

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

In the Matter of	)	
	)	
Promoting Spectrum Access for Wireless Microphone Operations	)	GN Docket No. 14-166
	)	
	)	
Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions	)	GN Docket No. 12-269
	)	

**COMMENTS OF SHURE INCORPORATED**

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## SUMMARY

Shure applauds the Commission's decision to develop a fulsome record regarding wireless microphone technology, and its commitment to identify and make available new supplemental spectrum for wireless microphone use. The importance of this proceeding to the wireless microphone industry and the broader community of industries that rely on wireless microphones cannot be overstated. Professional audio wireless microphone users have not recovered from the loss of 700 MHz spectrum repurposed in 2010 and now face the additional loss of 600 MHz spectrum the Commission proposes to repurpose in the forthcoming *Incentive Auction*.

A successful and expeditious outcome for the instant proceeding must occur to ensure continued United States leadership in the creation of multimedia content and the ability to produce complex live events. With respect to this proceeding, Shure urges the Commission to consider the following:

- Inadequate spectrum already affects many large-scale productions that rely on professional audio wireless microphones. The Commission now routinely grants special temporary authority for wireless microphones at these events to use spectrum outside of the Very High Frequency ("VHF") and Ultra High Frequency ("UHF") broadcast television bands.
- Jurisdictions in Europe and Asia have acknowledged that additional microphone spectrum is needed in their own markets due to the loss of 700 MHz spectrum, and acted aggressively to expand the availability of spectrum for wireless microphone use.
- Shure and other wireless microphone manufacturers have heavily invested in new technology over the past decade. Contemporary wireless microphones have become significantly more efficient during this period of substantial investment in research and technology.
- Further advances in efficiency will be driven by an ability to control intermodulation distortion ("IMD"), not the adoption of rules that require analog or digital modulation. Shure expects continued investment in both analog and

digital modulation schemes. End users should be permitted to decide whether an analog or digital microphone is better for their particular application.

- Professional audio wireless microphones do *not* serve as a transmission medium for voice communications. Instead, they are a medium for transmission of multimedia and artistic content, and have corresponding and unique performance requirements. Among other performance requirements, they must capture full audio range, have less than three (3) milliseconds of transmission latency (for some applications less than one (1) millisecond), and have reliability that meets or exceeds the expectations of a wired microphone user. These performance requirements necessitate a wider emission and require adequate, clean spectrum.
- Alternative wireless microphone applications that can sacrifice one or more of the performance characteristics of a professional audio wireless microphone can make opportunistic use of different types of spectrum that may not meet the needs of professional audio users.
- Wireless microphone manufacturers stand ready to conduct outreach and assist in the 600 MHz Band transition.
- A successful 600 MHz Band transition must involve steps to ensure that recently acquired wireless microphones operating in 600 MHz frequencies are not unnecessarily retired. Specifically, Shure urges the Commission to:
  - Permit Wireless microphones in the 600 MHz Band to operate through the 39 month transition period, or until such time as a new entrant turns on network facilities and registers their network as operational in a market through one of the existing White Space database administrators.
  - Automatically modify Part 74 licenses at the conclusion of the transition to reflect 600 MHz guard bands and duplex gap frequencies.
  - Allow wireless microphones that tune 600 MHz Band guard band and duplex gap frequencies to remain in operation without recertification or other onerous requirements after the transition. Such microphones should be permitted to manually check the availability of guard band and duplex gap spectrum.
- Service rules for existing Part 74 broadcast television VHF/UHF spectrum must be updated. Specifically, Shure recommends that the Commission:
  - Retain the 50 mW power limit for VHF microphones, but permit measurements to be based on conducted or radiated power, which will enable microphones with compact, omnidirectional antennas to better use longer VHF wavelengths.

- Permit co-channel operations with broadcast television stations on a secondary basis for licensed microphone users that manually register their locations and frequencies.
- Adopt more spectrally efficient contemporary European Telecommunications Standards Institute (“ETSI”) spectrum masks.
- Shure urges the Commission to act quickly to free additional spectrum capable of supporting professional audio applications, and recommends the following:
  - 941-960 MHz Band: Extend the existing 944-952 MHz range to 941-960 MHz. Permit any licensed Part 74 wireless microphone user to operate in this band pursuant to coordination or other appropriate steps to protect higher priority incumbent users.
  - 1435-1525 MHz Band: Enable licensed operations in the 1435-1525 MHz band, which is used solely by Aeronautical Telemetry. Wireless microphones have already demonstrated this band can be shared. During recent years special temporary authority (“STA”) has been routinely granted for use of this band for wireless microphone and low power auxiliary service (“LPAS”) at large events.
  - 169-172 MHz Part 90 VHF Band: Enable 200 kHz emissions in this band with a 50 mW power limit.
- Shure continues to aggressively explore other spectrum bands for use when customers have product requirements that can be accommodated in these frequencies. Specifically:
  - 902-928 MHz, 2.4 GHz and 5 GHz Unlicensed Bands: Shure already makes products that operate in these bands, and urges the Commission to adopt a more spectrally efficient 200 kHz bandwidth limit.
  - 3.5 GHz Band: Shure remains interested in exploring the 3.5 GHz band for microphone applications. Certain prerequisites, including a minimum bandwidth limit of 200 kHz, must be adopted to facilitate the development and manufacture of wireless microphones.
  - 1920-1930 MHz Band and 2020-2025 MHz Band: Shure proposes pairing the 1920-1930 MHz Unlicensed Personal Communications Service (“UPCS”) band with the fallow 2020-2025 MHz band to enable more spectrum for Digital Enhanced Cordless Telecommunications (“DECT”) use.
  - 6875-7125 MHz Band: Shure proposes a fulsome exploration of this band for wireless microphone operations, including the creation of a two (2)

thirteen (13) megahertz blocks of spectrum allocated for wireless microphone operations located at the upper and lower edge of this band.

## TABLE OF CONTENTS

	Page
SUMMARY.....	I
I. INTRODUCTION .....	2
II. SHURE’S RECENT CONTRIBUTIONS TO THE DEVELOPMENT OF NEW TECHNOLOGY HAVE ADVANCED THE COMMISSION’S GOALS OF IMPROVING WIRELESS MICROPHONE EFFICIENCY AND PERFORMANCE .....	4
III. WIRELESS MICROPHONE SPECTRUM NEEDS ALREADY GREATLY EXCEED AVAILABLE RESOURCES.....	5
IV. SHURE SUPPORTS THE COMMISSION’S GOAL OF DEVELOPING A FRAMEWORK FOR WIRELESS MICROPHONES INVOLVING A COMBINATION OF TV BAND AND SUITABLE SUPPLEMENTAL SPECTRUM .....	6
A. Professional Audio Wireless Microphone Require Spectrum Between 150 MHz and 2 GHz; Higher Frequencies Should be Explored for Less Demanding Alternative Microphone Uses.....	7
B. Shure Develops and Manufactures Wireless Microphones Based on Customer Needs, the Suitability of Available Spectrum, and Regulatory Stability .....	11
C. Time-to-Market for New Wireless Microphones is Highly Dependent on Service Rules and Frequency Allocation .....	15
V. THE PENDING 600 MHZ TRANSITION PRESENTS SIGNIFICANT CHALLENGES; THE FCC MUST MINIMIZE THE AMOUNT OF EQUIPMENT STRANDED; MANUFACTURER OUTREACH WILL ENSURE AWARENESS .....	15
A. The Commission Can Encourage a Timely Transition by Protecting Equipment Capable of Using Residual 600 MHz Spectrum.....	16
B. Prior to the Release of the Channel Assignment PN the Commission Must Ensure the Availability of Supplemental Spectrum below 2 GHz .....	18
C. Manufacturers Will Undertake Outreach to Promote the 600 MHz Band Transition .....	19
VI. INTERNATIONAL JURISDICTIONS HAVE IMPLEMENTED PROGRESSIVE REGULATIONS THAT ENSURE SPECTRUM FOR WIRELESS MICROPHONE .....	20

**TABLE OF CONTENTS**  
(continued)

	<b>Page</b>
A. Foreign Regulators Value Wireless Microphones and Proactively Ensured the Availability of Reserve Spectrum When Repurposing 700 MHz Spectrum.....	21
B. Foreign Regulators Relax Co-Channel Operation of Wireless Microphones with Broadcast Television in Controlled Settings .....	23
VII. WIRELESS MICROPHONE MANUFACTURERS AGGRESSIVELY PROMOTE TECHNOLOGICAL ADVANCES.....	24
VIII. SHURE RECOMMENDATIONS FOR EXISTING BROADCAST TELEVISION BANDS .....	29
A. VHF/UHF Television Bands.....	29
B. 169-172 MHz Band .....	33
IX. SHURE RECOMMENDATIONS FOR ALTERNATIVE BANDS CAPABLE OF SUPPORTING PROFESSIONAL AUDIO USE.....	35
A. 941-944 MHz, 944-952 MHz and 952-960 MHz Bands .....	36
B. 1435-1525 MHz Band.....	38
X. SHURE RECOMMENDATIONS FOR ADDITIONAL BANDS FOR ALTERNATIVE WIRELESS MICROPHONE USE.....	40
A. 26.100-26.480 MHz 161.625-161.775 MHz, 450-451 MHz and 455-456 MHz Bands .....	40
B. 88-108 MHz FM Band .....	41
C. Unlicensed Operations in the 902-928 MHz, 2.4 GHz and 5 GHz Bands.....	41
D. 1920-1930 MHz Unlicensed PCS Band.....	42
E. 3.5 GHz Band.....	43
F. 6875-7125 MHz Band.....	44
XI. CONCLUSION .....	44

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**COMMENTS OF SHURE INCORPORATED**

Shure Incorporated (“Shure”) hereby submits these comments in response to the Federal Communications Commission (“FCC” or “Commission”) Notice of Proposed Rulemaking (“NPRM” or “Notice”) in the above-captioned proceeding.<sup>1</sup> The NPRM addresses significant issues regarding how to accommodate long-term needs of wireless microphone users given recent and impending alterations to the existing regulatory environment - most significantly, the repurposing of broadcast television band spectrum in which wireless microphones operate.

