



Shure's Response to TRAI's Consultation Paper on "Regulating Converged Digital Technologies and Services – Enabling Convergence of Carriage of Broadcasting and Telecommunication services"

March 24th, 2023

Shri Sanjeev Kumar Sharma
Advisor (Broadband and Policy Analysis)
Telecom Regulatory Authority of India

Dear Shri Sanjeev Kumar Sharma,

[Shure Incorporated](#) applauds the work of the TRAI and welcomes the opportunity to provide its response to the above-mentioned TRAI's public consultation.

For more than 97 years, Shure has been a leading manufacturer of high-quality, innovative audio products. Shure's products are utilized worldwide in applications known as Programme Making and Special Events (PMSE), which is an ITU's inclusive term covering radio microphones, in-ear monitors, wireless cameras, talkback systems, etc.

We note that the TRAI consultation only addresses the use of the 470-703 MHz by IMT as well as by broadcasting. PMSE is another important user in the band that, unfortunately, is left out of the discussion in various documents by TRAI. In fact, this is the most important frequency range for PMSE and the question of its long-term availability for PMSE to support content creation needs to be considered.

Indeed, 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](#). 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.

PMSE supports India's very vibrant content creation industry with its film, music, theater and other sectors. This is recognized globally as noted in [The Hindu Businessline](#).¹

"As the recently concluded Cannes film festival celebrated India as the Country of Honour, it offered a great opportunity for us to display our potential to be the future content hub for the world".

The article even mentioned that *"India's creative economy may drive the next wave of growth" and "For this to happen the right kind of policy framework needs to be evolved"*.

¹ <https://www.thehindubusinessline.com/opinion/indias-creative-economy-may-drive-the-next-wave-of-growth/article65487350.ece>

Access to sufficient spectrum below 1 GHz to audio PMSE should be an important part of this policy.



Deepika Padukone at the The 75th Cannes Film Festival - Closing ceremony - Cannes, France

Furthermore, platforms like Netflix, Disney, Amazon Prime, Apple+, etc are spending tens of billions of dollars on content creation. To support all of this, audio PMSE uses spectrum in the 470-698 MHz range globally. For example, we have been deploying the largest single wireless install of our top tier solutions in India at the Jio World Center for the Reliance Group in this frequency range.

Audio PMSE: Everywhere, by anyone and at anytime

The infographic features a central green circle with the text "Content Consumption on New Delivery Platforms". Surrounding this circle are various logos for content delivery platforms: YouTube, Spotify, NETFLIX, Disney+, prime video, SONY liv, voot, ZEE5, Apple tv, Facebook LIVE, ANTENNA TV, and CABLE TV. To the left of the central circle, there are four categories of content consumption, each with a representative image: "Governmental Events" (Narendra Modi speaking), "Electronic News Gathering" (cricket players), "Live Music" (concert stage), and "Theater" (stage performance). Below these categories are two more images: "Live Music" (a woman singing) and "Content Production" (a scene from the movie 'Indian Idol'). A green box at the bottom right contains the text: "Demand for PMSE applications is increasing, driven by traditional audiences, mobile phone consumption and new delivery platforms. E.g., see Netflix Live Action - Production Sound [Best Practices](#)".

Like the mobile or satellite industry, PMSE's demand for spectrum is experiencing significant growth driven by both the traditional audiences and the new global audience realized by new

delivery platforms but as we know, this spectrum has been “eaten away” by the mobile industry in particular as the 700 MHz and the 600 MHz bands are opened for 4G and 5G worldwide. 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.

Therefore, as the TRAI studies the 470-703 MHz for IMT in India, we wanted to provide the comments hereafter to ensure that audio PMSE continues to get access to sufficient spectrum in the 470-698 MHz band (which can range from 60 MHz for some events to more than 100 MHz for major events like EXPO 2020 in Dubai or the Paris Olympic games or at the Jio World Center) to continue to support various events and contribute to the society and economy of India. It is essential for TRAI 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 spectrum loss.

Please do not hesitate to contact the undersigned if you have any questions or comments.

Respectfully submitted,
/s/ Prakash Moorut

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1. Programme Making & Special Events (PMSE) in India

PMSE 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. From primarily a film, theatre and TV industry content creation tool, PMSE is now important to every smartphone in the world as shown in this [video](#).

The PMSE applications continue to grow in scale and density worldwide to meet the needs of broadcast and event producers engaged in increasingly complex productions to meet audience expectations.

