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Shure's Comments to

Five-year spectrum outlook 2022–27 and 2022–23 work program Draft for consultation of ACMA

Shure Incorporated welcomes the opportunity to comment on ACMA's Five-Year Spectrum Outlook (FYSO).

For 97 years, Shure has been a leading manufacturer of high-quality, innovative audio products based in the United States. Shure products (www.shure.com) are utilized worldwide in applications known as audio Programme Making & Special Events (PMSE[1] also known as SAB/SAP[2]), which includes deployments in industries such as broadcast and film production and other professional indoor and outdoor media content creation, in addition to a variety of other civic, business, and special event contexts. These applications continue to grow annually in scale and density to meet the needs of broadcast (incl. streaming) and event producers engaged in increasingly complex productions to meet audience expectations.

Before we provide more details on the different frequency bands, we would like to share some general comments.

1. Importance of audio PMSE to content creation

PMSE can be considered the "pen and pencil" of the content production industry which includes web, theatre, adverts, films, sports, concerts and cultural events as emphasized in this video. This is particularly relevant for Australia which has a flourishing media industry, which includes the cinema and film industry.[3]

[1] PMSE is the ITU's inclusive term consisting of radio microphones, in-ear monitors, wireless cameras, talkback systems, etc
[2] Services Ancillary to Broadcasting (SAB)/Services Ancillary to Programme making (SAP)
[3] https://www.statista.com/topics/6499/cinema-in-australia/#topicHeader__wrapper

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Today, it is virtually impossible to produce creative content without PMSE. Audio is of prime importance in the world of PMSE. Without the "audio" part of an event, CEOs, politicians, and entertainers cannot communicate with impact to their audience. Ultra-High Definition (UHD) video would be of little interest without high quality sound to accompany it.

Wireless microphones are ubiquitous to public life. They are widely used and relied upon in schools, houses of worship, government buildings, museums, and many other public places. The lives of most citizens are touched and enhanced by wireless microphones every day, whether in one of these places or by enjoying programs that were produced using wireless microphones. In all of these applications, wireless microphones must operate flawlessly. Interruptions, interference, and noise are not tolerated. This highlights the need for adequate amount of appropriate, clean spectrum.

During the Covid pandemic we have seen a transition driven by the resilience of the sector and the power of the human spirit that have found new ways of reaching not only that same audience as before but a more diverse, wider global audience as well. The demands for high-quality online content and meetings have dramatically increased worldwide.

- Facebook and Instagram report that 800 million people per day are watching live streams. The trend is projected to continue with 74% of live stream viewers saying they would continue to watch live streams even after concerts returned, and 70% would be willing to pay for live stream.
- In addition to the traditional live audiences, both recorded & live streams to cinemas globally opened a whole new audience. In the face of a pandemic, this has grown to include the online, on demand, live-streaming platforms – a new engagement that is here to stay. To tackle this growing demand globally, there is mention of Netflix spending $17 billion on content creation in 2020, rising to $26bn in 2026. In 2022, Disney is making a $33 billion investment in content creation, $8 billion more than for 2021.

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2. Continued access to 470-698 MHz for audio PMSE is critical for its future

The continued availability of sufficient, interference-free spectrum is key to meet growing demand for wireless PMSE technologies (e.g., wireless microphones, In-Ear-Monitor Systems). With this in mind, Shure has actively participated in various spectrum proceedings around the world related to PMSE and is also actively involved in ITU-R on PMSE related matters such as the Agenda Item 1.5 for WRC-23 regarding possible regulatory actions in the frequency band 470-694 MHz.

A typical event production today needs 40 – 80 wireless microphones and in-ear monitoring systems with high quality of service, which requires more than 60 MHz of clean spectrum in the TV-UHF band below 1 GHz. Studies in Europe concluded that approximately 96 MHz are sufficient for the daily use of audio PMSE in the UHF band below 1 GHz [Lamy Report][4].

