

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

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
)	

COMMENTS OF AUDIO-TECHNICA U.S., INC.

Audio-Technica U.S., Inc.
1221 Commerce Dr.
Stow, OH 44224
330-686-2600

Bennet & Bennet, PLLC
10 G Street N.E.
Seventh Floor
Washington, DC 20002
202-371-1500

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TABLE OF CONTENTS

Summary.....ii

I. Introduction.....1

II. Wireless Microphone Operations Face Increasing Challenges3

III. The NPRM Understates the Interference Potential From Unlicensed Operations in the TV Bands.....6

IV. The Commission Should Proceed Cautiously in Opening the Broadcast Band to Unlicensed Operation9

V. There Are Several Actions the Commission Could Take to Mitigate the Potential for Interference.....12

VI. Conclusion14

Summary

In this proceeding, the Commission has proposed to allow unlicensed wireless systems to operate on unused core television channels between channels 5-36 and 38-51 (“TV Bands”). However, the Commission itself acknowledges that the proliferation of unlicensed wireless devices and services within the TV Bands is likely to have an adverse impact on broadcast auxiliary services, such as wireless microphone services, unless sufficient safeguards are adopted to protect such services from unwanted interference. Wireless microphone use is pervasive in our society and a necessary part of the video and audio production process. However, even in the current, largely analog RF environment, it is very difficult to achieve the quality of operation needed due to the sensitivity of microphones to intermodulation and other types of interference, especially when multiple systems must operate in tandem as for large event productions. These difficulties will be exacerbated by the digital transition. Both the universe of potential available television broadcast channels and the actual availability of those channels for wireless microphone services in any given market are diminishing and will continue to do so for the foreseeable future.

The Commission has understated the interference potential to wireless microphone services posed by operation of unlicensed devices in the broadcast spectrum. Specifically, the Commission’s overstates both the capability of smart radio technology to avoid interference and the ability of FM capture effect to prevent interference from unlicensed devices operating at low power. This, coupled with the highly dynamic nature of the digital transition, as evidenced by the Commission’s recently adopted channel packing process, and by its decision to authorize digital Class A, low power television and digital translator stations to operate in the TV Bands without a fixed transition deadline, requires that the Commission proceed cautiously and deliberately in allowing unlicensed operation in the TV Bands as it has done with other underlays. During this crucial period, the Commission should strictly limit authorized power levels for unlicensed operation, impose a frequency coordination requirement on unlicensed operations, set aside a sufficient number of channels in each market to accommodate wireless microphone needs free from unlicensed operation and support a wireless LAN approach to its “beacon proposal.” These solutions can then be revisited and revised as needed once the digital transition is complete and the operational environment in the TV Bands has stabilized.

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Audio-Technica U.S., Inc. (“A-T”) submits these comments in response to the Commission’s *Notice of Proposed Rulemaking* released on May 25, 2004, in the above-captioned proceeding.¹ In this proceeding, the Commission has proposed, *inter alia*, to allow unlicensed wireless systems to operate on unused core the television channels between channels 5-36 and 38-51 (“TV Bands”), subject to a requirement that such operations do not interfere with licensed communications on those channels.

I. INTRODUCTION

A-T has been dedicated to advancing the art and technology of electro-acoustic design and manufacturing since 1962. From a beginning in state-of-the-art phonograph cartridges, A-T has expanded over the years into high-performance headphones, microphones, mixers and electronic products for home and professional use. In each new area, the goal has been to create innovative, problem-solving products. The results of these engineering and production efforts can be seen in the effective use of A-T products in a broad spectrum of applications. Audio-Technica microphones, for example, are found in daily use in major broadcast and recording

¹ *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket Nos. 04-186, 02-380, Notice of Proposed Rulemaking, FCC 04-113 (rel. May 25, 2004) (“*NPRM*”).

studios, and relied upon by top touring musicians. A-T microphones are chosen for important installations and major events, such as the U.S. House of Representatives, the U.S. Senate, the Super Bowl, World Cup Soccer and the Olympics. Most recently, A-T microphones were used in all three of the Presidential debates.

