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Radio Spectrum Policy Group

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RADIO SPECTRUM POLICY GROUP

[Draft] Opinion on a long-term strategy on future spectrum needs and use of wireless audio and video PMSE applications

Executive Summary

As part of its work programme for 2016/2017, the RSPG was asked to advise the Commission on a long-term strategy on wireless audio and video PMSE spectrum use and requirements. This opinion focuses on the challenges of satisfying peak demand requirements.

In respect of audio PMSE the RSPG notes that;

- long-term regulatory certainty and visibility on spectrum access is desired by PMSE manufacturers and users.
- the Commission Implementing Decision for audio PMSE¹ harmonises “at Union level the availability of a baseline of about 60 MHz of sustainable spectrum to meet recurring ordinary needs”.
- the most commonly used audio PMSE applications are wireless microphones (handheld and body worn) and in-ear monitors.
- mass-market PMSE equipment is typically not used in the events where the peak bandwidth demands occurs.
- an up to date list of tuning ranges is identified in relevant CEPT deliverables^{2 3}.
- there has been growth in the use of wireless audio PMSE in the last decade. This does not necessarily mean that spectrum demand is increasing as there are methods to address growth such as better planning and coordination, technological evolution and more efficient use of spectrum.
- Member States shall adopt and make available their ‘national roadmap’ for re-assigning of terrestrial television in the UHF band by 30 June 2018⁴.
- removal of PMSE in parts of the 700 MHz band and re-planning terrestrial television will influence the amount of spectrum available for shared PMSE use in different local areas.
- the frequency band 470-694 MHz will, at least until 2030, continue to be an important frequency band for audio PMSE⁵.
- there are different views regarding whether UHF spectrum available on a national level post 2020 is enough to meet the future peak demands for audio PMSE.

In respect of video PMSE the RSPG notes that;

- the Commission Implementing Decision for video PMSE⁶ harmonises the frequency band 2010-2025 MHz on EU level.

¹ (2014/641/EU)

² ERC Recommendation 25-10 - Frequency Ranges for the Use of Terrestrial Audio and Video Programme Making and Special Events (PMSE) applications

³ ERC Recommendation 70-03 - Relating to the Use of Short Range Devices (SRD)

⁴ DECISION (EU) 2017/899 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2017 on the use of the 470-790 MHz frequency band in the Union

⁵ (EU) 2017/899

- growth in video PMSE at the largest events has been steady and the most commonly used applications are wireless cameras and video transmissions in terms of portable, mobile or temporary point to point radio links.
- tuning ranges for wireless video equipment are typically between 500 – 700 MHz wide.
- in some Member States certain sub bands within the 2 GHz range could be subject to some evolution of use at national level.

Taking the above into account, the RSPG;

- is of the view that due to the local and temporary nature of PMSE, especially for peak demand situations, requirements are best addressed on a case-by-case basis at a national level using the “tuning range concept” developed by CEPT.
- welcomes PMSE equipment that can operate with larger tuning ranges, which provides flexibility for operation in different countries and ensures more efficient local planning at a national level and encourages users to use this kind of equipment especially for peak demand events.
- is of the view that technology advances will improve the spectrum efficiency of PMSE and enable more efficient sharing with a wider range of users, technologies and applications.
- encourages the PMSE industry and academia to continue to research and develop more advanced and spectrally efficient technologies, including digital ones, and to implement these technologies in ETSI harmonised standards.
- recommends PMSE stakeholders further to explore the development of 5G regarding its potential for PMSE.
- is of the view that PMSE may benefit from R&D funding of related industries development.
- is of the view that operational advances like detailed planning, better on-site coordination and assistance by Member States, coupled with the adoption by PMSE users of more efficient working practices and technologies, can be used successfully to achieve high density spectrum use at peak demand events. Member States are encouraged to continue to provide information and share best practices on the CEPT Portal⁷.