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<sup>1</sup> *In the Matter of Promoting Spectrum Access for Wireless Microphone Operations, et al.*, Notice of Proposed Rulemaking, GN Docket Nos. 14-166, 12-268, FCC 14-145 (rel. Sep. 30, 2014) (“*NPRM*”).

## I. INTRODUCTION

Shure is the leading U.S.-based manufacturer of high-quality wireless microphones<sup>2</sup> and other professional audio products<sup>3</sup> classified as low-power auxiliary devices authorized under Part 74 of the Commission's Rules to operate on a secondary basis in the TV broadcasting spectrum.<sup>4</sup> Wireless microphones have successfully operated, on a secondary basis, on unassigned channels in the TV spectrum for decades. Wireless microphone use has grown rapidly and today, these devices provide critical support to a wide range of sectors including TV broadcasting, news casting, theater, live music, sports, religious, civic and academic institutions.

While wireless microphone use has rapidly expanded over the past decades, the soaring demand for spectrum for wireless broadband uses has prompted the Commission to take steps to repurpose a significant amount of spectrum previously available for

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<sup>2</sup> "Wireless microphones," as used herein, includes a variety of audio devices authorized under Part 74 and/or Part 15 of the Commission's Rules as secondary users of locally unoccupied television channels. In addition to microphones, this equipment includes in-ear monitors, wireless intercoms, wireless assist video devices ("WAVDs") and wireless cueing ("IFB") systems. This working definition is consistent with the definition of wireless microphone in the NPRM. 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, and Amendment of Part 74 of the Commission's Rules for Low Power Auxiliary Stations in the Repurposed 600 MHz Band and 600 MHz Duplex Gap, ET Docket No. 14-165, Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, GN Docket No. 12-268, *Notice of Proposed Rulemaking*, FCC 14-144, ¶ 148 (rel. Sept. 30, 2014) (proposing to define a wireless microphone as "a device that converts sound into electrical audio signals that are transmitted using radio signals to a receiver which converts the radio signals back into audio signals that are sent through a sound recording or amplifying system.").

<sup>3</sup> "Professional audio" microphones are used as a medium for transmission of multimedia and artistic content, and have corresponding and unique performance requirements. They must capture full audio range, have less than three (3) milliseconds of transmission latency (for some applications less than one (1) millisecond), and have reliability that meets or exceeds the expectations of a wired microphone user. These performance requirements necessitate a wider emission and require adequate, clean spectrum.

<sup>4</sup> Wireless microphones have historically operated on a secondary basis principally in the UHF television bands pursuant to Subpart H of Part 74. See 47 CFR §§ 74.801-74.882. Certain wireless microphone applications have also been accommodated on a secondary basis in the VHF television bands, in a narrow Part 90 VHF allocation, and in certain Industrial, Scientific and Medical bands under Part 15 unlicensed rules.

wireless microphone use to high-power wireless broadband.<sup>5</sup> Those steps have crowded wireless microphone operations into less and less spectrum raising the real possibility that some events simply will not be able to be supported in the future unless the Commission identifies sharing approaches and *additional* spectrum to supplement the available TV band spectrum suitable for low power microphone uses. In that context, Shure has participated extensively in various Commission proceedings grappling with the existing and growing spectrum needs of wireless microphones, such as ET Docket 04-186 (the “White Spaces Proceeding”) aimed at creating a database-driven sharing scheme that would allow new devices as well as incumbent wireless microphones to share TV spectrum; the Commission’s Broadcast Incentive Auction in GN docket No. 12-268; and the 3.5 GHz proceeding in GN Docket No. 12-354 proposing shared commercial and government use of the 3550-3650 MHz band.<sup>6</sup>

Shure applauds the Commission on its efforts to address the long-term needs of wireless microphone users and is hopeful that the proposals discussed herein and the corresponding rule changes adopted in this proceeding will provide additional sources of spectrum vital to wireless microphone operations. Shure also appreciates the urgency with which this issue is being addressed and that the Commission intends to issue an

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<sup>5</sup> See, e.g., *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, 60 CR 497, at ¶ 24 (2014) (“*Incentive Auction Order*”) (clarifying that the Commission “will also initiate a proceeding in the near future to find additional spectrum for microphone users in other bands in order to help address their long-term needs”).

<sup>6</sup> Shure’s contributions on spectrum-related issues affecting wireless microphones are reflected in numerous seminal FCC decisions. See, e.g., *Incentive Auction Order*, at ¶ 300 (2014) (citing to Shure’s comments when addressing the importance of wireless microphones to the creation of multimedia content). See also *Unlicensed Operation in the TV Broadcast Bands*, Second Report and Order and Memorandum Opinion and Order, 23 FCC Rcd 16807 (2008) (discussing throughout Shure’s contributions to the development of spectrum sharing technologies).

order before commencement of the incentive auction, which will result in a significant reduction of spectrum currently available for wireless microphone operations.<sup>7</sup>

## **II. SHURE'S RECENT CONTRIBUTIONS TO THE DEVELOPMENT OF NEW TECHNOLOGY HAVE ADVANCED THE COMMISSION'S GOALS OF IMPROVING WIRELESS MICROPHONE EFFICIENCY AND PERFORMANCE**

At the outset, Shure emphasizes that during the past decade it conducted unprecedented research and development efforts towards the advancement of wireless microphone technology. Shure has also been an active and productive participant in the various Commission proceedings initiated in recent years that addressed wireless microphone regulation directly or indirectly. These research, development and regulatory efforts yielded technological innovation that has already proven effective at improving wireless microphone efficiency and performance. Highlights from the past decade of innovation include:

- Axient Wireless Management System: Shure recently launched the Axient product line, which utilizes continuous spectrum monitoring to evaluate, prioritize and assign UHF frequencies to wireless microphone users. Axient effectively detects and avoids interference before degradation or disruption in audio performance occurs.<sup>8</sup>
- ULX-D Digital Wireless System: Shure's new digital ULX-D product line can accommodate in excess of 40 simultaneously transmitting wireless microphones on one six (6) megahertz UHF broadcast television channel.<sup>9</sup>
- Frequency Finder Database Integration: Shure is the first wireless microphone manufacturer to integrate and synchronize its online frequency selection portal, *Frequency Finder*, with real-time information provided directly from an approved White Space database administrator.

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<sup>7</sup> See NPRM at ¶ 2.

<sup>8</sup> Learn more about this product at: <http://www.shure.com/americas/axient/overview>.

<sup>9</sup> Learn more about this product at: <http://www.shure.com/americas/products/wireless-systems/ulxd-systems>. (Note: This product and certain performance limitations that correspond with its efficiency gains are discussed in Section VII.B.)

- White Space Testing: Shure coordinated testing of White Space technology at National Football League and Broadway sites to ensure viability of next generation frequency sharing technology.

Looking to the future, Shure remains committed to further advancing the state of wireless microphone technology, and exploring new opportunities and spectrum bands with the Commission in the instant proceeding.

### **III. WIRELESS MICROPHONE SPECTRUM NEEDS ALREADY GREATLY EXCEED AVAILABLE RESOURCES**

Shure appreciates the Commission's express acknowledgement that recent FCC actions reduced the availability of spectrum for wireless microphones in the UHF television band, the longstanding principal spectrum home for professional wireless microphones. The lack of viable spectrum for professional audio wireless microphone operations already routinely requires the FCC to grant special temporary authority to frequency coordinators responsible for the production of large scale events. In recent months, the Commission has granted special temporary authority for wireless microphones to use a variety of supplemental frequencies, including the 1435-1525 MHz band and 700 MHz frequencies allocated to the First Responder Network at professional sporting events, trade shows, and award ceremonies.<sup>10</sup>

This spectrum shortage presently affects large-scale events. Once 600 MHz frequencies are repurposed, modest events that require far fewer wireless audio channels

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<sup>10</sup> See, e.g., FCC Call Signs WG9XDA, WI9XAI, WI9XCX, WI9XEI, WQTF604, and WQTK418. These call signs involve special temporary authority to operate wireless microphones and low-power auxiliary equipment on non-broadcast frequencies for production of recent Super Bowls, PGA Tournaments, College Football Championship, GRAMMY Awards and Academy Awards)

are also likely to be affected. To avoid a worst case outcome where the production quality of various multimedia, sporting and live productions is degraded, the Commission must move expeditiously to create wireless microphone allocations and service rules in new alternative spectrum. Given the time constraints on the development and manufacture of new wireless microphone products discussed below, any delay in identifying new supplemental spectrum for wireless microphone use beyond the release of the *Channel Reassignment PN*<sup>11</sup> may also result in difficulties migrating wireless microphones from repurposed 600 MHz Band spectrum.

#### **IV. SHURE SUPPORTS THE COMMISSION’S GOAL OF DEVELOPING A FRAMEWORK FOR WIRELESS MICROPHONES INVOLVING A COMBINATION OF TV BAND AND SUITABLE SUPPLEMENTAL SPECTRUM**

The Commission seeks to develop an “overall framework” so that wireless microphone users “can have access in the coming years to a suite of devices operating in different spectrum bands that can address their respective needs, while also achieving [the FCC’s] spectrum management goals of promoting spectral efficiency.”<sup>12</sup> To achieve this goal, the Notice seeks to “explore the role of technological advances..., and particular frequency bands”<sup>13</sup> in achieving its goal of developing an overall framework. As a leader in the development and manufacture of advanced wireless microphones and complementary LPAS systems, Shure welcomes this opportunity to provide the

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<sup>11</sup> As the Commission notes, the *Channel Reassignment PN* will “identify the new channel assignments for full power and Class A television stations that have been reassigned to different channels resulting from the incentive auction and the repacking process.” NPRM at ¶ 36, n. 91 (internal citation omitted).

<sup>12</sup> NPRM at ¶ 30.

<sup>13</sup> NPRM at ¶ 30.

Commission with its insight on technological advances and suitable frequency bands for wireless microphone use.

