

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of)	
)	
National Association of Broadcasters)	Docket No. _____
Petition to Amend Sections 47 C.F.R)	
15.711(b) and 47 C.F.R 15.717)	RM - 11745
)	
Regarding Changes to Certain Rules for)	
Unlicensed Operations in the Television)	
Bands, Repurposed 600 MHz Band, 600)	
MHz Guard Bands and Duplex Gap and)	
Channel 37)	

**REPLY OF THE NATIONAL ASSOCIATION OF BROADCASTERS
TO OPPOSITIONS TO ITS PETITION FOR RULEMAKING**

May 18, 2015

TABLE OF CONTENTS

I.	TVWS PROPONENTS FAIL TO MAKE PERSUASIVE ARGUMENTS AGAINST THE RULE CHANGES NEEDED TO ENSURE INTERFERENCE-FREE UNLICENSED DEVICE OPERATION IN THE TV BANDS.....	2
II.	THE COMMISSION MUST AMEND ITS RULES TO ACCOUNT FOR THE LIKELIHOOD THAN NON-PROFESSIONAL USERS WILL HAVE THE ABILITY AND INCENTIVE TO FALSIFY DEVICE LOCATION INFORMATION.....	5
III.	AUTOMATIC GEOLOCATION IS THE ONLY SOLUTION THAT WILL ENSURE THE TVWS DATABASE HAS ACCURATE LOCATION INFORMATION.....	7
IV.	DATABASE ADMINISTRATORS MUST TAKE SOME RESPONSIBILITY FOR THE ACCURACY OF INFORMATION INCLUDED in the DATABASE.....	10
V.	CONCLUSION	14

SUMMARY

In its Petition for Rulemaking, the National Association of Broadcasters revealed a TV White Spaces (TVWS) database riddled with human errors. These errors highlight a need for more than just housekeeping; they warrant a re-evaluation of certain of the Commission's TVWS rules.

Requiring all devices to use fully automated geolocation so that location information – the most important information included in the database – is entered without the potential for human error or abuse would largely solve these problems. It would allow the operation of TVWS devices only on channels and in locations where they are unlikely to cause harmful interference. Indeed, personal portable TVWS devices are already required to include automatic geolocation capability. This approach would ensure white spaces to work for everyone, not just those with a stake in spreading TVWS use. Further, asking database administrators to take some responsibility for the accuracy of the information upon which this spectrum management regime rests is a reasonable step that will help ensure the Commission and licensed users know whom to contact in the event of interference.

Predictably, TVWS proponents caricature the Petition as an attempt to undermine the entire TVWS experiment or the value of unlicensed spectrum in general. In truth, while the Petition may have brought to light uncomfortable facts about a database approach that is not ready for prime time, it also proposed straightforward, workable rules changes that will strengthen the TVWS regime by ensuring long-term protection of licensed operations in the television and 600 MHz bands.

The uncontroverted fact is that the database has been, and remains, open to manipulation, abuse and human error. Indeed, months after the filing of our petition, the

latest database continues to include plainly inaccurate data for fixed devices, such as a device registered in the middle of Lake Michigan. It is baffling why anyone would defend a regime that allows such troubling inaccuracies.

The Commission should step back from the as-yet unfulfilled promise of TVWS technology to look at this dispute in its proper context. The fundamental principle of unlicensed operations is that they must not cause harmful interference to licensed services. Requiring licensed services to police unlicensed operations of what may, if the claims of TVWS advocates are to be believed, become widespread TVWS technology inappropriately and unfairly shifts this burden away from unlicensed operators, and onto licensed services. We urge the Commission to amend its rules to ensure that TVWS technology can live up to its promise: increased unlicensed opportunities *without* the possibility of harmful interference.

