

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554**

In the Matters of

Unlicensed Operation in the TV Broadcast Bands

ET Docket No. 04-186

Additional Spectrum for Unlicensed Devices
Below 900 MHz and in the 3 GHz Band

ET Docket No. 02-380

**COMMENTS OF DELL INC., GOOGLE, INC., THE
HEWLETT-PACKARD COMPANY, INTEL CORP., MICROSOFT
CORP., AND PHILIPS ELECTRONICS NORTH AMERICA CORP.**

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SUMMARY

Dell, Google, Hewlett-Packard, Intel, Microsoft, and Philips (collectively the “Coalition”) applaud the Commission’s decision to make available portions of unused spectrum in the television (“TV”) broadcast bands. This decision was a crucial first step towards providing broadband access to millions of Americans and enabling a wide range of innovative wireless devices and services which are not practical at higher frequencies. However, if the Commission adopts overly restrictive technical and operational rules, this first step could also be the last, depriving the public of tremendous benefits that could be realized by putting the valuable—but fallow—TV white spaces to use. To ensure that the white spaces are used to serve the public, the Coalition herein proposes an approach that will protect incumbent licensees from harmful interference while at the same time maximizing use of the white spaces by innovative unlicensed devices. Specifically, the Coalition urges the Commission to implement the following recommendations:

First, with respect to personal/portable unlicensed devices, the Commission should authorize the use of spectrum sensing technology rather than mandating the geo-location/database and control signal approaches discussed in the initial *Notice of Proposed Rulemaking*. The rigorous testing that the Commission intends to undertake will confirm that spectrum sensing, when implemented with the correct technical parameters as proposed herein, is the most reliable and efficient means of avoiding harmful interference to incumbent licensees. To this end, the Coalition will provide the Commission with a prototype device for testing purposes so that the Commission can confirm that the proposed unlicensed devices which the Coalition plans to market will not cause harmful interference.

Second, the Commission should authorize the use of personal/portable unlicensed devices contemporaneous with the authorization of fixed devices, and facilitate the use of personal/portable unlicensed devices by imposing the minimum regulation necessary to protect incumbent licensees. Technology has advanced sufficiently such that the high tech industry can manufacture mass market, low power devices for a wide range of innovative services that will protect licensees from harmful interference. These devices, however, cannot and should not operate pursuant to the restrictions applicable to fixed devices; personal/portable devices use lower power than fixed devices, and should be regulated accordingly. Moreover, a market comprised only of fixed devices would be much smaller, thereby limiting economies of scale and scope and potentially causing significant manufacturers to forego market entry—depriving many Americans of innovative wireless services and technologies.

Third, the Commission should ensure that the TV white spaces are used for unlicensed operation; spectrum should not be allocated on a licensed basis. The Commission has concluded correctly that unlicensed operations may be better suited to adapt to the “shifting spectrum environment” characterized by low power operations in the TV bands. Indeed, the phenomenal success of the Wi-Fi industry is merely a prelude to the benefits the country can expect from making unused television spectrum available on an unlicensed basis. With so much licensed spectrum already available below 1 GHz (including an additional 60 MHz to be freed up for nationwide licensed use by the DTV transition in the near future), it simply makes no sense to license the TV white spaces as well—particularly since licensing of this “Swiss cheese”, power-restricted spectrum will likely result in substantial underutilization. Moreover, licensing simply is not necessary

to protect incumbent licensees as some would contend; unlicensed manufacturers are strongly motivated to protect licensed users from harmful interference, and are fully capable of doing so.

In short, the Coalition strongly urges the Commission to adopt minimal technical and operational rules that maximize the potential innovative uses of the TV white spaces while protecting the legitimate rights of licensed users. By doing so, the Commission will help ensure that all Americans derive the highest benefit from this valuable, yet presently underused, public resource.

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Dell, Google, Hewlett-Packard, Intel, Microsoft, and Philips (collectively the “Coalition”) applaud the Commission’s decision in the *First Report and Order* to grant certain devices access to substantial portions of unused spectrum in the television (“TV”) broadcast bands.¹ This decision represents a crucial first step towards providing broadband access to millions of Americans and enabling a wide range of innovative wireless services and technologies, such as self-organizing mesh networks and distribution of high-definition multimedia content throughout the household. As the world’s largest producers of consumer electronics, software, semiconductors, personal computers, and peripheral devices, the Coalition’s members stand ready to commit substantial resources to bring these advancements to consumers.

The Coalition’s members believe that the phenomenal success of the billion dollar Wi-Fi industry—which has utilized what was once called “junk” spectrum to lower

¹ *Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, First Report and Order and Further Notice of Proposed Rule Making, 21 FCC Rcd. 12266 (2006) (“Further Notice” or “FNPRM”).

infrastructure costs and enable widespread, flexible broadband access—is merely a prelude to the benefits that can be achieved from opening up unused TV broadcast spectrum. For the first time, the public will have access to broadband-capable unlicensed spectrum below 900 MHz, and industry will be able to offer consumers a range of new products and services that take advantage of the superior propagation characteristics of this spectrum. In order to realize this vision, the Commission must strike the appropriate balance between the interests of incumbent license holders and the public’s right to use the airwaves in innovative ways. The existing users of the TV bands should be afforded the interference protection accorded to them by their licenses, but the overreaching measures proposed by some incumbents extend far beyond the rights their licenses provide, and are not necessary to protect licensees.² In fact, such measures will serve only to foreclose the benefits that full utilization of these bands can offer to millions of Americans.

Innovative use of the 2.4 GHz band—which currently accommodates over one billion devices—has been driven by the substantial flexibility and unlicensed access afforded to users of that band. Successful utilization of the TV white spaces will require a similar approach. The Coalition therefore is encouraged by the Commission’s recognition in the *Further Notice* that overly restrictive technical rules will render use of the TV white spaces infeasible, and endorses the Commission’s decision to conduct independent testing to determine the actual level of interference protection necessary for incumbents. In short, the Commission should adopt regulations that ensure the maximum

² For example, broadcasters have opposed the use of portable devices in the white spaces, and also have opposed allocating spectrum in these bands for unlicensed devices. *See generally* Joint Comments of the Association for Maximum Service Television, Inc. and the National Association of Broadcasters (filed Nov. 30, 2004) (“MSTV and NAB Comments”).

flexibility for innovation in the white spaces, while still protecting incumbent licensees from harmful interference.