The 96 MHz requirement for daily use does not consider large events including events of national or global interest like the Olympics games. Those events do generate a very high “peak” demand, which might require more than 100 MHz of spectrum. For example, the EXPO 2020[5] in the United Aram Emirates (UAE) required 318 wireless microphone channels at the center stage area and more than 1 000 channels (each channel is 200 kHz wide typically) on the EXPO campus (ceremonies, pavilions, broadcaster including news gathering teams) amounting to much more than 100 MHz of spectrum. Such special events require a very detailed frequency planning from a local frequency coordinator. This local frequency management might be in coordination with the national administration, which could setup a special license registration or could allow the use of special frequencies on a temporary basis.

The following figure shows the frequency management plan generated with Shure’s

[4] https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=6721
[5] https://www.youtube.com/watch?v=Rb5m8nT7meo

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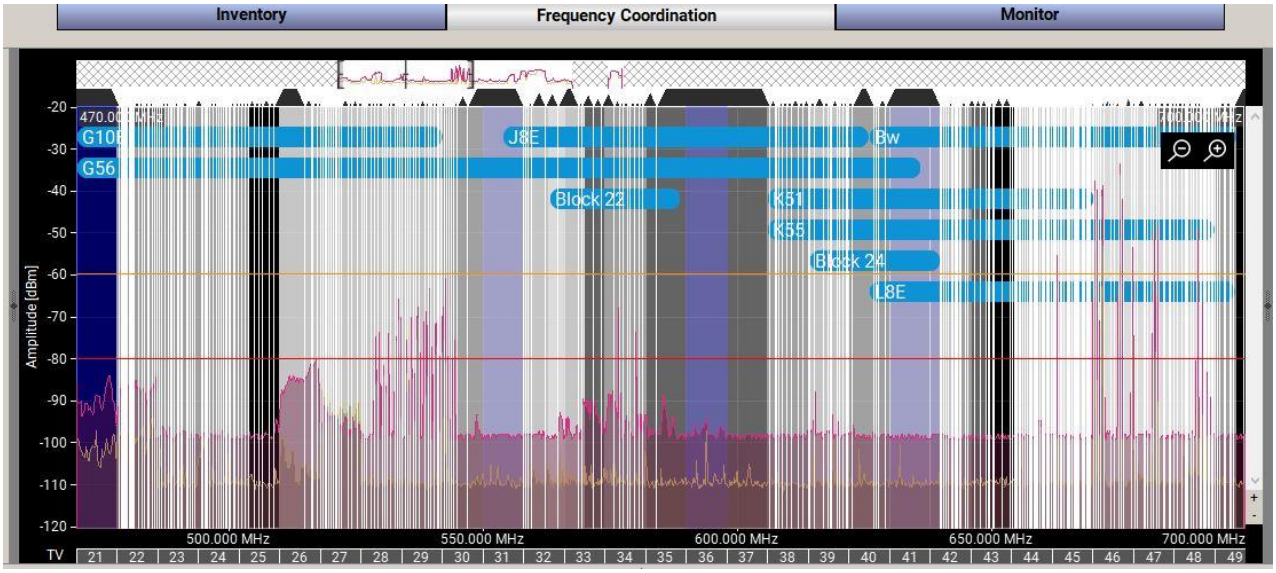
Wireless Workbench Software at EXPO 2020 in UAE.



Required spectrum grows each year for medium and large events. A study conducted by Swiss Radio and Television[6] to determine the spectrum need for audio PMSE, categorizes daily spectrum requirement into: permanent use, events, and exceptional spectrum requirements. The study analyses data of 111 events over the past three relevant years. The spectrum requirements for audio PMSE are summarized as follows:

Daily spectrum requirement:

Permanent use

- Campus-Installations, which were considered in this analysis, require up to **110 MHz** spectrum in the UHF Band:
    - Example: Campus SRF Leutschenbach
    - Example: Seebecken in Zurich

Events

- Today the 82 analyzed **Small Events** (Events with less than 50 coordinated links) require prevailing **42 MHz** in the UHF Band:

[6] https://apwpt.org/wp-content/uploads/2022/03/Report-PMSE-Audio-spectrum-requirement.pdf

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- Example sport: Engadiner Skimarathon, Fussball Super League
- Example culture: Zürcher Sächsilüte, SRF bi de Lüt

- Today the 18 analyzed **Medium Events** (Events with 50-100 coordinated links) require prevailing **69 MHz** in the UHF Band:
  - Example politics: Local elections in Tessin
  - Example sport: Football national team games, Swiss Indoors Basel
  - Example culture: eidg. Jodlerfest, Film Festival Locarno