As acknowledged by the Commission in the *NPRM*, the proliferation of unlicensed wireless devices and services within the TV Bands is likely to have an adverse impact on broadcast auxiliary services (“BAS”), such as wireless microphone services, unless sufficient safeguards are adopted to protect such services from unwanted interference.² The following comments are intended to provide the Commission with information as to the difficulties that are faced by users of the wireless microphone service in the current operating environment and that will be presented during the digital transition. Additionally, A-T wishes to correct some erroneous assumptions the Commission has made with respect to wireless microphone service and ensure that the Commission takes appropriate steps to prevent interference to wireless microphone services.

Given the highly dynamic nature of the digital transition, as evidenced by the Commission’s recently adopted channel packing process,³ and by its decision to authorize digital Class A, low power television (“LPTV”) and digital translator stations to operate in the TV Bands without a fixed transition deadline,⁴ the Commission should proceed cautiously and deliberately in allowing unlicensed operation in the TV Bands as proposed in its *NPRM*.

² *NPRM* at ¶¶ 5-6, 12, 16, 38.

³ *Second Periodic Review of the Commission’s Rules and Policies Affecting the Conversion to Digital Television*, MB Docket No. 03-15, RM 9832, Report and Order, FCC 04-192 (rel. September 7, 2004) (“*Channel Packing Order*”).

⁴ *Amendment of Parts 73 and 74 of the Commission’s Rules to Establish Rules for Digital Low Power Television, Television Translator, and Television Booster Stations and to Amend Rules for Class A Television Stations*, MB Docket No. 03-185, Report and Order, FCC 04-220 (rel. September 30, 2004) (“*Digital LPTV Order*”).

Specifically, the Commission must ensure that the particular interference vulnerabilities of low power broadcast auxiliary services, including wireless microphone services, are taken into account and fully addressed in any decision to allow unlicensed operation in the TV Bands and, at a minimum, the Commission should set aside a number of unoccupied television channels in each market free from unlicensed operation for wireless microphone use.

II. WIRELESS MICROPHONE OPERATIONS FACE INCREASING CHALLENGES.

Wireless microphones, ear monitors, hearing assist devices and similar communications systems have become pervasive in our society. On a daily basis, wireless microphones support and make possible a broad range of high quality services to the public. Broadcasters, television and movie producers, theatres, concert halls, educational institutions, places of worship, businesses, and entertainment companies make extensive use of wireless microphones on a regular basis. In the BAS, wireless microphones are an essential component of newsgathering and large special event productions. Wireless microphones are used in a variety of venues, from sporting events to political conventions, from newsgathering to concerts. These uses are both fixed (studio productions) and itinerant (newsgathering and special events).

Professional quality wireless microphone systems are designed to provide the high level of audio quality that consumers have come to expect. The proliferation of digital consumer audio and video products and the demand for integrated home theater systems has raised consumer expectations for better audio quality, and consumers have come to expect enhanced stereo effects and surround sound as part of their television viewing experience. As a result, more microphones of better quality are in demand from those producing the programming and, in many cases, those systems are wireless. Meeting this challenge has become increasingly difficult in the TV Bands as spectrum has become more crowded.

Even in the current, largely analog RF environment, it is very difficult to achieve the quality of operation the end user requires.⁵ For proper sound quality and communication discernment, the frequency response of these systems is typically 100Hz – 15,000 Hz with a greater than 100 dB dynamic range. This requires a certain amount of operating bandwidth: at least 150 kHz with another 50kHz for safety margins. In many settings, multiple systems are used in close proximity. In the mass consumer market category of “Low Cost Wireless,” The most common number of systems in use at a single location is between 4 and 8. However, in the more professional market categories, A-T frequently receives requests to coordinate frequency plans for 10-20 systems in simultaneous use and, for large events such as the Super Bowl, the Grammy’s, the Olympics and other prime-time broadcast events, the requirement for simultaneous channels in use at one time in near proximity often exceeds 40 units.

Setting up such systems can be a painstaking task, requiring careful analysis of intermodulation products and frequency coordination. A-T and other manufacturers of audio equipment routinely use many methods to overcome interference obstacles. These include:

- 1) Elaborate compression and expansion schemes;
- 2) Elaborate diversity reception schemes;
- 3) Improved receiver filtering and shielding;
- 4) Improved directional reception antennas;
- 5) Increased number of possible frequency selections in a single unit;
- 6) Increased front-end bandwidth to allow greater frequency selection range in a unit;

⁵ Reliable operation is a must. Besides the inconvenience that even a few moments of silence or interference might cause, there is potential for harm to equipment and humans. For example, large venue shows utilize large public address systems, including high-powered amplifiers and high output loudspeakers. Even with careful coordination, a multipath or near-far interference can upset the intermodulation rejection of a system. An “extra” frequency gets in and a large “hit” results. A “hit” is often accompanied by a large burst of sound. The resulting energy destroys loudspeaker drivers and damages hearing.