I. THE COMMISSION SHOULD AUTHORIZE SPECTRUM SENSING TECHNOLOGY TO ENABLE USE OF LOW POWER UNLICENSED DEVICES IN THE TV WHITE SPACES.

A. Spectrum Sensing Offers the Best Solution for Identifying and Utilizing Available White Spaces.

The Coalition enthusiastically endorses the Commission’s initial determination that devices operating in the TV white spaces could employ spectrum sensing to determine that a particular channel is available for use,³ and encourages the Commission to authorize spectrum sensing for low power personal/portable devices. Spectrum sensing will protect incumbent licensees and facilitate spectrum sharing with other low power devices in the white spaces, while avoiding the operational difficulties and economic burdens associated with the other interference avoidance mechanisms identified in this proceeding. In addition, since spectrum sensing does not depend on third party “assisting” technologies (such as databases of available channels and/or broadcast beacons) to implement, a spectrum sensing approach will better facilitate the creation of a mass market for devices – resulting in more affordable consumer products and more attractive prospects for wireless broadband, including in rural areas. In fact, it may be the single most significant action taken by the Commission to bring broadband access to rural America.

³ See FNPRM ¶ 3 (“We propose to require that TV band devices employ spectrum sensing to determine when TV channels are unused and to incorporate a dynamic frequency selection (DFS) mechanism to ensure that TV band devices operate only on vacant TV channels.”).

1. *Spectrum sensing is a proven, well understood technique.*

The primary concern raised to date by incumbent licensees with respect to spectrum sensing is that this approach is unproven.⁴ However, this is simply not the case. Wi-Fi devices operating in the unlicensed bands have been employing spectrum sensing technology for over 10 years. Moreover, as the Commission has recognized, the authorization of U-NII devices employing dynamic frequency selection (“DFS”) in the 5 GHz band provides a valuable precedent for the Commission to consider when determining the appropriate approach for interference avoidance in this proceeding.⁵ As discussed below, the Coalition advocates an even more conservative means of detecting protected signals than that used by U-NII devices. In order to protect incumbent licensees, the Coalition recommends -114 dBm as the threshold for establishing channel vacancy, 50 dB more than the Commission requires for U-NII devices.

Although the Commission correctly notes that differences between incumbent military radar in the 5 GHz band and TV broadcast signals will require modifications to the U-NII DFS approach, most of these differences make the case for spectrum sensing in the TV bands even more compelling. Unlike military radar, TV signals are designed to be detected. While differences between the bands will require different technical standards, the Coalition is confident that the Commission’s prototype device testing will confirm that the Coalition’s proposed operating parameters will protect licensees from harmful interference. Spectrum sensing obviates the need for base stations, geo-location

⁴ See, e.g., MSTV and NAB Comments at 15 (“While [spectrum sensing] technology may hold promise, the Commission cannot risk the health of the public’s broadcast television service today on the basis of technology that may or may not be developed tomorrow.”).

⁵ See FNPRM ¶ 34 (“We agree that the experience gained in developing the rules for 5 GHz U-NII is informative in considering the development of sensing techniques in the TV spectrum.”).

or control signals, and the Commission should authorize its use for unlicensed personal/portable devices.

2. *Proposed operating parameters for spectrum sensing.*

In its initial NPRM, the Commission proposed to limit the maximum power output of unlicensed personal/portable devices to 100 mW, with a maximum transmit and receive antenna gain of 6 dBi.⁶ In order to further reduce the likelihood of harmful interference, the Coalition recommends a maximum of 0 dBi for receive and transmit antennas rather than the 6 dBi gain proposed by the Commission. This restriction will result in an EIRP which is 6 dB less than was suggested by the Commission. The Coalition further notes that the operating parameters it suggests below will cause the unlicensed device to frequently transmit at powers less than its proposed maximum EIRP of 20 dBm.⁷

The Commission seeks comment on the appropriate level of sensitivity a device must have when determining the presence of other signals (*i.e.*, the “detection threshold”).⁸ The correct detection threshold must protect existing licensed uses, while at the same time not being so restrictive as to limit the usefulness of the unlicensed devices operating in the white spaces. As the *Further Notice* explains, “a lower detection threshold infers greater interference protection for services operating in the TV spectrum,

⁶ See *Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, Notice of Proposed Rule Making, 19 FCC Rcd. 10018 (¶ 22) (2004) (“Notice” or “NPRM”).

⁷ See, *e.g.*, discussion of transmit power control, *infra* p. 12.

⁸ FNPRM ¶ 35.

but could also result in increased false positives as a response to spurious radio noise ... sharply reducing the usefulness of this spectrum for TV band devices.”⁹

In determining an appropriate detection threshold, the Coalition recommends that the Commission use Threshold of Visibility (“TOV”) as the measurable and verifiable proxy for TV channel vacancy at the Grade B Contour. TOV is the received signal level at the input terminals of the TV receiver below which the DTV receiver cannot reproduce the transmitted picture. Accordingly, it is reasonable to conclude that a channel is vacant at a particular time and geographic location when the signal falls below TOV.

The Commission already has determined that existing DTV receivers are able to provide service until the signal level at the input terminal to the receiver falls below approximately -84 dBm (TOV) for UHF signals, and slightly higher for VHF.¹⁰ However, because the relative position of the TV transmitter, the TV receiver antenna, and the unlicensed device are unknown, a lower detection threshold is required for the unlicensed device to determine if a TV channel is vacant. The Coalition proposes that the detection threshold of the unlicensed device be set by the Commission at 30 dB below the Commission’s established threshold of visibility, or -114 dBm. As set forth below, because the Coalition’s prototype device is designed to detect analog as well as digital signals, the -114 dBm detection threshold also will provide the protection necessary for licensed wireless microphones and other incumbent analog operations.

⁹ *Id.* ¶ 38.

¹⁰ DTV receivers currently on the market are able to provide service at TOV at the following signal levels: -82.2 dBm (low VHF), -83.2 dBm (high VHF), and - 83.9 dBm (UHF). *See* Stephen R. Martin, *Tests of ATSC 8-VSB Reception Performance of Consumer Digital Television Receivers Available in 2005*, FCC/OET TR 05-1017 at 8-4 (Nov. 2, 2005).