**A. Professional Audio Wireless Microphone Require Spectrum Between 150 MHz and 2 GHz; Higher Frequencies Should be Explored for Less Demanding Alternative Microphone Uses**

The Notice seeks comment on “additional ways in which [it] could accommodate various wireless microphone operations in different bands, which include a range of frequencies as low as the television VHF bands and as high as 7 GHz,”<sup>14</sup> and on “how the nature of different bands, including the propagation features that are associated with them, should inform [the FCC’s] consideration of how to accommodate wireless microphones.”<sup>15</sup> The Notice seeks further input on the types of applications suitable for low, mid-range and higher spectrum, and how much bandwidth is required for different types of wireless microphone uses.<sup>16</sup>

Shure values the Commission’s dedication to finding appropriate spectrum solutions for future wireless microphone use, and the Commission’s willingness to conduct a fulsome exploration of what characteristics make a band viable for different microphone applications. Shure provides the following feedback to the Commission’s general questions regarding the suitability of different bands for wireless microphone applications.<sup>17</sup>

Future professional audio wireless microphone applications will continue to require access to adequate, clean spectrum below 2 GHz in the radiofrequency band.

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<sup>14</sup> *NPRM* at ¶ 39.

<sup>15</sup> *NPRM* at ¶ 39..

<sup>16</sup> *NPRM* at ¶ 40.

<sup>17</sup> Shure provides recommendations with respect to individual bands in Sections VIII through X.

Professional audio wireless microphone users have unique performance requirements. They demand high-fidelity (full audio range), uninterrupted,<sup>18</sup> and low-latency (<3 milliseconds) transmission.<sup>19</sup> They also require significant range (in some instances >100 meters with enough margin to overcome manmade or natural blockage between the wireless microphone and receiver), and routinely operate for many hours continuously, which necessitates low power levels to preserve battery life. Professional audio wireless microphones must also satisfy rigid form factor requirements (professional audio microphones must be capable of being handheld or body worn), which limits the size and gain of wireless microphone antennas.

These performance requirements make Ultra High Frequency (“UHF”) spectrum between 450 MHz and 1 GHz the most desirable frequencies for professional audio microphones. The unique spectral qualities in the UHF range enable the use of compact, omni-directional antennas while maintaining modest power levels and adequate range. These qualities are the reason the majority of contemporary professional audio wireless microphones operate within the UHF television broadcast bands between 470 MHz and 698 MHz.

Although the 450 MHz to 1 GHz frequency range remains the ideal spectral home for professional audio wireless microphones, the 1 GHz to 2 GHz range can accommodate professional audio microphones with appropriate service rules. Based on Shure’s extensive analysis and ongoing microphone and LPAS operations in the band

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<sup>18</sup> Professional audio wireless microphones are intended to replicate the performance of a traditional wired microphone, including the extremely high levels of reliability enjoyed by wired microphones, which generally meet or exceed 99.99%.

<sup>19</sup> Certain professional audio applications, including on-stage performances involving in-ear monitors that must provide the performers instant feedback, may not tolerate even three (3) milliseconds of latency.

conducted pursuant to special temporary authority, professional audio microphones operating in the 1 GHz to 2 GHz range can meet user performance requirements.<sup>20</sup> The shorter wavelengths in the 1 GHz to 2 GHz range may require modification to certain components (e.g., higher gain receiver antennas), but such adjustments will still enable operation under current or slightly revised Part 74 rules.

Shure expects frequencies above 2 GHz to receive consideration from the microphone manufacturing community for alternative non-professional audio applications that generally involve less critical and lower density specialized uses, where certain performance prerequisites demanded by the professional audio community can be compromised (e.g., range, latency, fidelity). Such applications might include microphones operated for amateur or semi-professional music and theater performances, in a corporate setting, at retail events and trade shows, or in Houses of Worship not involved in broadcasting or video content creation. Shure itself presently manufactures wireless microphones that operate in the 2400-2483.5 MHz Industrial, Scientific and Medical (“ISM”) band, and is reviewing the proposed service rules in the 3550-3650 MHz Citizen’s Broadband Radio Service (“CBRS”) band.<sup>21</sup>

Frequencies above 2 GHz generally lack the availability and low ambient noise environment required for professional audio microphones. Service rules that have been

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<sup>20</sup> See, e.g., FCC Call Signs WG9XDA, WI9XAI, WI9XCX and WI9XEI, involving the use of 1.4 GHz spectrum for various high-profile productions. See also Japan’s Frequency Allocation Table, Table 2 (27.50MHz-1000MHz), Annex 6-1, available at <http://www.tele.soumu.go.jp/e/adm/freq/search/share/plan.htm> (establishing the 1240-1260 MHz band as new alternative reserve band for microphones displaced by cellular services); Harmonized Technical Conditions of Radio Spectrum Use by Wireless Audio Programme Making and Special Events Equipment in the Union, Commission Implementing Decision, 2014/641/EU, Article 3 (2014) (requiring that EU jurisdictions set aside reserve spectrum for wireless microphones in certain bands, including 1785-1805 MHz).

<sup>21</sup> See *In the Matter of Amendment of the Commission’s Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Comments of Shure Incorporated, GN Docket No. 12-354 (filed July 14, 2014).

adopted or presently given consideration for bands above 2 GHz primarily contemplate a shared environment with wideband digital emissions and other interference mitigation techniques.<sup>22</sup> While such transmission technologies may enable devices to operate in a crowded environment with many competing users, they also create a noisy and unpredictable environment that can degrade quickly given the many competing uses vying for the spectrum. The existing Part 15 rules<sup>23</sup> that apply to many of the ISM bands where wireless microphone operations might occur above 2 GHz require a minimum emission bandwidth of 500 kHz, which prevents a wireless microphone manufacturer from operating large numbers of microphones simultaneously, even if the spectrum environment were quiet enough and sufficiently predictable to deploy a professional device. Finally, the need to use digital modulation coupled with other techniques necessary to overcome the interference associated with such an inherently noisy environment introduces latency into the transmission between the wireless microphone and receiver.

Frequencies between 150 MHz and 450 MHz, including Very High Frequency (“VHF”) broadcast television bands, have longer wavelengths which complicate the development of wireless microphones that meet the form factor needs of professional audio wireless microphone users described above. In particular, the efficiency of compact, omni-directional antennas embedded within a handheld microphone or extending from a body worn microphone falls off dramatically at the longer wavelengths below 450 MHz. This can affect range, power and other operating characteristics of a

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<sup>22</sup> See generally 47 C.F.R. Part 15 (employing channel hopping and spread spectrum transmissions in several ISM bands).

<sup>23</sup> See 47 C.F.R. § 15.247(a)(2).

wireless microphone. Frequencies in the 150 MHz to 450 MHz range are also inherently noisy due to spurious emissions from all manner of manmade devices, including unintentional radiators.<sup>24</sup>

The value of frequencies between 150 MHz and 450 MHz for professional audio use can be improved by adjusting the Part 74 service rules, including increasing the output of VHF wireless microphones as proposed by Shure in Section VIII.A. To the extent these recommendations are adopted by the Commission, Shure expects renewed interest in the 150 MHz to 450 MHz frequency range, given that this spectrum will remain available for wireless microphone use in the higher broadcast television VHF bands.

Frequencies below 150 MHz will not effectively support wireless microphone applications. Small antennas employed by handheld and body worn microphones lose efficiency dramatically below 150 MHz. The losses in efficiency experienced below 150 MHz likely prohibit the development of professional and non-professional audio equipment for manufacture and use.

**B. Shure Develops and Manufactures Wireless Microphones Based on Customer Needs, the Suitability of Available Spectrum, and Regulatory Stability**

The Notice seeks comment on the “factors that manufacturers take into account as they consider and evaluate whether to develop and manufacture new devices for distribution in the near and longer term.”<sup>25</sup> The Notice seeks comment generally, but also specific input as to the extent to which “propagation features, the size of [the] band,

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<sup>24</sup> Television stations have migrated into the UHF in recent decades in part because of the need for larger antennas and inherent noise in the VHF bands.

<sup>25</sup> *NPRM* at ¶ 41.

potential availability (or lack of availability) of different segments of the band, the extent to which the band allows licensed or unlicensed uses, the technical rules (existing or as revised), the certainty that the band will continue to be available over the long term, or other aspects contribute to the likelihood that new devices will be made for a particular band.”<sup>26</sup> The Notice seeks further comment on the factors “manufacturers consider with respect to developing different types of wireless microphones for different users and applications, whether for highest audio quality or for communications that do not require such performance quality.”<sup>27</sup>

When determining whether to develop and manufacture new technology, Shure first evaluates its customers’ needs and expectations. After a fulsome evaluation of the customers’ requirements, Shure examines a number of factors to determine whether a new product that meets or exceeds the customers’ expectations can be effectively developed and manufactured. The characteristics that Shure weighs to determine whether radiofrequency spectrum is both available and suitable for a wireless microphone application include:

Propagation Characteristics: As discussed in Section IV.A above, professional audio microphones are power restricted and enabled with compact omni-directional antennas. Despite these power and form factor limitations, professional audio wireless microphones must operate at considerable range (>100 meters), have enough signal margin to penetrate walls, overcome loss due to body absorption, stage obstructions and costumes, and satisfy unyielding demands with respect to reliability. These unique operating parameters focus viable spectrum for professional audio applications to

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<sup>26</sup> *NPRM* at ¶ 42.

<sup>27</sup> *NPRM* at ¶ 42.

frequencies between approximately 150 MHz and 2 GHz. Accordingly, the availability of spectrum within this frequency range is likely to be a gating item for Shure to expend research and development resources on new wireless products intended to support the professional audio industry.

Alternative wireless microphone applications (*e.g.*, microphones used in corporate environments) with less demanding use cases (*e.g.*, reduced range and shorter periods of continuous operation) may be viable in spectrum above 2 GHz. Shure has and will continue to develop microphones for use in higher frequencies, but such microphones may not be suitable for more demanding professional audio applications depending on propagation, service rules and ambient radiofrequency noise levels.