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of)	
)	
National Association of Broadcasters)	Docket No. _____
Petition to Amend Sections 47 C.F.R)	
15.711(b) and 47 C.F.R 15.717)	RM - 11745
)	
Regarding Changes to Certain Rules for)	
Unlicensed Operations in the Television)	
Bands, Repurposed 600 MHz Band, 600)	
MHz Guard Bands and Duplex Gap and)	
Channel 37)	

**REPLY OF THE NATIONAL ASSOCIATION OF BROADCASTERS
TO OPPOSITIONS TO ITS PETITION FOR RULEMAKING**

The National Association of Broadcasters (NAB),¹ through these comments, replies to both the oppositions against our petition for rulemaking² and as well as various supporting commenters. Nothing in the record presented thus far has altered the fact that the TV White Spaces (TVWS) regime has serious and fundamental design flaws that will eventually allow significant harmful interference to licensed operations in the TV and 600 MHz bands, and adversely affect the use of licensed spectrum in these bands.

¹ The National Association of Broadcasters is a nonprofit trade association that advocates on behalf of free local radio and television stations and broadcast networks before Congress, the Federal Communications Commission and other federal agencies, and the courts.

² National Association of Broadcasters Emergency Motion for Suspension of Operations and Petition for Rulemaking, RM-11745 (filed Mar. 19, 2015) (Petition).

In our Petition, NAB asked the Commission to amend Sections 15.711(b) and 15.717 of its rules to mandate geo-location capability in all fixed TVWS devices and to “create a workable enforcement regime that requires automatic checks of information accuracy at input, establishes periodic audits and reporting to the Commission and imposes responsibility on database administrators who fail to correct false or inaccurate information.”³ We also asked the Commission to hold its recent TVWS *Notice of Proposed Rulemaking*⁴ in abeyance until it resolves the issues laid out in the Petition.⁵

I. TVWS PROPONENTS FAIL TO MAKE PERSUASIVE ARGUMENTS AGAINST THE RULE CHANGES NEEDED TO ENSURE INTERFERENCE-FREE UNLICENSED DEVICE OPERATION IN THE TV BANDS

Predictably, the various proponents of the TVWS device industry have made an aggressive, but ultimately unpersuasive, defense for why the TVWS database was riddled with errors and why the Petition’s simple proposed fixes should not be adopted. TVWS proponents assure the Commission that there is nothing to see here, much like a child standing in front of a can of spilled paint. They suggest that the rampant database errors identified in the Petition are “likely test entries used by device manufacturers and database administrators to ensure that the broadcaster-protection system is working properly.”⁶

Tellingly, however, this explanation is proffered with something less than full confidence. Microsoft says, for example, that the database entries NAB cites in its petition

³ Petition at 3.

⁴ *Amendment of Part 15 of the Commission’s Rules for Unlicensed Operations in the Television Bands, Repurposed 600 MHz Band, 600 MHz Guard Bands and Duplex Gap, and Channel 37*, ET Docket No. 14-165, et al., Notice of Proposed Rulemaking, 29 FCC Rcd 12248 (2014) (Notice).

⁵ *Id.* at 3-4.

⁶ See Opposition of Google, Inc., RM-11745, at 1 (filed May 1, 2015) (Google Opposition); see also Comments of Spectrum Bridge, Inc., RM-11745, at 4 (filed May 1, 2015) (Spectrum Bridge Comments).

“likely are not errors at all,”⁷ while the Wireless Internet Service Providers Association (WISPA) claims that, “the registration of a large number of devices at a single location *may well* indicate a manufacturing facility or a testing site where devices are tested.”⁸ It is remarkable that with so few devices in the database, the cause of the various incorrect entries NAB identified, whether they are a manufacturer’s test, ghost data from previous tests, or something else, remains a mystery to the industry players that are best positioned to identify and prevent inaccurate data. If there are mysterious problems now, with 500 devices, there will almost certainly be major problems, including widespread harmful interference, when there are a million devices. Even if all of the errors NAB identified could be explained away as test entries, which we do not believe to be the case, the fact that so many inaccurate entries could be allowed to pollute the database without raising concern from any of the major industry players should be cause for concern.

TVWS proponents’ other core argument – that the petition does not identify instances of harmful interference to broadcast operations – is not a testament, as TVWS proponents claim, that the rules are working as intended.⁹ Instead, as the Affiliate Associations rightly note, it is merely reflective of the failure of the TVWS industry to develop a viable marketplace.¹⁰ It is completely unsurprising that the very limited number of devices which

⁷ Comments of Microsoft, RM-11745, at 1 (filed May 1, 2015) (Microsoft Comments) (emphasis added).

