

**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
	)	

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## Introduction

These comments are submitted to the Commission by New America Foundation and the expert parties listed on the first page (collectively “NAF, *et al.*”). Appendix I gives a brief summary of each of the parties signing these comments. NAF, *et al.* has participated in this proceeding since its formal initiation, and prior to that participated in the dialogue with FCC staff and the FCC Spectrum Policy Task Force that preceded the initial NPRM.

NAF, *et al.* applaud the Commission for its well thought out and bold decision in the *First Report and Order and Further Notice of Proposed Rulemaking* (FNPRM) adopted on October 12, 2006. Despite the apparently confusing and contradictory claims in the record, the Commission made three clear findings that agree with our previous filings:

- [T]hat the record and information developed in response to the *Notice of Proposed Rulemaking* in this proceeding supports a conclusion that low power devices can generally be allowed to operate on TV channels in areas where those frequencies are not being used for TV or other incumbent licensed services if such devices comply with appropriate protective measures for ensuring that they do not cause interference to already authorized services.<sup>1</sup>
- We find that allowing low power devices to operate in the TV bands on frequencies that are not being used by authorized services could have significant benefits for the public by enabling the development and operation of new wireless communications devices and systems that would promote access to broadband internet and other services.<sup>2</sup>
- [U]pon completion of the DTV transition, there will be significant unused TV spectrum available in many areas in the country, either because of the separations required between authorized stations to avoid interference or because available TV channels have not been assigned and other services are not using vacant channels.<sup>3</sup>

In these comments NAF, *et al.* address the issues raised in the FNPRM. We believe that it is in the public interest that the proposed access to unused TV band frequencies by what the Commission has termed “TV band devices” should be *unlicensed*. The detailed justification for this is contained in a separate non-technical filing that New America Foundation is making in this proceeding. In this document, we explain the key conditions needed if the Commission decides to make some or all TV band use subject to license. We describe some of the reasons that auctions and exclusive licensing are extremely problematic in this band. We also address why all three technical alternatives for interference avoidance proposed in this proceeding are indeed feasible, and how these technologies can be combined to ensure the non-interfering use of Channels 14-to-20 both for fixed and mobile devices.

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<sup>1</sup> FNPRM at ¶2.  
<sup>2</sup> FNPRM at ¶12.  
<sup>3</sup> FNPRM at ¶17.

## Obstacles to Exclusive Licensing

The FNPRM raises the possibility that TV band devices might only be authorized as licensed services and seeks comment on this issue.<sup>4</sup> The details of the licensing scheme are not given, but it seems reasonable that the “700 MHz guard band manager” scheme of Docket 99-168 and codified in Part 27 Subpart G would be a prime precedent. The Commission has described this as follows:

The Guard Band Manager will be a new class of commercial licensee who will be engaged in the business of leasing spectrum for value to third parties which could include both commercial service providers and private parties. Guard Band Managers will be required to adhere to strict frequency coordination and interference rules, and control use of the spectrum so as to facilitate protection for public safety. The Guard Band Manager may subdivide its spectrum in any manner it chooses and make it available to system operators or directly to end users for fixed or mobile communications, consistent with the frequency coordination and interference rules specified for these bands. This licensing represents an innovative spectrum management approach that should enable parties to more readily acquire spectrum for varied uses, while streamlining the Commission's spectrum management responsibilities.<sup>5</sup>

The purpose of this section is to show that successful licensing and auctioning of the right to authorize TV band devices is not practical without major changes to the present broadcast auxiliary uses of the band and, in particular, to the related rules in Part 74 Subpart H. The logical conclusion is that in this circumstance the broadcast auxiliary users in this band must *either* be relocated elsewhere *or* be subordinated to the new licensees, since otherwise the new licensees would not have a rational business plan.

In raising the licensing issue in Section IV.A of the FNPRM, the Commission clearly 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.<sup>6</sup> (Emphasis added.)

Clearly the spectrum at hand is not “exclusive” and there is even some question as to whether it is “clearly defined.” The TV spectrum under consideration in this proceeding contains TV broadcasting facilities licensed under Part 73 of the Commission’s Rules and broadcasting directly to the general public. It also 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—which do not involve direct broadcast to the general public and are authorized under Part 74 Subpart H of the Commission’s Rules. These “auxiliary stations” are, in fact, similar in end use to other

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<sup>4</sup> FNPRM at ¶26-32.

<sup>5</sup> [http://www.fcc.gov/Bureaus/Wireless/News\\_Releases/2000/nrwl0009.html](http://www.fcc.gov/Bureaus/Wireless/News_Releases/2000/nrwl0009.html).

<sup>6</sup> FNPRM at ¶27.

FCC rule parts and are available only to narrowly defined groups under terms that are anachronistic and inconsistent with the past decade of spectrum policy at FCC.

The history of this band is that it was allocated to Part 73 Broadcast Television in an era when the first NTSC black and white system (1941), and later the NTSC color analog television system (1953), were extremely sensitive to the presence of other co-channel signals, adjacent channel signals, and even certain TV signals up to 15 channels away! This necessitated the creation of “TV taboos” such as Table I of §73.698 that severely restricted the use of TV channels for broadcasting in a given area and made the creation of large amounts of “white space” in the TV band inevitable. In the UHF-TV band, the constraints necessitated by the combination of inherently vulnerable analog signals and the level of TV receiver rejection of unwanted signals and immunity anticipated by the Commission in 1952 resulted in the use of only 1 out of every 6 channels in a given city of license.<sup>7</sup>

The sharing of UHF-TV band by various Part 74 Subpart H devices subject to manual coordination made sense given the amount of whitespace and the lack of technical alternatives for efficiently identifying whitespace for interference-free uses. This resulted in UHF spectrum use permitted by Subpart H that is limited to only the specific eligibles enumerated in §74.832(a):

- (1) A licensee of an AM, FM, TV, or International broadcast station (*e.g.*, shortwave broadcasting station) or low power TV station. Low power auxiliary stations will be licensed for use with a specific broadcast or low power TV station or combination of stations licensed to the same licensee within the same community.
- (2) A broadcast network entity.
- (3) A cable television system operator who operates a cable system that produces program material for origination or access cablecasting, as defined in §76.5(r).
- (4) Motion picture producers as defined in §74.801.
- (5) Television program producers as defined in §74.801.
- (6) Licensees and conditional licensees of stations in the Service and Multichannel Multipoint Distribution Service as defined in §21.2 of this chapter, or entities that hold an executed lease

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<sup>7</sup> For example, the NTSC channels in Washington, D.C. before the DTV transition were 14, 20, 26, 32, etc. Channel 22 was only allowed because it was located in Annapolis, MD and hence not subject to all the taboos relating to Washington, D.C. The receiver immunity standards assumed in 1952 became a “self-fulfilling prophecy.” This is because the taboo system protected poor-immunity receivers, and receivers with improved immunity would have few direct consumer benefits to justify their increased cost since their improved performance would not be noticeable to the buyer in the ongoing taboo environment.

It should be noted that the Commission’s UHF Task Force in the 1970s advocated more intensive use of UHF-TV spectrum by broadcast systems—which would have resulted in less whitespace—by taking advantage of the receiver immunity capability of new receiver technology such as surface acoustic wave filters. At the time, the broadcast industry strongly opposed such changes and the UHF taboos were only changed later in the course of DTV implementation.

agreement with an MDS or MMDS licensee or conditional licensee or with an Instructional Television Fixed Service licensee or permittee.<sup>8</sup>

In addition, only “television broadcast auxiliary licensees and motion picture and television producers” are eligible to use the same spectrum under the provisions of §74.870 for “wireless video assistance devices”—short range nonbroadcast video links that have not been mentioned in this proceeding to date.

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 of the U.S. covered by all of these short-range devices. Yet under present Commission policies, only these specifically enumerated users and uses are allowed and no other access to this whitespace 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:

§74.832(b) only requires that “(a)n application for a new or renewal of low power auxiliary license shall specify the frequency band or bands desired.”

§74.832(f) only requires that “(a)pplications for the use of the bands allocated for TV broadcasting must specify the usual area of operation within which the low power auxiliary station will be used. This area of operation may, for example, be specified as the metropolitan area in which the broadcast licensee serves, or the usual area within which motion picture and television producers are operating.”

While these uses are therefore “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 frequency assignment and location. Indeed, this “licensed” use is actually closer to unlicensed use in practice, except that it is restricted to a small group of eligibles who have used their influence in the Commission in past decades to get exclusive access to this spectrum and deny it to all others. While many of these eligibles are local broadcasters who can be said to know one another personally, and thus efficiently coordinate their use, a reading of §74.832(a) shows that many of the eligibles are not based in the communities where they can use spectrum and cannot be presumed to have local knowledge and contacts. Conversely, certain local entities who *do* have local knowledge and contacts with Part 74 Subpart H users in an area are forbidden any access to this spectrum unless their industry lobbyists previously gained them access through the provisions of §74.832(a). Thus, the present narrowly defined eligibility rule seems to be based on favoritism to influential industries rather than on objective criteria to prevent interference or to assure efficient spectrum use.