- 7) Elaborate tone squelch methods to prevent interference if corresponding transmitter is not on;
- 8) Use of purchased broadcast coverage maps on a zip-code basis for pre-determination of operability
- 9) Use of proprietary frequency selection software in order to determine the maximum number of simultaneous units possible in a given environment.

Even with these techniques, A-T has found that, under the best of circumstances, it is possible to place only 6 units reliably (occasionally up to 8) in 6 MHz of broadcast spectrum bandwidth.

As broadcast stations transition to digital operation, and the amount of broadcast spectrum is reduced from 67 channels to 49 channels, these difficulties will be greatly exacerbated. Unlike analog broadcast operations, where wireless microphones can sometimes find room to operate by squeezing in between the video, aural and other components that comprise the broadcaster's signal, digital television signals utilize the entirety of their 6 MHz bandwidth. Accordingly, in the digital environment, wireless microphones will be required to find totally unused broadcast channels on which to operate at a given location. This will be increasingly difficult to accomplish as the broadcast spectrum repacking process moves forward and as the availability of core channels in a given market is even further reduced by the digital translators Class A stations and LPTV stations that the Commission recently authorized to operate in the TV Bands in its *Digital LPTV Order*. Thus, the transition to digital television represents a "double whammy" for wireless microphone services. Both the universe of potential available television broadcast channels and the actual availability of those channels for wireless

microphone services in any given market are diminishing and will continue to do so for the foreseeable future.⁶

It is in this context that the Commission's proposal to allow unlicensed devices to operate where there are no TV stations must be considered. Despite promising but as yet unproven "smart radio" technology, there is a real danger that these additional devices will directly interfere with audio equipment operation. Certainly, these devices will produce additional intermodulation components that are impossible to avoid. Even the best technology cannot change the laws of physics and those laws cause additions, multipaths, FM capture or near-far effects in ways that are only partially predictable.

III. THE NPRM UNDERSTATES THE INTERFERENCE POTENTIAL FROM UNLICENSED OPERATIONS IN THE TV BANDS.

In the *NPRM*, the Commission has understated the interference potential to wireless microphone services posed by operation of unlicensed devices in the broadcast spectrum. Specifically, the Commission's overstates both the capability of smart radio technology to avoid interference and the ability of FM capture effect to prevent interference from unlicensed devices operating at low power. Each of these is discussed in turn.

The Commission's proposal to allow unlicensed operators to deploy digital smart radios in the broadcast band will not provide sufficient interference protection to BAS licensees and users of wireless microphones. Although A-T is encouraged that such technology will be compatible with wireless microphones within the next ten years, BAS operators and wireless microphone users still operate in an analog world. Digital technology for such devices, while being engineered, has not lived up to its promise and is marked by delayed audio transmission

⁶ In its *Digital LPTV Order*, the Commission refused to adopt a firm date for the transition of LPTV and translator stations and indicated that, in the future, it would accept applications for new (non-incumbent) low power facilities that will further encumber efforts to find open channels for BAS operations. *Id.* at ¶¶19, 155.

and unacceptable background noise. Should unlicensed operators utilize digital smart radios while BAS operators still operate analog equipment, the interference that could potentially be caused to wireless microphone operation could render such devices unusable.

Additionally, the sensitivity of wireless microphones to interference is such that smart radios will most likely never be able to be interference free. Wireless audio use is intermittent, itinerant and unpredictable. A smart radio might decide that a given frequency is clear, and indeed it might be clear at that location at that precise moment. However, should a BAS user subsequently turn on its equipment, the smart device will be in the way and interference can occur. Even assuming the smart device functions as it is supposed to by sensing the presence of another wireless product and moving off that frequency, the harm will already have occurred.