While the Commission has expressed some concern that a spectrum sensing approach could be subject to a “hidden node” problem,¹¹ the -114 dBm detection threshold proposed by the Coalition provides sufficient margin to resolve this potential issue. A “hidden node” problem can occur when an obstacle such as a building sits between a licensee’s signal and the device performing signal detection. Citing this phenomenon, broadcasters erroneously contend that the unlicensed device would be unable to protect an otherwise usable TV signal and may begin transmitting, thus causing harmful interference (*e.g.*, a nearby TV receiver is connected to an antenna on a roof that is placed above the obstruction blocking the signal to the unlicensed device). However, there are several reasons why the risk of a hidden node problem is for practical purposes eliminated in the TV band context using the detection threshold proposed by the Coalition.

As the Commission has observed, the TV bands have superior propagation characteristics,¹² which substantially reduce the likelihood that an incumbent licensee’s signals will be blocked. Moreover, unlike a TV receiver, an unlicensed sensor does not have to demodulate and reproduce a picture to perform its function. It only has to confirm the presence of a signal—a task that can be accomplished for signals substantially weaker than those required to reproduce a transmitted picture. Indeed, as the Commission explained in the *Cognitive Radio NPRM*, “[t]he use of a feature detector much more sensitive than the TV receiver ... makes [a hidden node problem] much less

¹¹ See FNPRM ¶ 39 (noting that hidden nodes are a “potential problem” for spectrum sensing and requesting views on the scope of the problem).

¹² See *id.* ¶ 1 (noting that “transmissions in the TV band are subject to less propagation attenuation than transmissions in other bands where lower power operations are permitted”).

likely.”¹³ Furthermore, transmit power control (“TPC”) capabilities for TV band unlicensed devices (discussed below) would further reduce the likelihood of harmful interference to incumbent licensees in the TV bands.¹⁴

As the following examples illustrate, the proposed -114 dBm detection threshold is more than sufficient to protect broadcast services from harmful interference:

Example 1 - A DTV signal with a 6 dB gain outdoor TV antenna is -90 dBm and the cable from the antenna to the TV is lossless. The signal at the input of the receiver will be at TOV or -84 dBm (+6 dB - 90 dBm). Assuming that the building DTV signal attenuation at the unlicensed device is 15 dB, and the unlicensed device employs a 0 dB (unity gain) omnidirectional antenna, the received signal at the unlicensed device will be -105 dBm (-90 dBm - 15dB). So if the detection threshold for the unlicensed device is set at -114 dBm, the device will conclude that the channel is occupied with 9 dB of margin to spare.

Example 2 - A TV is attached to a 0 dB (unity gain) indoor antenna instead of an outdoor antenna. The TV will then receive a signal of -105 dBm (-90 dBm - 15dB) producing no visible picture. Since the unlicensed device will still receive a signal of -105 dBm, it will conclude that the channel is occupied and not transmit on it (even though it would cause no harmful interference even if it did transmit).

¹³ *Facilitating Opportunities for Flexible, Efficient, and Reliable Spectrum Use Employing Cognitive Radio Technologies; Authorization and Use of Software Defined Radios*, Notice of Proposed Rule Making and Order, 18 FCC Rcd. 26859, 26869 (¶ 25 n. 35) (2003) (“*Cognitive Radio NPRM*”).

¹⁴ See FNPRM ¶ 45 (“[W]e invite comment as to whether we should permit adjustments to any TV band device operating parameters, such as the detection threshold, if a TV band device operates at a power level substantially below the limit.”).

Though these two simple examples do not represent all possible situations, they do provide confidence that a -114 dBm detection threshold provides more than adequate protection. Coalition empirical testing, hopefully to be verified by Commission testing, eliminates any doubt that -114 dBm is more than sufficient to protect all incumbent license holders.

In short, spectrum sensing provides a reliable means of determining whether a particular channel is available for use by an unlicensed device. The Coalition fully endorses its use and urges the Commission to do the same.

B. The Geolocation/Database and Control Signal Approaches are Neither Practicable nor Desirable.

The Commission also seeks additional comment on the geo-location/database and control signal approaches discussed in the initial *Notice of Proposed Rulemaking* in this proceeding.¹⁵ Even assuming that these approaches are feasible, however, the Commission should not make either approach mandatory for personal/portable devices. Most importantly, each of these solutions requires the creation and maintenance of centralized infrastructure to utilize the white spaces, which would eliminate the ability to create organic, decentralized networks. Thus, mandating either of these approaches would deprive the white spaces of the flexibility that has characterized the success of the 2.4 GHz band. Concerns raised by the Commission in the *Further Notice* with respect to these mechanisms further underscore why a pure spectrum sensing approach provides a superior alternative for preventing harmful interference to incumbent licensees.

¹⁵ *Id.* ¶¶ 49-55.

First, as the Commission has observed, a complete database of TV stations must be created and updated in real-time.¹⁶ The Commission notes that it could rely on a private party to maintain such a database,¹⁷ but this approach would add unnecessary costs, such as administrative fees for access to the database. An approach dependent on third party infrastructure deployments could also create a disastrous Catch-22: database and/or control signal providers may not offer services unless they believe that the number of unlicensed devices would make it profitable to do so, while manufacturers and service providers may not invest resources unless they are certain a viable database/control signal is available. It is therefore easy to conceive of a situation where no one moves forward and, in spite of the Commission's efforts, the TV white spaces remain unused.

Moreover, even assuming the existence of a database provider, this approach raises other operational concerns.¹⁸ With respect to the geo-location approach, the requirement that a base station communicate with an unlicensed device will require a service provider to lease space to situate the base station. Such a requirement will delay, if not effectively prohibit, deployment and add substantial additional costs. Professional installation would add even more costs, and would be inapplicable to personal/portable devices.

While unlicensed outdoor devices could employ GPS technology in lieu of professional installation, indoor GPS receivers often are unable to communicate with

¹⁶ *Id.* ¶ 50.