Allocation Size: Reasonable contiguous allocations of spectrum are required, and will encourage wireless microphone manufacturers to develop devices. Given the loss of 700 MHz television broadcast spectrum, and likely loss of significant 600 MHz television broadcast spectrum, professional audio wireless microphone manufacturers will likely explore the development and manufacture of wireless microphones in any allocation between 150 MHz and 2 GHz that provides at least 18-24 megahertz of spectrum with consistent operating rules. With respect to the proposals within the Notice, the planned secondary allocations for wireless microphones in the 941-960 MHz band and 1435-1525 MHz would provide adequate contiguous blocks of spectrum to motivate wireless microphone manufacturers to develop and manufacture devices, so long as the service rules and operating parameters promulgated in these bands are reasonable.<sup>28</sup>

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<sup>28</sup> *NPRM* at ¶¶ 149, 177. *See also* Electromagnetic compatibility and Radio Spectrum Matters; Wireless microphones in the 25 MHz to 3 GHz frequency range; Part 1: Technical characteristics and methods of measurement, ETSI EN 300 422-1 V1.3.2, Sec. 8.1.3.2, *available at*

Allocation Stability & Availability: The Commission must ensure that future allocations made available for professional audio wireless microphones remain stable and prevent unnecessary migrations. Shure’s customers expect devices to have a minimum useful life of ten (10) years, although in many instances, Shure professional audio microphones remain in use for significantly longer periods of time. Shure’s customers and the broader professional audio community have also experienced significant hardship due to the 700 MHz Band migration that occurred in 2010, and the pending migration from 600 MHz Band frequencies, where the Commission encouraged professional audio microphones to migrate after 2010 by creating dedicated reserve channels for microphone use around Channel 37. Given this expectation and the hardship inflicted by multiple migrations, Shure can only invest in research and development for future bands of spectrum that it feels highly confident will continue to be available long-term for professional audio use.

With respect to alternative microphone operations in spectrum above 2 GHz or certain other bands that may be employed opportunistically for less demanding applications (*e.g.*, 2.4 GHz ISM bands), Shure also urges the Commission to ensure long-term stability. The enormous volume of already fielded unlicensed equipment in these bands, however, likely prevents the Commission from taking dramatic steps to repurpose this spectrum for an alternative use in the foreseeable future.<sup>29</sup> This installed user base

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[http://www.etsi.org/deliver/etsi\\_en/300400\\_300499/30042201/01.03.02\\_60/en\\_30042201v010302p.pdf](http://www.etsi.org/deliver/etsi_en/300400_300499/30042201/01.03.02_60/en_30042201v010302p.pdf) (“*ETSI EN 300 422-1 V1.3.2*”).

<sup>29</sup> In excess of \$1 billion in Wi-Fi equipment intended for the 2.4 GHz and 5 GHz unlicensed bands ships every quarter globally. See IDC Corporate Data WLAN Study, available at: <http://www.idc.com/getdoc.jsp?containerId=prUS25077714>.

minimizes Shure’s concern that wireless microphone equipment may become stranded due to a dramatic and unexpected change in the Commission’s regulations.

**C. Time-to-Market for New Wireless Microphones is Highly Dependent on Service Rules and Frequency Allocation**

The time-to-market generally varies between two to four years for a new wireless microphone product from inception. There are many variables in the development of a new product, however, and this rough estimate can vary depending on whether off-the-shelf components are available or need to be engineered, the complexity of the product line,<sup>30</sup> whether special technical requirements must be satisfied, and the complexity of the regulatory obligations that must be satisfied before the new product can be marketed and sold. As a general rule, products being developed for existing bands under established service rules will have a shorter time-to-market.

**V. THE PENDING 600 MHZ TRANSITION PRESENTS SIGNIFICANT CHALLENGES; THE FCC MUST MINIMIZE THE AMOUNT OF EQUIPMENT STRANDED; MANUFACTURER OUTREACH WILL ENSURE AWARENESS**

The Notice seeks comment generally on the “range [of] issues affecting transitioning of wireless microphone users” from 600 MHz Band spectrum.<sup>31</sup> The NPRM also explains that the Commission “anticipate[s] that many wireless microphone users will need to move their operations out of the repurposed spectrum no later than 39 months following the issuance of the *Channel Reassignment PN*, and many wireless microphone users accessing spectrum that may remain allocated for television services

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<sup>30</sup> For example, time-to-market for a single handheld microphone will generally be a less involved effort and more expeditious than the development of a full product line that involves handheld and body worn microphones as well as complementary LPAS (*e.g.*, in-ear monitors).

<sup>31</sup> NPRM at ¶ 44.

may seek to transition to different devices, including more efficient digital devices, or replace older devices, that may operate both in the bands likely to remain allocated for television or in other bands.”<sup>32</sup> In addition, the Notice seeks input on short-term and long-term action the Commission and wireless microphone manufacturers can take to “facilitate a smooth transition out of the repurposed 600 MHz.”<sup>33</sup>

Shure seeks to dispel any misconceptions that the installed user base in the 600 MHz Band employs inefficient devices. A large percentage of the equipment in the 600 MHz Band was actually purchased in the last two to five years to replace 700 MHz equipment whose operation was prohibited in 2010 at the conclusion of the digital television transition.<sup>34</sup> Much of this equipment is state-of-the-art and spectrally efficient, given the rigorous demands of a professional audio microphone user. Given that the cost of few (if any) 600 MHz microphones will have been amortized at the conclusion of the transition, it will be difficult to convince such end users to limit its use. The Commission can take action to promote cooperation.

**A. The Commission Can Encourage a Timely Transition by Protecting Equipment Capable of Using Residual 600 MHz Spectrum**

Given the substantial and recent investment in technologically advanced 600 MHz Band microphones, Shure urges the Commission to ensure that this equipment is not unnecessarily stranded. In particular, Shure believes the Commission can improve the

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<sup>32</sup> *NPRM* at ¶ 45.

<sup>33</sup> *NPRM* at ¶ 47.

<sup>34</sup> *See In the Matter of Revisions to Rules Authorizing the Operation of Low Power Auxiliary Stations in the 698-806 MHz Band, et al.*, Report and Order and Further Notice of Proposed Rulemaking, 25 FCC Rcd 643, at ¶ 2 (2010).

probability of a smooth transition by taking the following action with respect to 600 MHz Band wireless microphones.

Implement Safeguards but Enable Use of Wireless Microphones Capable of Operating in Residual 600 MHz Spectrum: The Commission intends to permit wireless microphones to continue operating in certain portions of the 600 MHz Band, including four (4) megahertz of exclusive spectrum in the duplex gap between the uplink and downlink bands, shared use with White Space Devices (“WSDs”) in an additional six (6) megahertz of duplex gap spectrum, in guard band spectrum bracketing Channel 37, and in the lower guard band separating cellular broadband services from repacked broadcast television services in UHF frequencies below the 600 MHz Band.<sup>35</sup>

To the extent that a wireless microphone has the ability to operate on one or more of the above residual portions of the 600 MHz Band that will remain available, Shure urges the Commission to facilitate such use. Specifically, Shure recommends the following Commission action to ensure that viable wireless microphones are not unnecessarily stranded:

- Permit the Operation of 600 MHz Band Wireless Microphones During the Repack Effort: To ensure that wireless microphone end users (that in many instances have new or nearly new devices) can use their equipment, and to avoid leaving the 600 MHz Band fallow for an extended period of time, permit the operation of wireless microphones until the end of the 39 month transition window that begins with the release of the *Channel Reassignment PN*. To the extent that a new entrant in the 600 MHz Band deploys and operates network facilities in the band prior to the conclusion of the 39 month transition window, require the new entrant to register its active frequencies as occupied spectrum through one of the existing White Space Database administrators.<sup>36</sup>

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<sup>35</sup> Shure’s detailed recommendations with respect wireless microphones in 600 MHz spectrum are provided in the company’s concurrently filed Comments in ET Docket No. 14-165.

<sup>36</sup> Shure has confirmed that White Space database administrator Key Bridge Global has the capability to notch out frequencies in the 600 MHz Band in 5 or 10 megahertz increments.

- Automatically Modify Part 74 Microphone Licenses to Reflect Duplex Gap and Guard Band Frequencies: At the conclusion of the 39 month transition period that begins with the release of the *Channel Reassignment PN*, the Commission should automatically modify the licenses of Part 74 wireless microphone users to reflect the guard bands and duplex gap as authorized frequencies in the licensee's market.
- Avoid Unnecessary Prohibitions on the Operation of Already Fielded 600 MHz Microphones After the Transition: Given that some wireless microphone operations will continue in portions of the 600 MHz Band, the Commission must avoid overly inclusive and unnecessary blanket prohibitions on the operation of wireless microphones that can transmit on 600 MHz Band duplex gap and guard band frequencies.<sup>37</sup> If a wireless microphone has already been certificated for operation in frequencies that cover any portion of the duplex gap or guard bands, the operation of that microphone should be permissible subject to appropriate coordination via manual check of the geolocation database or manufacturer-provided information based on the database results.

**B. Prior to the Release of the Channel Assignment PN the Commission Must Ensure the Availability of Supplemental Spectrum below 2 GHz**

The Commission intends to transition wireless microphones to alternative spectrum beyond the television broadcast bands not later than the conclusion of the repacking and repurposing of the 600 MHz Band.<sup>38</sup> Shure urges the Commission to improve upon this commitment to ensure the long-term success of the 600 MHz band. Specifically, given that it will require manufacturers two to four years to make available new wireless microphones for alternative frequencies, Shure asks the Commission to identify new supplemental spectrum below 2 GHz for wireless microphone use before the release of the *Channel Assignment PN*, which initiates the 39 month repacking effort.

Given that many large productions already require Commission special temporary authority to accommodate the requisite wireless audio channels needed to produce the event, the loss of 600 MHz spectrum will make many of these events untenable or may

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<sup>37</sup> It is unclear how such a prohibition could be effectively implemented given the likely variability in the lower boundary of the 600 MHz Band from market-to-market.

<sup>38</sup> See *NPRM* at ¶ 96.

dramatically decrease their production value.<sup>39</sup> By ensuring that supplemental spectrum and service rules that make such spectrum available to end users of wireless microphone technology are in place prior to the conclusion of the 600 MHz Band transition, the Commission will encourage 600 MHz Band wireless microphone users to discontinue operations outside the duplex gap and guard bands, and provide wireless microphone manufacturers and frequency coordinators with a spectrum refuge where end users desperate for wireless channels can be directed.