⁸ Opposition of The Wireless Internet Service Providers Association to Emergency Motion for Suspension of Operations and Petition for Rulemaking, RM-11754, at 3 (filed May 1, 2015) (WISPA Opposition) (emphasis added).

⁹ See, e.g., Google Opposition at 5; Microsoft Comments at 1; WISPA Comments at 3.

¹⁰ See Comments of the ABC Television Affiliates Association, *et al.*, RM-11745, at 4 (filed May 1, 2015) (Affiliate Associations Comments) (nothing that “if TVWS devices ever do live up to their oft-heralded potential . . . interference would become more widespread and frequent than the Commission could possibly police.”).

are actually in operation – probably far less than the database indicates – have yet to cause widespread interference problems.

Further, when a TVWS device causes interference to, for example, wireless microphones or TV reception, it is highly unlikely that an aggrieved party would be able to readily identify the source of the interference, or would even recognize it as interference. The vast majority of Americans have never heard of TVWS devices. If interference causes a TV channel to fail, a TV viewer isn't going to launch a full-scale investigation into the problem. She is going to change the channel. Similarly, if interference causes dropped calls or interrupted downloads to a wireless carrier operating in the 600 MHz band, that carrier's subscriber is not going to examine the TVWS database. He is going to switch carriers.

NAB is aware that the Commission has made a substantial effort to clean up many of the errors identified in the Petition. As part of this effort, the FCC had TVWS database providers delete over 60 device registrations – representing more than 10 percent of the database entries. We commend the Commission's efforts. Unfortunately, the very need to correct or delete so many erroneous registrations only underscores NAB's position that the TVWS database has systemic flaws. Moreover, the problems we identified in the Petition are a going-forward concern. As the Affiliate Associations note in their comments, “[t]he current system can be cleaned up every single day, but it will still be re-populated with inaccurate data as users seek to utilize their devices in otherwise congested markets.” In fact, the most recent database has already seen a return of a “John Doe” entry. The changes proposed in the Petition remain essential to ensure that, as the market for TVWS develops, unlicensed devices do not cause harmful interference to licensed operations.

To be clear, NAB is not opposed to unlicensed operations, spectrum sharing, or TVWS devices. But we are opposed to a loose set of rules that allows – and even incentivizes –

disregard for the hierarchy intrinsic to spectrum sharing regimes. Unlicensed devices should not cause interference to licensed operations, and the burden is on unlicensed operators, not licensed users, to come up with workable solutions to avoid such interference. If they cannot do so, they cannot operate. The Commission's rules should ensure that reasonable efforts are made to prevent harmful interference, rather than simply hoping for the best and entrusting the future of spectrum management to an undefined, unregulated, imaginary class of "professional installers." The Commission must, if it is to continue to fulfill its core mission, correct the problems we identified in our Petition before the TVWS marketplace develops. Correcting these systemic issues now is the only sensible choice.

II. THE COMMISSION MUST AMEND ITS RULES TO ACCOUNT FOR THE LIKELIHOOD THAN NON-PROFESSIONAL USERS WILL HAVE THE ABILITY AND INCENTIVE TO FALSIFY DEVICE LOCATION INFORMATION

In the Petition, we noted that the Commission's reliance on "professional installation" of fixed devices is misplaced.¹¹ The Commission has never defined "professional installer." We noted in the Petition that TVWS devices are available for purchase online directly from manufacturers and that at least one manufacturer included its professional installer manual online for anyone to download.¹² There is absolutely no barrier, in either the Commission's rules or in industry practice, to a non-professional purchasing, installing, and operating a fixed TVWS device.

In their oppositions, TVWS advocates defended the "professional installer" loophole. They argue that "professional installation" is necessary because GPS or similar built-in

¹¹ Petition at 11.

¹² *Id.* at 11-12.

geolocation capability is too expensive and will not work in every instance to determine location.¹³ We refute those arguments below.