¹⁷ *Id.*

¹⁸ *See id.* ¶ 51 (“If a device is professionally installed, who should be permitted to install it? What is the appropriate method of determining the required separation from authorized users in the TV bands? How will the geo-location/database approach protect other authorized services, such as wireless microphones, the location of which may not be included in the databases?”).

GPS satellites. The Commission has asked about the possibility of implementing Assisted GPS (“AGPS”) to make position fixes more likely in areas where GPS signals are weak,¹⁹ but AGPS requires access to a reference network—such as the cellular networks deployed by CMRS providers—to “assist” the GPS receiver by transmitting data that helps the device determine its location. To the Coalition’s knowledge, no CMRS provider has made access to their networks commercially available for this purpose. Even assuming that such access could be obtained, it would add yet another unnecessary cost for devices, further decreasing the likelihood of economic viability. Addressing the above issues might make a geo-location/database approach a technologically viable mechanism for interference avoidance, but at best it would remain more cumbersome and significantly more costly than a spectrum sensing approach, with no offsetting benefit.

A solution based on control signals presents even greater implementation concerns.²⁰ As with geo-location, sending a control signal to a device containing a listing of vacant TV channels in the signal’s service area would require the creation and maintenance of a real-time TV database, with the resulting unnecessary costs. A number of parties also have raised concerns about such an approach even in areas where control signals would be available, including conflict of interest problems associated with

¹⁹ *Id.* ¶ 51 n. 64.

²⁰ While the NPRM initially proposed a control signal requirement for personal/portable unlicensed devices, the FNPRM recognized the possibility that “one interference avoidance scheme could be used effectively for both types of TV band devices.” FNPRM ¶ 25. For the reasons set forth below, the Coalition strongly opposes a mandatory control signal requirement, and urges the Commission to make clear that it will not impose such a requirement on personal/portable devices.

allowing broadcasters to operate and/or charge for access to control signal information,²¹ as well as the potential for devices to receive conflicting signals from multiple sources.²²

C. Other Operating Parameters.

1. Transmit power control.

The Commission proposes to employ transmit power control (“TPC”) limits for unlicensed devices operating in the TV band.²³ The Coalition supports TPC requirements, which “further reduce the potential for interference”²⁴ and provide an even greater degree of confidence that a spectrum sensing approach will protect incumbent users. Consistent with the requirements for U-NII devices in the 5 GHz band, the Commission proposes to require a TPC dynamic range of 6 dB, and asks whether a greater dynamic range of power limits might be appropriate as long as that power level is still sufficient to communicate.²⁵ The Coalition suggests a minimum TPC dynamic range of 20 dB, which will provide 14 dB more protection than was proposed by the Commission.²⁶ Moreover, this recommendation is in addition to the 6 dB reduction from the original operating parameters proposed in the NPRM that will be realized by using antennas with a maximum of 0 dBi (unity gain). Coalition members plan to design devices that, while capable of transmitting at a maximum power of 100 mW EIRP, will

²¹ *Id.* ¶ 53.

²² *Id.*

²³ *Id.* ¶ 45.

²⁴ *Id.*

²⁵ *Id.*

²⁶ *Id.*

employ TPC whenever possible to ensure that the minimum power required for reliable transmission between the transmitter and the receivers within range is used.

2. *Other technical considerations.*

The Commission also seeks comment on a number of specific proposals regarding technical rules necessary to implement a spectrum sensing approach.²⁷ The Coalition agrees that the majority of these proposals will help ensure the successful implementation of spectrum sensing for unlicensed devices operating in the TV band.²⁸

Channel availability check time, move time, and non-occupancy period - The Coalition agrees with the Commission that unlicensed devices should establish that a TV channel is vacant at a particular time and geographic location before transmitting. The Commission asks whether there is a need to provide a specific period of time over which initial sensing must occur.²⁹ It should not. There is no need to specify a standard sensing interval for all devices, as the optimum check time for each device will be dictated by algorithms implemented by each manufacturer to meet the minimum threshold of detection requirements that the Commission ultimately requires. The Commission should specify only the required threshold of detection, and the time to sense that level should be left to the manufacturer, provided the prerequisite sensitivity is achieved before a signal is transmitted.

²⁷ *Id.* ¶¶ 40-48.

²⁸ *Id.* ¶ 34 (“Based on our experience in developing the spectrum sensing rules for 5 GHz U-NII devices, we do, however, believe that the DFS approach in those rules can, with appropriate modifications, be applied to TV band devices.”).

²⁹ *Id.* ¶ 41.

The Coalition also believes that a requirement to re-check a particular channel in use by an unlicensed device operating in the TV bands would not be unreasonable,³⁰ though a requirement to re-check every 10 seconds is wholly unnecessary and would reduce the throughput of unlicensed devices with no appreciable increase in protection for broadcasters. Rather, in light of the “always on” nature of incumbent licensees, a re-check requirement on the order of one minute is more appropriate. With respect to move time after a station’s presence is detected, however, the Coalition believes that the period of 10 seconds proposed by the Commission in the *First Report and Order* is sufficient.³¹

Finally, the Coalition agrees with the Commission that it is unnecessary to establish a fixed period during which an unlicensed device operating in the TV bands must stay off the air in a particular channel after the device determines that the channel is occupied.³² As the Commission has observed, incumbent licensees will receive adequate protection from unlicensed devices operating in the TV bands, even without a requirement to stay off a channel for a particular period of time—as devices still will be required to confirm that a channel is unoccupied at the commencement of operation and to periodically monitor that channel for use by incumbent licensees.³³

Adjacent Channel Interference - The Commission has recognized that low power personal/portable devices are not likely to pose an interference problem when operating

³⁰ *Id.*

³¹ *See id.* Appx. B, Proposed Rules, § 15.707(f)(iii).

³² *Id.* ¶ 41.

³³ *Id.* ¶ 41.

in channels adjacent to channels occupied by TV signals.³⁴ Nevertheless, the Commission seeks comment on the need for adjacent channel sensing by such devices.³⁵ Although the potential for harmful adjacent channel interference by low power personal/portable devices operating within the parameters proposed herein is small, the Coalition is not opposed to some measures to provide a greater degree of confidence that incumbent licensees will not face harmful interference. The Coalition plans to utilize TPC combined with over-the-air sensing to achieve Commission-mandated adjacent channel D/U (desired to undesired) signal ratios, and is confident that Commission testing of the Coalition's prototype will verify that this approach is more than adequate to protect incumbent licensees on adjacent channels.