India holds a dominant position in the world of content production with its film and other industries. For example, Shure has been deploying the largest single wireless install of our top tier solutions in India at the Jio World Center for the Reliance Group. The contribution of content production to the Indian economy has been growing as shown by the data hereafter:

India Music Industry²:

Summing up the revenues across the three main sub-industries (LIVE, Recording & Publishing), we estimate the scope of the Indian music market at **\$443 million**.

Value of the live events market in India from 2016-2023³:

- In 2020, the live events market across India was valued at 27 billion Indian rupees (\$380million).
- It was forecast to reach 95 billion rupees (\$1.3bn) by 2023 and represents a 50% growth in 4 years (2016-2019).
- 70% growth is predicted over 7 years 2016-2023

India Film, TV and Online Video Services (OVS) sector - referred to as Creative industries⁴:

- The film, television, and OVS industries in India represent a combined revenue of around US \$ 13.3 bn
- Anticipated growth in creative industries of more than 10% over the next few years, and with appropriate support, a higher growth trajectory of 14–15% is possible.
- In 2017, OVS grew 50% from \$37m to over \$55m.
- By 2019, it generated over \$600m with similar growth forecast.

Global content creation sector:

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.

- 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

² Indian Music Industry Revenue by Source, 2018 - Sources: [IFPI](#), [PwC](#), [VISION 2022](#), [IPRS](#)

³ Published by [Tanushree Basuroy](#)

⁴ Source: [Deloitte India](#) – Economic impact of the film, television and online video services industry in India 2019

billion on content creation in 2020, rising to \$26bn in 2026. In 2022, Disney has made \$33 billion investment in content creation, \$8 billion more than for 2021.

These wireless technologies are used extensively in the production of entertainment content, adding significant value to production. Figure 1 below illustrates the relation between PMSE and content consumption.

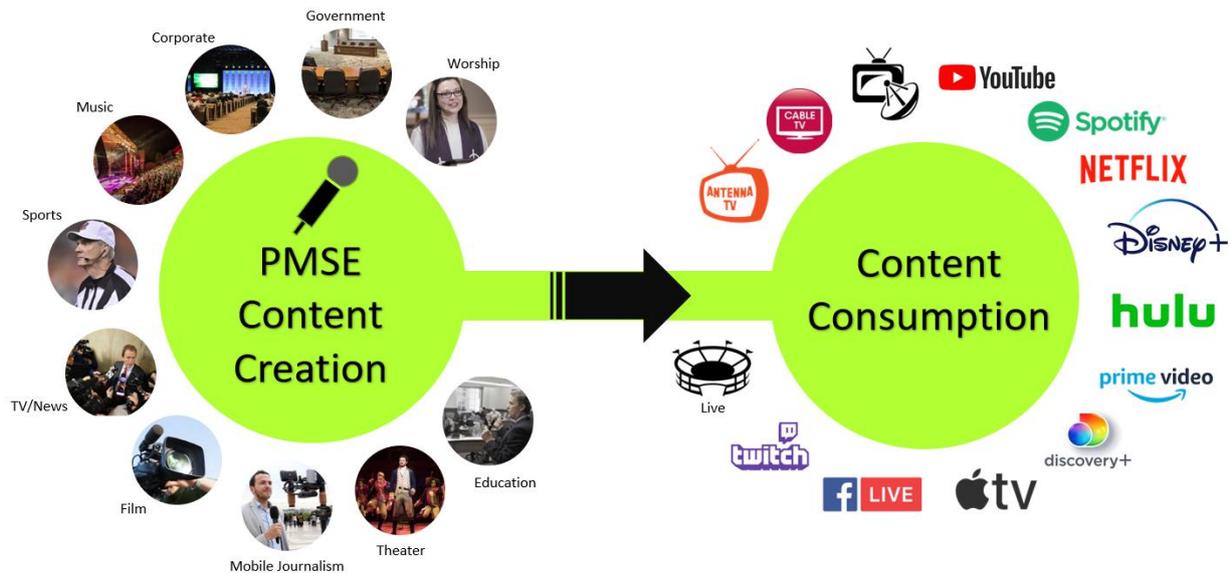


Figure 1: PMSE Enables Content Consumption.