TVWS proponents also argue that professional installers are, in fact, professionals that “would not expose the databases to tampering”¹⁴ and “who will be especially unlikely to commit inadvertent errors, and have a great deal to lose by intentionally entering incorrect information.”¹⁵ Google argues that allowance for “professional installation” as an alternative to automated geolocation capability is “an entirely appropriate choice” because “[f]ixed devices are likely to be deployed by commercial network operators or in institutional or enterprise settings.”¹⁶ In other words, Google says, fixed TVWS devices are not for “mass market consumers.”¹⁷

We do not know whether most of the few hundred TVWS devices, all fixed, that have been put into the field thus far were installed by professional-minded individuals, although the sheer number of errors in the database suggests that their collective professionalism needs improvement.¹⁸ We do have concerns, however, as should the Commission, that the market for fixed TVWS devices may quickly evolve past this nascent stage, where only “enterprise” or “institutional” companies purchase and operate the devices, to a place where manufacturers market “Super WiFi” devices to the masses. As the Affiliate

¹³ See, e.g., Opposition of Carlson Wireless Technologies, Inc., et al., RM-11745, at 2 (filed May 1, 2015) (White Spaces Manufacturers Opposition); WISPA Opposition at 7.

¹⁴ White Spaces Manufacturers Opposition at 2.

¹⁵ Microsoft Comments at 2.

¹⁶ Google Opposition at 6.

¹⁷ *Id.*

¹⁸ For example, at least one “professional installer” authorized by a device manufacturer has written a “white paper” describing how they improved the operation of a TVWS device by employing higher gain antennas despite the fact that the specific TVWS device being used was only authorized by the FCC to operate with the manufacturer’s supplied antenna. See <http://www.zcorum.com/zcorum-takes-a-dip-into-tv-white-space-part-two/>.

Associations point out, the Commission's recent proposal to allow for the provision of fixed devices operating at lower power adjacent to occupied TV channels will "[open] the market to a host of new operators with no real oversight by the Commission."¹⁹ The Commission itself has said that the changes proposed in last year's TVWS notice "will enhance the ability of these devices to provide broadband services to a wide variety of consumers"²⁰ and, specifically, that the proposal to allow fixed devices to operate on channels adjacent to occupied TV channels was designed to counteract the loss of vacant TV channels after the incentive auction, "particularly in urban areas."²¹

As with any industry, as the market for TVWS devices develops and matures, the price of each individual unit will drop, likely by a significant amount. Further, with consumer-focused companies like Google and Microsoft driving the industry, it only a matter of time until the devices are repackaged and marketed for direct sale to unsophisticated consumers. The Commission must anticipate this likelihood and adjust its rules accordingly. The rules the Commission establishes now will set the tone for a market that may develop over the course of the next decade and beyond.

III. AUTOMATIC GEOLOCATION IS THE ONLY SOLUTION THAT WILL ENSURE THE TVWS DATABASE HAS ACCURATE LOCATION INFORMATION

A number of commenters assert that the inclusion of automatic geolocation capability in fixed TVWS devices will be cost prohibitive or impractical. Neither one of these claims withstands scrutiny and, in any event, experience has demonstrated that the current reliance on professional installation is all too easy to exploit.

¹⁹ Affiliate Associations Comments at 6 (citing *Notice* at ¶¶ 39-43.).

²⁰ *Notice* at ¶ 21.

²¹ *Id.* at ¶ 34.

With respect to the cost of equipping fixed TVWS devices with automatic geolocation capability, certain manufacturers claim that implementation of automatic geolocation capability in fixed devices would cost an estimated \$50 per unit, and that the “redesign of white spaces equipment would also cost at least an additional \$125,000 for each manufacturer, and significantly delay the market deployment of white spaces equipment.”²² As far as delay, currently, after five years, there are no more than 500-600 TVWS devices deployed nationwide. It is unclear how market deployment could be delayed any more than it already has been.

For this reason, the manufacturers are forced to concede that their estimate of \$50 per device is based on “current sales volumes.”²³ Of course, NAB agrees that when several manufacturers have combined to manufacture and sell just a few hundred devices, incorporating additional capabilities will be expensive on a per-device basis. In the event, however, that a market for this TVWS devices actually develops, perhaps in another five years, increased scale of production would drive the per-unit price down significantly. We also note that while some parties have argued that GPS is too expensive, they appear to be assuming a comparison between adding GPS capability on the one hand, and zero cost professional installation on the other. In fact, adding this capability would reduce or eliminate the expense of professional installation. Theoretically, at least, professional installers should be charging a fee for their installation, including their determination of the location of the device.

