

Before the
Federal Communications Commission
Washington DC 20554

In the Matter of)	
)	
Sennheiser Electronic Corporation, Request for)	RM-11821
Amendment of Part 74 of the Commission's Rules)	
to Allow the Use of Spectrum Efficient Wireless)	
Microphone Equipment)	

**REPLY COMMENTS OF
SENNHEISER ELECTRONIC CORPORATION**

Sennheiser Electronic Corporation respectfully submits these reply comments pursuant to Section 1.405(b) of the Commission's rules.¹

Sennheiser's petition seeks a rule change that would allow the use of a Wireless Multi-Channel Audio System (WMAS) technology that combines twelve or more wireless microphone devices onto a single 6 MHz channel. This will yield much better spectrum efficiency than the same number of microphones operating on separate 200 kHz channels, as is presently required.

I. SUMMARY

A. MICROPHONE DENSITY

Sennheiser proposed a minimum of twelve wireless microphone devices per 6 MHz WMAS channel. Shure suggests the minimum should be three audio channels per MHz,

¹ This filing was originally due on January 14, 2019. That date fell during the Commission's closure due to a lapse in funding. The submittal today complies with the Commission's guidance on the timing of filings that came due during the closure. See *Revisions to Filing and Other Deadlines Following Resumption of Normal Commission Operations*, Public Notice, DA 19-26 (released Jan. 29, 2019).

equivalent to 18 microphones per 6 MHz channel.² Alteros thinks the number should be 24.³ Microsoft says 15 or 24.⁴

For comparison, the Commission required a minimum of 6-8 microphones in non-TVWS channels before unlicensed users could register for protection in the TVWS database.⁵ Sennheiser's proposal almost doubles that number. Requirements for still higher numbers would have the perverse effect of barring WMAS in cases where a user needs 13-17 or 13-23 microphones, even though WMAS in those situations would greatly improve spectrum efficiency.

B. POWER AND POWER SPECTRAL DENSITY

Microsoft fears that retaining the current power spectral density (PSD) limits, but allowing wider transmission bandwidths, would permit excessive total power levels.⁶

Sennheiser proposes a maximum transmit power limit for WMAS equal to that for a 200 kHz conventional wireless microphone. This yields a much lower PSD due to the transmit power being distributed over a much larger (6 MHz) bandwidth. WMAS is far less of an interference threat than the twelve or more individual microphones it will replace.

C. COMPATIBILITY AND EMISSIONS MASK

Compatibility of WMAS to services in adjacent bands, relative to conventional wireless microphones, follows from the reduced PSD and the transmitter emission mask requirements.

² Shure at 4-5.

³ Alteros at 3, 5.

⁴ Microsoft at 7, 9.

⁵ *Unlicensed Operation in the TV Broadcast Bands*, Second Memorandum Opinion and Order, 25 FCC Rcd 18661 at ¶ 33 (2010).

⁶ Microsoft at 5.

Current 200 kHz wireless and other wideband transmissions (*i.e.* TV signals) routinely operate on nearby frequencies without interference to either.

Section 74.861(e)(7) presently specifies separate ETSI masks for analog and digital wireless microphones. The ETSI standard references in that rule, EN 300 422, also includes an emission mask for WMAS devices.⁷ We urge the Commission to specify that mask in its rules. The ETSI specifications require WMAS out-of-band and spurious emissions to be the same as or better than narrowband systems.⁸

Alteros asks, in effect, that multiple manufacturers' devices be able to share a WMAS unit.⁹ We oppose such a requirement. Achieving compatibility would entail an industry-wide standard-setting process to develop the necessary connections and protocols; and the need to accommodate many types of equipment is likely to reduce efficiency overall. The Sennheiser petition noted that other manufacturers are developing similar systems. We expect to see vigorous competition in this market, as there is for wireless microphones generally.