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<sup>8</sup> Presumably this last provision was overlooked when MMDS and ITFS were replaced with BRS and EBS recently. Thus, it is unclear if BRS and EBS licensees are actually eligible for Part 74 licenses.

*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 would have no idea what frequencies Part 74 Subpart H users may be on and they only know “the usual area of operations” of the transmitter locations. Furthermore, this does not even address the issue that the vast majority of wireless microphones in this band are used by parties not eligible for licensing in Part 74 and who thus have no licensing records. And yet, advocates of such parties in this proceeding feel they are entitled to “protection.”

To consider licensing and auctioning TV band frequencies available on a market-by-market basis for licensed TV band devices forces the Commission to recognize the anachronism of the Part 74 Subpart H use of this band and the large-scale illegal use of the band by wireless microphone users. It would thus force the Commission to develop an effective transition plan for moving these users to more appropriate spectrum. Such new policies 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.

Recently, David Donovan, president of the Association for Maximum Service Television, was quoted on a similar issue dealing with a request by a truck stop owner to use this same spectrum to facilitate the downloading of audio books, email and other services for drivers. Mr. Donovan told a trade magazine, “this is a multibillion dollar company. It is not clear at all to me why they couldn’t buy spectrum at auction (or) use the unlicensed bands.”<sup>9</sup> Couldn’t Part 74 Subpart H users make avail of the same options?

*If* the Commission decides that marketplace forces are key for the successful use of the TV spectrum whitespaces by TV band devices and decides to license band managers, NAF, *et al.* believes that it is essential that this be accompanied with a transition plan to either move both the Part 74 Subpart H users and illegal users out of this band or subordinate them, subject to the control of the new band managers. This presumably means that they will have to start paying for the spectrum use that they now get without cost and which is denied to all other entities not enumerated in §74.832(a). Without either eviction or subordination, bidders for the band manager licenses will be unable to formulate rational business plans, as users entitled to protection could pop up anywhere at anytime.

In a later section we will discuss protection of these Part 74 Subpart H users in a purely unlicensed TV band device environment. This is only possible if the Commission affirms that the TV band devices are secondary to the Part 74 systems and must vacate spectrum to the Part 74 systems to prevent interference. Obviously, such a condition would not be attractive for band managers purchasing exclusive licenses at auction.

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<sup>9</sup> “MSTV to Help with ‘Nuts and Bolts’ of DTV,” *TV Newsday*, January 4, 2007, [www.tvnewsday.com](http://www.tvnewsday.com).

## Protection Distance Issues

This section deals with the issue of whether TV band devices must have transmit frequency selection technology and transmitter output parameters adequate to protect TV receivers in the same household. In the FNPRM, the Commission states:

While radars and TV transmitters both transmit high power signals, radar operation is different from TV service in that a single radar receive system is typically co-located with its associated transmitter while TV receivers are located throughout a station's service area. In the radar case, the co-location of transmitter and receiver allows the sensing level to be set so as to prevent unlicensed devices from operating within a specified distance of the radar site. This approach follows from the facts that a radio signal attenuates with distance from the transmitter in a predictable manner, that is, as the distance from the transmitter increases the signal becomes weaker, and the distance over which the radar and unlicensed signals propagate are the same, albeit in different directions. In the U-NII case, we set the sensing level at a value where the distance at which the specified level of radar signal will be present is far enough from the radar site that the radar receiver will not receive interference from an unlicensed device operating at its maximum allowed power. ...

In the TV case, the spread out pattern of TV receiver locations produces a situation where the distance between the TV transmitter and a TV band device is generally different than the distance between a TV receiver and that TV band device. It is, in fact, reasonable to expect that a TV band device would operate quite close to a TV set, *i.e.*, in the same or adjacent residences/businesses, and both would be relatively far from the TV transmitter. Here, the TV set would be attempting to receive a relatively weak TV signal in the presence of a relatively strong unlicensed signal. This suggests that the detection threshold for TV band devices must be lower to account for their expected proximity to TV receivers.<sup>10</sup>

The geometry is different in the two cases. It is theoretically possible that the TV band device is so close to the TV receiver antenna that its signal strength at the receiver input is very high. But the Commission has long established precedent that it does not have to be concerned about interference to TV receivers so close to the TV band device that they must be in the same household.

Docket 20780 was a 1970s rulemaking that initiated the regulation of digital device/personal computer unintentional emissions after initial personal computer models caused a rash of interference complaints from licensed radio systems (this rulemaking initiated the now ubiquitous FCC label on personal computers and accessories). These emissions rules are now codified as Part 15, Subpart B. In the Docket 20780 Report and Order adopting these rules the Commission stated,

The technical rationale for these limits is given in Appendix C, attached. It uses the same approach as that used by CBEMA in its Report. However, instead of using a separation distance of 30 meters, we are assuming that the home computing device is at least 10 meters from the (TV) receiver. The separation distance is a basic parameter in computing tolerable levels of signal that may be radiated by a computer...We are most interested in protecting an individual who is receiving interference from his neighbor's computer. To a lesser extent, we are concerned about devices in the same household.<sup>11</sup>

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<sup>10</sup> FNPRM at ¶36-37.

<sup>11</sup> First Report and Order, Docket 20780, October 11, 1979 at ¶53-54.

However, significantly, the Commission observed later in that document,

*We believe that in most cases interfering radiation from computing devices is a less valuable use of spectrum than the radio and television services that would be interfered with.* Therefore, we consider it appropriate that our regulations deny to computing devices an interfering use of the spectrum (*except where the interference is to other equipment of the computer owner*). We have made this judgment by comparing the benefits of allowing current uses of spectrum to continue without interference from computing equipment with the costs of denying interfering use of the spectrum to computers.”<sup>12</sup> (emphasis added)

In the present case the potential “interfering radiation” is not worthless unintentional radio noise from personal computer emissions as in the Docket 20780 case, but rather a communications signal in its own right—such as broadband Internet, voice or video communication—with real social value and First Amendment implications. Thus, if the Commission follows the logic of the Docket 20780 decision, the goal of interference protection from TV band devices should be 10 meters *or greater*. In fact, future home entertainment systems could integrate the wireless communication devices with the TV set to provide both a plethora of new applications as well as what is called “Layer 2” interference mitigation .

Thus, there is a practical limit to the minimal distance between a TV band device and a TV receiver.<sup>13</sup> This is in contrast to the FNPRM statement quoted above that “(i)t is, in fact, reasonable to expect that a TV band device would operate quite close to a TV set, *i.e.*, in the same or adjacent residences/businesses, and both would be relatively far from the TV transmitter.”<sup>14</sup> Opponents of this rulemaking have even suggested that the rules be crafted to protect a scenario where a “portable device (“TV band device” in the nomenclature of the FNPRM), especially in apartments, could be as close as 0.5m to the nearest indoor TV antenna.”<sup>15</sup>

NAF, *et al.* urge the Commission to reject these overly zealous protection demands, which probably are not even achieved (especially in the 0.5 meter case) by present-day licensed and unlicensed consumer electronics. Rather, the Commission should base protection on the long-standing, well-established and successful goal of its Docket 20780 precedent. It should clearly state that TV receivers within a distance of 10 meters (or possibly somewhat greater if the Commission agrees with our suggested interpretation of the above quote from ¶54 of the Docket 20780 *Report and Order*) should not be the basis of protection planning, just as they are not protected from the now ubiquitous personal

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<sup>12</sup> *Ibid.* at ¶67.

<sup>13</sup> The Commission has also found that in 2005 only 14 percent of TV households depended on over-the-air reception of TV signals and that the fraction has been decreasing over a long period. *See* 12th Annual Video Competition Report to Congress, [http://hraunfoss.fcc.gov/edocs\\_public/attachmatch/FCC-06-11A1.pdf](http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-06-11A1.pdf). Thus, 86 percent of households with TV sets next to TV band devices will experience no interference *regardless of separation distance*.

<sup>14</sup> FNPRM at ¶37.

<sup>15</sup> Comments of TV Transmission Antenna Group, Docket 04-186, November 21, 2006 at p. 8.

computer and related digital devices (a situation that results in few, if any, reported cases of interference). It is entirely reasonable to expect that individuals in the same household—or even proximate neighbors—can coordinate the positioning and use of their respective devices, much as consumers have been doing for years, at a far lower social cost than would be incurred if the Commission precluded advanced wireless services or devices from the TV white spaces.

In stating that the protection distance should be 10 meters or greater based on the Docket 20780 precedent, NAF, *et al.* is not suggesting that the TV band device be capable of determining directly the distance to the nearest TV receiver. Rather, the TV band device output power and out-of-band emission limits should be selected so that when a TV channel is verified to be vacant, the TV band device emissions will not cause interference to TV receivers whose antennae are less than the stated distance, because they are assumed to be in the same household. The present unintentional emission limit for personal computers, §15.109, was selected to protect TV receivers 10 meters or more away from a personal computer.