Indeed, current sales volumes are likely partially responsible for the very high prices of fixed TVWS devices themselves. All TVWS devices currently approved by the FCC cost at

²² White Spaces Manufacturers Opposition at 3.

²³ *Id.*

least \$1,000, and as much as \$5,000. Viewed in that context, then, \$50 per device could add as little as one percent to the cost of the device. More importantly, these costs will only drop if sale volumes ever do increase. As for the costs of redesigning equipment to incorporate automatic geolocation capability, this only underscores the urgency of establishing such a requirement now, while the industry is still developing, rather than waiting until there are both more types of devices offered by every manufacturer and more individual units.

Turning to the question of practicality, a number of commenters oppose automatic geolocation capability because GPS technology is unreliable indoors.²⁴ As an initial matter, the vast majority of fixed TVWS devices currently authorized are intended to be installed outdoors or, at a minimum, to have outdoor antennas. This is particularly true for the rural “Super WiFi” capabilities many TVWS proponents support. The viability of GPS as an indoor solution is no objection at all with respect to these devices, which represent the great majority of present and expected deployments.

Further, there are alternative approaches for fixed TVWS devices that are truly intended to be used only indoors. Those devices could be connected to an outdoor antenna. Alternatively, they could register their location near a window, or on a rooftop, and then re-register their location when the device is moved.

More fundamentally, the question of whether GPS technology is a perfect solution for fixed TVWS devices that operate exclusively indoors cannot control the resolution of how unlicensed TVWS devices are required to protect against harmful interference. Given the demonstrable susceptibility of the TVWS database to abuse, the industry simply has to come

²⁴ See, e.g., White Spaces Manufacturers Opposition at 3; Opposition of WhiteSpace Alliance at 6, RM-11745 (filed May 1, 2015) (WSA Opposition).

up with better alternatives to professional installation. When it comes to protecting against harmful interference, the burden should be on unlicensed users to develop a system that actually works – not on licensed users to solve the technical challenges unlicensed use presents. The bottom line on this issue is that experience with the professional installation solution the Commission’s current rules allow demonstrates that the database is readily subject to abuse. If the TVWS industry is unable to come up with a workable, automatic geolocation solution for indoor fixed TVWS devices, those devices should not be permitted to operate.