D. PATENT ISSUES

Alteros notes that Sennheiser has filed a patent application (Publication # US 2018/0302702) that describes how to execute diversity processing signals of antenna modules.¹⁰

⁷ For the WMAS mask, *see* ETSI TR 103 450, *System Reference document (SRdoc); Technical characteristics and parameters for Wireless Multichannel Audio Systems (WMAS)* at § 7.2.2.2 (version 2017-07), available at: https://www.etsi.org/deliver/etsi_tr/103400_103499/103450/01.01.01_60/tr_103450v010101p.pdf

For more general ETSI wireless microphone specifications, *see* EN 300 422, *Wireless Microphones; Audio PMSE up to 3 GHz*, published in three parts, available at: https://www.etsi.org/deliver/etsi_en/300400_300499/30042201/02.01.02_60/en_30042201v020102p.pdf https://www.etsi.org/deliver/etsi_en/300400_300499/30042202/02.01.01_60/en_30042202v020101p.pdf https://www.etsi.org/deliver/etsi_en/300400_300499/30042203/02.01.01_60/en_30042203v020101p.pdf

⁸ ETSI TR 103 450, above, at § 7.2.1.3.

⁹ Alteros at 5.

¹⁰ Alteros at 4-5.

This technique is not specific to WMAS and can be applied to all wireless microphone systems, regardless of bandwidth. Nor is WMAS dependent on the patent subject matter, Alteros's concern that the requested rule change would only benefit a single company has no basis.

E. NOTICE OF PROPOSED RULEMAKING

We agree with Shure that an NPRM should fully address the issues Shure mentions: frequency bands, power, channel bandwidth, out-of-band emissions, and certification testing.¹¹

F. 1435-1525 MHz BAND

Shure suggests that WMAS be precluded from the 1435-1525 MHz band as an initial matter, on the ground that coordination software for the band is still under development.¹² The coordination requirements are separate and distinct from the issues here. WMAS will have to comply with all such requirements, so there is no reason to exclude it from the band. WMAS is targeted at professionals staging major events that require a large number of microphone channels—the same users who will have access to 1435-1525 MHz.

G. LICENSED VS. UNLICENSED

Microsoft raises questions about unlicensed WMAS operation on TV White Space (TVWS) frequencies, particularly in the 6 MHz channel in the 600 MHz duplex gap.¹³

Sennheiser clarifies its request in response to Microsoft's concerns. Sennheiser seeks to use WMAS for microphones licensed under Part 74. We do not request any change in the rules applicable to unlicensed microphones. If future applications offer benefits for operation of WMAS in unlicensed TV White Space spectrum, WMAS would have to comply with the Part 15 white space device rules.

¹¹ Shure at 5-6.

¹² Shure at 5.

¹³ Microsoft at 1, 3-5.

II. DISCUSSION

A. ETSI PRECEDENTS

WMAS offers improved spectral efficiency and operational flexibility while maintaining or improving interference protection to other services in the same bands. Technical characteristics and parameters for WMAS appear in the System Reference Document ETSI TR 103 450, developed and published by European Technical Standards Institute (ETSI).¹⁴ This family of documents informs the European Conference of Postal and Telecommunications Administrations (CEPT) and European National Regulatory Authorities on new wireless technologies for the purpose of studies and to request changes in current European frequency regulations. These same resources may also be helpful to the Commission.

In response to ETSI TR 103 450, CEPT updated its relevant recommendation ERC Rec 70-03, changing the “maximum occupied bandwidth” in the relevant frequency ranges from “200 kHz” to “not specified.”¹⁵ The maximum transmit power of equipment is left unchanged, with the result that transmitted PSD is reduced at higher occupied bandwidths. The process to establish this change in the national regulations of all CEPT countries is ongoing.

WMAS is defined and included in the current published versions of EN 300 422 – Part 1/2/3,¹⁶ which have been listed in the Official Journal of the European Union. As with all Audio PMSE equipment,¹⁷ EN 300 422 defines only the essential technical characteristics, requirements, and the corresponding test methods for Audio PMSE transmitters and receivers.

