December 9, 2014

Via Electronic Filing

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, SW
Washington, D.C. 20554

Re: GN Docket Nos. 12-268 and 14-165 and ET Docket No. 166
Ex Parte Filing of Sennheiser Electronic Corporation

Dear Ms. Dortch:


Introduction

Sennheiser agrees with most of MSS’s technical statements. Some of those, however, are only valid under theoretical assumptions that do not always hold up in the real world. This proceeding is not writing on a clean slate. Like other communications industries that predate the digital age, wireless microphone manufacturers have been changing over to new technological platforms, while at the same time delivering products that work flawlessly not only when first

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powered up, but for a decade or more afterward, notwithstanding the ongoing evolution of the radio-frequency and regulatory environments in which they must function.

*Sennheiser’s Request for a Reserve Block of Spectrum is Reasonable.*

MSS asserts that providing UHF for spectrum wireless microphone use will create forever a disincentive for manufacturers to engineer more efficient microphones.\(^2\) To the contrary, Sennheiser has always innovated in microphone design and will continue doing so, maintaining successful performance as available bandwidth shrinks. The Digital 9000 system, the SK 5212-II, and SKM 5200-II are examples of equipment introduced within the past five years that allow denser packing of microphones in an available channel, without compromise to audio quality and RF transmission reliability. Increasing demands for wireless microphones in the years to come, coupled with reduced available spectrum due to further channel repacking, will apply competitive pressure that ensures innovation will continue. Regulatory mandates will only hinder the process over the long run.

MSS asserts that low spectrum utilization will occur on UHF frequencies because wireless microphones will not be in use on this spectrum all of the time.\(^3\) Today, microphone operators routinely use many units spread over multiple UHF channels. Many of those channels will become unavailable in the future, requiring greater concentration of critical links within the remaining UHF channels. Sennheiser has acknowledged the need to move non-critical links to spectrum outside UHF over time, a step the industry is taking currently. Wireless microphones, however, are hardly unique in using spectrum non-uniformly. Most FCC-regulated services vary their loads according to place and time of day. Public safety frequencies carry more traffic in New York City than in small-town Madrid, New Mexico, and consumer wireless bands that are congested during the day fall largely idle at night.

MSS additionally claims that “virtually … no other commercial nonsafety spectrum user” has free spectrum.\(^4\) This is incorrect. The Commission has allocated site-licensed (“free”) spectrum.

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\(^2\) Marcus Ex Parte at 7.

\(^3\) Marcus Ex Parte at 5.

\(^4\) Marcus Ex Parte at 4.
spectrum for private land mobile radio, point-to-point fixed microwave, satellite services, and broadcast auxiliary services, among others. MSS cites Broadway ticket prices as evidence that wireless microphone users can afford to pay for spectrum. But Broadway is the exception, not the rule. The large majority of wireless microphone users derive little or no revenue from their microphone-supported activities.

MSS then concludes that “free” spectrum invariably attracts inefficient use – citing as sole authority his own lecture slides. Again, MSS is just wrong. Instances of efficiently used free spectrum include fixed point-to-point microwave, which carries heavy traffic within and between population centers, satellite operations, and wireless microphones themselves, densely deployed where demand is high, such as Broadway, the Las Vegas Strip, theme parks and any major TV studio. Unlicensed operation is both free and heavily used (although to date not so for white space devices). As well, FCC has pursued a policy in recent years of opening more spectrum for “free” unlicensed use, including Wi-Fi and additional white space device spectrum in UHF, which clearly indicates that the Commission sees a benefit in doing so. Conversely, and contrary to MSS’s reasoning, some auctioned and paid-for spectrum bands are models of inefficient use. These include the auctioned fixed spectrum at 24, 28, 31, and 39 GHz, which has attracted so little activity, in many locations, that the Commission has taken back hundreds of licenses for failure to construct facilities.

Sennheiser Stands by its Technical Information.

MSS condemns FM technology largely on the basis of its being old, implying that wireless microphones have been slow to innovate. The longevity of an otherwise effective

5 Marcus Ex Parte at 6.

6 Marcus Ex Parte at 12.

7 See In the Matter of Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, Report and Order, 29 FCC Rcd 6567, 662 (2014) (noting that the Commission was “taking a number of actions to make available a significant amount of spectrum for unlicensed [white space device] use in the post-auction television bands”).