Shure reemphasizes that supplemental spectrum made available to offset the loss of the 600 MHz Band must be below 2 GHz to have utility for the professional audio users that will require it to offset the loss of 600 MHz Band frequencies. As discussed in Section IV.B above, the propagation characteristics of frequencies above 2 GHz will not support professional audio user needs.

### **C. Manufacturers Will Undertake Outreach to Promote the 600 MHz Band Transition**

Shure intends to contribute to an expeditious transition from spectrum repurposed for new entrants and ongoing wireless microphone operation in the 600 MHz Band duplex gap and guard bands through the following actions:

Manufacturer outreach: Shure can undertake an outreach effort comparable to the program implemented to ensure that 700 MHz Band wireless microphone operations ceased on June 10, 2010. Such a program would involve individual meetings with distributors, resellers and end users, webinars explaining 600 MHz Band transition issues, information dissemination with industry trade press and presentations and education at

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<sup>39</sup> For example, large events like the GRAMMYS and Academy Awards may have fewer visual effects due to an inability to support them with audio content. Alternatively, musical performances and sketches may need to be eliminated or dramatically scaled back. The possibility of microphones interfering with each other and degrading or disrupting performances or sketches is also a possibility.

tradeshows and industry events. Shure would encourage other high-volume wireless microphone manufacturers to undertake similar outreach efforts.

Online tools and services: Shure provides online support and tools to its customer base, including the state-of-art Frequency Finder portal that serves as a near real-time resource for professional audio customers attempting to identify available local channels for microphone use. In anticipation of the 600 MHz transition, Shure will proactively update online resources and tools to ensure that they appropriately identify available frequencies throughout the transition, including channels that become restricted as new entrants power up network facilities.<sup>40</sup>

In addition to the already contemplated initiatives above to promote a smooth 600 MHz band transition, Shure remains open to suggestions from its customers and Commission recommendations that may enhance the company's transition efforts.

## **VI. INTERNATIONAL JURISDICTIONS HAVE IMPLEMENTED PROGRESSIVE REGULATIONS THAT ENSURE SPECTRUM FOR WIRELESS MICROPHONE**

The Notice seeks comment on whether “regulatory schemes for wireless microphone operations in other countries should inform our approach in this proceeding,” and whether such models would be “appropriate for particular bands as [the Commission] consider[s] revisions to [its] rules.”<sup>41</sup> Shure has participated in proceedings related to the revision or modernization of wireless microphone service rules in several international jurisdictions. Shure has observed that other jurisdictions place a high priority on the preservation of professional audio wireless microphone uses, and value the significant

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<sup>40</sup> Shure already synchronizes its Frequency Finder portal in near real-time with an FCC-approved geolocation database.

<sup>41</sup> *NPRM* at ¶ 49.

social, cultural and business contributions that wireless microphones provide. Aspects of modernized rules adopted in several international jurisdictions have contributed to the availability of additional spectrum for wireless microphones. Shure highlights below several noteworthy actions implemented in other jurisdiction that may help inform the Commission’s approach in the instant proceeding.

**A. Foreign Regulators Value Wireless Microphones and Proactively Ensured the Availability of Reserve Spectrum When Repurposing 700 MHz Spectrum**

Creating harmonized and dedicated reserve spectrum for wireless microphone operations has remained a priority in the European Union (“EU”). Specifically, in late 2014, the European Commission (“EC”) reaffirmed “cultural and creative industries as one of Europe’s most dynamic economic sectors and...,” and “stress[ed] the importance of [wireless microphones]” in supporting this sector of the economy.<sup>42</sup> Explaining that wireless microphones and other complementary professional audio devices may consume up to 144 megahertz of spectrum at certain events, the EC created a requirement for individual EU jurisdictions to set aside up to 30 megahertz of reserve spectrum for wireless microphones within white spaces in the 470-790 MHz UHF television broadcast bands as well as dedicated reserve channels in duplex gap frequencies between cellular uplink and downlink bands at 1785-1805 MHz and 823-832 MHz.<sup>43</sup> In its recent “*Lamy Report*,” the rapporteur (reporter) of the EC’s UHF Working Group (broadcasters, wireless broadband providers and the Program Making Special Events (“PMSE,” which

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<sup>42</sup> Harmonized Technical Conditions of Radio Spectrum Use by Wireless Audio Programme Making and Special Events Equipment in the Union, Commission Implementing Decision, 2014/641/EU, at ¶ 2 (“*2014 EC Reserve Channel Decision*”).

<sup>43</sup> See *2014 EC Reserve Channel Decision*, Article 3.

include wireless microphones) industry) states that “Member States should ensure that broadcasters and [wireless microphone] users are left no worse or no better off than they would have been without any clearance of the 700 MHz band . . . . The timely identification and harmonization of additional spectrum (tuning ranges) for [wireless microphones] is required as a substitute capacity.” *Lamy* concludes that “the broadcasting and [wireless microphone] sectors should not be disadvantaged by such a transition and cost compensation should be duly addressed.”<sup>44</sup> Accordingly, the French regulator ARCEP has suggested various frequencies in its 700 MHz consultation document to use the 694-698, 698-703 and 733-758 MHz bands for wireless microphones with the 694-698 and 743-748 MHz bands (9 MHz) for sole PMSE [including wireless microphone] use.<sup>45</sup> The U.K. regulator *Ofcom* in its 2014 Consultation on future use of the 700 MHz band (May 2014) also recognizes that “the use of wireless microphones and other PMSE applications delivers significant cultural benefits to the UK.”<sup>46</sup> *Ofcom* is considering, in particular, a use of the “700 MHz center gap and guard band” and of the 823 to 832 MHz and 1785 to 1805 MHz for low power PMSE use.<sup>47</sup>

The Japanese Ministry of Internal Affairs and Communications (“MIAC”) similarly established reserve spectrum for wireless microphones displaced by cellular

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<sup>44</sup> Results of the Work of the High Level Group on the Future Use of the UHF Band, Report to the European Commission, at 12-13, *available at* [http://ec.europa.eu/information\\_society/newsroom/cf/dae/document.cfm?doc\\_id=6721](http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=6721). The EC has published a report on these proposals and is seeking comments by April 12, 2015.

<sup>45</sup> ARCEP Consultation document (in French only- « Revue stratégique du spectre pour le très haut débit mobile ») at 37 (rel. Dec. 16, 2014), *available at* [http://www.arcep.fr/uploads/tx\\_gspublication/consult-THD-mobile-700mhz-161214.pdf](http://www.arcep.fr/uploads/tx_gspublication/consult-THD-mobile-700mhz-161214.pdf).

<sup>46</sup> Consultation on future use of the 700 MHz band, *Ofcom*, at Sec. 2.11(rel. May 28, 2014), *available at* <http://stakeholders.ofcom.org.uk/binaries/consultations/700MHz/summary/main.pdf>.

<sup>47</sup> *Id.* at Sec. 7.32. *Ofcom* also considers the 960 to 1350 MHz and 1525 to 1710 MHz bands for PMSE- which are predominantly used for satellite services, including the mobile satellite service, earth exploration and space service and GNSS. “Initial work suggests that there is potential for sharing in some parts of this band and this may provide a helpful contribution to PMSE spectrum supply” *Id.* at Sec. 7.30.

services. Although wireless microphones in Japan retain use of white space spectrum in the 470-710 MHz range, when reserve spectrum dedicated to professional audio wireless microphones between 779-806 MHz was repurposed for cellular use in 2012, the MIAC promptly established the 1240-1260 MHz band as new alternative reserve band for microphones.<sup>48</sup>

In the instant proceeding Shure provides input on proposed secondary allocations that would create reserve spectrum with comparable benefits to the programs established by the EC and MIAC, and which Shure believes will help enable continued U.S. leadership in multimedia and content creation. Given that these industries are critical drivers for our own economy, and given that these industries remain heavily affected by the 700 MHz transition (*see* Section V above), the need for reserve and other supplemental spectrum remains critical.

#### **B. Foreign Regulators Relax Co-Channel Operation of Wireless Microphones with Broadcast Television in Controlled Settings**

Given the loss of 700 MHz Band “Digital Dividend” frequencies other jurisdictions have begun to review and relax limitations on wireless microphone operations co-channel with broadcast television stations. For example, effective July 14, 2014 the Australian Communications and Media Authority (“ACMA”) has permitted wireless microphones to operate co-channel with any television broadcaster in the 520-694 MHz UHF range so long as the following requisites are satisfied:

- Wireless microphone co-channel operations must be indoors.
- Maximum effective isotropic radiated power must not exceed 100 mW.

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<sup>48</sup> See Japan’s Frequency Allocation Table, Table 2 (27.5 MHz-1000MHz), Annex 6-1, available at <http://www.tele.soumu.go.jp/e/adm/freq/search/share/plan.htm>.

- Wireless microphone operations must not create interference.
- The microphone must comply with either ETSI Standard EN 301 357 or EN 300 422.<sup>49</sup>

In approving co-channel wireless microphone operations, Chris Chapman, ACMA Chairman, stated “while these changes will be useful to all wireless microphone users, large-scale production companies, in particular, will benefit from this [change] as they can continue to deliver high-quality audio experiences for theatre patrons, concert-goers and sporting buffs around the country.”<sup>50</sup>

Shure believes that the fulsome record leading the ACMA to make its decision on relaxed co-channel operations may prove informative for the Commission and Shure also provides additional recommendations on adjustments to operation in the remainder of 470-698 MHz UHF range in Section VIII below.

## **VII. WIRELESS MICROPHONE MANUFACTURERS AGGRESSIVELY PROMOTE TECHNOLOGICAL ADVANCES**

The Notice seeks to develop a fulsome record regarding “technological developments in the basic design of wireless microphones that can enable more efficient wireless microphone operations.”<sup>51</sup> The Commission emphasizes that it believes analog and digital devices may be appropriate for different applications, and seeks comment on the “range of efficiency gains that may be possible depending on whether analog or

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<sup>49</sup> See *Radiocommunications (Low Interference Potential Devices)*, Class License 2000, ACMA (rel. July 14, 2014).