### **The Three Options for Non-Interfering Device Access**

In this section, we will discuss the three options for spectrum access that were originally raised in the NPRM and discussed again in the FNPRM. These are a listen-before-talk approach that the FNPRM refers to as “Dynamic Frequency Selection” (DFS), the control signal approach, and the geo-locate/database approach. We discuss these options in the reverse order of the FNPRM to order them by their increasing complexity with respect to interference risk, a point not made clear in the record of this proceeding. In this context, we also discuss the Master/Client Operation proposed in FNPRM ¶46, and show its overall impact in reducing interference threat.

As a general matter, NAF, *et al.* favor performance-based standards with technical neutrality for any methods that are designated for enabling spectrum access by TV band devices. The opponents of this rulemaking have made various protection demands, in one case discussed below, they asked for protection from TV band devices just 0.5m away from a TV antenna! 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. It should then use this policy determination to derive performance parameters for TV band devices that can be objectively measured in the Commission’s Equipment Authorization Program. These parameters should be factors such as position-determining accuracy, DTV signal detection threshold for DFS devices, emission mask details, etc. The adopted rules should require only performance criteria that can readily be tested. 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.

NAF, *et al.* recommends that the Commission follow its own precedent, implemented in the U-NII DFS case, by developing a detailed Compliance Measurement Procedure<sup>16</sup> to allow reproducible testing by multiple laboratories in consultation with affected parties after the TV band device rules are adopted in the instant proceeding. It is customary in FCC practice that all new types of equipment authorization require hands-on testing by the FCC Laboratory until clear test procedures, such as a Compliance Measurement Procedure, are developed.

### ***Geo-Locate/Database Option***

In the FNPRM, the Commission explained this option as follows:

“(we) proposed to require that fixed/access devices incorporate a geo-location method such as GPS or be professionally installed to determine their geographic coordinates. These coordinates would be used in conjunction with a database of incumbent TV band licensed stations and appropriate computational software to identify vacant channels at the unlicensed device’s location.”<sup>17</sup>

The opponents of this proceeding “raised various concerns about this approach, such as whether GPS incorporated in an unlicensed device would be a reliable method for performing geo-location because it may not work indoors or at outdoor locations where the GPS signal is obstructed.”<sup>18</sup> Indeed, conventional standalone consumer-grade GPS, usually sold in mass markets, does not work inside. Note, however, that the

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<sup>16</sup> The Compliance Measurement Procedure for U-NII DFS is contained in the Appendix of the Docket No. 03-122 Memorandum Opinion and Order, June 30, 2006.

<sup>17</sup> FNPRM at ¶49.

<sup>18</sup> FNPRM at ¶49 and fn. 60.

Commission's discussion did not specifically mention consumer-grade GPS. Rather, it referred more broadly to devices that would be professionally installed or incorporate "a geo-location method *such as GPS*" (emphasis added). The Commission is well aware that assisted GPS<sup>19</sup> is widely used in the cellular industry to meet its E-911 requirements under §20.18, which addresses the locating ability that must be achieved indoors and outdoors. As noted above, the Commission's historical approach is evidenced in the (arguably more challenging) authorization of U-NII sharing with federal government radars in the 5 GHz band. The Commission set the threshold and parameters necessary to protect the primary service and left industry with the challenge to innovate and meet that goal if it wanted to market devices with shared access to the band.

We note also that GPS is not the only geo-location system either available or possible in the future. The NPRM and FNPRM did not explicitly outline a requirement for GPS technology; they only required geo-location, broadly defined. The European Galileo system is expected in 2010, Part 90 Subpart M authorizes certain geo-location technologies, and additional services—based on hyperbolic triangulation of digital broadcast services—have been discussed and are likely as DTV and digital audio broadcasting become firmly established.

NAF, *et al.* propose the following specific recommendation to the Commission for the final rule: Equipment to be authorized under the geolocate/database option must demonstrate during equipment authorization that it will only enable transmission if it has

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Wikipedia explains assisted GPS (A-GPS) as follows,

"A-GPS differs from regular GPS by adding another element to the equation, the Assistance Server. In regular GPS networks there are only GPS satellites and GPS receivers. In A-GPS networks, the receiver, being limited in processing power and normally under less than ideal locations for position fixing, communicates with the assistance server that has high processing power and access to a reference network. Since the A-GPS receiver and the Assistance Server share tasks, the process is quicker and more efficient than regular GPS, albeit dependent on cellular coverage.

Assisted GPS describes a system where outside sources, such as an assistance server (Mobile Location Server) via a network, help a GPS receiver perform the tasks required to make range measurements and calculate position solutions. The assistance server has the ability to access information from the reference network and also has computing power far beyond that of the GPS receiver. In such a system, the assistance server communicates with the GPS receiver on the mobile phone on a cellular network. With assistance from the network, the receiver can operate more quickly and efficiently than it would unassisted, because a set of tasks that it would normally handle is shared with the assistance server. The resulting AGPS system boosts performance beyond that of the same receiver in a stand-alone mode.

Ordinarily, a standard GPS device needs to have a clear line-of-sight to at least four GPS satellites before it can calculate its position. In addition, it needs enough processing power to transform the data streams from the satellites into a position. In one mode of A-GPS, the mobile receiver takes a snapshot of the satellite signals and transmits these to a cell tower to relay the data to an assistance server that performs the necessary calculations for a position fix. The server may send the fix back to the mobile receiver or to a 911 dispatcher. Some mobile phones will accept converted data streams to compute a position themselves."

[http://en.wikipedia.org/w/index.php?title=Assisted\\_GPS&oldid=102816278](http://en.wikipedia.org/w/index.php?title=Assisted_GPS&oldid=102816278).

produced a geolocation with a  $1\sigma$  accuracy of 250 meters within the last 10 minutes, and that the location satisfies the constraints of the database for permitted locations; if the accuracy is better than 250 meters, the device may transmit closer to the edge of the restricted area. This formulation of the rule puts the burden squarely on the equipment in a fail-safe way: no valid geolocation, no transmission.

We note that no one in the record has opposed the professional installation option.

The final concern raised in the comments about this option was described in the FNPRM as follows: “There were also concerns about the method that should be used (*e.g.*, the F(50,50) curves or the Longley-Rice propagation model) to calculate how far an unlicensed device must be from a TV or other station to avoid causing interference.”<sup>20</sup> While reasonable people can disagree on which propagation curve should be used, the Commission has over 50 years experience in developing standards in protecting TV stations from other TV stations and other types of transmitters, as well as in determining TV channel coverage areas under SHVIA.<sup>21</sup> Stating that there is uncertainty over propagation models is a classic FUD (*i.e.*, fear, uncertainty, and doubt) tactic. Historically, the Commission has protected TV stations to their grade B contour. NAF, *et al.* propose that the protection from TV band devices similarly be at the grade B contour (perhaps with an additional few kilometers of exempt broadcasting space added to ensure that harmful interference is even more unlikely), but is open to reasonable alternatives from the broadcast community.

Implementation of this option requires the development of the stated database and consensus among affected parties that the database is adequate. In reality, this will incur both cost and delay in the deployment of equipment and service to the public. But since it is straightforward that this option will provide adequate protection to TV reception, NAF, *et al.* believes that it should be included as an option for equipment developers and that it could at some time become economically preferable.

### ***Control Signal Approach***

The FNPRM described this approach as follows:

(T)he Commission proposed to require that personal/portable devices operate only when they receive a control signal from a fixed radio transmitter source such as an FM, TV or CMRS transmitter. The control signal would contain a listing of the TV channels that are vacant within the service area of the control signal. The TV band device would only be permitted to transmit on a vacant TV channel listed in the control signal; multiple control signals could be accessed. If no TV channels were vacant at that particular location, or if the TV band device could not receive a control signal, it would not be permitted to transmit. The list of vacant channels transmitted by the control signal would be determined by the use of a database and appropriate computational software, similar to the geo-location/database approach, but with one important difference. Instead of determining vacant channels at a single point (the TV band device transmitter), channels included in the vacant channel list must be vacant at every point within the service area

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<sup>20</sup> FNPRM ¶49 and fn. 61.

<sup>21</sup> See §73.683(d).

of the station transmitting the control signal (e.g., within the noise limited coverage area of a DTV station).<sup>22</sup>

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.<sup>23</sup> 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 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 been the subject of another FUD attack by the opponents of this rulemaking.

There are some difficult and complex issues in this proceeding that require thoughtful analysis to meet the Commission's necessary interference protection goals. However, the basic viability of both the geo-locate database approach and the control signal approach are not such complex issues. If the opponents of this rulemaking are sincere in solving problems and preventing interference, then a short dialogue with the advocates of this rulemaking would suffice to reach consensus on the technical details of these approaches that would satisfy rational interference concerns.

Absent such a dialogue, NAF, *et al.* recommend to the Commission that final rules specify the use of a terrain-based propagation model such as ILLR<sup>24</sup>. The rules should state that the probability of reception of the control signal outside the area of validity at ground level and at the height of existing and planned buildings, given its transmitter power and antenna parameters, must be less than one percent. Such a provision will adequately address the concerns raised by the opponents.