The Coalition's own testing strongly suggests that the FCC laboratory will be able to confirm that an outright ban on adjacent channel usage by low power devices is not necessary or advisable, and will serve only to create an artificial scarcity of white spaces in congested areas. The ability to offer devices that will work in both urban and rural areas will create a substantially more robust market—with resulting economies of scale and scope—than would a market made up of devices that could operate only in rural areas.

Sensing bandwidth - The Commission also has inquired as to whether it should specify a particular minimum sensing bandwidth in addition to the detection threshold.³⁶

³⁴ NPRM ¶ 30 (“We ... believe that the requirements needed to protect television service from digital unlicensed devices should be limited to co- and adjacent channel operations only for fixed/access operations and co-channel operations only for personal/portable operations.”).

³⁵ FNPRM ¶ 42.

³⁶ *Id.* ¶ 43.

It should not. Consistent with the Coalition’s view that the Commission should mandate performance requirements rather than specific implementation schemes, industry should be allowed to determine the implementation that works best for each device. In this way, the Commission can ensure that innovative approaches to interference avoidance are not stifled by “one size fits all” implementation requirements.

Antenna Requirements - The Commission has proposed the use of an omnidirectional antenna with a gain of 0 dBi (unity gain) for sensing, and asks what considerations need to be taken into account if devices use a gain antenna for transmitting.³⁷ As noted above, the Coalition is not opposed to a requirement that both receive and transmit antennas have a maximum gain of 0 dBi, which will provide further assurances that incumbent licensees will be protected from harmful interference.

The Commission also asks whether it should establish minimum transmit height antenna requirements or require reduction in power when antennas are above a certain height.³⁸

The Coalition believes that, for personal/portable devices, height restrictions should not be imposed since they would be impossible to administer and are unnecessary given the low power (below 100 mW EIRP) at which these devices would operate. However, the Coalition recommends that devices should not have antennas that can be removed by the consumer, and that consumers should not be permitted to connect devices to separate external antennas.

Spectrum Sharing - The Coalition applauds the Commission’s recognition that industry has the capability to develop standards and protocols that will facilitate sharing

³⁷ *Id.* ¶ 44.

³⁸ *Id.*

of TV white spaces.³⁹ However, the Coalition also agrees with the Commission that the ability of a single device or network to monopolize a particular channel or geographic area would dramatically decrease the usefulness of these bands.⁴⁰ Thus, the Coalition is not opposed to a minimal regulatory requirement to ensure spectrum sharing among devices. Specifically, the Coalition proposes a maximum channel occupancy time of 400 milliseconds, to be followed by a minimum 100 microsecond interval during which the device may not transmit on the previously vacated channel. Because this restriction will be more than sufficient to ensure that one device does not monopolize a particular channel, the Commission should not impose additional restrictions, such as prohibiting simultaneous transmission on more than one channel, on unlicensed devices.

Distributed Sensing – Finally, the Commission has inquired about the possibility of implementing a requirement that TV band devices share channel availability information (“distributed sensing”) to reduce the threat of harmful interference.⁴¹ As discussed above, the Coalition has determined that a detection threshold of -114 dBm is more than sufficient to protect incumbent licensees. While the availability of distributed sensing presumably would allow the operation of devices with a less conservative detection threshold, the Coalition believes that the best approach would be to require all devices to operate at -114 dBm to ensure operation even in instances where channel availability information from other unlicensed devices may be unavailable.

³⁹ *Id.* ¶ 47.

⁴⁰ *Id.*

⁴¹ *Id.* ¶ 39.

D. Testing.

The Coalition enthusiastically endorses the Commission's commitment to perform lab testing to determine the true potential for harmful interference to incumbent licensees by devices operating in the TV white spaces.⁴² Rules for operation in TV white spaces should be guided by how actual prototype devices perform in a series of objective and unbiased tests, rather than on speculation fueled by experiments based on devices that no one plans to build with RF outputs designed to maximize interference. The Coalition already has responded to the invitation of the Office of Engineering and Technology to submit a prototype TV band device for testing,⁴³ and will provide a prototype in the near future.

It is the Coalition's belief that the Commission's testing will confirm that the proposed device will protect incumbent licensees from harmful interference, and that personal/portable devices utilizing spectrum sensing are a viable approach that not only should be permitted, but encouraged. If requested to do so, the Coalition stands ready to provide the Commission with qualified engineers to aid in the testing under Commission supervision and be available to answer questions concerning the prototype device.

II. THE COMMISSION SHOULD NOT IMPOSE ADDITIONAL RESTRICTIONS ON PERSONAL/PORTABLE UNLICENSED DEVICES.

Although the Commission's initial *Notice* proposed using different interference avoidance mechanisms for fixed/access and personal/portable unlicensed devices, the Commission recognized in the *Further Notice* that certain interference avoidance

⁴² *Id.* ¶ 3.

⁴³ *See* Public Notice: Office of Engineering and Technology Invites Submittal of Prototype TV Band Devices for Testing, DA 06-2571 (rel. Dec. 21, 2006).

schemes could be employed for both fixed and personal/portable devices.⁴⁴ While the Commission has expressed concern that personal/portable devices could present a greater threat of harmful interference and interfering devices could be more difficult to locate,⁴⁵ these concerns—even if valid—are more than offset by the much lower power at which personal/portable devices operate. More fundamentally, however, the Commission can alleviate harmful interference concerns by setting the underlying performance criteria it expects the devices to meet, and then allowing industry to implement the means to meet those criteria. As set forth in greater detail above, the spectrum sensing approach works for personal/portable devices, and the Coalition is confident that the Commission’s independent tests will confirm these results.

The Coalition is particularly concerned that the Commission’s initial determination to permit the use of fixed devices, but to seek further comment on personal/portable devices,⁴⁶ could presage delays in authorizing—or even failure to authorize—the use of such devices. Failure to authorize personal/portable devices would be a major blow to U.S. competitiveness and the nation’s consumers. Fixed devices can only be deployed if there is a service provider willing to invest in base station infrastructure and lease locations to situate base stations. In addition, as envisioned by the Commission, fixed devices must avoid adjacent channel operations, excluding access to significant amounts of spectrum in congested urban areas.