⁶ Commission Implementing Decision (EU) 2016/339 on the harmonisation of the 2 010-2 025 MHz frequency band for portable or mobile wireless video links and cordless cameras used for programme making and special events

⁷ <http://cept.org/ecc/topics/programme-making-and-special-events-applications-pmse>

Further concerning audio PMSE the RSPG;

- Concludes that spectrum requirements beyond the baseline identified by the Commission Implementing Decision ⁸, are best addressed on a case-by-case basis at a national level using the tuning range concept.
- Will continue to monitor developments in UHF spectrum (e.g. the recent auction for mobile in the 600 MHz band in the US), and consider whether this has any implications for PMSE use in Europe, taking into account that spectrum bands below 694 MHz will remain available for PMSE until at least 2030 on the basis of national needs in accordance with Decision (EU) 2017/899 and will be subject to a review anticipated by 2025 in the Lamy report.
- Recommends that future requirements for PMSE should be considered in conjunction with a review of the UHF band anticipated by 2025 in the Lamy Report⁹. This review should carefully consider technological developments and the evolution of demand for PMSE. If considered necessary, a strategy to identify spectrum options below 2 GHz for audio PMSE may be needed, considering aspects such as the potential for widespread adoption on a global level (in order to achieve economies of scale), and the request from the PMSE community for long term stability and regulatory certainty.

Further concerning video PMSE the RSPG;

- Concludes that the EC decision on video PMSE¹⁰ does not need to be modified in order for Member States to satisfy spectrum needs.
- Is of the view that PMSE demand requirements beyond this harmonised spectrum are best addressed on a case-by-case basis on a national level using the tuning range concept.
- Is of the view that further mandatory harmonisation measures are not necessary since the current equipment often operate over larger tuning ranges which are typically wide enough to adapt to various situations in Member States. If necessary, the tuning range of future equipment should be further increased.
- Is of the view that Member States, in which the 2 GHz range is subject to evolution of use, may need to maintain national flexibility to enable continued use of video PMSE in this core frequency range.

⁸ Commission Implementing Decision on harmonised technical conditions of radio spectrum use by wireless audio programme making and special events equipment in the Union, (2014/641/EU)

⁹ <https://ec.europa.eu/digital-single-market/en/news/report-results-work-high-level-group-future-use-uhf-band>

¹⁰ (2016/339/EU)

- Encourages Member States to continue to supplement video PMSE use with spectrum not designated to PMSE at a national level to meet specific short-term peak demand where possible and appropriate.
- Encourages Member States to enable the use of tuning ranges in higher frequency bands, particularly from around 7 GHz and above, for certain video PMSE applications if required on a national level.

DRAFT

Scope of work

RSPG shall assist and advise the Commission on radio spectrum policy issues. On the 40th RSPG meeting, the Commission issued a Request for Opinion on a long-term strategy on wireless audio and video PMSE spectrum use and requirements, “in particular noting the requirement for high quality of services in case of professional practice”. More specifically, the requested Opinion should:

- Assess possible solutions and options for meeting the expected future needs and use of audio and video PMSE applications in a time frame after 2020, taking into account the bands currently in use by audio and video PMSE and the expected spectrum re-allocations within relevant bands (e.g. 700 MHz band), while ensuring a sufficient flexibility and acknowledging that the needs vary greatly between different Member States. Which solutions are sustainable in the long term, taking due account of high quality and latency requirements of certain types of PMSE applications?
- Indicate technological developments and regulatory requirements related to spectrum use which could contribute to meet the spectrum and quality of service demands for wireless audio and video PMSE. In this context consider shared use of spectrum, which could include appropriate and innovative sharing approaches e.g. the availability of geo-location databases with an appropriate geographic reach, the digitalisation of audio PMSE equipment, opportunities in higher frequency ranges, a higher level of certainty than a framework of non-interference and non-protection accessibility of spectrum in identified cases, as well as a common approach on authorisations and opportunities of localised temporary shared use of spectrum in case of large spectrum needs.
- Assess the relevance of a common "roadmap" identifying principles and approaches of spectrum availability for audio and video PMSE. In this context collect Member States' best practices in providing spectrum use with the required level of quality of service and increasingly flexible conditions of spectrum access for wireless audio and video PMSE applications.

In respect of the principle of subsidiarity a co-ordination of policy approaches amongst the RSPG Member States with regard to the expected future needs and use of audio and video PMSE applications, and in order to reach economies of scale and to address the variety in needs of Member States is appropriate only insofar as similar needs in all Member States are identified and the aim to fulfil these needs can be satisfied appropriately at Union level only. Otherwise, identified national needs can be satisfied better on national level according to national circumstances. Therefore, the following opinion turns particular attention to differentiate between EU-wide and national needs and will provide recommendations only with regard to activities required at Union level.