As in the geo-located/database option, implementation of this option 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.

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<sup>22</sup> FNPRM at ¶52.

<sup>23</sup> See *Report and Order and Memorandum Opinion and Order*, Docket 04-151, March 16, 2005.

<sup>24</sup> OET Bulletin Number 72, The ILLR Computer Program, July 2, 2002, [http://www.fcc.gov/Bureaus/Engineering\\_Technology/Documents/bulletins/oet72/oet72.pdf](http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet72/oet72.pdf).

But as in the case of the previous option, NAF, *et al.* feel that this straightforward option should be made available to provide service to the public.

### ***Dynamic Frequency Selection (DFS) Option***

This is the third and most complex option in the NPRM for the enabling of transmissions. It is not that complex from the technical point of view, but it requires a significant change in Commission thinking about spectrum protection and it is understandable that incumbents are concerned about it. This 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 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.

While the opponents of this rulemaking have consistently expressed concern about the “hidden node problem”<sup>25</sup> making DFS unreliable, they also consistently refuse to recognize or even address the concept that the TV signal detector in a DFS-enabled TV band device can be orders of magnitude more sensitive than a DTV receiver. The consistent refusal of the opponents to even address the topic of sensitive detectors is puzzling in view of the long record of this topic at the Commission including the February 2003 Commission-sponsored public tutorial by Dr. John Betz of MITRE Corporation,<sup>26</sup> the discussion of this technology in the Docket 03-108 NPRM,<sup>27</sup> and

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<sup>25</sup> The hidden node problem refers to a situation in which a TV receiver receives a stronger TV signal, due to its location, than a nearby TV band device that, for example, is shielded from the TV transmitter by buildings or terrain, yet has a clear propagation path to the TV receiver. This situation can theoretically create the potential for the TV band device to interfere with the TV receiver because the TV band device thinks it is further from the TV transmitter than it actually is, and transmits at a power level that could interfere with the TV receiver due to the unhindered propagation path between the TV receiver and TV band device. This problem is well known in the technical literature and is discussed in the NAF Issue Brief on this proceeding, “Why Unlicensed Use of Vacant TV Spectrum Will Not Interfere with Television Reception,” available online at: [http://www.newamerica.net/publications/policy/why\\_unlicensed\\_use\\_of\\_vacant\\_tv\\_spectrum\\_will\\_not\\_interfere\\_with\\_television\\_reception](http://www.newamerica.net/publications/policy/why_unlicensed_use_of_vacant_tv_spectrum_will_not_interfere_with_television_reception).

<sup>26</sup> The Commission has the video of this presentation and the slides used are publicly available at: <http://www.fcc.gov/realaudio/presentations/2003/021203/featuredetection.pdf>.

<sup>27</sup> The Docket 03-108 NPRM states,  
“There are techniques that can be used to increase the ability of a sensing receiver to reliably detect other signals in a band which rely on the fact that it is not necessary to decode the information in a signal to determine whether a signal is present. For example, the use of specialized detectors can improve the ability to sense the presence of other signals by 30-40 dB.

actual test data filed in the instant proceeding by Shared Spectrum Company. How many times does this topic have to be mentioned before the opponents will state a technical opinion on it?

If the opponents of this rulemaking continue to refuse to address the fact that DFS detectors can be significantly more sensitive than DTV receivers in their filed comments and replies, NAF, et al. urge Commission staff to clarify this issue for the public record in any *ex parte* meetings that the opponents request with staff.

There are two basic approaches to achieving high detector sensitivity. Both take advantage of the fact that the DFS detector does not have to make 18 million binary decisions a second as to the bits in the DTV signal, as a DTV receiver must do with reasonable accuracy to display a picture.<sup>28</sup> Rather, the DFS detector may take longer than 1/18,000,000 of a second to make a decision, and may look only at the parts of the DTV signal that are most favorable to detection. The ratio of the time needed to make the detection decision and 1/18,000,000 of a second is the potential “processing gain” for improvement of sensitivity relative to a DTV receiver. In other words, whereas a consumer DTV receiver needs a signal strong enough to display a picture, the DFS detector only needs to measure whether a DTV signal is present, which can be accomplished despite a very high degree of attenuation.

The Betz presentation and the Docket 03-108 discussion deal with “cyclostationary detectors” that are also called “feature detectors” that look at the known structure of the signal, not its actual contents. While mathematically complex, this technology is well within the capability of today’s off-the-shelf consumer grade microprocessors and is, for example, no more complex than the graphical algorithms used in widely-sold electronic games.

A second approach is used in the data reported by Shared Spectrum Corporation and is under consideration by other proponents of this rulemaking. This approach focuses on the narrowband pilot tone at the low end of the DTV signal. If a DTV signal is really present, this pilot tone will be consistently present with only minor changes in amplitude and frequency resulting from multipath propagation and Doppler shifts from reflective

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Most applications of signal detection in commercial practice are based on “radiometric detectors” which only function if the signal is greater than the noise level in the receiver system. However, in the past decade information has become available about an alternative technology called cyclostationary detectors or feature detectors which use longer sensing times and internal computation to achieve signal sensitivities below the noise level for signals of known format. By processing a large number of transmitted symbols, without the need to demodulate them individually, such a feature detector can achieve a processing gain over a radiometric detector which does not use knowledge of the signal format. In practice, processing gains of 30-40 dB can be achieved with computation resources typical of today’s microprocessors. With such a detector capable of receiving signals more than 30 dB below the noise floor the hidden node problem that might result in missing the presence of a signal becomes much less likely than with radiometric detectors.” (§25, Citations deleted).

<sup>28</sup> The DTV receiver detections do not have to be all correct since the error control mechanisms in the DTV standard allow small error rates without degrading the received image.

objects. Thus, by focusing on this pilot tone and the areas on either side of it and then averaging the power present in several narrow “frequency bins,” a TV band device can reliably detect signal levels much lower than a DTV receiver can.

The opponents of this rulemaking repeatedly have said that this is a different problem than the U-NII DFS detection of Federal Government radars provided for in §15.407. In many ways, it is a far easier problem to solve! DTV transmitters are on continuously, often for 24 hours a day. They have highly-placed antennas, not low ones like ground-to-air radars, and their signals have 100 percent duty factors, not the intermittent pulsed signals associated with surveillance radars.<sup>29</sup>

The FNPRM mentions the IEEE 802.22 consideration threshold of -116 dBm for the DTV signal for DFS detection. This is 33 dB less than the ASTC A/74<sup>30</sup> recommendation for DTV receiver sensitivity of -83 dBm with no external noise and no propagation degradation, which in practice decrease sensitivity a few dB. NAF, *et al.* believe that a sensitivity level in the range of -110 to -115 dBm should be adequate to protect TV receivers given mobile powers of 100 mW. New America Foundation has just published the results of an engineering study, submitted as an attachment with this filing,<sup>31</sup> that shows this range is feasible and is adequate for receiver protection.

The final choice of DFS sensitivity number depends on many factors, particularly including the maximum allowed mobile power, emission mask, and treatment of adjacent channel issues. NAF, *et al.* plan to make a more precise recommendation in the reply comment phase of the FNPRM.

## Channel 14-20 Issues

The FNPRM prohibits “personal/portable TV band devices from operating on those channels in all areas of the country” and seeks “additional comment in this *Further Notice* on whether fixed TV band devices should be allowed on channels 14-20 in those areas of the country where those channels are not used by public safety.”<sup>32</sup> This is

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<sup>29</sup> Some ground-to-air antiaircraft missile systems such as the U.S. military’s HAWK and the former Soviet Union’s SA-6 use continuous rather than pulsed radar signals. (In these systems, the radar receiver is in the moving missile so interference from low power ground-based systems would not be a concern.) But that was not NTIA’s concern in the U-NII band. The radars that had to be protected were all monostatic pulsed radars with low duty factors.

<sup>30</sup> ATSC Recommended Practice A/74: Receiver Performance Guidelines, June 2004, [http://www.atsc.org/standards/a\\_74.pdf](http://www.atsc.org/standards/a_74.pdf), at p. 11.

<sup>31</sup> 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, available at: [http://www.newamerica.net/publications/policy/can\\_cognitive\\_radio\\_operating\\_in\\_the\\_tv\\_white\\_spaces\\_completely\\_protect\\_licensed\\_tv\\_broadcasting](http://www.newamerica.net/publications/policy/can_cognitive_radio_operating_in_the_tv_white_spaces_completely_protect_licensed_tv_broadcasting).

<sup>32</sup> FNPRM at ¶56.

because of concerns rising from the TV/land mobile sharing of some of these channels in 13 metropolitan areas under §90.311. But these 13 areas constitute only a small fraction of the surface area of the U.S. and do not include significant rural areas. Even in these areas, only one or two TV channels out of six are actually used for land mobile. Thus, significant whitespace exists throughout the country in these channels, including in the 13 geographical areas with TV/land mobile sharing.