⁴⁴ FNPRM ¶ 25.

⁴⁵ *Id.* ¶ 18.

⁴⁶ *Id.* ¶ 2.

These requirements will at best delay implementation and add significant unnecessary costs, increasing the likelihood that service providers will deploy infrastructure only in the most lucrative markets—once again depriving rural America of advances in broadband technology. In addition, the devices themselves will be much more expensive; the relatively limited deployment that a fixed requirement entails would create a far smaller market, thus limiting economies of scale and scope. Perhaps most importantly, the increased cost to consumers and the limited market would cause manufactures to reassess whether they should enter this market at all.

Delaying the eventual authorization of personal/portable unlicensed devices would also be a serious mistake. The Coalition fully endorses the Commission’s commitment to allow the sale of TV band devices as of February 17, 2009,⁴⁷ and strongly urges the Commission not to change this date even in the unlikely event that the DTV transition is delayed. The Coalition has a personal/portable prototype specifically developed for the TV bands available today, and has solid roadmaps for delivery of innovative TV band unlicensed devices in the near term. Any concerns that the Commission has that may require further study and analysis are best accomplished now, while the Coalition and various other companies are eager to commit resources to help. Continuing to postpone a ripe decision (as the Commission has for the last two years) will inevitably drive domestic industry resources away from the TV white spaces. The time for the Commission to act is now—so that consumers can enjoy innovative products, and the U.S. can take the competitive lead in this space.

⁴⁷ *Id.* ¶ 16.

III. THE WHITE SPACES SHOULD BE ALLOCATED FOR UNLICENSED USE.

A. White Spaces are Ill-Suited for Deployment of Licensed Services.

As the Commission has observed, allocating spectrum via license is appropriate when spectrum rights are (1) clearly defined; (2) exclusive; (3) flexible; and (4) transferable.⁴⁸ Spectrum rights lacking these attributes are more efficiently allocated through unlicensed operation.⁴⁹ The *Further Notice* provides ample evidence that the TV white spaces do not meet the Commission’s criteria for licensed operation. Most significantly, a licensing regime will not lessen any of the obligations that would be imposed on devices under an unlicensed model. Devices still must transmit at lower power than typical licensed use, deploy a reliable means of determining whether a channel is in use by an incumbent licensee, and cease operation in cases where that spectrum is or becomes occupied by a licensee with a higher authorization.⁵⁰ Such restrictions are not imposed on licensed use as a matter of course, and the Commission is therefore right to be concerned that “Unlicensed operations may ... be better able to dynamically adapt to a shifting spectrum environment characterized by low power operation.”⁵¹ The Coalition concurs with the Commission; unlicensed operations are better able to adapt to a shifting spectrum environment, and thus are the appropriate use for the TV white spaces.

⁴⁸ *Id.* ¶ 27.

⁴⁹ *Id.* ¶ 27.

⁵⁰ *See id.* ¶ 28.

⁵¹ *Id.* ¶ 29.

The fact that the “Swiss cheese” patterns of available TV white space spectrum are impractical to license is perhaps best illustrated by the Commission’s proposed channel re-check requirements. Devices must monitor spectrum because their “right” to transmit on a particular channel can be foreclosed at any time (for instance when a licensed wireless microphone commences operation), a situation that stands in stark contrast to the certainty typically afforded by a license.⁵² Moreover, TV band devices must implement power limits and other inflexible restrictions, and the ability to transmit is contingent on the unpredictable actions of others, including incumbent users with higher status (such as licensed wireless microphones). What happens, for example, to a TV white space licensee if the Commission decides to license a wireless microphone operator or another broadcaster within the territory of that white space licensee? TV band allocations do and will change, and it is hard to envision that any party would bid aggressively for a license filled with such restrictions and uncertainties.

Finally, the Commission asks briefly whether it should consider a non-exclusive licensing model.⁵³ It should not. The Commission began this proceeding with the recognition that the “significant growth of and consumer demand for unlicensed wireless broadband applications” supported opening up the white spaces for unlicensed use.⁵⁴ Attempting to meet that demand by issuing a substantial number of non-exclusive licenses would impose significant burdens and expense on applicants as well as the

⁵² As the Commission has recognized, the amount of available spectrum not only varies dramatically based on geography, but also could be subject to change at a given time within a particular location. *Id.* ¶ 28.

⁵³ *Id.* ¶ 31.

⁵⁴ NPRM ¶ 7.

Commission, with no offsetting benefit. The Coalition urges the Commission to reject a non-exclusive licensing model, which would amount to nothing more than an unnecessary registration requirement for white space use.

B. Unlicensed Use of White Spaces Will Provide Substantial Benefits.

Even if the Commission were to successfully allocate TV white space spectrum to a handful of licensees, the case for unlicensed use of white spaces is far more compelling—particularly since the Commission will soon license more unencumbered 700 MHz spectrum in the DTV transition auctions. Before the advent of unlicensed Wi-Fi, the 2.4 GHz band was widely derided as a “junk band.” Yet use of Wi-Fi created a multi-billion dollar industry at a time when most telecommunications businesses were in a downturn, almost indisputably creating substantially greater value than if the band had been allocated for exclusive use.⁵⁵ At last count, over one billion devices have been deployed in the 2.4 GHz band alone.⁵⁶

The superior propagation characteristics of TV channels promise not only to replicate the success of unlicensed Wi-Fi deployments, but to outshine it. Unlicensed devices operating in the TV band will offer longer transmission ranges using the same power, less risk of signal attenuation or harmful interference, and less power consumption at the same range as Wi-Fi.⁵⁷

⁵⁵ See, e.g., Remarks of Kevin Werbach, Former FCC Counsel for New Technology Policy, Stanford University “Spectrum Policy: Property or Commons” Conference (Mar. 1, 2003), available at http://werbach.com/docs/spectrum_conf_comments.html (last visited Nov. 21, 2006); Jesse Sunenblick, *Into the Great Wide Open*, COLUMBIA JOURNALISM REVIEW (Mar./Apr. 2005).