¹⁴ See link in note 7 above.

¹⁵ ERC Recommendation 70-03, *Relating to the use of Short Range Devices (SRD)* at Annex 10 (5 October 2018), available at https://www.efis.dk/adhoc_grabber.jsp?annex=13

¹⁶ See links in note 7 above.

¹⁷ PMSE stands for Programme-Making and Special Events; Audio PMSE equipment is another term for wireless microphone equipment.

For the sake of technology neutrality, EN 300 422 does not define or require specific implementations, allowing those to vary among manufacturers, applications, and frequency ranges.

B. SPECTRAL EFFICIENCY BENCHMARKS

Audio engineers have a toolbox of modulation and coding techniques to best use a wireless channel for specific applications, enabling trade-offs among data rate, bandwidth, latency, reliability, range, and (for battery-driven devices) power consumption.

Spectrum efficiency depends on a wireless technology fulfilling the application requirements in the field, often in crowded spectrum, not just on paper. A technology that claims to be spectrum efficient on the basis of peak values of bit/s/Hz may still, in practice, result in an inefficient, or even useless, implementation.

The Audio PMSE industry, including Sennheiser, currently uses analog and digital technologies that employ narrowband modulation, typically in 200 kHz channels. WMAS will target multi-channel audio applications in major productions. WMAS will not replace all narrowband equipment, as that would be inefficient for applications requiring just a few audio channels.

Analog modulation (typically frequency modulation) offers close to 0 ms latency, while state of the art digital narrowband systems deliver latencies of 2-3 ms. WMAS will offer new flexibility for trade-offs. Appropriately configured WMAS can offer very low latency, or can trade off higher latency for improved performance in other respects on the same channel, or on other channels within the same WMAS spectrum.

As noted above, a 2010 Commission order suggested a benchmark of six to eight wireless microphones per 6 MHz TV channel. Sennheiser's petition sets a higher minimum of twelve

microphones per TV channel for high-end systems that stage sophisticated events: Broadway type theater productions, arena sized live events, major sports productions, political events, etc. Applications with less demanding needs for audio quality, range, latency, transmission robustness, etc. can pack far more microphones into a 6 MHz channel. To accommodate the more critical applications, we think twelve is the right minimum.

ETSI EN 300 422 defines spectral efficiency as the number of audio channels or links transmitted per MHz.¹⁸ The standard imposes no dependency on bits/Hz or audio quality, since wireless multi-channel audio systems can have various combinations of transmission parameters to meet particular goals for audio quality, working range, etc. WMAS is required to have at least one mode, which ETSI calls Standard Mode, that supports a minimum of three audio channels/links per MHz. We agree with Shure that WMAS should include this mode.¹⁹ ETSI does not define this as a minimum requirement, but merely specifies the ability to handle at least three audio channels per MHz. It avoids mandating any minimum number, providing flexibility for a variety of embodiments. We expect WMAS to accommodate more than twelve channels in most applications. A higher requirement would reduce the flexibility of the system, could preclude future high-resolution audio formats, and will certainly force the use of current, less efficient technology in the frequent cases that require only a few microphones in excess of twelve.

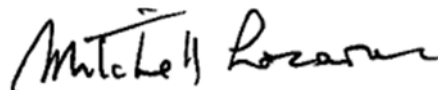
¹⁸ ETSI EN 300 422, note 7 above, Part 1, § 4.4.

¹⁹ Shure at 4.

III. CONCLUSION

No party opposes Sennheiser's proposal, as clarified here. We ask the Commission to proceed expeditiously to a Notice of Proposed Rulemaking.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "Mitchell Lazarus". The signature is written in a cursive, flowing style.

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February 8, 2019

CERTIFICATE OF SERVICE

I, Mitchell Lazarus, an attorney with the law firm of Fletcher, Heald & Hildreth, PLC, hereby state that I have caused true copies of the foregoing REPLY COMMENTS to be sent by first class mail, postage prepaid, on February 8, 2018, to the following:

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