NAF, *et al.* fully agree with the Commission that the DFS option is very challenging for protecting land mobile due to its inherently mobile and intermittent use and the lack of a standard signal type in the land mobile use of this spectrum. This is further complicated by the presence of high-priority public safety users whose mission and communications architecture are such that their mobile radios cannot tolerate *any* risk of interference. Therefore, it is inappropriate to consider TV band device access to these channels based solely on DFS at this time.

However, NAF, *et al.* strongly support fixed station access to channels 14-20, based on the geo-locate/database option and the control signal approach, and note its potential to serve rural areas as well as the lack of credible interference threat to any land mobile systems in channels 14-20. Both of these approaches depend on mapping the parts of the country where TV band device use on these channels would be permitted. In view of the critical nature of public safety communications systems, cities with §90.311 should be given a large berth. But we note that *even* if we exclude TV band devices from an excessively protective 200-mile radius of each of the 13 cities, we exclude only 1.6 million square miles—less than 45 percent of the 3.7 million square-mile land area of the U.S. A more detailed calculation using a smaller and more realistic protection radius that takes into account overlaps between protection areas and accounts for coastal cities, where much of the protection area is in the ocean, would yield a small fraction of the country where TV band devices on channels used for TV/land mobile sharing would be unacceptable under any circumstance. Thus, it would be incredibly inefficient and disproportionately harmful to rural areas and constituencies for the Commission to prohibit all use of channels 14-20 if they can be used safely in the majority of the land mass of the country and the rules can be crafted to prevent harmful (or any) interference in the 13 metropolitan areas subject to TV/land mobile sharing.

In view of the challenges in getting broadband to rural areas, the total denial of channels 14-20 to our rural citizens is especially burdensome. We see no substantive allegations in the record that use of geo-locate/database or control signals for fixed stations poses *any* interference risk to land mobile users *provided* that it is done with the conditions for these approaches that are enumerated above in the respective sections of this filing.

Further, given that fixed station use is practical in these channels using geo-locational or control signals, mobile use would also be safe if such use in channels 14-20 were conditioned on the use of the master-client relationship discussed in ¶46 of the *FNPRM*. As the *FNPRM* notes, this concept has already been used in U-NII and is a

noncontroversial aspect of the new 3650 MHz rules,<sup>33</sup> where it protects sensitive satellite earth stations. If the Commission decides to allow mobile use based on master-client relationships and geo-location/database or control signal authorization of fixed stations, it should err on the conservative side in deciding the protection radius around each of the 13 metropolitan areas for the channels that are actually used for land mobile use.

New America Foundation has filed a timely reconsideration request<sup>34</sup> on the channel 14-20 finding in the Report and Order section of the *FNPRM*. NAF, *et al.* urge the Commission to consider the responsible and efficient use of channels 14-20 by TV band devices with appropriate protections in either this phase or a future phase of this proceeding. We see no basic technical impediment to such use along with real benefits for our rural citizens. It is important to heed the concerns of critical public safety users. However, “protecting” them from responsible systems designs that in reality pose no interference threat does not further public safety—it only denies the public use of the spectrum and stymies innovation.

## Wireless Microphone Issues for Unlicensed TV band Devices

The *FNPRM* introduces this issue as follows:

“Manufacturers and users of wireless microphones and other broadcast auxiliary services submit that unlicensed devices would cause harmful interference to those services. These parties recommend that the Commission take a number of steps to protect auxiliary services, including reducing power for portable unlicensed devices, reserving several TV channels in each market for wireless microphone use, requiring unlicensed devices to incorporate spectrum sensing to detect the presence of wireless microphones, and requiring unlicensed devices to recognize a “smart beacon” transmitted where wireless microphones are in use.”<sup>35</sup>

As discussed earlier in the licensing section of these comments, the Part 74 Subpart H use of this band is anachronistic, inconsistent with contemporary general spectrum policy that prefers the use of marketplace forces, and inefficiently uses a tiny fraction of the available space-time-frequency resource that is available. In addition, there is significant documentation that the overwhelming majority of the wireless microphones in this band are used by users that are not eligible under Part 74 and hence are in criminal violation of §301 of the Communications Act of 1934 as amended. These devices are properly regarded, most charitably, as *unlicensed* devices. For example, a recent Internet posting by a wireless microphone group stated,

“And although a lot of people ignore the fact, wireless audio systems actually require a license and are really only supposed to be operated—in the TV band—by broadcasters and media producers.... But according to Stanfill, only about 10 to 15 percent of the systems in use in the United States are properly licensed.”<sup>36</sup>

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<sup>33</sup> See §90.1333.

<sup>34</sup> *Petition for Reconsideration*, New America Foundation and CUWiN, Docket 04-186, December 18, 2006 at p. 7-8.

<sup>35</sup> *FNPRM* at ¶10.

<sup>36</sup> See [http://mixonline.com/mag/audio\\_hear\\_2/index.html](http://mixonline.com/mag/audio_hear_2/index.html).

There is also anecdotal evidence that the wireless microphone manufacturers who have commented in this proceeding are very well aware of the illegal nature of most of their product use and employ independent dealer networks to isolate them from direct sales to largely ineligible end users.<sup>37</sup> An indication of this illegal use can be found even in the record of this proceeding where several parties complain about interference threat to their wireless microphone use as a result of the proposed rules, yet they give no indication whether they have a license (as is customary although not required in pleadings) nor do they even appear to be eligible for a license based on their self descriptions.

While wireless microphone use is clearly of some social value, continuing the present practice of dedicating *all* of the TV band whitespace to such use only by two groups: (1) a narrow set of Part 74 eligible users whose use is geographically limited and (2) a larger set of illegal users who have “grabbed the bull by the horns” and used the spectrum without any legal basis, does not appear to be sound spectrum policy. Either way, sole use of this whitespace by wireless microphones would constitute perhaps the most inefficient remaining use of “beachfront” spectrum. The spatially isolated users of short range wireless microphones only use a tiny fraction of the available whitespace and a negligible fraction of that in rural areas. The Commission must find an accommodation for present and future wireless microphone users other than the *status quo*.

As of this filing date, no one has demonstrated a technical solution to allow TV band devices and protect all present legal and illegal wireless microphone use. Such a solution may be technically possible but should it not be available in time for this rulemaking NAF, *et al.* propose below a strategy to protect wireless microphone use during a transition period and then to migrate such use during the transition period to spectrum more appropriate for this application.

A long-term solution to the wireless microphone issue would be to migrate the present users, both legal and illegal, to alternative technologies that can share spectrum efficiently with the greater spectrum-user community. Professional users such as broadcasters, film producers, and theatrical users could purchase spectrum access from licensees either under secondary market/spectrum leasing provisions of subpart X of Part 1 of the Commission’s Rules, or from CMRS services offered to the public. For example, the recently auctioned AWS or 3G band is anticipated to be used in whole or in part for IMT2000 3G cellular services that will support arbitrary digital transmissions at a variety of data rates. While normal 3G cell phones are inappropriate replacements for most wireless microphone uses, it would be easy for specialized manufacturers to take the digital transmission circuitry of such cell phones and merge it with a high quality microphone and appropriate analog-to-digital converter<sup>38</sup> to yield a straightforward

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<sup>37</sup> There appears to be no Commission rule at present that explicitly bars marketing of transmitters certified under Part 74 to noneligibles. Such a rule may be possible under the Commission’s §302 powers and has certain precedents.

<sup>38</sup> In the United Kingdom the DTV transition has resulted in the need to realign wireless microphone spectrum policies. Users there have repeatedly stated that only analog wireless microphones, generally wide deviation FM, are acceptable because digital will inevitably result in delays that are

system. Would it cost more than the current systems? Of course! *Free licensed spectrum with economic externalities usually results in lower direct costs to users than spectrum use based on marketplace forces*—which the Commission favors in most non-public safety applications except in cases where an unlicensed “commons model” is justified<sup>39</sup>. But such an approach would result in better long-term spectrum utilization.

Other spectrum users with less critical demands and less price flexibility could use a new generation of wireless microphones that use various unlicensed provisions of Part 15, including the rules under consideration in this proceeding. They could also use the licensed provisions of Part 90 if more protection was needed. In most cases, enough short range Part 90 spectrum should be available for the relatively small number of microphones needed for everything from churches to night clubs.

But existing users, both legal and illegal, cannot realistically be expected to transition immediately or consistent with the announced schedule of this rulemaking. Indeed, 3G service is not widely available in the US at this writing and the equipment discussed above will need to be designed, manufactured and marketed after the Commission makes a decision. Thus, a transition plan is necessary to maintain comity among both the legal and illegal users.

NAF, *et al.* propose the following transition plan for wireless microphone users. Since the provisions of this plan appear to be outside the scope of the FNPRM, additional APA notice in either this docket or a new docket would appear to be needed to implement them.