<sup>50</sup> ACMA helps wireless mic users get ready for 1 January, ACMA (July 30, 2014), available at <http://www.acma.gov.au/Citizen/Consumer-info/All-about-spectrum/Wireless-microphones/acma-helps-wireless-mic-users-get-ready-for-1-january>.

<sup>51</sup> *NPRM* at ¶ 51.

digital devices, or a mix of the two, are used.”<sup>52</sup> The Commission further requests that “commenters fully address the benefits and tradeoff associated with use of analog and digital technologies”<sup>53</sup>

At the outset, Shure seeks to clarify that wireless microphones, and professional audio microphones in particular, do not serve as a transmission medium for communications. Instead, wireless microphones provide a medium for multimedia or artistic content, and are evaluated by a wholly unique set of criteria relative to a basic communications device (*e.g.*, cellular telephones or business radios). As discussed above in Section IV.A, an effective professional audio wireless microphone conveys full audio range, transmits with virtually no latency, and must provide reliability equivalent to a wired microphone, all while satisfying extreme form factor and power limitations. Wireless microphones also represent the first component in what is usually a complex chain of equipment, capturing content at its source and transmitting it to other components for dissemination or production. As a result, any issue degrading the performance of a wireless microphone (*e.g.*, undesired artifacts, latency) affects every downstream component and the ultimate quality of the production.

Given these unique performance requirements, wireless microphones require more bandwidth on a per channel basis and a more stable environment relative to a communications application intended to deliver basic voice service. Transitioning the underlying modulation scheme used by a wireless microphone from analog to digital does not change this fundamental requirement. Moreover, digital modulation has some unique

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<sup>52</sup> *NPRM* at ¶ 53.

<sup>53</sup> *NPRM* at ¶ 53.

disadvantages that acutely affect professional audio wireless microphones. For example, the processing involved in digital modulation introduces latency.

**A. Shure Has Invested Heavily and Dramatically Improved the Efficiency of Its Current Generation of Wireless Microphones**

Over the last five (5) years Shure and other wireless microphone manufacturers have achieved roughly a two-fold improvement in professional audio wireless microphone efficiency. Specifically, using current generation hardware a six (6) megahertz UHF channel can accommodate between 14-16 professional audio wireless microphone channels. Using earlier equipment, saturation of a UHF channel generally occurred with between 6-8 professional audio wireless microphones.

This improvement in efficiency has been accomplished through an intensive research and development effort, and the introduction of sharper filters and more linear amplifiers among other factors.

**B. Controlling Intermodulation Distortion Will Yield the Most Significant Future Efficiency Gains for Professional Audio Wireless Microphones**

The primary factor that limits the simultaneous operation of wireless microphones on an individual UHF or VHF channel is intermodulation distortion (“IMD”). The mechanisms that cause IMD occur in various radiofrequency components within the signal chain, and affect both analog and digital microphones.

When IMD is effectively controlled, it becomes possible to operate wireless microphones in close proximity with significantly greater density. Shure presently has a high-density wireless microphone system that enables the operation of 40+ microphones

on an individual UHF channel.<sup>54</sup> Shure achieves this level of efficiency while maintaining audio quality, but makes other sacrifices in performance. Output power for individual high-density microphones must be reduced to 1.0 milliwatt, which results in a commensurate reduction in range. Shure's current generation of high-density wireless microphones have a range of approximately 30 meters, assuming clear line-of-sight transmission without obstructions or blockage to attenuate the signal strength.

Extending the range of high-density wireless microphones will involve overcoming significant technical challenges. Circulators have been used in the past to reduce IMD interference, but they are large, expensive, and inherently narrowband, which would limit a wireless microphone's tuning range. Alternative technologies to further linearize the wireless microphone transmitter's output stage consume unacceptably high levels of power for a battery-enabled device.

### **C. General Purpose Wireless Standards Have Limited Utility for Wireless Microphone Applications**

The Notice seeks comment on the viability of wireless microphones in the 902-928 MHz, 1920-1930 MHz, 2400-2483.5 MHz, and 5 GHz bands using one or more derivatives of the 802.11, DECT or alternative voluntary standards.<sup>55</sup> Shure addresses the use of the ISM bands below in Section X.C for alternative, non-professional audio applications using Shure-proprietary transmission protocols. Given the number of compromises that are involved in the use of general purpose wireless standards (e.g.,

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<sup>54</sup> See *Shure ULX-D Digital Wireless Systems*, Shure.com, available at <http://www.shure.com/americas/products/wireless-systems/ulxd-systems#details>.

<sup>55</sup> See *NPRM* at ¶ 60.

latency, restrictive contention protocols, etc...), their utility for wireless microphones remain limited.

**D. Alternative Technological Developments May Facilitate Wireless Microphone Operations in Supplemental Bands and Merit Further Exploration**

The Notice seeks comment on how a number of specific technological developments might help accommodate wireless microphone operations in different bands over the longer term.<sup>56</sup> Shure provides the feedback on these technologies below:

- Replaceable or Modular Components: The extremely compact form factor of wireless microphones limits the utility of replaceable or modular components. Moreover, many features of wireless microphones can be controlled, and in certain circumstances upgraded, through software or firmware. The need for the modular components to be compatible with the antennas and other sub-systems of the wireless microphone also presents complications. The software and hardware components of a wireless microphone must be compatible for operation in a particular frequency band.
- Tunability of Equipment within Bands: Tunability remains a fundamental feature of all wireless microphones. Incorporating the functionality to tune wider swathes of spectrum increases component cost, and microphones that tune a broad range of frequencies are generally marketed to professional audio users. Tunability can be incorporated in future microphones, but manufacturers need to understand future changes in adjacent spectrum allocations with a high degree of certainty in order to ensure next generation equipment accommodates supplemental frequencies.
- Multi-Band Equipment: The introduction of multi-band equipment that operates across wide swathes of spectrum (and potentially different service rules) increases cost, complexity and power consumption. Antennas that support operations in all target frequencies are also a prerequisite, and must fit within the tight form factor required by wireless microphone users. Compact multi-band antennas are not as efficient as single band units.

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<sup>56</sup> See NPRM at ¶¶ 61-67.

- Database Connectivity: It will be infeasible for the installed user base of television broadcast band microphones, which cannot be retrofitted with a geolocation capability to interconnect with a geolocation database. It will be equally impractical for future devices in alternative spectrum if geolocation functionality is required, given that most wireless microphones are operated indoors. Database connectivity may offer utility if the feature enables access to alternative spectrum and geographic coordinates can be input manually akin to fixed devices under current Part 15 White Space rules.
- Electronic Keys: An electronic key may be a possible database alternative given that wireless microphones are increasingly being controlled by software programs such as Shure's *Wireless Workbench*. Such technology would likely be more appealing for higher end professional audio wireless microphones that can be equipped with a software interface.
- Other Technologies (Dynamic Power Control): Dynamic power control may be helpful in managing the overall power of multiple wireless microphones operating in a known environment. Specifically, dynamic power control may enable optimized power levels and more densely populated channels where the environment permits some microphones to transmit at lower power levels while still maintaining the requisite reliability.

## VIII. SHURE RECOMMENDATIONS FOR EXISTING BROADCAST TELEVISION BANDS

The Notice seeks comment on “opportunities for wireless microphone operations in different spectrum bands . . . in which wireless microphones currently are authorized to operate.”<sup>57</sup> Shure provides feedback on such use below.

### A. VHF/UHF Television Bands

The VHF/UHF television bands have historically served as the principal home for wireless microphones, and UHF frequencies from 470 MHz upwards have been favored by professional audio users for their propagation characteristics and quiet environment. Shure provides general feedback above in Section V on 600 MHz Band transition issues,

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<sup>57</sup> NPRM at ¶ 68.

and submits the following input on specific technical issues and related reforms that will enable the development and manufacture of more sophisticated and efficient wireless microphones in both VHF and UHF frequencies that remain available post-transition.

### **1. VHF and UHF Band Revisions**

The Notice requests comment on the “potential for expanding use of [VHF] spectrum for wireless microphone operations in the future...,” and to what extent “technical impediments” hamper use of the VHF band.<sup>58</sup> Shure supports the Commission’s effort to expand use of the VHF broadcast television bands for wireless microphone operation and believes this goal can be achieved with discrete revisions to the existing Part 74 rules.

VHF broadcast television frequencies have been less heavily utilized by wireless microphone manufacturers in part because the VHF band has more ambient noise due to inherent spurious emissions from intentional and unintentional radiators, and in part because the compact, omni-directional antennas necessitated by the form factor of most wireless microphone dramatically lose efficiency between the bottom of the UHF band at 470 MHz and the top of the VHF band at 216 MHz. The loss of antenna efficiency is compounded by the Commission’s 50 milliwatt power limitation on VHF microphones.<sup>59</sup> Shure recommends the following revisions to Part 74 to improve the viability of wireless microphones in the VHF bands, and urges the Commission to harmonize power limits throughout all UHF and VHF television broadcast frequencies regulated under Part 74.

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<sup>58</sup> *NPRM* at ¶ 77.

<sup>59</sup> See 47 C.F.R. § 74.861.

- Retain the 50 milliwatt power limit, but revise Part 74 Rules to allow output power to be measured on either a conducted or radiated (EIRP) basis.
- Apply the conducted limit to devices with detachable antennas, while the radiated limit would apply to devices with embedded or permanently affixed antennas.
- Apply this rule revision to all VHF frequencies regulated under Part 74 (54-72 MHz, 82-88 MHz and 174-216 MHz) and from 470 MHz to the upper edge of the UHF band.
- Apply this rule uniformly to licensed and unlicensed wireless microphones.

These proposed rule changes, although subtle, will help wireless microphones with small internal or external antennas overcome some of the efficiency loss that results from the longer wavelengths in VHF frequencies and harmonize operations throughout the television broadcast bands. Further, it permits equipment designers to make tradeoffs in power consumption and system performance based on customer requirements.