Background

The term Programme Making and Special Events applications (PMSE) describes radio applications used for SAP/SAB, ENG/OB and applications used in meetings, conferences, cultural and education activities, trade fairs, local entertainment, sport, religious and other public or private events for perceived real-time presentation of audio/visual information, including the transmission of audio, video and data signals. Simplified, there are three main groups of PMSE, Audio PMSE, video PMSE and PMSE service links. A more detailed description of PMSE can be found in ECC Report 204.

PMSE is an enabler for the creation of audio and video content which is broadcast and consumed globally using a variety of platforms. PMSE content capture sits at the start of the supply and value chains for a wide range of products, such as recordings of live performances or the archiving of culturally significant material. Consequently, content capture is expected to provide the highest quality possible, with producers and programme makers taking steps to ensure the quality and robustness of content capture and delivery.

For these reasons quality and reliability of the radio link are fundamental to PMSE users. For high-end (live) PMSE productions especially, the commercial pressures on users are significant as there is no opportunity for recovery, and so the tolerance for disturbance to the quality of service is extremely low.

PMSE applications typically share spectrum with other services based on sharing criteria, primarily defined to protect these other services from interference from PMSE. Another important aspect of these sharing arrangements is that the spectrum is able to provide the high quality of service required for live events and programme making i.e. there should be a predictable sharing environment.

This Opinion places in addition a particular emphasis on PMSE usage for large scale events and other situations in which it may be challenging to meet the spectrum demand. The previous RSPG analysis on PMSE in RSPG sectoral needs and RSPG Opinion on RSPP, as well as the RSPG opinion on a long-term strategy on the future use of the UHF band (470-790 MHz) in the European Union, also covered PMSE.

Spectrum availability for both audio and video PMSE has already been, or may be, reduced. In assessing the spectrum requirement for PMSE, it must be borne in mind that PMSE demand is mainly time and location specific. Meeting peak demand at large events only becomes acute if spectrum at both the time and at the location it is required is difficult to supply. It therefore does not automatically follow that a greater number of large events over the course of a year – as has been the trend - presents any

more of a challenge for PMSE spectrum availability¹¹. In the context of large events there may be also variations between spectrum needs for each type of application in use.

Pre-existing constraints in Member States' national circumstances adds a further dimension and challenge to the adoption of EU-wide co-ordinated policy approaches. This is due to national differences in PMSE demand, but also due to different use in many of the frequency bands that PMSE shares with.

Apart from the harmonised baseline for Member States the use of PMSE equipment is not fully harmonised across the Member States due to differing national PMSE requirements and divergent national frequency plans. PMSE stakeholders that operate internationally have a strong preference for equipment which may be operated across multiple countries.

This desire lies behind the recommended “tuning ranges” for PMSE by CEPT. A “tuning range” is a range of frequencies over which radio equipment is envisaged to be capable of operating. Within this tuning range the use in any one Member State of radio equipment will be limited to the range of frequencies identified nationally (if any) within that country for PMSE, and will be operated in accordance with the related national regulatory conditions and requirements. This concept has also been helpful to respond to the demand in case of large events. This approach is also in place for all CEPT Administrations and is in consequence supported and recommended.

A harmonised baseline to meet “recurring ordinary spectrum needs” is provided by Commission Implementing Decision for audio PMSE (2014/641/EU). Commission Implementing Decision 2016/339/EU harmonises the frequency band 2010-2025 MHz for video PMSE on an EU level.

Technological advances

In general, technology advances will make possible the continued deployment of peak demand events for both audio and video PMSE. We address separately the technology mitigation for audio and video PMSE below and the RSPG recommends that the PMSE industry and academia continue research and development of more advanced and spectrally efficient technologies to better use the available spectrum.

Radio mics and IEM equipment is available now which can use spectrum between 2.5x as efficiently (against current practice analogue systems) and 3x as efficiently (as

¹¹ Although not affecting peak spectrum demand in most cases, there is considerable growth in the number of live music events overall.

against digital transmission)¹². The high density mode¹³ by modern high end equipment might enable additional gains in certain use cases. This increased spectral efficiency is today, however, the preserve of top-end equipment which is usually used at peak demand scenarios but gains could begin to trickle down over the next few years.

Investment in new technology is, however, heavily dependent on there being sufficient incentives to invest. This means, as a minimum, encouraging an environment for the PMSE sector which is as stable as possible and which therefore incentivises development and allows production costs to be suitably amortised over time, particularly for the relatively small manufactured volumes of high-end equipment.