- Subpart H Part 74 could be modified so that five years after the effective date of the TV band device rules, usage under this subpart would no longer be primary but would have to tolerate interference from authorized TV band devices. Such sharing by licensed systems with Part 15 devices would be analogous to existing safe harbor provisions for licensed LMS under §90.361.
- During the five-year transition, wireless microphones would be primary only in a specified block of at most six channels<sup>40</sup> that would initially be forbidden to TV band devices.

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troublesome to the audience. This viewpoint is a misconception resulting from observations of the highly compressed analog-to-digital converters/LPC vocoders generally used in 2G and 3G cell phones that are optimized for low digital output rates to increase overall cellular system efficiency. Short range systems are not so constrained with respect to bandwidth and older generation analog-to-digital converter types can be designed to have arbitrarily low delay and high voice quality at the expense of higher data rates.

<sup>39</sup> Spectrum Policy Task Force Report, Docket 02-135, November 2002 at p. 38-41.

<sup>40</sup> In a given location, some of these channels would not be available for wireless microphone use due to their use by local TV stations. The December 13, 2006 *ex parte* filing by Shure, Inc. in this proceeding indicated that present broadcast industry practice may require 30-100 200kHz channels or 6 MHz to 20 MHz for large scale events. Depending of the geometry of the site not all contiguous 200 kHz channels can be used. Thus multiple channels are needed for the infrequent large events such as political conventions and major sports events. The *temporary* exclusion of TV band devices from certain TV

- After three years of the transition, wireless microphones would be considered purely primary only if either the wireless microphone were collocated with a beacon signal of specified power that emulated the pilot tone of a DTV signal<sup>41</sup> covering the 6 MHz block in which the microphone was operating, or if they were properly licensed and formally coordinated and entered into a database that would be used to drive geo-location/database systems or control signal systems. (Note the pilot tone approach allows quick-reaction mobile use and temporary use, while the licensing coordination approach protects fixed installations such as theatres and film lots.)
- New equipment authorizations for Subpart H Part 74 devices would stop after four years, and manufacturing would cease after six years.
- Throughout the entire transition period, the Commission would certify unlicensed devices to operate on the six designated channels only if they are specially certified as meeting performance-based criteria, including the capability to detect and avoid harmful interference with eligible wireless microphone systems.

After the transition period, remaining wireless microphones would have no protection in the TV band from unlicensed devices and new equipment could no longer be sold. Users could remain in the band with grandfathered equipment as long as they wished with no guarantees of protection (but little real risk of interference in many cases). Alternatively they could use the options enumerated previously for migrating to other options, *e.g.*, AWS/3G-based services, Part 90-based services and Part 15-based services, that are appropriate for their deployments, budgets, and reliability requirements and which are consistent with the Commission's general reliance on marketplace forces to determine spectrum availability.

This is a complicated proposal for transition and will no doubt be unpopular among the wireless microphone users who have exclusive free access to a valuable block of "beachfront property" spectrum under anachronistic rules adopted in a different technical and spectrum policy era. However, it has been crafted to respect the equity of existing users, provide for reasonable protection of ongoing operations in the short term, and give enough time for a reasonable transition to a better long-term policy.

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channels would allow broadcasters suppliers time to develop and market new equipment and allow broadcasters a safe harbor for wireless microphones during the initial years of TV band device use.

<sup>41</sup> This beacon signal is essentially the same approached as proposed by Shure, Inc in p. 17 of their December 13, 2006 *ex parte* filing where it is referred to as a "wireless beacon."

## Emission Limits

Emission limits are usually an esoteric topic arousing little interest in spectrum rulemakings. In this case they have become a major issue.

The FNPRM proposes the following emission limits,

### § 15.707 General technical requirements.

- (a) The maximum conducted output power is 1 watt. If a transmitting antenna of directional gain greater than 6 dBi is used, the peak output power shall be reduced by the amount in dB that the maximum directional gain of the antenna exceeds 6 dBi.
- (b) Unwanted emissions shall comply with the following:
  - (1) Unwanted emissions outside the channel of operation must comply with the general field strength limits set forth in Section 15.209.
  - (2) The provisions of Section 15.205 of this part apply to intentional radiators operating under this section. [This essentially forbids operation on channel 37 which is actually allocated only to radio astronomy.]

The opponents of this rulemaking have discussed emission issues repeatedly in their attempt to stop this proceeding. They have even made a video, “*Your Neighbor’s Static*,” that is not filed in this proceeding but no doubt has been seen by many of the Commission’s staff on the MSTV website, [www.mstv.org](http://www.mstv.org).

Emission limits are critical to ensuring interference-free sharing of the TV band between the proposed TV band devices and the small percentage of households that depend on over-the-air reception of TV signals. The opponents’ alarmist cries are unrealistic and their concerns can be addressed with reasonable emission limits. However, the above requirements in the proposed §15.707 are inadequate.

### ***On-channel Power***

In the case of the geo-locate/database approach and the control signal approach, the 1W limit is adequately protective provided that the spatial boundaries drawn to authorize power on each channel are consistent. More power should mean less possible area of use. This becomes particularly important since, for portable equipment, the 1W proposed output power limit in many cases would far higher than the equipment is capable of generating due to the specific absorption rate (SAR) (radio frequency body exposure) limit of §2.1093 that, in practice, is the limiting factor of transmitter power in many consumer devices.<sup>42</sup> NAF, *et al.* recommend that TV band devices with a lower transmit power be allowed to utilize their lower potential interference range by having the spatial boundaries (i.e., exclusion zones) depend on the device's maximum transmitter power.

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<sup>42</sup> In effect, the exterior physical design details of the transmitter greatly affect the maximum power that can be used with the equipment staying in compliance with SAR limitations.

Thus, a 0.2W system could operate in a wider usage area than a 1W system. Stated differently, a 0.1 or 0.2W device should not require the same-sized geographic exclusion zone as a 0.5W or 1.0W system since the lower powered devices have less interference potential.

For DFS systems, the power limit should be related to the detector sensitivity that is implemented and demonstrated in equipment authorization tests, although 1.0W seems to be a reasonable maximum.<sup>43</sup> The greater the sensitivity of the detector, the more power that may be used. Models with lower sensitivity, due to either implementation cost issues or inability to achieve maximum sensitivity in early models, should be permitted less power.<sup>44</sup>

### ***Desensitization***

Desensitization is an obscure term for a problem that happens with real radio receivers. The Commission recognized this phenomenon in §73.318 (where it is called “blanketing interference”), which deals with FM broadcast receivers that have decreased sensitivity due to the presence of a strong nearby signal in the same band. In desensitization, there is a very strong signal in the same band as the desired channel, but possibly many channels away. This strong signal overwhelms the electronics in the first stage of the receiver with its strength and blocks/desensitizes the reception of much weaker signals that would normally be receivable.

It should be noted that this term was almost unknown until recently in TV band discussions despite the longstanding presence of 5 MW analog UHF-TV stations and TV/land mobile sharing that brought car-based radios with 10-25W transmit power and portable radios with approximately 1W power very close to consumer TV receivers. Apparently neither of these caused documented receiver desensitization.

In a joint filing by NAB and MSTV in this proceeding,<sup>45</sup> a test report by the Communications Research Centre Canada (CRCC) was included that appears to show that TV band devices could cause interference to the whole UHF-TV band at considerable distances. Broadcast interests have circulated a second report on Capitol Hill that appears to be the basis of the now-debunked MSTV video, but this second report is not in the record of this rulemaking and hence has not been subject to public comment.<sup>46</sup>

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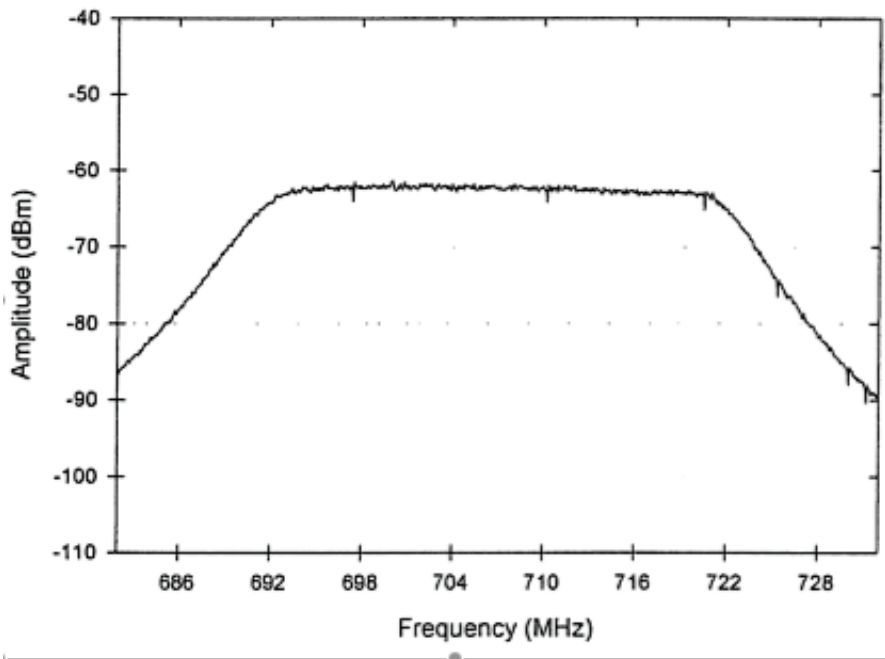
<sup>43</sup> The exception may be rural areas where bands of many contiguous unused channels can be accessed (for example, in most of Alaska and Maine, 85 percent or more of TV band channels will be unused at the end of the DTV transition). See New America Foundation and Free Press, “Measuring the TV ‘White Space’ Available for Unlicensed Wireless Broadband,” January 5, 2006, available at: [http://www.newamerica.net/publications/policy/measuring\\_tv\\_white\\_space\\_available\\_for\\_unlicensed\\_wireless\\_broadband](http://www.newamerica.net/publications/policy/measuring_tv_white_space_available_for_unlicensed_wireless_broadband).