8 Marcus Ex Parte at 9.
technology is not, by itself, any reason to abandon it; and in fact digital microphones using advanced modulation techniques have been available for years. Sennheiser introduced its first digital microphone system in 2001. The adoption of any new technology makes sense only when doing so provides overall advantages in a balance of performance, price, and spectrum efficiency. Many parameters of wireless microphone operation are beyond the manufacturer’s control. Transmitter power is limited by battery life (and the Commission’s rules). Needed range is set by the layout of the performance venue. Needed noise tolerance depends on the local radio-frequency environment. Data rate depends mathematically on the audio quality required and the tolerable latency. The acceptable error rate likewise depends on quality requirements. And radio bandwidth depends on all the others. For these reasons, in some venues, under some conditions and price constraints, advanced FM microphones still provide the best comprehensive solution.

MSS devotes a long discussion to intermodulation issues. The off-hand suggestion that wireless microphones implement automatic power control and time-division multiplex or OFDMA/LTE merely shows MSS has not taken into account real-world problems and constraints. Sennheiser has explained the steps it is taking to successfully address intermodulation throughout the signal chain, and hence to pack more microphones into each UHF channel. Sennheiser systems were renowned for their intermodulation suppression as far back as 1987, and have improved enormously since then. Evidence of this success shows up in TV and stage productions that require many microphones in close proximity.

As Sennheiser noted previously, the absence of competitively-priced units from the market is one indication of the engineering barriers to making devices that combine the highest

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9 Marcus Ex Parte at 7-10.

10 Automatic power control, for example, requires additional channel capacity and hence reduces spectrum efficiency, other things being equal. Similarly, MSS’s comparisons to Wi-Fi and MIMO, Marcus Ex Parte at 13, overlook the differences in behavior of narrow and wide band transmission systems in terms of propagation as well as acceptable latency and audio quality requirements. The techniques that make a 25 MHz Wi-Fi channel robust at 2.4 GHz will not work for a 200 kHz channel in UHF (or higher) frequencies.

audio quality with the theoretically densest possible spectrum packing – a combination of properties that Sennheiser’s customers would welcome, were it technically feasible.

MSS appears to concede that major gains in spectrum efficiency require compression, which in turn adds to latency.\textsuperscript{12} While the DPCM/ADCPM techniques that MSS mentions do not themselves add latency,\textsuperscript{13} they can require additional steps to maintain audio quality and robustness that do add latency, and in any event provide only limited gains in spectrum efficiency. More significant bandwidth reduction always introduces latency.

We have explained elsewhere in this docket that the practical upper limit on latency is less than ten thousandths of a second through the entire system, from the microphone transducer back to the ear monitor.\textsuperscript{14} MSS cites multiple analog/digital and digital/analog conversions as a source of latency,\textsuperscript{15} but a properly designed system does only one of each such conversion, both easily tolerated within the 10 millisecond limit. In contrast, the levels of compression needed to provide significant gains in spectrum efficiency entail far greater latencies. In fact, MSS does concede, for example, that telephone and cell systems gain spectrum efficiency by accepting latencies of up to 100 milliseconds\textsuperscript{16} – levels of delay that would not only throw any performer into confusion, it would also cause an intolerably unpleasant audience viewing experience.\textsuperscript{17}

Finally, Sennheiser’s petition included a brief discussion of information theory to make one point: digital modulation with uncompressed audio is not significantly more spectrum-efficient than analog modulation. MSS questions our use of audio CDs as a basis for the calculation.\textsuperscript{18} We choose CDs for the sake of simplicity and familiarity. Other technologies will

\textsuperscript{12} Marcus Ex Parte at 11.

\textsuperscript{13} Marcus Ex Parte at 12.

\textsuperscript{14} Comment of Sennheiser Electronic Corporation, Docket No. 12-268, at 6 (filed Jan. 25, 2013).

\textsuperscript{15} Marcus Ex Parte at 11.

\textsuperscript{16} Marcus Ex Parte at 11.

\textsuperscript{17} Some performers object to latency even considerably lower than 10 milliseconds. We understand that Taylor Swift, whom MSS cites on a point of economics, Marcus Ex Parte at 4, is particularly sensitive to latency in her live performances.

\textsuperscript{18} Marcus Ex Parte at 11-13.
give somewhat different results. It remains true, however, that digitization by itself does not
greatly improve spectrum efficiency.

Conclusion

Nothing in the Marcus Ex Parte submission validly counters Sennheiser’s Petition for
Reconsideration. The Commission should grant the petition without delay.

Respectfully submitted,

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