- Today the 11 analyzed **Large Events** (Events with 100-200 coordinated links) require prevailing **115 MHz** in the UHF Band:
  - Example politics: Federal council elections
  - Example sport: Ski races in Adelboden and Wengen (Lauberhorn)
  - Example culture: Gurtenfestival

Exceptional spectrum requirement:

- Major Events (events with more than 200 coordinated links) do not take place periodically. They have an exceptional cultural value and large media response at national and international level. There were 5 Major Events between 2016 and 2019 analyzed. They had together during **54 event days** (excl. setup & rehearsal) and average spectrum requirement of **174 MHz** in the UHF Band:
  - Example sport: Ski World Championship St. Moritz
  - Example culture: National wine festival “Fête de Vignerons”

However, over the last decade we have seen audio PMSE spectrum reduce dramatically to go to the mobile service use while the demand for audio PMSE created content is experiencing significant growth driven by both the traditional audiences and the new global audience realized by new delivery platforms as explained above. It is essential to recognize the significance and social and economic value of audio PMSE and the efforts the audio PMSE industry has made to improve spectral efficiency to mitigate the losses.

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We note that ACMA's spectrum strategy document does not specifically mention any provision for the future spectrum needs of wireless microphones[7], which share spectrum with digital television services in the TV-UHF band below 1GHz. The spectrum range from 470-698 MHz below the 700 MHz band is critical for audio PMSE and the biggest possible amount of spectrum in that frequency range should be allowed for audio PMSE so that it can continue to support content creation.[8]

In summary, we ask ACMA to please take into account the PMSE spectrum needs in any future plans for bands below 1 GHz, especially for the 470-698 MHz range.

3. Technical considerations as to why audio PMSE needs access to the TV-UHF Band below 1 GHz

The TV-UHF band is and will likely remain the primary global spectrum band for wireless microphone operation. It has been successfully shared with television broadcasting services for many years on a cooperative basis. For technical reasons, UHF spectrum is uniquely suited and vitally important to the operation of these devices.

Wireless Microphones including In-Ear Monitors and Interruptible Foldback Monitors (IFBs) are small, highly portable devices that give users mobility, which is critical for many types of content production activities. As mobile devices, they are dependent on batteries, making power consumption, size, and weight important considerations. The characteristics of the spectrum in which wireless microphones operate are the single most important high-level determiner of power consumption and link reliability. UHF spectrum below 1 GHz is ideal for wireless microphone applications from a technical standpoint.

One characteristic of the TV-UHF spectrum that makes it useful for wireless microphone

[7] Wireless Microphones are essential equipment for Programme Making and Special Events (PMSE), along with In Ear Monitors (IEM), Interruptible Foldback Monitors (IFB) and similar equipment.
[8] https://www.cept.org/ecc/groups/ecc/cpg/cpg-ptd/client/meeting-documents/file-history/?fid=68607

operation is wavelength. Because wireless microphones are physically small devices, antenna size is an important consideration. In this UHF band, it is possible to obtain relatively good efficiency using antennas that fit inside the device or extend a short distance outside of it. Lower (e.g., VHF) frequencies require larger antennas for efficient operation. It is possible to use electrically short antennas, but this results in lower efficiency, narrower bandwidth, or both. Lower efficiency causes higher power consumption and reduced transmission range.

Another characteristic of UHF spectrum that is relevant to wireless microphone operation is the ambient noise level. Electrical noise typically declines with frequency. Thus, the amount of background noise present at UHF frequencies is lower than at VHF frequencies. The noise level is important because it determines how much power is required for a reliable radio link to be established. A higher noise level requires more transmitting power, which in turn means higher power drain and shorter operating time on batteries.

At frequencies above the 1 GHz range, both body absorption and path loss increase. Since wireless microphones are normally worn on the body or held in the hand, these losses have a negative impact on operation. Lab measurements indicate losses of 20 dB or more due to body absorption and shadowing. In addition, wireless microphone signals must often travel through obstructed paths like, e.g., the scenery on a theatre stage. Once again, this translates into a need for higher power, resulting in shorter battery life. UHF signals are better able to pass through such obstructions than higher frequency signals.