<sup>44</sup> We note that a personal computer without a TV band device is already allowed under §15.109 unintentional emissions of 200µV/m at 3 m or -40 dBm/MHz.

<sup>45</sup> Joint comments of NAB and MSTV, Docket 04-186, November 30, 2004. The attached report is entitled “Laboratory Evaluation of Unlicensed Devices Interference to NTSC and ATSC DTV Systems in the UHF Band,” Communications Research Centre Canada, November 29, 2004.

<sup>46</sup> See Communication Research Centre Canada (CRCC), “Laboratory Evaluation of Unlicensed Devices Interference to NTSC and STSC DTV Systems in the UHF Band, Phase II, Report (February 3,

The February 3, 2005 report differs from the earlier report in its use of a much wider simulated TV band device signal. The report describes the 3-dB bandwidth as being about “30 MHz” or five TV channels. This signal is shown in Figure 1 which is copied from Figure 4 of the CRCC report. This signal is actually 5-to-6 TV channels wide, unlike anything that has been discussed by any of the proponents of this rulemaking. Perhaps it complies with the standards in the original NPRM, but the FNPRM limits TV band devices to a single TV channel of occupancy and in practice there are few places in the U.S. where 5-to-6 contiguous channels would be vacant. While MSTV has stated that the video on their website was made in accordance with the CRCC tests, they have never clarified which report they are talking about. We believe they are referring to this second report, and they have produced negligible details about how the video was made and refused to provide necessary details for independent verification of their research results.



**Figure 1:** *Simulated TV band device signal from February 3, 2005 CRCC report*

The November 29, 2004 CRCC report states that a -74.2 dBm undesired 5.6 MHz signal, equivalent in power to a modest-strength TV signal (since the ATSC recommended sensitivity<sup>47</sup> for a DTV receiver is -84 dBm or only a factor of 10 less) causes significant desensitization of a DTV receiver, reported to be 24-27 dB, a power sensitivity decrease of almost 1000.

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2005), appended to Statement of Robert W. Hubbard, President & CEO, Hubbard Television Group, Before the U.S. Senate Committee on Commerce, Science and Transportation, March 14, 2006 (Appendix A).

<sup>47</sup> ATSC Recommended Practice A/74: Receiver Performance Guidelines, June 2004, [http://www.atsc.org/standards/a\\_74.pdf](http://www.atsc.org/standards/a_74.pdf), at p. 11.

The February 3, 2005 report used a signal of  $-89 \text{ dBm}/120 \text{ kHz}$  or  $-89 + 17 = -72 \text{ dBm}$  per TV channel or a total of about  $-89 + 24 = -65 \text{ dBm}$  for the whole five channels covered. The undesired signal is said to have produced desensitization of 9-22 dB in the DTV test receivers.

NAF has commissioned the University of Kansas (KU) Information & Telecommunication Technology Center, Lawrence, Kansas, a state university laboratory independent of the two industries in conflict in this proceeding, to try to reproduce the desensitization results in the two CRCC reports. The test results to date are included in a separate filing in this docket. KU has been unable to reproduce the same results. While we have the greatest respect for CRCC as an institution, we believe that there were subtle technical errors in the measurements in the two reports and welcome ongoing FCC Laboratory tests to verify the actual protection requirements. The CRCC tests used laboratory antennas a few feet apart, as shown in Figure 2, to send both the desired and undesired signal to an antenna for the receiver being tested. The KU researchers observed that the antennas used by CRCC were in the near field of each other and thus were probably cross-coupled. This, in turn, may have resulted in unintended cross-modulation of the signals, distorting the CRCC results. By contrast, KU did not radiate the two signals but combined them in a more controlled way in a cable that was then connected to the DTV receiver. This created a more controlled laboratory environment for testing the CRCC's claims.



**Figure 2:** *Desired and undesired antennas from November 29, 2004 CRCC report. (Figure 3-3 in original CRCC report.)*

The KU results are summarized in Figure 3, which reproduces a figure from the KU report. Four labeled straight lines show how much power TV band devices of 10mW, 100mW, 1W, and 10W would transfer to a TV receiver assuming 10 meters separation and 0 dBi antenna gain. The four curves show results from three receivers and the ATSC A/74 receiver quality standard (data points shown by small triangles). (One of the three receivers tests was a 1999 set top box that does not consistently comply with ATSC A/74 criteria.)

It must be noted that these tests used a proxy for TV band devices: a modest-cost personal computer card designed for the European market to generate the European DTV signals. Thus the proxy device generates an orthogonal frequency division multiplex (OFDM) signal similar to the better-known IEEE 802.16 WiMAX standard. The TV band device proxy was not subjected to any additional filtering that might have removed more out-of-band emissions from its signal. Thus, these results show the interference potential of a realistic type of TV band device, but do not show the impact of additional filtering that would decrease interference even more, although such filtering would result in a cost increase in any final receiver product. NAF, *et al.* feel that manufacturers are in a better position to discuss this type of cost/performance tradeoff.

A 100 mW RF device is equivalent to 20 dBm of transmission power, converting to dBm. The free space path loss for a distance of 10 meters at 600 MHz is -48 dB for 0 dB antennas. This gives the TV receiver power of  $20 - 48 = -28$  dBm from the TV band device at a 10 meter distance.

From the data in Figure 3, which is reproduced from Figure A. 11 of the KU report, it can be seen that -28 dBm lies above the measured data, showing that emissions from a 100 mW TV band device do **not** cause interference to ATSC A/74 quality standard compliant receivers, nor to the other contemporary receivers tested, if the channel used for the TV signal is avoided and if the adjacent channel is also avoided. Since the KU tests only addressed the use of TV band devices centered in TV channels, additional data would be needed to show if the adjacent channel can be used with a partial offset from the occupied channel. As mentioned earlier, additional filtering of the unlicensed device transmission would improve the performance shown in Figure 3 in all channels except the channel occupied by TV signal. Such filtering, however, has some cost and performance implications for the TV band device.

NAF, *et al.* believe that the results of the KU test are consistent with the aforementioned lack of experience with TV receiver desensitization in operational practice near TV transmitters and TV/land mobile sharing transmitters. We believe, based upon independently conducted and replicable research, that the desensitization concerns of the opponents in the proceeding are baseless. We anticipate that this will be independently reconfirmed in coming months by the FCC's Laboratory test results.