⁵⁶ See Bluetooth Technology in the Hands of One Billion, available at <http://www.bluetooth.com/Bluetooth/SIG/Billion.htm> (last visited Jan. 17, 2007).

⁵⁷ This last characteristic becomes an especially significant consideration for mobile devices such as laptops and PDAs that rely on battery power.

Unlicensed use of the TV white spaces is particularly well suited for:

- **Media distribution.** The improved bandwidth made possible by use of TV band spectrum will facilitate access to and management of electronic media, enabling innovations such as next generation home media centers that provide on-demand access to stored or streamed content—including high definition video—from any number of devices. In addition, the increased bandwidth afforded to unlicensed devices will make it more feasible for schools and other non-profit entities to provide enterprise tools such as videoconferencing at a number of receive points at those locations.
- **Point-to-multi-point systems.** The favorable propagation characteristics of TV band signals will allow for deployment of more effective broadband access.⁵⁸ WISPs can reach more customers with less infrastructure, and broadband deployment becomes substantially cheaper and quicker.
- **Neighborhood mesh networks.** The range provided by TV band devices can be used to create self-organizing mesh networks free from subscription service and free from monthly charges. They can also substantially reduce deployment costs for municipal mesh network operators and help create *ad hoc* public safety networks. Indeed, mesh networks are particularly well suited to public safety and emergency response scenarios:
 - **Delivery of Communications at Emergency Sites and in the Event of Catastrophic Network Failure.** Mesh networks allow communications to be readily deployed in emergencies when existing communications infrastructure is damaged or unavailable.
 - **Supplementing Existing Infrastructure When There is Degradation.** Public safety personnel can use IP-based mesh networks to supplement dedicated public safety networks and provide emergency site local interoperability.
 - **Aiding Resiliency.** Because mesh networks have no single point of failure they assure reliability.

As some of these likely applications illustrate, many advantages of the TV bands simply cannot be realized by licensed use. To be sure, there are also some benefits from licensed services; however, the Commission has already committed to licensing 60 MHz of spectrum in the 700 MHz band pursuant to the upcoming DTV transition auctions.

⁵⁸ See FNPRM ¶ 13.

The only question is whether the distinct benefits of unlicensed services will also be made available. Thus, while the Coalition supports the licensed model for the spectrum to be cleared in the DTV transition, it urges the Commission to reaffirm its initial determination that the unlicensed model is most appropriate for the TV white spaces.

In addition, the *Further Notice* overstates the possible benefits of licensed services in the TV white spaces. The Commission notes that one possible justification for licensed use is that it may facilitate the location and termination of sources of harmful interference.⁵⁹ This rationale presupposes both that interfering licensed uses will be easier to shut off and that unlicensed users will have greater incentive to interfere—neither of which is true.

As a threshold matter, once a licensed device becomes available in the marketplace, the licensee has no viable means by which to detect or prevent individual non-conforming interfering uses. For example, the Commission is aware that users have on occasion tampered with licensed devices such as cell phones, and also that these devices fail from time to time. Thus, licensed devices can cause harmful interference unbeknownst to the license holder. Even if an incumbent licensee suspects that harmful interference is a result of a licensed white space device and notifies the white space licensee, there is little the white space licensee can do about it short of shutting down a sizeable portion of its network—thus shutting down many unoffending devices to stop one offending device.

⁵⁹ *Id.* ¶ 30.

Nor is it clear that licensed operators would have a greater economic incentive to ensure that deployed devices do not cause harmful interference.⁶⁰ While the Commission can and does take action against non-conforming uses, neither of the Commission's primary mechanisms for safeguarding against harmful interference—equipment authorization and fines—are in any way dependent on the licensing of services. Because licensed devices can be modified to work beyond the scope of their authorizations just as easily as unlicensed devices can, enforcement—not licensing—will be the primary deterrent to interference irrespective of the spectrum allocation approach the Commission ultimately adopts.

The contention that licensees will have a greater incentive to ensure non-interfering use fails for the additional reason that those who intend to develop and deploy such devices are highly motivated to ensure that these devices do not cause harmful interference. The Coalition's members have already invested substantial resources in the research and development of unlicensed TV band devices, and intend to invest even more upon receiving positive indications that such use will be permitted without onerous restrictions. The high tech industry has the expertise to ensure that devices do not cause harmful interference, and simply would not endanger substantial investments in such devices by creating the risk of FCC enforcement that would destroy the very market they seek to create.

The Coalition also notes that its members have the economic incentive to ensure that the Commission finds the correct balance between allowing innovative new services

⁶⁰ Compare, e.g., the substantial interference caused by Nextel Communications, Inc. to other licensees—including public safety operations—in the 800 MHz band. See generally *Improving Public Safety Communications in the 800 MHz Band*, Report and Order, 19 FCC Rcd. 14969 (2004).

and protecting incumbent licensees, as members of the Coalition derive substantial benefit from ensuring that demand for over-the-air TV is preserved. For example:

- Philips, Dell, and HP are global leaders in developing and manufacturing digital televisions, collectively representing over 13 percent of the entire market for plasma and LCD TVs in North America.
- Philips, Dell, and HP also make media center devices that enable viewing and recording of over-the-air DTV content.
- Microsoft creates the software that powers these media center devices. For example, Windows XP Media Center Edition allows devices to store, rewind, and fast forward over-the-air DTV content, and includes a built-in antenna signal strength meter to allow the user to adjust his or her antenna to get the best reception possible.⁶¹
- Intel develops and markets tuner and demodulator products for digital televisions.

This interest in the success of both broadcast TV and unlicensed technology stands in contrast to those of the broadcasters and other advocates of a licensing regime, who have absolutely no market incentive to heed the Commission's concerns about balancing the needs of incumbents with obtaining substantial innovative value from the white spaces.

Finally, the parameters proposed by the Coalition eliminate the fears expressed by some that individual unlicensed users will be compelled to transmit at the greatest possible power to be heard over the din, creating a "tragedy of the commons"—as advocates of a licensed regime would like the Commission to believe.⁶² Indeed, the substantial success of unlicensed operations in the 2.4 GHz and 5 GHz bands demonstrates that the very opposite is true. The same success will happen for unlicensed devices in the TV white spaces, if the Commission allows it.

⁶¹ The ability to access over-the-air signals is also a crucial feature of the media center editions of Microsoft's next generation Vista operating system.