IV. DATABASE ADMINISTRATORS MUST TAKE SOME RESPONSIBILITY FOR THE ACCURACY OF INFORMATION INCLUDED IN THE DATABASE

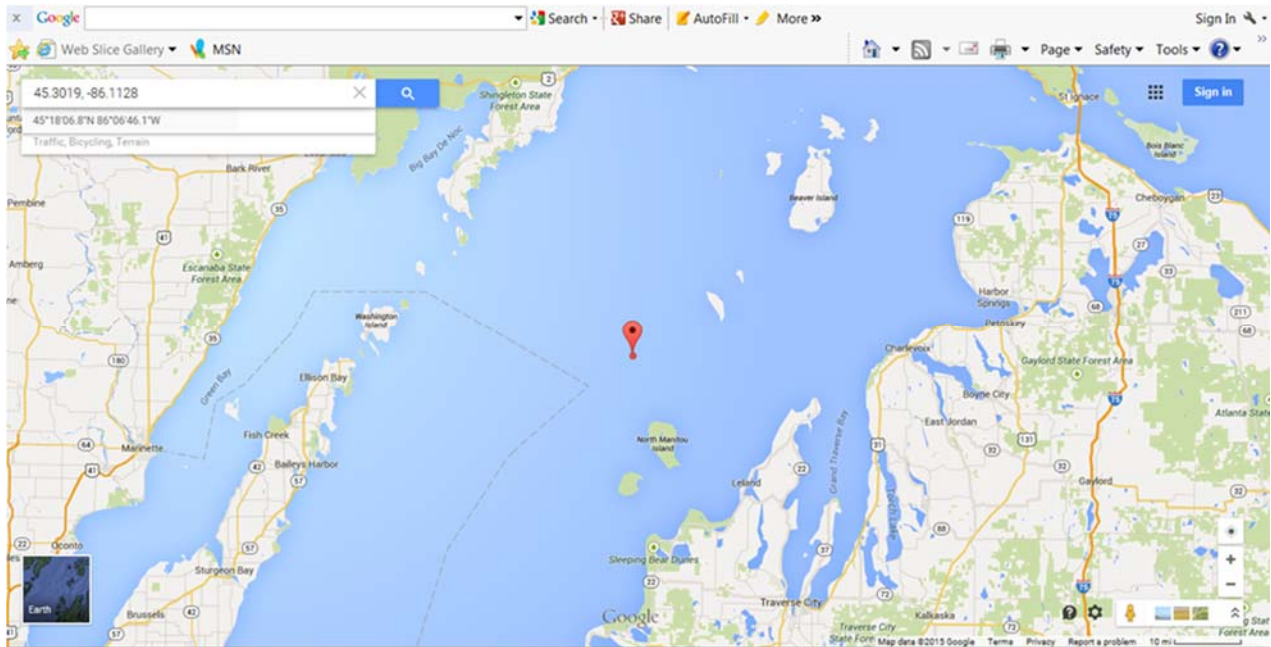
Commenters opposing NAB’s petition describe that petition as “replete with hyperbole,”²⁵ “radical,”²⁶ “ill-conceived”²⁷ and filled with “innuendo and speculation.”²⁸ Despite this handwringing over NAB’s petition, a cursory examination of the database demonstrates its ongoing unreliability. As of this writing, two months after NAB filed its petition, the database continues to show a device registered in the middle of Lake Michigan.

²⁵ WSA Opposition at 2;

²⁶ *Id.* at 3.

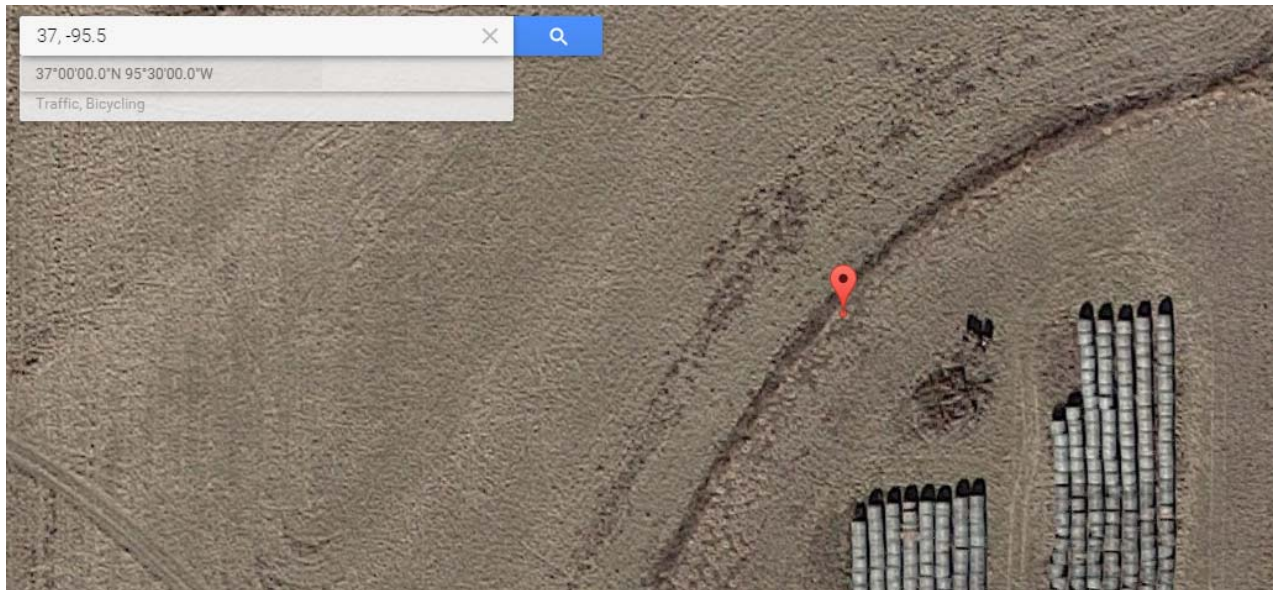
²⁷ WISPA Opposition at 2.