Some technologically driven mitigations only become effective once a significant majority of its users have deployed the new technology. It is therefore desirable to foster the migration of users onto more efficient technologies and, where possible, to have a longer term perspective of spectrum access (many PMSE users expressed a view that this should ideally be a period of between 5 – 10 years, but could in some cases be longer, depending on how long they typically hold equipment for).

Making new spectrum available will not necessarily lead to it being utilised if there is no interest from the users or manufacturer to migrate. The existing equipment will be used while it works and there is no incentive to migrate unless the equipment no longer works.

Sufficient amount of frequencies available for PMSE within a defined tuning range is frequently cited as far preferable for large-scale event planning and production. This requires additional planning as intermodulation products become an issue mainly for audio PMSE. In general technology improvements support the use of tuning ranges of spectrum.

Extended tuning ranges, however, have their practical limits and bring increased complexity (which also increases cost), size and power consumption to the design. The development of new technology, such as Wideband Multichannel Audio Systems (WMAS)¹⁴ may contribute to increased spectral efficiency and the development of

¹² High Density mode creates additional bandwidth for more channels in crowded RF environments. Frequency efficiency is optimized by running at 1 mW RF transmit power and narrowing the modulation bandwidth, allowing for the channel spacing to be reduced from 350 kHz to 125 kHz. Transmitters can be positioned on adjacent channels with unsubstantial intermodulation distortion Technology Evolution in the PMSE Sector (also referenced in Report by Cambridge Consultants for Ofcom, UK

¹³ See footnote 6

¹⁴ Defined under section 4.4 and elsewhere in the draft ETSI EN 300 422 v.2.1.1 standard (http://www.etsi.org/deliver/etsi_en/300400_300499/30042204/02.01.01_60/en_30042204v020101p.pdf)

new harmonised standards which foster greater spectral efficiency should be encouraged.

Cognitive PMSE

Cognitive systems in PMSE come in a number of forms, a simpler form now commonly used is that a scan of the available spectrum is taken at the start of an event and the system automatically (or in some cases manually) tunes the transmitters and receivers to clean spectrum. A more advanced form was developed in the C-PMSE research project ran in Germany.

Cognitive PMSE systems may eventually enable a higher degree of automation of the frequency utilization within the assigned frequency spectrum as well as a higher flexibility and re-configurability, and contribute to a more coordinated coexistence of different users in the same frequency range thereby resulting in increased spectral efficiency. In addition sharing with services PMSE traditionally has not shared with may be enabled. Cognitive capabilities for PMSE are therefore encouraged to be further studied.

PMSE in 5G

From a technical point of view, 5G may probably handle PMSE use cases. 5G features such as low latency and “network slicing” make it possible to manage and prioritize traffic from individual users in order to offer the required level of QoS.

There is however a degree of uncertainty whether the future 5G network providers will really offer tailored services to PMSE users. One prerequisite is that there is an attractive business case for the mobile operators to address this market and also acceptable prices and usage conditions for the PMSE users. Offering these services may be associated with a high cost to make the necessary networks investments, and the prioritization may also affect the service and performance of other customers especially in large events.

In order to analyse the technological and economic feasibility of using 5G technology for PMSE in more detail there is an ongoing joint research project from industry and academia¹⁵.

In addition, for some use cases, video cameras can already operate 4G networks (subject to constraints in load and capacity in mobile networks). The advent of 5G, given its characteristics — in particular it’s low latency and guaranteed quality of service — could present new opportunities for video PMSE.

An alternative in the future for talkback services could be the use of LTE or 5G-Platforms since PMR functionalities are being added to the LTE technology. The

¹⁵ A project funded by German Federal Ministry of Transport and Digital Infrastructure titled the PMSE-xG project started in March 2017: <http://pmse-xg.research-project.de/>

development of a 5G platform for PMSE on a local (private) node basis could also contribute to more advanced technical solutions for example by enabling more sharing and maximising latency advantages.

Monitoring the development in the area of 5G should be fostered – it could have an impact on the long term bandwidth needs of extra spectrum for video PMSE and multichannel Audio PMSE.

As a consequence, the European standardisation organisations could, also in response to the development in the area of 5G, be mandated to develop more technical advanced and standards for equipment, which uses spectrum more efficiently. RSPG therefore also invites manufactures and academia to put more effort in research and development in more efficient techniques for audio and video PMSE. The possibilities of joint efforts in R & D and the possibilities of R & D funding could also be included in programmes like the Horizon 2020 Programme (see also <https://ec.europa.eu/digital-single-market/information-communication-technologies-horizon-2020>).