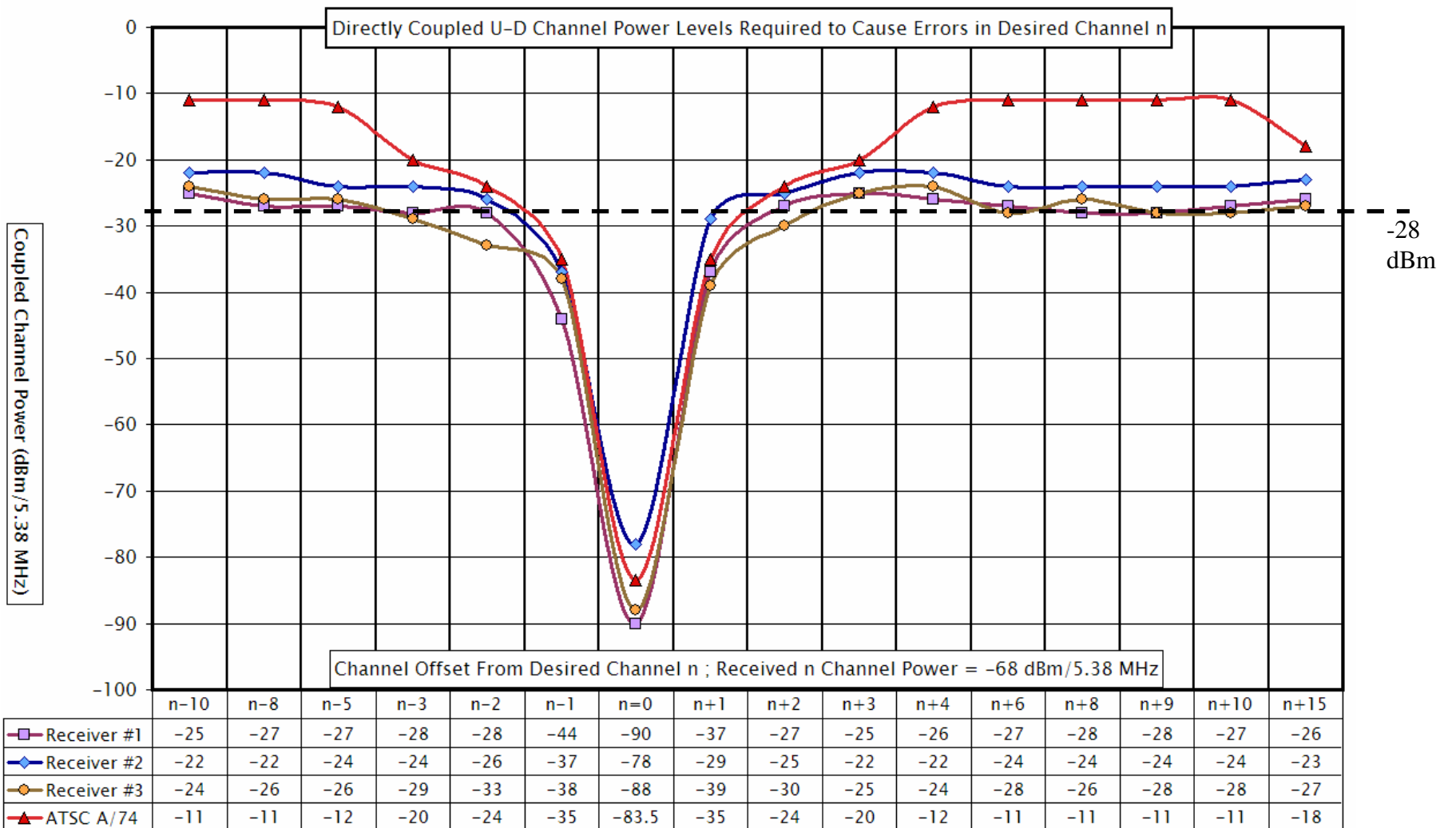


Figure 3: Data from KU report

### ***Use of Channels 2-to-4***

¶57 of the FNPRM deals with the possible prohibition of TV band device use of channels 2-4 “to avoid possible interference to TV interface devices such as VCRs, DVDs, satellite and cable boxes that operate on or adjacent to those channels.” Due to their low frequency, these channels would be of great value in rural areas where long-distance propagation is key.

While most of the arguments of the opponents to this rulemaking have focused on protecting Part 73 and Part 74 licensed services, this issue does not involve the protection of a licensed service. At issue is protection of “VCRs, DVDs, satellite and cable boxes,” all of which are regulated by the Commission as Part 15 unintentional emitters, and which are bound the terms of §15.5(b):

Operation of an intentional, unintentional, or incidental radiator is subject to the conditions that no harmful interference is caused and that interference must be accepted that may be caused by the operation of an authorized radio station, by another intentional or unintentional radiator, by industrial, scientific and medical (ISM) equipment, or by an incidental radiator. (Emphasis added)

Denying potentially useful service to rural America to protect devices not entitled to any protection would be a rather odd policy outcome. Furthermore, those opposing use of channels 2-4 have not shown that use of these channels would be inconsistent with the 10 meters-or-greater protection goal established by the Docket 20780 precedent discussed above, nor have they stated what protection distance they favor.

### **Adjacent Channel Protection**

The proposed §15.707 standards may not be adequate to protect TV receivers from all cases of interference arising from TV band device use of vacant channels adjacent to weak TV channels. Indeed, attention may be needed in this area. However, these numerical limits will depend on the distance the Commission selects as its interference protection goal. We have argued above that based on the longstanding and successful Docket 20780 precedent that mitigated personal computer interference to TV receivers, the limit should be 10 meters or greater.

If the TV band device can determine that the adjacent channel is vacant through any of the three approaches in the FNPRM, it should be allowed to transmit up to the channel edge with the out-of-band emissions given by the proposed §15.707(b)(2). However, if it cannot confirm that the adjacent channel is vacant, then a different approach may be needed.

The traditional spectrum mask approach that the Commission has used for out-of-band emissions is not flexible enough here to give TV band devices enough design flexibility *either* to design practical equipment *or* to protect TV receivers from interference. This approach is based on the World War II-era Stoddart Noise Meters (later called Singer Noise Meters after the well known sewing machine company diversified their offerings

with this product line). These meters measure signals manually in 120-kHz channels, a common bandwidth in the 1940s. No one uses this type of equipment anymore. Rather, \$50,000+ modern digital spectrum analyzers with external digital interfaces (and often with internal computation capability) are used to emulate the archaic equipment since the Commission's rules are based on such equipment. In the traditional spectrum mask approach, every 120 kHz spectrum block, or bin, outside the occupied bandwidth must comply with a specified limit. This may have been a necessary heuristic given 1940s technology, but this is not a precise measure of the real interference mechanism for many types of receivers, especially not for digital systems such as DTV (which, of course, simply did not exist when the regulation was developed).

Given 60+ years of technological innovation, rather than relying on a technologically obsolete spectrum mask to protect adjacent weak channels, NAF, *et al.* urge the Commission to consider adopting a protection standard based on current best practices—a weighted sum of all the out-of-band power from the TV band device, with the weight of each spectrum block/bin based on the rejection of mediocre (but common) DTV receivers, with power in the respective bin. Such measurements would have been excessively time-consuming with Stoddart/Singer Noise Meters. Now, they can be made instantly with contemporary digital spectrum analyzers using internal computation, or using external computation with the ubiquitous personal computer.

## Conclusion

NAF, *et al.* urge the Commission to continue its innovative leadership role in spectrum management by adopting regulations based upon current technological capabilities and commence the adoption of rules allowing the basic unlicensed use proposed in this proceeding with the safeguards enumerated above.

Respectfully submitted,

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## Appendix: Commentors

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**Robert Brodersen** is the John Whinnery Chair Professor and Co-Scientific Director of the Berkeley Wireless Research Center at the University of California, Berkeley, where he has taught since 1976. Professor Brodersen's research is focused in the areas of low power design and wireless communications and the CAD tools necessary to support these activities. He has won several awards over the last two decades from IEEE, including being named one of the top ten contributors in the last 50 years to the IEEE International Solid-State Circuits Conference. <http://bwrc.eecs.berkeley.edu/People/Faculty/rb/>

**Timothy X. Brown** is an Associate Professor in Interdisciplinary Telecommunications, Electrical and Computer Engineering, and Computer Science at the University of Colorado, Boulder. His research focuses include adaptive and massively parallel computational approaches in communication systems. Among his many honors and publications, in 2003 he was named the Global Wireless Education Consortium's Educator of the Year. <http://ece-www.colorado.edu/~timxb/>

**Paul Kolodzy** is the former head of the FCC's Spectrum Policy Task Force and is now Director of the Center for Wireless Network Security at Stevens Institute of Technology. Prior to his time with the FCC, Dr. Kolodzy was a tenured professor at MIT and a manager for the development of advanced technology and communications with the Defense Department's Advanced Technology Office of the Defense Advanced Research Projects Agency (DARPA).

**Andrew Lippman** is the founding Associate Director of the MIT Media Laboratory and a Senior Scientist at MIT. He currently directs a \$5.5 Million/year research consortium entitled "Digital Life" that addresses commerce, personal expression and community in a connected world. Dr. Lippman has been on the editorial board of IEEE Multimedia Systems Journal and Image Communications Journal, and is a Science Advisor to the non-profit Cross Industry Working Group organized by Robert Kahn's Corporation for National Research Initiatives. Dr. Lippman's newest research program Viral Communications brings innovation to wired and wireless networks by shifting their control to the individual in much the same way the way PCs revised computing twenty years ago. <http://web.media.mit.edu/~lip/>

**Sascha Meinrath** is the Director of Municipal and Community Networking for CAIDA, the Cooperative Association for Internet Data Analysis, which provides tools and analyses promoting the engineering and maintenance of a robust, scalable global Internet infrastructure. He is a regular contributor to GovTech.net and MuniWireless.com and the Founder and Executive Director of the CUWiN Foundation, the world's leading open source mesh wireless R&D initiative. Sascha serves on the Board of Directors for

CTCnet, a US-based network of more than 1000 organizations united in their commitment to improve the educational, economic, cultural and political life of their communities through technology. In 2006, Sascha founded EthosWireless.com, a wireless consultancy focused on community and municipal wireless. [www.saschameinrath.com](http://www.saschameinrath.com)

**Marvin A. Sirbu** is a Professor of Engineering and Public Policy, Industrial Administration, and Electrical and Computer Engineering and Chairman of the Executive Committee of the Information Networking Institute at Carnegie Mellon University. Dr. Sirbu coordinates research in telecommunications information technology, policy and management. The research is concerned with how public policies influence the deployment of new information technologies, and conversely, what public policies are required to accommodate new technological developments. <http://www.epp.cmu.edu/people/bios/sirbu.html>

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