value of the hypothesized DTV white space. Revenue estimates using the latter technique will be presented below. It is also patent from review of Table 2 that any argument that the PCS and AWS-1 are genuine market comparables to any portion of the hypothesized DTV white space must explain and overcome the profound differences in auction dynamics and outcomes between those auctions and the previous white space auctions, a task which Jackson and Robyn eschew.

Jackson and Robyn also grossly overestimate the mean dollar per MHz-pop prices fetched by licenses in the AWS-1 auction. The source of this error is a BIA Financial Network analysis of the auction which has been uncritically adopted by industry analysts and which claims a mean dollar per MHz-pop value of $0.54. This analysis calculates the variable in the usual way (gross high bid/MHz/population of license area), then weights the results by population. It is unclear why this was done, since the initial calculation is weighted for population, and it has the effect of inflating the dollar per MHz-pop price means enormously,[45] because population relatively strongly correlated with high PWB bid in the auction. BIA then took an unweighted average of the five inflated means by spectrum category ($0.41, $0.51, $0.43, $0.59, and $0.73, respectively) to arrive at the $0.54 per MHz-pop mean for the AWS-1 auction as a whole. Calculating from the FCC raw data for the auction – and without the erroneous weighting – the correct means for the five categories of spectrum are:

[45] For the 20 MHz CMA licenses the estimate is inflated by 2.46 times over the calculation from raw FCC data, for the 10 MHz BEA licenses by 2.11 times, for the 20 MHz BEA licenses by 1.97, for the 10 MHz REAG licenses by 1.41 times, and for the 20 MHz REAG licenses by 1.38 times.

Table 3.
Mean $/MHz/Pop Calculation for AWS-1 Auction

License Type	Pct.of Licenses PWB	Mean $/MHz/Pop
CMA 20 MHz	65.56	0.1624
BEA 10 MHz	15.93	0.2407
BEA 20 MHz	15.84	0.2187
REAG 10 MHz	1.84	0.4183
REAG 20 MHz	0.83	0.5276
AWS-1 Mean	-	0.3135
AWS-1 Mean Weighted by Pct. Of Licenses in Type	-	0.1916

It is the case that by weighting the averages for each license type by the percent of total licenses PWB in each type one arrives at a dollar per MHZ-pop mean which more closely reflects overall performance at auction, although the revenue estimates below will be calculated for both the weighted and unweighted mean values for AWS-1 dollar per MHZ-pop.

It is more methodologically sound to generate a number of plausible scenarios under which DTV white space might be auctioned so as to estimate the range of revenue which might accrue rather than selecting a scenario which maximizes the revenue estimate, as Jackson and Robyn have done. I begin with the scenario which Jackson and Robyn chose: all DTV and Class A TV stations and land systems, and TV translators with adjacent channel protection. Under this scenario there is a base case estimate of 27.2 billion MHz-pop of white space available and a "high end" estimate of 20.6 billion MHz-pop of general white space and one 24 MHz nationwide white space license. Using as a market comparable the eleven previous FCC white space auctions of unpaired bandwidth, the mean dollar per MHz-pop, weighted by the percent of total bandwidth cleared in all eleven auctions, is a valuation of $0.12 per MHz-pop. I take the actual mean dollar per MHz valuation of licenses in the AWS-1 auction, weighted by percent of licenses auctioned in each bandwidth/regionality category, $0.19, as a market comparable to the hypothesized nationwide 24 MHz white space license. The base case estimate of revenue from an auction under this scenario is $3.26 billion the "high end" estimate is $3.73 billion.

The second scenario is one treated by Jackson and Robyn as assuming unlicensed use of white space spectrum: all DTV and Class A TV stations and land systems, and TV translators with a geographic buffer in the co-channel and adjacent channel. This is, however, judging from past performance, the form of interference protection most likely to be adopted even for licensed DTV white space spectrum. Under this scenario there is an estimated 18.5 billion MHz-pop of available white space, but insufficient white space for a nationwide 24 MHz license. Again using as a market comparable the eleven

previous FCC white space auctions of unpaired bandwidth, the mean dollar per MHz-pop, weighted by the percent of total bandwidth cleared in all eleven auctions, is $0.12 per MHz-pop. Revenue from an auction under this scenario is estimated at $2.22 billion.

The third scenario is treated by Jackson and Robyn as assuming unlicensed use of white space spectrum under more restrictive interference protection: all DTV and Class A TV stations and land systems, and TV translators with a geographic buffer in the co-channel and adjacent channel with channels 2-4 and 14-20 excluded. This, in fact, is a plausible scenario if eventual approval of white space allocation is significantly conditioned by the preferences of the broadcasting incumbents. Under this scenario there is an estimated 13.3 billion MHz-pop of available white space, but insufficient white space for a nationwide 24 MHz license. Again using as a market comparable the eleven previous FCC white space auctions of unpaired bandwidth, the mean dollar per MHz-pop, weighted by the percent of total bandwidth cleared in all eleven auctions, is $0.12 per MHz-pop. Revenue from an auction under this scenario is estimated at $1.6 billion.

The Jackson and Robyn comments considerably overestimate revenue accruing from an auction of DTV white space. More realistically, the revenue obtainable from such an auction is likely to be in the range to $1.6 billion to $3.73 billion.