## **2. Enhanced Co-Channel Operations**

The NPRM proposes to “allow LPAS licensees to operate co-channel with television closer to the television station than provided by the separation distance rules, including inside the DTV contour, in locations in which the co-channel TV signal is below a specified threshold, which would indicate that the over-the-air TV signal [is] unlikely to be received or receivable.”<sup>60</sup> Shure supports a cautious expansion of wireless microphone co-channel operations with television stations. As discussed above in Section VI, other jurisdictions are exploring expanded co-channel operations as one option to supplement wireless microphone operations after the loss of 700 MHz Band

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<sup>60</sup> NPRM at ¶ 82.

frequencies. Shure proposes the following framework for co-channel television operations:

- Permit co-channel operations on a secondary, non-interference basis with the television broadcasters within the protected contour.
- Limit co-channel operations to licensed microphone users.
- Require co-channel microphone users to register their sites and frequencies to give television broadcasters full awareness of the extent of these operations, and an ability to identify co-channel users if necessary.
- Enable automated registration through an FCC portal synchronized with the White Space database administrators, or, alternatively through direct registration with the database administrators.

Shure believes that adoption of the above registration process will enable expanded co-channel operations without compromising the integrity of television broadcast signals. In the unlikely event of interference, given that wireless microphones are generally not operated in close proximity to over-the-air television receivers, such a framework would also permit expeditious resolution of an issue.

### **3. Adoption of Contemporary Spectral Masks**

The Commission explains that emission mask requirements for wireless microphones have not been updated since 1987 and seeks comment on requiring digital and analog wireless microphones to comply with ETSI standards.<sup>61</sup> Shure agrees that emission mask limits for wireless microphones can be improved and endorses the

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<sup>61</sup> See *NPRM* at ¶ 89.

adoption of the ETSI masks with certain modest adjustments. Specifically, Shure urges the Commission to:

- Adopt the analog mask provided in ETSI standard EN 300 422-1, Section 8.3.1.2.<sup>62</sup> Shure agrees that this analog mask should be applied to 200 kHz wireless microphones regardless of the operating frequency.
- Adopt the digital mask provided in ETSI standard EN 300 422-1, Section 8.3.2.2 for digital emissions below 1 GHz in the radiofrequency band.<sup>63</sup>
- For all analog microphones, and digital microphones operating below 1 GHz, Shure concurs with the FCC recommendation to apply the FCC 15.209 emission limits beyond +/- 1 MHz from the carrier or center frequency of the microphone transmission.

Shure endorses the ETSI analog mask generally and the ETSI digital mask below 1 GHz in the radiofrequency band because these masks markedly improve the efficiency of wireless microphones relative to the existing Part 74 emission limits, which can be tightened without comprising wireless microphone performance. Implementation of the ETSI masks for analog microphones and digital microphones below 1 GHz could take effect immediately. Current generation Shure microphones meet these masks.

## **B. 169-172 MHz Band**

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<sup>62</sup> See Electromagnetic compatibility and Radio Spectrum Matters; Wireless microphones in the 25 MHz to 3 GHz frequency range; Part 1: Technical characteristics and methods of measurement, ETSI EN 300 422-1 V1.3.2, Sec. 8.1.3.2, available at [http://www.etsi.org/deliver/etsi\\_en/300400\\_300499/30042201/01.03.02\\_60/en\\_30042201v010302p.pdf](http://www.etsi.org/deliver/etsi_en/300400_300499/30042201/01.03.02_60/en_30042201v010302p.pdf) (“*ETSI EN 300 422-1 V1.3.2*”).

<sup>63</sup> See *ETSI EN 300 422-1 V1.3.2*, Sec. 8.3.2.2.

The Notice seeks comment on the “potential for more expansive and intensive use” of the 169-172 MHz band.<sup>64</sup> The Notice elaborates that there are presently only eight frequencies available for wireless microphones in this band (169.445 MHz, 169.505 MHz, 170.245 MHz, 170.305 MHz, 171.045 MHz, 171.105 MHz, 171.845 MHz and 171.905 MHz), that emission bandwidth for these frequencies may not exceed 54 kHz, and that frequency stability for the microphones must limit the total emission to within + 32.5 kHz of the assigned frequency and power is limited to 50 mW.<sup>65</sup> Shure believes the 169-172 MHz Part 90 band has potential for additional utility for wireless microphones and proposes several discrete rule changes that will enable better utilization of the band for wireless microphone operations while continuing to protect incumbent federal users. Specifically, Shure proposes to:

- Retain the 50 mW power limit, but revise Part 74 Rules to allow output power to be measured on either a conducted or radiated (EIRP) basis, as discussed in Section VIII.A.1.
- Authorize 200 kHz wireless microphones for operation in the 169-172 MHz band.
- Create a raster that divides the 169-172 MHz band into 120 evenly spaced 25 kHz increments.
- Create guardbands at the top and bottom of the band that prevent the assignment of center frequencies for wireless microphones within the 100 kHz of spectrum immediately adjacent to each band edge, thus making the lowest assignable center frequency 169.100 MHz and the highest assignable center frequency 171.900 MHz.

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<sup>64</sup> *NPRM* at ¶ 128.

<sup>65</sup> *See NPRM* at ¶ 125; *see also* 47 CFR § 90.265.

- Remove the regulation of 169-172 MHz wireless microphones from Part 90. Permit operations on an unlicensed basis under Part 15, and Part 74 for service rules. Pursuant to Part 15 rules, limit operation to a non-interference, sufferance basis.

Under this new framework, the 169-172 MHz band yields additional spectrum for non-critical wireless microphone applications, while protecting higher priority federal users in the band that operate with dramatically higher power levels and spectrum density in narrow 12.5 kHz channels.

#### **IX. SHURE RECOMMENDATIONS FOR ALTERNATIVE BANDS CAPABLE OF SUPPORTING PROFESSIONAL AUDIO USE**

The Notice seeks comment on rule changes that might facilitate the operation of wireless microphone operation on bands “that may hold potential for accommodating wireless microphone uses,”<sup>66</sup> including frequencies between 150 MHz and 2 GHz in the radiofrequency band with sufficient bandwidth to propagation characteristics to support multiple professional audio wireless microphones. Shure enthusiastically supports the Commission’s effort to make this spectrum available. The expedited availability of this spectrum will ensure a smooth 600 MHz Band transition and also help preserve U.S. leadership in multimedia content production. With respect to individual bands proposed by the Commission, Shure provides the following feedback.

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<sup>66</sup> *NPRM* at ¶ 68.

**A. 941-944 MHz, 944-952 MHz and 952-960 MHz Bands**

The Commission seeks comment on adopting the ETSI analog and digital masks for the 941-944 MHz, 944-952 MHz and 952-960 MHz bands (“941-960 MHz Band”) and permitting wireless microphone licensees to have access to this spectrum on a secondary basis.<sup>67</sup> Shure currently manufactures wireless microphones for the 944-952 MHz sub-segment of the proposed 941-960 MHz Band. This band exhibits propagation characteristics comparable to the principal 470-698 MHz UHF broadcast television band, and Shure can develop and manufacture microphones for this expanded frequency range on an expedited basis. Shure proposes the following framework for the 941-960 MHz Band. Specifically, Shure recommends that the Commission:

- Adopt the spectrally efficient 200 kHz analog and digital masks provided in ETSI standard EN 300 422-1, Sections 8.3.1.2 and 8.3.2.2<sup>68</sup> and implement a 25 kHz channel raster.
- Retain a licensing requirement for operations in the 941-960 MHz band, but expand eligibility to align with current Part 74 Rules.
- Implement a power limit of 250 mW consistent with wireless microphone rules in the broader UHF broadcast television band.
- Require licensees to reduce co-channel power to 50 mW or notch out/block the relevant frequencies in markets where public safety users occupy portions of the 941-944 MHz and/or 952-960 MHz bands.
- Require licensees to coordinate operations through the use of online databases to ensure interference protection for other LPAS incumbents in the band.

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<sup>67</sup> See *NPRM* at ¶ 134.

<sup>68</sup> See *ETSI EN 300 422-1 V1.3.2*, Sec. 8.3.1.2, 8.3.2.2.

Wireless microphone operations in the 941-960 MHz band can be accomplished while fully protecting incumbent spectrum users. As the Commission notes, the vast majority of licenses issued in the 941.5-944 MHz sub-band are for Fixed Point-to-Point Microwave services, used for “long distance, low data-rate links between locations that have line of sight capability” and which “employ directional antennas and operate with fairly high effective isotropic radiated power.”<sup>69</sup>

The 941.0-941.5 MHz sub-band is authorized for Multiple Address Service (“MAS”) operations, including public safety services.<sup>70</sup> Most of the 952-960 MHz band is licensed for Part 101 Fixed Microwave Service operations, with 1.2 total MHz designated for MAS operations (952-952.85 MHz; 956.25-956.45 MHz; and 959.85-960 MHz).<sup>71</sup> Shure has evaluated public safety frequency use near major wireless microphone venues in Los Angeles, Washington, D.C. and New York and determined that critical microwave public safety pool users are primarily isolated in the discrete 941.0-941.5 MHz and 952.0-952.85 MHz sub-segments of this band and thus easily avoided by wireless microphone users if necessary.<sup>72</sup>

Shure agrees with the Commission’s assertion that “[g]iven that wireless microphones operate at low power over short distances . . . they are not likely to cause interference to the types of fixed or mobile operations that operate at higher power in these bands” and that “wireless microphones should be able to co-exist and share access

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<sup>69</sup> *NPRM* at ¶ 143.

<sup>70</sup> *NPRM* at ¶ 144.

<sup>71</sup> *NPRM* at ¶¶ 146, 147.

<sup>72</sup> Geographic searches were conducted using the Commission’s Universal Licensing System on February 3, 2015 to evaluate public safety licenses in the 941-944 MHz and 952-960 MHz bands within a two kilometer radius of the Gershwin Theater (New York, NY), the Kennedy Center (Washington, D.C.) and the Staples Center (Los Angeles, CA).

to the spectrum in these bands . . . on a secondary basis without causing harmful interference.”<sup>73</sup> If necessary, wireless microphones could operate at a reduced power level of 50 mW on these frequencies to avoid interference, or avoid co-channel operations on impacted frequencies altogether. Shure notes that wireless microphones have operated successfully in the 944-952 MHz sub-segment of the proposed band.<sup>74</sup> Reference to online frequency databases will ensure that studio links are not affected by expanded, licensed wireless microphone operations.