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

1. Audio PMSE Spectrum Requirements

Like all wireless communications technologies, audio PMSE needs spectrum. As India designs a policy and regulatory framework to support the development of new wireless technologies, they should ensure that audio PMSE continues to get access to a sufficient amount of usable spectrum. In particular, the UHF TV band within 470-698 MHz is the primary band for professional wireless audio PMSE operation globally, especially for touring productions. This band offers the most reliable operation due to a combination of good propagation, satisfactory antenna efficiency, and relatively low and predictable ambient noise and interference levels. The audio PMSE industry is very innovative, resourceful and embracing of new technologies to constantly improve spectral efficiency and end-user experience. However, we caution that anticipated technology developments cannot make up for a lack of suitable spectrum for audio PMSE operation. Intensive reuse of spectrum already takes place at large events where users are assigned different time slots and/or locations.

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]⁵.

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.

Required spectrum grows each year for medium and large events. A study conducted by Swiss Radio and Television⁶ 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:

a. Daily spectrum requirement:

Even, if the below examples are based on a PMSE database in Switzerland, the amount of needed PMSE devices and frequencies is very similar globally.

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:
 - 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)

⁵ https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=6721

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

- Example culture: Gurtenfestival

b. 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”
 - Example international major event: Expo 2020 Dubai

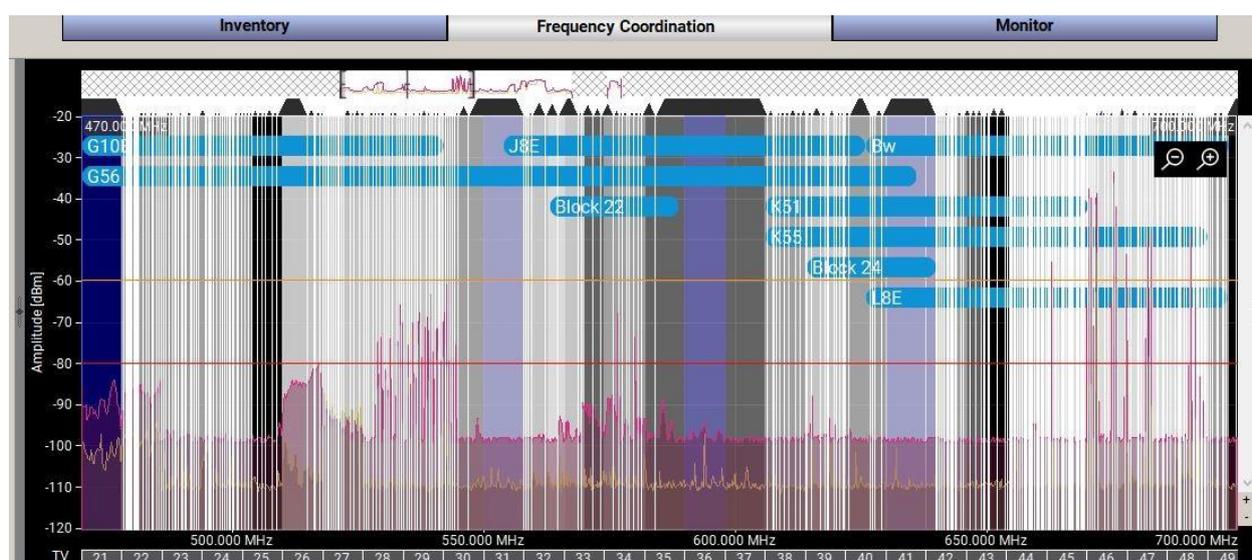
2. Case Studies from a PMSE perspective - Events Around the World

Hosting a global event can give many economic, social and cultural benefits to the host country including raising the profile of the host country in addition to social and economic benefits. Such special events require a very detailed frequency planning from a local frequency coordinator. Organizing and planning large events may take several months in advance. Case studies from past and future (planned) events are summarized below.

a. EXPO 2020 – Dubai, United Arab Emirates

EXPO 2020⁷ in the United Arab Emirates (UAE) required 318 wireless microphone channels at the centre stage area and more than 1000 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.

The following figure shows the frequency management plan generated with Shure’s Wireless Workbench Software at EXPO 2020 in UAE.