²⁸ *Id.*



Setting aside the unlikely explanation that a device is registered on a buoy, this is an inaccurate location. No other TVWS devices are registered within a reasonable communication range. It is possible that the “professional installer” who installed this device, wherever it actually is, falsified the location information. It is just as likely that the professional installer simply made one or more typos when entering the coordinates for the device. Neither explanation suggests professional installation is a reliable method for determining the location of a fixed TVWS device.

Since the filing of NAB’s petition, while many obviously false entries have been corrected or deleted, yet another device has been registered to “John Doe.” This one is located in the middle of a field on the Kansas-Oklahoma border, near what appear to be bales of hay.



We would have been happy to contact Mr. Doe to ask for more information about his TVWS device, but his contact e-mail address is jd@example.com, and his contact phone number is (232) 555-1212.

Whether or not this is a “test” entry is both unknowable and beside the point. This example demonstrates just how easy it is for a user to enter a false location, false name, false e-mail address, and false phone number. *Nothing in the TVWS database or the FCC’s rules prevents this.* Entries such as this plainly refute the assertion that database entries are not open to tampering.²⁹ The database is not only open to tampering, it actually has been, and continues to be, tampered with.³⁰

One of the most obvious solutions to this problem is to make database administrators take more responsibility for the accuracy of the information in their databases. At a minimum, database administrators should automatically screen information

²⁹ Letter from H. Nwana, Dynamic Spectrum Alliance to Marlene H. Dortch at 2, RM-11745 (filed May 1, 2015) (DSA Comments) (“Nor are the database entries open to tampering.”)

³⁰ The examples provided here are far from the only examples of suspicious location information included in the database.

entered into the database to determine if the e-mail address, phone number, serial number, and FCC equipment identification number are valid.

Remarkably, TVWS proponents reject even this modest suggestion. Google, for example, asserts that requiring database administrators to validate contact and location information for fixed TVWS devices would somehow *increase* the risk of erroneous information being included in the database.³¹ That is, according to Google, any additional layer of review will decrease accuracy. Beyond the counterintuitive nature of this claim, it is plainly both achievable and reasonable for database administrators to verify the accuracy of contact information by confirming the validity of the e-mail address entered (for example, by requiring users to respond to an e-mail to confirm registration) and the telephone number entered (for example, by calling the number). These simple steps would also provide an opportunity for database administrators to confirm the identity of the registrant as well as the contact address and the physical location of the device itself.

Unfortunately, Google cannot even bring itself to acknowledge the importance of accurate information in the database. Google asserts that “obviously fictitious contact names, addresses, and device serial numbers” found in the TVWS database are “informational only, and have no operational significance.”³² But fictitious contact information clearly has operational significance by providing a point of contact for both licensed services and the FCC itself in the event of harmful interference. How exactly would Google have the Enforcement Bureau contact, for example, John or Jane Doe?

³¹ Google Opposition at 8 (“Inserting a manual review process into this automated data flow would create new risks of delay and error.”).

³² *Id.* at 2.

The ongoing unreliability of the database also underscores the fallacy of relying on professional installers' fear of consequences for entering false or erroneous information in the database. The Dynamic Spectrum Alliance, for example, attempts to reassure the Commission that, "it is reasonable for the FCC to assume that professional installers follow the rules, as there are potentially severe consequences for non-compliance."³³ Yet, the Dynamic Spectrum Alliance never explains what exactly these "potentially severe consequences" might be. Professional installers are not defined by the FCC and they are not regulated or certified by the FCC. They do not hold FCC licenses, and they do not necessarily operate the TVWS equipment they install. What would be the basis for FCC enforcement action against a professional installer who decided to provide his or her client with better service by falsifying location information to access channels that are locally unavailable? In the event a professional installer makes a mistake entering coordinates, what consequences might he or she face? The mere possibility of reputational harm for that professional installer is cold comfort for licensed users. This is particularly true given the low likelihood of being able to monitor the database or pinpoint the source of harmful interference in the event TVWS technology ever lives up to its potential and becomes widely adopted.