Additionally, the unlicensed device has no way to predict what licensed wireless audio products might show up in the future and, because the unlicensed operations will not show up in any FCC database, the wireless audio product user has no way to predict how many unlicensed devices might be operating in geographic proximity. This will present great difficulties to wireless users attempting to coordinate and set up multiple systems for a large event in a given area as the process becomes random. Collisions are going to occur. Even in the absence of direct interference, another device in a close frequency range will cause unpredictable intermodulation products that cannot be accounted for when initially setting up a wireless frequency plan for a particular event.

The FCC has also overstated the utility of the “FM capture” or “near-far” effects in mitigating the likelihood of harmful interference from unlicensed devices.⁷ Even very low levels (-60 dBm can often result in significant effects) of frequency presence added to A-T’s intermodulation calculations would be harmful. The Commission itself has recognized and

⁷ *NPRM* at ¶38.

expressed concern about the possible additive effects that even low levels of RF may cause and the potential negative impact that raising the general RF noise floor could have on existing users.⁸ Indeed, the effective power levels proposed for unlicensed devices in this proceeding are significantly higher than the restrictions placed on UWB where the Commission voiced such concerns.

In addition to concerns about additive noise and intermodulation effects, A-T's extensive field experience reveals that, in many situations, the effective output power of its licensed wireless audio devices drops quite low due to the nature of physical wave propagation. Obstructions and reflections can weaken wireless microphone signals even over short distances, and cause desired to undesired signal ratios to fall below what may be needed to ensure interference free operation. For a typical operating range of 300 feet, noise squelch is often set around -90 dBm. Adjusting this even as little as 15 dB reduces the range of the unit significantly, to under 50 feet. Even in the current "static" and "clear" environment, near-far problems are routinely encountered.

Part of the FCC's reliance on FM capture as a mitigating factor stems from its assumption that because wireless microphones are *authorized* to operate at output power levels of up to 250mW, they actually operate at those power levels.⁹ Theoretically, operation at such power levels would solve many of the current reliability problems routinely encountered in the current RF environment. However, manufacturers are not building units that operate at these output levels due to technological limitations. There is a certain size requirement for the units currently in use. The units must be small and light enough to be held in a hand, strapped to a

⁸ See generally, *Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, 17 FCC Rcd 7435 (February 14, 2002) ("*UWB Report and Order*").

⁹ *NPRM* at ¶38.

belt, or fastened on a camera. Such units can accommodate a single 9V or 2 AA size batteries. While manufacturers have worked diligently to make circuits as efficient as possible, they are still only able to get approximately 6 hours of use per set of batteries. This just about meets the time needed in a live show (2 hours prep and 4 hours show), and is almost equal to the time required for a broadcast sporting event (although some units have to be changed at half time for large events). If power levels increased, end-users would not be able to complete their activities without replacing batteries. In fact, of wireless microphone systems typically operate well below 50 mW ERP, normally at power levels between 10 mW and 30 mW, due to battery life expectations and antenna efficiencies. At these power levels, FM capture effects are significantly diminished and would be insufficient to provide interference protection from nearby unlicensed wireless devices in many instances.

The power level/battery life limitation equation also prohibits current wireless microphones from incorporating “smart” components in wireless transmitters. Digital devices are, for the time-being, large current draw components. Current wireless microphones and transmitters simply cannot economically incorporate smart components within the present limits of battery technology and device power consumption.

IV. THE COMMISSION SHOULD PROCEED CAUTIOUSLY IN OPENING THE BROADCAST BAND TO UNLICENSED OPERATION.

A-T urges the Commission to delay establishing an unlicensed underlay in the television TV Bands until it has enacted measures to adequately ensure that BAS licensees and users of wireless microphones are protected from harmful interference that is predicted to be caused by the operation of digital smart radios in the TV Bands. Such a cautious, “take it slow” approach has been used by the Commission in other “underlay” proceedings and is warranted in this proceeding as well.