⁷ <https://www.youtube.com/watch?v=Rb5m8nT7meo>

Figure 2: Frequency Management Plan at EXPO 2020

As observed from the figure, each thin white line represents a 200kHz wireless RF channel for audio PMSE. **Typically, special events do generate a very high “peak” demand, which might require more than 100 MHz of spectrum.**

b. Super Bowl – USA⁸

In the USA, the Super Bowl, which is considered the biggest game in American football, takes place once every year. Technical and radio frequency planning for the Super Bowl begins months in advance and is dependent on available frequency bands. Mobile Network Operator T-Mobile has been building out its network on the 600 MHz since the auction in 2017. Audio companies and even organizers which relied on these frequencies to host large events had to apply for Special Temporary Authority licenses with the FCC to operate on the 600 MHz mobile band to accommodate the needs of the Super Bowl since there was not enough spectrum below the mobile band.

Since there is currently no PMSE equipment that operate out of the UHF band and to meet audio PMSE requirements at the Super Bowl, the FCC had to grant a special temporary authorization for the use of 614-673 MHz for the event area. Luckily, equipment from other regions, where this band is still available, e.g., Europe, Middle East & Africa, was used for this event.

c. Olympics and Paralympic Games 2024 – Paris, France

The summer Olympic and Paralympic Games (“the Paris 2024 Games”) will be held between July and September 2024 in Paris, France. To anticipate the spectrum needed for the Paris 2024 Olympic and Paralympic Games (OPG), the national frequency agency (ANFR) and OPG organizing committee studied past OPG as well as other major international sport events, considering technological evolutions. The ANFR and OPG committee released the [Spectrum Management Plan](#) and conditions for the Paris Olympics.

Figure 3 shows frequency bands assigned to wireless microphones and In-Ear Monitoring (IEM) systems.

⁸ <https://www.sportsvideo.org/2023/01/18/super-bowl-lvii-phoenix-state-farm-stadium-raise-rf-coordination-to-new-level/>

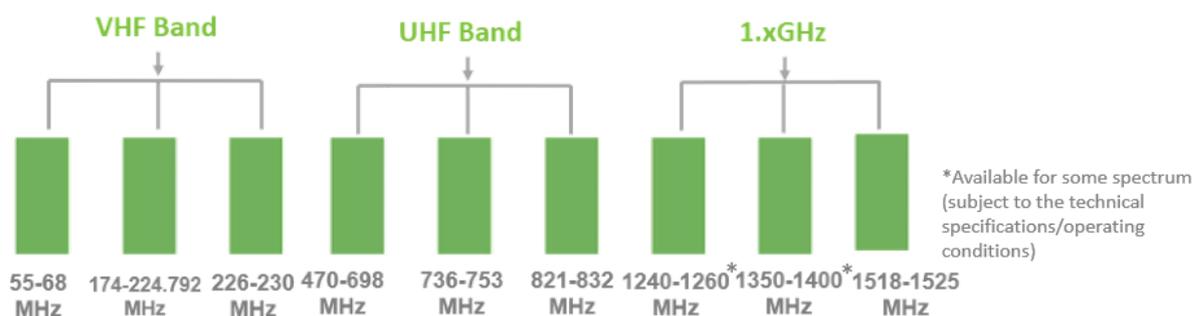


Figure 3: Spectrum for PMSE Use at Paris 2024 Olympics.

The host city, and its suburbs gather 16 % of the French population and most of the head offices of the main companies established in France, and there is accordingly already a very high use level of radio spectrum. **Also, 5G deployments are reducing the bands historically allocated to the PMSE usages.** It is anticipated that the demand for spectrum for wireless microphones at music concerts or theatres in and around the Paris area will increase during the Games.

In addition to the 470-694 MHz band that is shared with TV and opening 3 additional bands in the 1.x GHz range, France recommends using wired communication systems for microphones whenever possible to accommodate the high PMSE demand. While we understand the recommendation for stakeholders to use wired microphones because of the spectrum crunch, it is clearly not aligned with the trend we are seeing with increasing demand for wireless microphones. It would be interesting to see how this recommendation is actually put in use by the users. Shure will continue to work with regulators worldwide to ensure that enough spectrum in the 470-698 MHz band is available for audio PMSE.

3. Potential Future Technology for Audio PMSE

To overcome the shrinking access to TV-UHF band and cater for growing demands, the audio PMSE industry is continuously developing spectrally efficient and innovative products, but these advances cannot completely make up for any lack of spectrum.

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

A recent development is Wireless Multichannel Audio System (WMAS) technology which brings wideband functionality into the PMSE domain, enabling centralized and automated controls for a

diverse array of traffic types and client devices operating on a bi-directional basis. WMAS technology is the “next generation” wireless microphone system: technology that makes possible significantly more operating channels per megahertz through use of wideband. Technology neutral rules would also allow deployment of these technologies in various bands in addition to 3GPP-based or IEEE-based technologies.