Improvements in working practices

Especially for the largest events, detailed planning and assistance from a Member State's band manager or administration (both at the design stage and implementation phase of an event), coupled with the adoption by PMSE users of more efficient working practices can be used successfully to achieve high density spectrum usage with minimal impact on the quality of production.

Authorisation regimes vary between Member States and should remain a national prerogative. Whereby mass-market PMSE equipment usually underlies a general authorisation, the solutions to meet peak demand often include on-site coordination by using appropriate national authorisation regimes.

It does not, however, preclude sharing best practices on a larger scale than EU Member States. Such knowledge transfer between spectrum managers would be very helpful in the mitigation of peak demand. Member States are therefore requested to provide this kind of information on the PMSE page¹⁶ of the CEPT site including a best practice platform.

Additional information on PMSE framework at special events and other regulatory aspects may be found in ECC Report 44.

The tuning range concept and frequency bands

Within each tuning range, Member States may assign specific sub-bands or particular frequencies for PMSE links subject to availability, actual demand and sharing

¹⁶ Link to CEPT website on PMSE: <http://cept.org/ecc/topics/programme-making-and-special-events-applications-pmse>

arrangements with primary services using those bands. Ideally, PMSE equipment should be capable of being operated within the whole tuning range and even beyond in order to provide flexibility for operation in different countries.

When considering the spectrum identified for use by PMSE on a tuning range basis, it can appear on initial inspection that there is a large amount of spectrum available. However, PMSE has always shared spectrum with a wide range of services and to manage use, individual licenses can be issued for a specific use on a specific date and at a specific location. The sharing conditions in a given country depend on the regulatory framework of a given application. The available spectrum within the tuning ranges in any particular country is determined on a national basis; each tuning range may be wholly, partially or not available on a given day, in a given location, in a given country. This is part of national expertise which needs to be maintained¹⁷.

For spectrum requirements on a national level that go beyond the harmonised baseline, tuning ranges are identified according to Member States' requirements for both audio and video PMSE. A number of tuning ranges available to audio and video PMSE across Europe and beyond has been recently implemented in the European Communications Office Frequency Information System (EFIS)¹⁸, which provides the relevant information to PMSE users¹⁹. If further needs are identified by Member States, after successful studies within CEPT future additional bands may be added to a voluntary framework in CEPT deliverables in order to encourage manufacturers to develop equipment and to promote availability of frequencies of these bands for PMSE in CEPT countries, thereby fostering harmonisation.

¹⁷ The available spectrum identified for PMSE in CEPT can be found in ERC Rec 25-10.

¹⁸ <http://www.efis.dk/> and <http://www.efis.dk/views2/pmserec2510.jsp>

¹⁹ See an electronic version of the recommendations contained in ERC REC 25-10 and ERC REC 70-03.

Audio PMSE

The most commonly used PMSE audio applications are wireless microphones (handheld and body worn) and in-ear monitoring. Point to point applications such as for example broadcast links or service links as talkback systems²⁰ are also within the range of PMSE applications and often play an important part in the production of programs and special events, but these applications typically use spectrum allocated for other radio services such as PMR, fixed service or SRD. These are only considered as far as they use audio PMSE spectrum.

Frequency demand

There has been significant growth in the use of wireless audio PMSE in the last decade. High-end wireless PMSE audio devices now achieve the very high quality of service required and work as well as wired devices in almost all cases and allow safe freedom of movement by the user. In many cases, such as live outdoor music events, following this considerable rise in device numbers, almost everyone who could be using a wireless audio device is doing so, and so further growth is likely to be gradual. This does not necessarily mean that spectrum demand is increasing. Meeting this demand is highly dependent on better planning and coordination, technological evolution and more efficient use of spectrum.

The PMSE audio applications cover a wide market that range from for example microphones at a school or a conference center to theatres, opera houses, larger concerts and major sporting events. Even though these different market segments and applications often use the same frequency bands, the requirements regarding for example Quality of Service (tolerance in disruption) and bandwidth demand are very different. When addressing the spectrum demand it is very important to consider these differences, and not to treat PMSE audio as one homogenous set of applications.

Mass-market PMSE equipment is typically not used in the events where the peak bandwidth demands occurs, and the conclusion is that the harmonised frequency bands and tuning ranges identified in different CEPT deliverables, including frequency bands assigned to *SRD* and *RLAN/WAS*, satisfy the demand and capacity for this kind of applications.