#### **B. 1435-1525 MHz Band**

The Notice proposes to make “1.4 GHz Band (1435-1525 MHz) spectrum available for use by wireless microphones on a secondary licensed basis.”<sup>75</sup> The Commission explains that subsequent to the 600 MHz Band transition “there is no assurance that sufficient spectrum will remain to accommodate” large scale events.<sup>76</sup> The Commission seeks comment on licensed use of the 1.4 GHz Band as well as options for ensuring interference protection for the primary user of the spectrum, aeronautical mobile telemetry (“AMT”) operations.<sup>77</sup> Given that wireless microphones have been operating pursuant to special temporary authority in the 1.4 GHz Band for several years at diverse venues throughout the country, Shure expects the successful introduction of microphones on a more routine secondary use basis while providing AMT operations

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<sup>73</sup> *NPRM* at ¶ 151.

<sup>74</sup> *See NPRM* at ¶ 134.

<sup>75</sup> *NPRM* at ¶ 177.

<sup>76</sup> *NPRM* at ¶ 178.

<sup>77</sup> *NPRM* at ¶¶ 177-179.

with full and comprehensive interference protection. Shure offers the following recommendations for wireless microphone operations in the 1.4 GHz Band:

- Permit 200 kHz analog and digital emission masks for the band and implement a 25 kHz channel raster across the band.
- Adopt the ETSI standard EN 300 422-1, Section 8.3.1.2.
- Require licensing for operations in the 1.4 GHz band, carrying forward the current eligibility requirements for a Part 74 wireless microphone license.
- Implement a power limit of 250 mW consistent with wireless microphone rules in the broader UHF broadcast television band.
- Require licensees to coordinate operations through the FCC with the Aerospace and Flight Test Radio Coordinating Council (“AFTRCC”), which already serves as the coordinating body for the existing primary users in the 1.4 GHz Band.

For large-scale events that require an ever increasing number of wireless audio channels, Shure believes the 1.4 GHz Band has potential to provide a meaningful amount of spectrum capable of offsetting the already repurposed 700 MHz Band and pending repurpose of the 600 MHz Band. The characteristics of AMT operations and wireless microphones also make the two services inherently compatible and capable of sharing spectrum. AMT operations are generally conducted during the day, over unpopulated areas in relatively discrete locations. With certain exceptions, wireless microphone operations generally occur in and around populated areas, at low power levels. The large-scale events that urgently require spectrum to offset the loss of the 600 MHz Band and 700 MHz Band also in many instances occur at night to maximize attendance or

viewership.<sup>78</sup> Given these inherent compatibilities, shared use of the band, with wireless microphones operating on a secondary and non-interfering basis, enables more efficient use of spectrum that is at present underutilized, while ensuring the band retains its utility for the incumbent user. Such an arrangement also promotes the President’s long-term goal of increasing shared use of federal spectrum with commercial entities.<sup>79</sup>

## **X. SHURE RECOMMENDATIONS FOR ADDITIONAL BANDS FOR ALTERNATIVE WIRELESS MICROPHONE USE**

The Notice seeks comment on several radiofrequency bands that may have utility for corporate or consumer-grade wireless microphone applications, or other alternative wireless microphone uses that can accommodate a relaxation in one or more of the performance characteristics that professional audio wireless microphone users could not tolerate.<sup>80</sup> To the extent these frequencies have not already been addressed above with Shure’s discussion on technological advances, feedback on these bands follows below.

### **A. 26.100-26.480 MHz 161.625-161.775 MHz, 450-451 MHz and 455-456 MHz Bands<sup>81</sup>**

Shure would not discourage the Commission from relaxing eligibility requirements for wireless microphone licensees in the 26.100-26.480 MHz, 161.625-161.775 MHz, 450-451 MHz and 455-456 MHz Bands (“Mixed Broadcast Bands”), but notes that these bands have limited utility and Commission resources are better served exploring opportunities in other bands. To the extent available, the Mixed Broadcast

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<sup>78</sup> For example, most major sporting and theatrical events occur after business hours.

<sup>79</sup> See *Expanding America’s Leadership in Wireless Innovation*, Presidential Memorandum (June 14, 2013), available at <http://www.whitehouse.gov/the-press-office/2013/06/14/presidential-memorandum-expanding-americas-leadership-wireless-innovatio>.

<sup>80</sup> See *NPRM* at ¶ 68, et seq.

<sup>81</sup> See *NPRM* at ¶ 121.

Bands offer only enough spectrum to accommodate a handful of wireless microphones. The long wavelengths at 26.100-26.480 MHz and 161.625-161.775 MHz also make the use of compact, omni-directional antennas problematic if not infeasible. Given these limitations, investment in these bands is unlikely.

**B. 88-108 MHz FM Band<sup>82</sup>**

To the extent that wireless microphone operations were permitted in the 88-108 MHz band, Shure does not believe this band would have meaningful utility. The wavelengths in this low frequency band are too long to effectively work with a form factor limited device with small antennas. Shure understands that wireless microphones employed in this band in the 1960s and/or 1970s had a form factor that facilitated a large antenna that would be unacceptable for most contemporary wireless microphone applications.

**C. Unlicensed Operations in the 902-928 MHz, 2.4 GHz and 5 GHz Bands<sup>83</sup>**

The 902-928 MHz, 2.4 GHz (2400-2483.5 MHz), and 5 GHz (5725-5850 MHz) bands have utility for wireless microphone applications where relaxation of one or more of the performance characteristics of a professional audio wireless microphone can be accommodated. Specifically, given that these bands are shared by many different end users for a variety of applications on a sufferance basis, the ambient levels of energy in these bands can change dramatically without warning. Because of this instability, these

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<sup>82</sup> See *NPRM* at ¶ 123.

<sup>83</sup> See *NPRM* at ¶ 157.

bands do not fully satisfy the needs of professional-audio microphones that require clean spectrum.

Although not appropriate for many professional audio microphone applications, Shure has developed products in the 902-928 MHz and 2400-2483.5 MHz bands for less demanding applications and further believes these bands have utility for other wireless microphone applications, particularly if subtle adjustments can be made to the Part 15 rules that regulate them. Specifically, the present requirement for digital devices to have a minimum bandwidth of at least 500 kHz does not promote spectral efficiency and in some instances may limit the availability of the band.<sup>84</sup> Reducing the minimum bandwidth limit to 200 kHz would facilitate the development and manufacture of additional wireless microphone devices in these frequencies.

**D. 1920-1930 MHz Unlicensed PCS Band<sup>85</sup>**

The 1920-1930 MHz Unlicensed PCS Band (“UPCS Band”) has potential for expanded use for Digital Enhanced Cordless Telecommunications (“DECT”) wireless microphones increasingly used in corporate environments. As a means of extracting more utility from the UPCS Band Shure proposes pairing the band with the currently fallow 2020-2025 MHz Band. Such a pairing would enable additional microphone channels for DECT systems that are currently spectrum constrained and bring the U.S. more in line with other jurisdictions that have made additional spectrum available for DECT applications.

Shure proposes a secondary rulemaking to further explore this proposal.

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<sup>84</sup> See 47 CFR § 15.247(a)(2).

<sup>85</sup> See *NPRM* at ¶ 170.

### **E. 3.5 GHz Band<sup>86</sup>**

Shure filed comments in support of making the 3.5 GHz Band (3550-3650 MHz) available for wireless microphone applications, and continues to monitor the proceeding.<sup>87</sup> If appropriate service rules are adopted, Shure anticipates the development and manufacture of wireless microphones for the 3.5 GHz Band. Such rules would need to ensure the following:

- Low-power wireless microphones must have the ability to operate within coastal exclusion zones that encompassed major metropolitan areas in the original notice. The 3.5 GHz Band has limited utility for any new microphone use if operations in New York, Boston, Los Angeles, San Francisco, etc... are prohibited.
- Wireless microphones must enjoy access to clean, stable spectrum. The Commission can accommodate such access by creating the proposed Contained Access Users (“CAU”) class of devices that would be entitled to interference protection within the confines of a facility.
- 200 kHz bandwidth emissions with reasonable power levels (not to exceed 250 mW) must be permitted.
- Requirements to communicate with the Spectrum Access Service (“SAS”) for frequency assignments must take into consideration that most wireless microphones are operated indoors and may have difficulty implementing a geolocation feature. For such microphones, qualified end users should be able to enter geographic coordinates manually or through an alternative interface with the SAS.

Given the dynamic environment presently envisioned by the Commission for the 3.5 GHz Band, with many different devices and applications operating concurrently, Shure expects the band is more likely to serve as a home for alternative wireless microphone uses with one or more of the performance parameters required by a professional audio wireless microphone relaxed.

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<sup>86</sup> See *NPRM* at ¶ 191.

<sup>87</sup> See Comments of Shure Incorporated, GN Docket No. 12-354, filed July 14, 2014.

## **F. 6875-7125 MHz Band<sup>88</sup>**

Shure supports the further exploration of two (2) assigned blocks of frequency within the 6875-7125 MHz band (“7 GHz Band”) for dedicated wireless microphone use and proposes two 13 MHz wireless microphone bands at the top and bottom edges of the band. Although the 7 GHz Band involves higher frequencies with shorter wavelengths that may present challenges for form-factor and power-limited wireless microphones, there may be applications where this band proves valuable as a replacement for UHF broadcast spectrum. For example, such applications might include microphones and complementary auxiliary equipment used for short-range Electronic News Gathering (ENG) applications and at certain high-profile sporting events (*e.g.*, race car or race track mounted microphones intended to capture the sound of the cars, or microphones used at professional golf tournaments).

Shure proposes a secondary rulemaking to further explore this proposal.

## **XI. CONCLUSION**

Shure enthusiastically supports the Commission’s efforts in this proceeding, and looks forward to contributing further input on the various technical and regulatory issues that must be addressed to develop a comprehensive record and identify future supplemental spectrum for wireless microphone use.

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<sup>88</sup> See *NPRM* at ¶ 194.

Respectfully submitted,

/s/\_\_\_\_\_

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