(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 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 422¹⁰ 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 Currently, the biggest challenge for 5G technology to meet is the latency requirement for professional live audio production. Beyond the technical challenge, the business case for PMSE on a 5G network is to be studied. 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). PMSE is also being discussed as a potential application of IMT in the preliminary draft new IMT Applications report that is being drafted in ITU-R WP 5D.¹²

⁹ <https://docs.fcc.gov/public/attachments/DOC-371281A1.pdf>

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 \(Volume 32, Issue 2, 2018\)](#)

¹² Preliminary draft new report ITU-R M.[IMT.Applications]. Applications of the terrestrial component of IMT for specific societal, industrial and enterprise usages.

4. Audio PMSE spectrum in India

TRAI does not explicitly address the important question of long-term availability of spectrum to support content creation in its document. 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 TRAI rightfully pointed out in its consultation paper in Section 3.66 (a):

Considering the facts that presently (i) band plan(s) for the frequency range 526-612 MHz is yet to be defined by 3GPP/ITU, (ii) development of ecosystem for IMT in 526-612 MHz frequency range will take some time and (iii) MIB is using 526-582 MHz band extensively across the country for TV transmitters; the 526-612 MHz frequency range should not be put to auction in the forthcoming auction.

We would go one step further and suggest that TRAI should be very careful not to auction any additional spectrum below 612 MHz to 5G even longer term as PMSE needs that spectrum.

Indeed, global spectrum requirements and deployments of 5G in the low bands have focused on 700 MHz (e.g., Asia-Pacific band 28 covering 703 – 748 MHz Uplink/ 758 – 803 MHz Downlink). We note, however, that there are many countries which are still to auction this band and even fewer where IMT networks have been deployed.

Still, if TRAI decides that more spectrum than 700 MHz is required to meet the mobile needs in India, then the US 600 MHz band or the APT 600 MHz band seems to be more than enough for any 5G and even 6G deployments, especially if this is coupled with 700 MHz.

We further note that there appears to be little appetite for spectrum below this US 600 MHz band for mobile use. For instance, the T-band (470 MHz to 512 MHz) auction was cancelled in the USA because there was a concern that it would not generate enough interest from mobile operators.¹³ Instead, the focus in the USA has been on mid-bands with the C-band (3.7-3.98 GHz) and 3.45-3.55 GHz auctions that concluded with record-breaking bids.

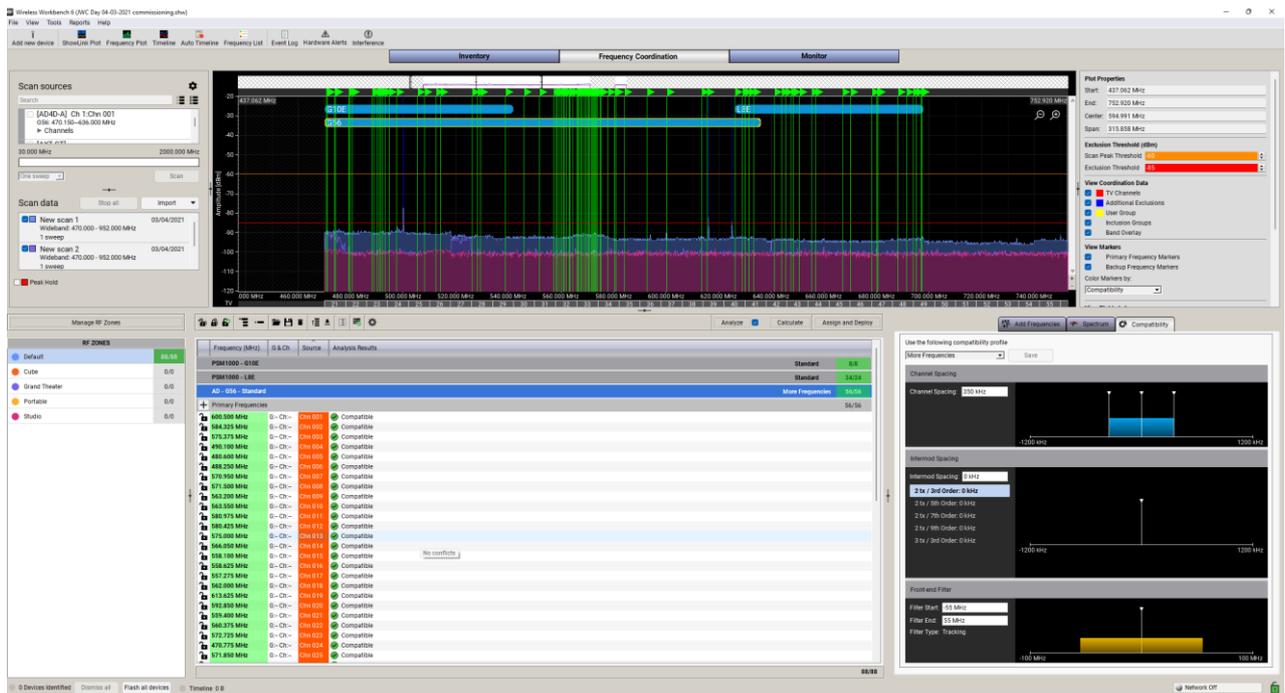
While there is no interest and no ecosystem for 5G in the spectrum range below the US 600 MHz band (i.e., below 617 MHz), this range from 470-617 MHz is very important for PMSE. For example, the United States allows audio PMSE operation below 608 MHz as well as in the duplex gap of the US 600 MHz band and guard band of the US 600 MHz band with TV below that band.¹⁴ While co-channel sharing of mobile with audio PMSE is problematic, audio PMSE has