Reallocations and auctions of UHF television channels in some countries have dramatically reduced the amount of spectrum available for wireless microphones to use, particularly in cities where a great deal of content production takes place. In response, wireless microphone manufacturers have invested millions of dollars in developing spectrally efficient digital technologies. However, this technology requires clean spectrum in order to work properly.

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4. Technology advances for audio PMSE

The reason why most of today's audio PMSE devices are based on proprietary transmission schemes is the need to meet the following extensive requirements simultaneously and during the whole operating period:

- Ultra-low latency
- Very high transmission reliability
- Very high audio quality
- High spectrum efficiency

Innovations in audio PMSE technology are happening to make more efficient use of spectrum but these advances cannot completely make up for any lack of spectrum.

We kindly ask ACMA to also consider the Wireless Multi-Channel Audio System (WMAS)[9] technologies in their spectrum outlook. Technology neutral rules would also allow deployment of WMAS in various bands in addition to 3GPP-based or IEEE-based technologies. WMAS in its RF Interface Requirements and Licensing schemes is also important for the spectrum outlook and generally for ACMA's long-term spectrum planning. We kindly ask ACMA to consider authorizing the use of WMAS technology with higher bandwidths for PMSE.

(a) Example of USA

The U.S. Federal Communications Commission in the United States has opened a Notice of Proposed Rule Making (NPRM)[9] to consider amending Parts 15 and 74 of its Rules for Wireless Microphones in the TV Bands and other bands and frequencies where they are authorized to operate in order to permit the use of newly developed Wideband Multi-Channel Audio System (WMAS) technology. This technology will enable further improvements in spectral efficiency beyond what has been achieved with

[9] https://docs.fcc.gov/public/attachments/DOC-371281A1.pdf

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narrowband digital systems, and it is well-suited for operation in the TV-UHF band.

(b) Example of European Union

The wireless microphone standard EN 300 422[10] describes test procedure for WMAS. Although WMAS systems are not available in the market yet, regulation has prepared for its future implementation by deleting the maximum bandwidth limitation of 200 kHz, which was part of ERC Recommendation 70-03.

Furthermore, Shure is very careful when it comes to the assertions made about the potential applicability of 5G technology for PMSE applications as various publications on the subject show.[11] Indeed, at the present time, the feasibility of integrating audio PMSE applications into 5G is unproven and undefined on either a technology or economic basis. It, therefore, cannot be considered as a viable solution for audio PMSE in the foreseeable future. That said, Shure and other audio PMSE stakeholders are exploring the potential development of audio PMSE technologies based on 5G and taking part in various industry efforts like, e.g., the 5G-Media Action Group (5G-MAG).

5. Additional Comments to specific sections

In addition to above sections on the importance of 470-698 MHz for audio PMSE, we wanted to offer some comments on:

1.9 GHz (1880–1920 MHz)

DECT is one of the most successful communication technologies in bands like 1880-1900 MHz. Due to the success of this technology, an expansion band from 1900-1920 MHz is under discussion by the European regulatory body, CEPT.

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[10] EN 300 422-1 - V2.1.2 - Wireless Microphones; Audio PMSE up to 3 GHz; Part 1: Class A Receivers; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU (etsi.org)

11 [1]: Guirao M., Wilzeck A., Schmidt A., Septinus K., Thein C.: "Locally and Temporary Shared Spectrum as Opportunity for Vertical Sectors in 5G", IEEE Network (Volume 31, Issue 6, 2017)

[2]: Pilz J., Holfeld B., Schmidt A., Septinus K.: "Professional Live Audio Production – A highly synchronized 5G URLLC Use-Case", IEEE Network (Volume 32, Issue 2, 2018)

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With the reduction of the TV-UHF band, some PMSE applications have adopted DECT technology, e.g., talkback, Intercom and AV conferencing, thereby taking the place of systems that would traditionally share spectrum with wireless microphones and IEMs. It has the advantage of maximizing availability of spectrum for wireless microphones and IEMs in the range 470-698 MHz. The robust nature of DECT and the ability to deploy complex private networks is particularly attractive, and it serves a valuable purpose, though it does not achieve the low latency required for high quality PMSE applications.