Specifically, the FCC used a similarly cautious approach with respect to the authorization of ultra-wideband (“UWB”) technology.¹⁰ In its *UWB Report and Order*, the Commission noted that “we are proceeding cautiously in authorizing UWB technology, based in large measure on standards . . . found to be [sic] necessary to protect against interference to vital federal government operations.”¹¹ While the Commission acknowledged that the standards it adopted in its *UWB Report and Order* may have been overprotective, a number of issues, including interference protection, the lack of experience with UWB equipment, and public interest concerns caused the Commission to slow the pace of this proceeding and revisit a number of the technical issues associated with UWB “within the next six to twelve months.”¹²

Similarly, just a few months ago, the Commission declined to adopt an underlay for high-power unlicensed operations in the Broadband Radio Service (“BRS”) and Educational Broadband Service (“EBS”) (formerly, Multipoint Distribution Service and Instructional Television Fixed Service, respectively) bands.¹³ In declining to adopt a high-power unlicensed underlay in these bands that will be transitioned to a low-power service over the next three years, the Commission noted that “given the complex transition [the FCC is] undertaking in this band . . . allowing high-powered unlicensed operation in this band could add an additional layer of complexity that could delay deployment in this band by licensed operators.”¹⁴ The Commission also expressed concern that unlicensed operation would cause harmful interference

¹⁰ See generally, “New Public Safety Applications and Broadband Internet Access Among Uses Envisioned by FCC Authorization of Ultra-Wideband Technology,” FCC News Release, February 14, 2002.

¹¹ *UWB Report and Order* at ¶1.

¹² *Id.*

¹³ *Amendment of Parts 1, 21, 73, 74 and 101 of the Commission’s Rules to Facilitate the Provision of Fixed and Mobile Broadband Access, Educational and Other Advanced Services in the 2150-2162 and 2500-2690 MHz Bands*, Report and Order and Further Notice of Proposed Rulemaking, WT Docket No. 03-66, (*rel.* July 29, 2004).

¹⁴ *Id.* at ¶138.

to licensed services in the band and noted that such high-power unlicensed operation should be considered in the context of other proceedings, including this one.¹⁵

The same caution applied to establishing underlays in government and non-government bands in relation to UWB operation, and in the BRS and EBS bands in relation to unlicensed operation, should be applied to the TV Bands as well. The TV Bands are in the midst of a complicated and costly transition during which analog broadcasters are changing frequencies and relocating into the “core” broadcast channels so that they may initiate digital broadcast services and so that they can make room for 700 MHz Band licensees. The channel repacking plan adopted by the Commission contemplates no less than three rounds of channel elections during which the channel assignments used by full power broadcasters will be in a state of flux. Even if everything goes as planned, all full service stations will not be operating on their permanently assigned channels with fully replicated and maximized contours until August, 2006 at the earliest.¹⁶ However, this game of musical chairs will continue for an undetermined period beyond that date as digital Class A stations, LPTV stations and translators begin to move their operations into the core channels with no firm transition deadline.¹⁷

During this radical broadcast transition, the Commission should focus its efforts on ensuring that incumbent users of the bands, including BAS licensees, are adequately protected from harmful interference. Following the completion of the digital transition, the Commission can again visit establishing unlicensed underlays in the “core” TV Bands and ease restrictions based upon actual operational experience. Accordingly, while Audio-Technica does not oppose the implementation of a “limited underlay” for unlicensed operation in the TV Bands, the

¹⁵ *Id.*

¹⁶ *Channel Packing Order* at ¶65.

¹⁷ *Digital LPTV Order* at ¶19.

Commission should proceed with extreme caution and implement rules and policies designed to prevent harmful interference that will most certainly be experienced by wireless microphone operators should the Commission's proposals, as written, be adopted.

V. THERE ARE SEVERAL ACTIONS THE COMMISSION COULD TAKE TO MITIGATE THE POTENTIAL FOR INTERFERENCE.

There are several steps the Commission can take to ensure the continued reliable operation of licensed wireless audio products while, at the same time, allowing low power unlicensed devices to operate in the TV Bands. First, the Commission should set strict and very low power limits for unlicensed devices, especially for the "fixed/access" category of unlicensed devices where the Commission has indicated that it plans to allow operation at higher power levels than allowed for portable devices.¹⁸ Lower power levels will reduce the likelihood of harmful interference to BAS services, especially where those service operate as itinerant stations.