¹³ <https://www.rrmediagroup.com/News/NewsDetails/NewsID/20384>

¹⁴ <https://www.fcc.gov/consumers/guides/operation-wireless-microphones>

been sharing the 470-698 MHz band with TV stations for more than 60 years successfully, without creating interference issues.

At some locations, there is no TV signal as can be seen in the spectrum scan at an indoor location at Jio World Center where Shure is deploying the largest single wireless install of our top tier solutions in India with Reliance Group, meaning that there is no TV channel which the wireless microphones need to avoid. In this particular case, the whole range from 470 – 703 MHz is available to support a major event at that indoor location at Jio World Center. The picture below shows a spectrum scan of Shure’s Wireless Workbench (WWB), a frequency management tool for high-tier multi-channel applications. With Shure’s WWB, the user is able to develop a proper frequency management plan for the local event. The green lines show the wireless microphone channels. This Jio World Center frequency management plan considers several aspects for developing the most efficient frequency plan. This includes RF environment scans, considerations of RF attenuation of walls and between different rooms as well as antenna placement. Such an extensive frequency planning can be realized in such an installation with controllable RF environment to maximize the experience for the audience while mitigating any interference issues.



5. Conclusion

In summary, Shure will continue to support India’s efforts to secure access to sufficient spectrum in the 470-703 MHz range for audio PMSE as a vital industry that provides a critical service to the economy, society and culture of the India. If audio PMSE can no longer operate in

the whole 526-703 MHz range, we may not be able to support events at the Jio World Center or any major political, cultural or sports event that India would host for example.

If there is an additional need for more low-band spectrum below 1 GHz for 5G, TRAI could try to auction the APT 600 MHz (612-652/663-703 MHz) again which would add 5 MHz of spectrum to the uplink and downlink of the US 600 MHz band (617-652/663-698 MHz). However, we note that there is no ecosystem for the APT 600 MHz band while an ecosystem exists for the US 600 MHz band.

In any case, even with this 5 MHz expansion, spectrum below that new band, i.e., below 612 MHz should be allowed for audio PMSE and TRAI should not extend IMT below 612 MHz as it could jeopardize the capability of India to support content creation and various important events.

We further recommend that if a particular frequency range would not be allowed for wireless microphones operation in the future, there should be a time period to help smooth the transition of wireless microphones out of that particular frequency range, similar to what USA did when they auctioned the US 600 MHz band in March 2017 and allowed wireless microphones to operate in the US 600 MHz band till July 2020.¹⁵

To conclude, there does not seem to be any clear justification as to why the whole range of 526-703 MHz should be open for IMT. On the other hand, this spectrum range from 470-703 MHz 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 in India.¹⁶

¹⁵ <https://www.fcc.gov/consumers/guides/operation-wireless-microphones>

¹⁶ <https://www.cept.org/ecc/groups/ecc/cpg/cpg-ptd/client/meeting-documents/file-history/?fid=68607>