The frequency bands often used today to meet the peak demand are mainly the UHF-band, and according to national variations also the VHF band, and increasingly the 1800 MHz band.

To meet specific demand, RSPG recognises that Member States may, where possible and appropriate, supplement audio PMSE usage possibilities with spectrum not designated to PMSE, for example frequencies in bands allocated to PMSE in other regions or use of DECT technology.

Commission Implementing Decision for audio PMSE (2014/641/EU) harmonises “at Union level the availability of a baseline of about 60 MHz of sustainable spectrum to meet recurring ordinary needs for wireless audio PMSE equipment users, even if this

²⁰ This refers to definitions in ECC Report 204 and REC 25-10, see <http://www.erodocdb.dk/>

would not cover all possible requirements which may occur”. In addition to the harmonised 800 MHz and 1800 MHz bands, the Commission Implementing Decision for audio PMSE also indicates that such spectrum should be selected from tuning ranges to be decided by Member States, preferably in the 470-790 MHz spectrum range and that the exact amount of spectrum to be either assigned or authorized should depend on the specific demands expressed and may not always require all 30 MHz. In addition, it is concluded that, “spectrum requirements beyond this baseline which may appear in specific geographical areas, such as content production areas or theatre districts, or for large and exceptional events, are best addressed on a case-by-case basis at national level taking into account specific geographical and time constraints”. RSPG confirms these conclusions.

Technological development

RSPG expects the use of digital wireless microphones to become more widespread. Spectral efficiency is likely to be greatly increased but digital PMSE should not be seen as the sole solution. For some PMSE use cases analogue technology still remains an attractive option for some time (e.g. for IEM). RSPG anticipates major improvements in digital but also in analogue audio PMSE technology to enable more efficient use of spectrum, for example in the design of very linear power amplifiers in both radio microphones and IEMs which will improve the reverse intermodulation performance. Some manufacturers are confident that channel widths can be halved (from 200 kHz to 100 kHz)²¹ with no loss of utility/fidelity for high-end productions. They also express confidence that new technology will offer greater channel density based on reduced intermodulation effects and reduced channel spacing.

In previous years the tuning span of many wireless audio devices has been in the region of 24 MHz, but in response to spectrum becoming more fragmented tuning spans are widening with equipment capable of 66 MHz, 75 MHz, or in some cases 200 MHz or more. This extension of span is not strictly an improvement in spectral efficiency, but it can provide technical mitigation of the effects of fragmentation, and an alternative to hiring in more equipment (this is difficult for some PMSE users such as film production, if different equipment for different scenarios is needed).

The widespread availability of equipment with larger tuning ranges will also provide more flexibility for spectrum planning and on-site coordination, which, especially at larger events, could contribute to more frequency efficient solutions.

Ongoing activities in the UHF band

In some Member States, the pressure on spectrum typically used for audio PMSE could shortly become acute due to the repurposing of the 700 MHz band for ECS.

Article 3 of the recent Commission Implementing Decision 2016/687²² specifies the other uses Member States may choose to implement in 700 MHz sub-bands (of which audio PMSE in all or part of 694 – 703 MHz and 733 – 758 MHz remains an option

²¹ referenced in Report by Cambridge Consultants for Ofcom, UK

²² on the harmonisation of the 694-790 MHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services and for flexible national use in the Union

subject to Member States' national decisions). DECISION (EU) 2017/899²³ of the European Parliament and Council sets an implementation deadline for Decision 2016/687 of 30 June 2020 and sets a time limit, that Member States shall adopt and make public their national plan and schedule ('national roadmap'), including detailed steps for making available their plans for re-assigning DTT according to the 700 MHz introduction no later than 30 June 2018. This decision also makes clear that Member States have to ensure availability of the 470-694 MHz ('sub-700 MHz') frequency band for broadcasting and for use by wireless audio PMSE on the basis of national needs at least until 2030. Furthermore this decision also states, that this is to be reviewed by 2025²⁴.

The loss of parts in the 700 MHz band and the re-planning as well as evolution of DTT may influence the amount of spectrum for shared PMSE²⁵ use in different local areas. This also influences whether sufficient UHF spectrum is available on a national level to meet the future peak demands for audio PMSE, which may be different in each Member State.