V. CONCLUSION

The Commission has before it a golden opportunity to correct the wayward course of its TVWS experiment before the market expands to a point where harmful interference to licensed operations is unavoidable. Smart spectrum policy requires the Commission to make an honest assessment of how its rules – conceived in the abstract – have played out in

³³ DSA Comments at 2.

reality. In the Petition, NAB identified clear design issues with the TVWS system, particularly loopholes that allow TVWS operators to falsify device location. These problems undermine the entire purpose of the TVWS database. We have proposed rational, easy-to-implement solutions to fix these design problems and to ensure the TVWS system works for everyone – not just those who will profit from its expansion. Unsurprisingly, the TVWS industry has twisted our concerns, suggesting that our Petition is merely an attempt to scuttle the entire concept of spectrum sharing. That is a wholly inaccurate characterization. NAB is not opposed to TVWS technology, or to unlicensed operation in general. There are, however, legitimate problems with the TVWS structure that require revisiting the existing rules and developing lasting solutions. We urge the Commission to carefully consider our proposals to strengthen the TVWS system and provide long-term protection for licensed services in the band.

Respectfully submitted,

**NATIONAL ASSOCIATION OF
BROADCASTERS**

1771 N Street, NW
Washington, DC 20036
(202) 429-5430



Rick Kaplan
Patrick McFadden
Scott Goodwin

Bruce Franca
Robert Weller

May 18, 2015

CERTIFICATE OF SERVICE

I, Patrick McFadden, state that copies of the foregoing Reply Comments were sent via first-class mail to the following parties:

Austin C. Schlick
Aparna Sridhar
Google, Inc.
25 Massachusetts Avenue, NW
Ninth Floor
Washington, DC 20001

H. Nwana
Dynamic Spectrum Alliance Limited
3855 SW 153rd Drive
Beaverton, OR 97003

Paula Boyd
Microsoft Corporation
901 K Street, NW, 11th Floor
Washington, DC 20037

Michael Daum
One Microsoft Way
Redmond, WA 98052

Karl Voss
8225 E. Clarendon Ave
Scottsdale, AZ 85251

Jennifer A. Johnson
Covington & Burling LLP
One CityCenter
850 Tenth Street N.W.
Washington, DC 20001

Wade Hargrove
Brooks, Pierce, McLendon,
Humphrey & Leonard, L.L.P.
Wells Fargo Capitol Center, Suite 1600
Raleigh, N.C. 27601

John R. Feore
Cooley LLP
1299 Pennsylvania Avenue, NW
Suite 700
Washington, DC 20004-2400

William L. Roughton, Jr.
Michael Goggin
Gary L. Phillips
David Lawson
AT&T Services, Inc.
1120 20th Street, N.W.
Suite 1000
Washington, DC 20036

Peter Tannenwald
Fletcher, Heald & Hildreth, P.L.C.
1300 N. 17th Street, 11th Floor
Arlington, VA 22209-3801

Peter Stanforth
Spectrum Bridge Inc.
110 Timberlachen Circle, Suite 1012
Lake Mary, FL 32736

Haiyun Tang
Adaptrum, Inc.
25 E. Trimble Road
San Jose, CA 95131

James Carlson
Carlson Wireless Technologies, Inc.
2700 Foster Ave.
Arcata, CA 95521

Robert Wu
6Harmonics Inc.
21 Concourse Gate, Suite 9 & 10
Ottawa, Ontario, Canada K2E 7S4

William M. Koos
KTS Wireless, Inc.
1025 Greenwood Blvd, Suite 391
Lake Mary, FL 32746

Jordan Du Val
MELD Technology, Inc.
1642 Canary Drive
Sunnyvale, CA 94087

Dr. Apurva N. Mody
WhiteSpace Alliance
119 Drum Hill Road, #369
Chelmsford, MA 01824

Chuck Hogg
Alex Phillips
Jack Unger
Wireless Internet Service Providers
Association
1095 Hilltop Dr. #317
Redding, CA 96003