Second, A-T supports the FCC's suggestion that a certain number of channels should be set aside in each market for wireless microphone operations.¹⁹ However the 1 to 2 channels proposed by the Commission are insufficient for this purpose. As indicated above, 4 to 8 wireless microphones in operation at a given location represents the most common configuration required for most applications. As a single, 6 MHz broadcast channel can normally accommodate only up to 6 microphones, a single channel in a given market would be totally insufficient for even baseline normal operations, not to mention coverage of frequent special events where 10 to 20 microphones are required, or large scale events, such as the Olympics, where 50 or more systems may be needed. Rather, the Commission should set aside a minimum of 3 channels (12-18 MHz) in each market for wireless microphone use that would provide

¹⁸ *NPRM* at ¶19.

¹⁹ *Id.* at ¶38.

sufficient spectrum to support all applications other than the infrequent largest events. As experience is gained with unlicensed deployment, and digital broadcast allocations become fixed over time, the Commission could revisit this allocation and make adjustments as warranted. As mentioned earlier, such an approach is totally consistent with the Commission's actions in other underlay proceedings.

Third, A-T supports the designation of a frequency coordinator or clearinghouse. Frequency coordinators have been used by A-T and other companies in Europe with some success. Such an approach also has the advantage of allowing wireless microphone users to identify the unlicensed operations in a given geographic area and account for those operations in calculating potential intermodulation and other interference effects to be expected in a particular deployment. Without such a coordination requirement, wireless microphone users have no way to know in advance what unlicensed operations exist in a particular geographic area and cannot possibly attempt to find a possible deployment solution that would avoid potential interference problems.

Finally, on a long-term basis, A-T supports the use some type of "cognitive" beacon to assist in frequency allocation and coordination within a specific metropolitan or market area. Due to the fact that whatever channel set asides the Commission ultimately adopts will not be sufficient to accommodate very large special events, additional measures will most certainly be needed to avoid interference to BAS services. In this respect, A-T supports the proposal advanced by Shure, Inc. in this proceeding to implement a wireless LAN solution that would use a standard WiFi card and associated software to communicate channel occupancy and location information to unlicensed wireless systems in a given area. Such a system has several

advantages over the FCC's proposal of embedding channel occupancy data into the broadcast stream of a digital television signal operating in a particular market.

First, the solution can be implemented by the BAS licensee without the need to utilize TV station facilities or obtain the consent of any broadcaster. Second, the information will be distributed over a limited geographic area where interference can be expected to occur, rather than throughout the entire market served by a particular television station providing a beacon signal. Third, by providing specific frequency and geographic information on an as needed basis, the need for frequent (almost daily) updates to a user deployment database can be avoided, and the chance of interference resulting from use of outdated data is significantly reduced. While some work among BAS licensees and unlicensed users will be needed to agree on common protocols, this solution can be implemented with relatively inexpensive, readily available hardware and software.

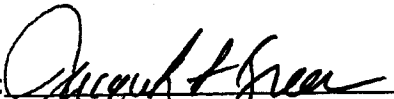
VI. CONCLUSION

Based on the foregoing, A-T respectfully requests that the Commission recognize the particular interference vulnerabilities of wireless microphone services and take those vulnerabilities into in any decision to allow unlicensed operation in the TV Bands. As in other underlay proceedings, the Commission should proceed cautiously and deliberately to ensure that BAS licensees are not adversely affected by the introduction of unlicensed services into the TV Bands. This is especially important given the dynamic and fluid nature of broadcast channel assignments during the pendency of the digital transition. During this crucial period, the Commission should strictly limit authorized power levels for unlicensed operation, impose a frequency coordination requirement on unlicensed operations, set aside a sufficient number of channels in each market to accommodate wireless microphone needs free from unlicensed

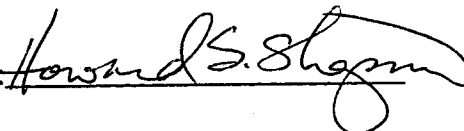
operation and support a wireless LAN approach to its "beacon proposal." These solutions can then be revisited and revised as needed once the digital transition is complete and the operational environment in the TV Bands has stabilized.

Respectfully submitted,

Audio-Technica U.S., Inc.

By: 

Jacquelyn A. Green
V.P. R&D/Engineering
Audio-Technica U.S., Inc.
1221 Commerce Dr.
Stow, OH 44224
(330) 686-2600

By: 

Howard S. Shapiro
Bennet & Bennet, PLLC
10 G Street N.E.
Seventh Floor
Washington, DC 20002
202-371-1500
Its Attorneys

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