⁶² See, e.g., Comments of Qualcomm, Inc. at 13 (filed Nov. 20, 2004); MSTV and NAB Comments at 25.

The Commission also speculates that a licensing regime may provide the most effective means of balancing competing uses in areas where the amount of unused TV band spectrum is comparatively low.⁶³ However, there is no reason to believe that numerous unlicensed devices will be unable to share the TV white spaces effectively. For example, after the DTV transition, one of the more crowded markets in terms of incumbent licensees will be Trenton, New Jersey, which is served by numerous licensees in nearby cities including New York, Philadelphia, Newark, and Wilmington, DE. The New America Foundation has concluded that even this crowded market will have approximately 90 MHz of post-transition white space spectrum, most of which will be available for use by personal/portable devices assuming that such devices are authorized to use adjacent channels as the Coalition has proposed.⁶⁴ Moreover, unlike TV stations, unlicensed devices will not always be transmitting. Finally, the Coalition notes that a number of technological advancements in telecommunications and computer networks, including substantial breakthroughs in multiplexing, have been driven by the need to share scarce resources. If white space spectrum in congested areas is heavily used by unlicensed devices, this scenario may well encourage development of technologies that could use that spectrum more efficiently.

⁶³ FNPRM ¶ 30.

⁶⁴ See Free Press and New America Foundation, *Measuring the TV “White Space” Available for Unlicensed Wireless Broadband* at 49 (Nov. 18, 2005) available at http://www.newamerica.net/files/archive/Doc_File_2713_1.pdf (last visited Dec. 14, 2006).

IV. OTHER ISSUES.

A. Out of band Emission Limits.

The Commission has proposed to require TV band devices to comply with the out of band emission limits set forth in Section 15.209 of its rules, but seeks comment as to whether different emission limits would be more appropriate.⁶⁵ With the exception of adjacent channel interference discussed above, the Coalition believes that Section 15.209 provides more than adequate out of band emission limits.

B. Direct Pickup Interference/Receiver Desensitization.

The Commission seeks comment as to whether operation of unlicensed devices in close proximity to TV receivers would affect receivers adversely, either through direct signal pickup through the receiver chassis or by “desensitizing” the receiver so that it receives harmful interference on each channel.⁶⁶ The Coalition has confirmed that, by operating within the parameters it is proposing, devices will not cause these problems, and looks forward to the Commission’s testing, which the Coalition is confident will verify these results.

C. Wireless Microphones.

The Coalition has determined that the proposed -114 dBm threshold detection sensitivity used to protect TV receivers also is more than adequate to protect licensed wireless microphones. Theoretical and empirical studies conducted by the Coalition verify that the proposed operating parameters that it has chosen will protect licensed wireless microphones. The Coalition is confident that Commission testing will confirm

⁶⁵ FNPRM ¶ 60.

⁶⁶ *Id.* ¶ 62.

that the Coalition prototype will provide wireless microphone licensees with the interference protection to which they are entitled.

D. Unlicensed Use in Border Areas.

Finally, the Commission has observed that, under current international agreements with Canada and Mexico, certain low power TV operations must be referred to these countries for prior approval.⁶⁷ Specifically, low power TV assignments within 20 miles of the Canadian border and 25 or 37 miles (for low power UHF and VHF, respectively) from the Mexican border require prior approval for operation.⁶⁸ The Commission seeks comment as to whether these agreements must be modified before unlicensed operations can commence in these areas.⁶⁹

The Coalition believes that the pre-approval requirements in these agreements would not need to be modified. The concerns the Commission has raised relate to restrictions on TV station operations, not on other devices that may operate in the TV bands using significantly less power than even low power TV stations. More fundamentally, however, use of TV band devices is not inconsistent with these agreements assuming the devices use spectrum sensing to avoid Mexican and Canadian

⁶⁷ *Id.* ¶ 65.

⁶⁸ *See Working Arrangement for Allotment and Assignment of VHF and UHF Television Broadcasting Channels under the Agreement between the Government of the United States of America and the Government of Canada Relating to the TV Broadcasting Service*, (Mar. 1, 1989), available at <http://www.fcc.gov/ib/sand/agree/files/can-bc/can-tv.pdf> (last visited Nov. 22, 2006); *Agreement Amending the Agreement Relating to Assignments and Usage of Television Broadcasting Channels in the Frequency Range 470-806 MHz (Channels 14-69) along the United States-Mexico Border* (Nov. 21, 1988), available at <http://www.fcc.gov/ib/sand/agree/files/mex-bc/lpuhfbc.pdf> (last visited Nov. 22, 2006); *untitled amendment to the United States-Mexican agreement on VHF stations dated Sept. 14-26, 1988*, available at <http://www.fcc.gov/ib/sand/agree/files/mex-bc/lpvhfbc.pdf> (last visited Nov. 21, 2006).

⁶⁹ FNPRM ¶ 65.

TV signals. To that end, the Coalition's prototype device has been designed to detect not only the digital television signals that will be used in the United States, but also analog television signals that may still be in use in Canada and Mexico after the U.S. DTV transition has completed. Accordingly, the Commission should not require modification of either of these agreements before allowing unlicensed use of the TV whitespaces.

CONCLUSION

The Commission's decision to allow wireless devices to access unused broadcast TV spectrum is a promising first step toward providing ubiquitous and affordable Internet access, as well as toward the development and deployment of a number of exciting and innovative new consumer technologies and services. However, these goals can only be realized if the Commission adopts minimal technical and operational rules that will allow innovation to flourish. Each implementation decision the Commission makes should provide incumbent licensees with adequate protection from harmful interference, while maximizing the potential uses of the TV white spaces by adopting flexible rules that will allow for the widespread deployment of personal/portable devices. In particular, the Commission should reaffirm its initial determination that the unlicensed model is most appropriate for the TV white spaces, concurrently authorize the use of personal/portable and fixed/access devices, and adopt spectrum sensing with a detection threshold of -114 dBm as a means by which unlicensed devices may avoid causing harmful interference. In doing so, the Commission can help ensure that all Americans derive substantial benefit from this valuable public resource and that the U.S. leads the way in technological innovation in this space.

Respectfully submitted,

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