In addition, DECT, together with the next generation of DECT, DECT-2020 NR, presents an exciting opportunity to bring new applications to Australia, with considerable economic and user benefits. The new DECT-2020 NR has been designed to be 100% spectrum-compatible with DECT, and hence this opportunity comes with no co-existence downside – in sharp contrast to the prospect of new technologies that are not compatible with DECT, including 3GPP-based NR technologies, sharing the band, that would likely cause interference, degrading Quality of Service.

We hereby attach details about DECT and its evolution in the attached document named “DECT Professional Overview”.

3700–4200 MHz

We support ACMA’s proposals to introduce arrangements for local area wireless broadband (LA WBB) in 3700–3800 MHz in remote areas, and in 3800–4000 MHz Australia-wide on a shared basis with existing fixed satellite service (FSS) and fixed point-to-point (PTP) service types.

The following are some of the local/shared licensing approaches that can be considered/adapted:

- USA FCC’s Broadband Radio Service (CBRS) band in which new commercial operations are governed by a Spectrum Access System (SAS) which ensures that the new systems can coexist with the incumbent military radar systems.[6] The

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CBRS framework can be streamlined to something much simpler to satisfy Australia's 3.8-4.2 GHz needs since the incumbents are static FSS earth stations and not radars embarked on ships in USA. The CBRS specifications developed by the Wireless Innovation Forum (WInnForum) for the interactions of the SAS with the new commercial users can be adapted for the Australia situation.[7]

- UK OFCOM introduced a new licensing approach in the 3.8-4.2 GHz, through local licences (called Shared Access licences).[8] Potential users can apply to OFCOM for coordinated access to these bands in specific locations on a first-come-first-served basis. Longer term, OFCOM is studying the use of automated spectrum management tools that would allow adjustment of technical parameters of these new users over time. These tools could be an adaptation of the SAS developed in the USA for the CBRS band or the Automated Frequency Coordination (AFC) system in the 6GHz band.
- Germany's regulator BNetzA assigned frequencies in the 3.7-3.8 GHz band for local networks. The bandwidth requested can be from 10 MHz to 100 MHz. The spectrum can be used in particular for industry 4.0, but also in the agricultural and forestry sector.[9]

We would respectfully suggest that Non-Public Network spectrum is valuable in providing a base for other industries to develop new innovative systems and solutions.

6 GHz (5925–7125 MHz)

Given that the extensive growth of Wi-Fi needs more spectrum, we support the opening of the whole frequency range from 5925 MHz to 7125 MHz ("6 GHz") for RLAN use. While the use of the upper 6 GHz for IMT is under study for WRC-23, we note that no regulator has issued rules for IMT use of that band. While certain entities are asking to wait for WRC-23 decision before deciding on the use of the upper 6 GHz band, we are of the view that Australia should open that band as soon as possible on an unlicensed basis so that its citizens can benefit from the 6 GHz Wi-Fi ecosystem enjoyed by the USA, Canada, Brazil and South Korea.

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Furthermore, to make more efficient use of the spectrum, enable new use cases and benefit from the unlicensed ecosystem emerging from the USA, ACMA could consider the additional FCC's regulations as follows:[10]

- higher standard power indoor and outdoor operations controlled by an Automated Frequency Coordination (AFC)[11] system that would prevent interference to any incumbent fixed systems with:
  - Access Points Power up to 36 dBm EIRP (EIRP PSD of 23 dBm/MHz).
  - Client Devices power up to 30 dBm EIRP (EIRP PSD of 17 dBm/MHz).

The FCC's regulations could also be considered to protect incumbent Fixed Satellite Service uplink operation:

- Standard power access points and fixed client devices located outdoors must limit their maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon to 21 dBm (125 mW) to protect fixed satellite services.

In summary, we wanted to make sure that the spectrum needs for audio PMSE, especially in the 470-698 MHz TV-UHF band and the 1.9 GHz DECT band are taken into account as the ACMA defines their spectrum outlook so that PMSE can continue to support various events and contribute to the society and economy of Australia.

Please contact the undersigned if you have any questions.

Respectfully submitted,
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Attachment: Document named “DECT Professional Overview”