Manufacturers and users in the PMSE sector are waiting for the national new DTT channel plans to be finalised before making investment decisions, in order to avoid the risk of producing and purchasing equipment in the remaining 470 – 694 MHz band cannot be used in the geographical area of intended use.

Meeting long-term peak demand

The biggest challenge regarding access to spectrum is the peak demand at large events or multiple concentrated events. The frequency band 470 - 694 MHz will, in accordance with Article 4 of DECISION (EU) 2017/899 be available at least until 2030²⁶, and will continue to be an important frequency band for audio PMSE. The long term strategy for the band 470-694 MHz is addressed in the RSPG opinion on a long-term strategy on the future use of the UHF band (470 - 790 MHz) in the European Union and PMSE should be carefully considered in the review expected in 2025.

It should, however, still be considered that there presently exists a contiguous blocks of spectrum (the 470 – 694 MHz band and parts of 694 – 832 MHz) which is widely used for PMSE around the globe, nearly all known manufacturers produce PMSE equipment which uses frequencies in this band.

The VHF band (174 - 216 MHz) is also included in ERC Recommendation 25-10. More intensive use of this band could compensate for the loss of parts of the 700 MHz band by 2020. Some new digital equipment is already available on the market in the

²³ DECISION (EU) 2017/899 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2017 on the use of the 470-790 MHz frequency band in the Union - <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017D0899&from=EN>

²⁴ this also has to be seen in connection with an Agenda item on this topic at WRC-23

²⁵ In some Member States some outdoor locations, such as those where the transmissions from multiple TV transmitters overlap, already have very low availability of spectrum for audio PMSE devices especially in border areas, e.g. for the locations Mörbisch, Bregenz and Salzburg in Austria during the Easter, summer and autumn festivals (mainly outdoor).

²⁶ Reference to Lamy Report - http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=8423

VHF band, which shows the growing interest of PMSE manufacturers and users in this frequency range. However there is a variation in the availability of spectrum, but in countries where DAB/DAB+ is used, the sharing scenario and the regulatory conditions could be considered similar to the UHF-TV band with geographically shared access to spectrum.

There are different views whether UHF spectrum available on a national level post 2020 is enough to meet the future peak demands for audio PMSE. In countries where the UHF band does not offer enough capacity in such context, national solutions may be needed using additional frequency bands where PMSE can be introduced on a shared basis.

ERC Rec 25-10 has recently been updated with a number of suitable bands for the introduction on European Scale for long term stability. Noting the current national difference in availability of the identified tuning ranges, and the long term regulatory status of the UHF band for PMSE use, RSPG supports further work in CEPT aimed at identifying new Sub 2 GHz (appropriate characteristics for audio PMSE) spectrum for audio PMSE applications operating on a sharing basis.

This view is in line with the Opinion on a long-term strategy on the future use of the UHF band (470 – 790 MHz) in the European Union²⁷ which concluded that “In the case the capacity in the available bands will not be sufficient to address the requirements of the PMSE applications, a timely identification of additional spectrum for PMSE is required as part of this long term strategy”.

Member states have implemented the commission implementing decision (2014/641/EU of 1 September 2014) on harmonized technical conditions of radio spectrum use by wireless audio programme making and special events equipment in the Union. This decision indicates that the requirements for social and cultural events will often exceed the amount of 29 MHz available in the duplex gaps of the 800 MHz and 1 800 MHz bands. Member states should therefore provide up to an additional amount of 30 MHz to meet possible demand for wireless audio PMSE applications at social and cultural events. Such spectrum should be selected from tuning ranges to be decided by Member States, preferably in the 470 - 790 MHz spectrum range.

At this stage, the UHF band remains the key band for audio PMSE and its use is secured until 2030 following the EC decision (DECISION (EU) 2017/899 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2017 on the use of the 470-790 MHz frequency band in the Union). ECC has considered the future of the UHF band in ECC report 224, which recommends that administrations should consider within the context of the national legal and regulatory framework, when deciding on a particular scenario for the use of the band 470 - 694 MHz

Taking this into account RSPG recommends that the situation for PMSE should be reviewed around 2025. This should take into account further information with regards to the existing users of the bands, consider the progress of PMSE technology as projected in this Opinion (i.e. wider set of tuning ranges, increase of efficiency and flexibility in sharing, cognitive capabilities, impact of 5G etc.) as well as demand evolutions including the need for maintaining or identifying relevant spectrum for

²⁷ RSPG 15-595 Final of 19 February 2015

PMSE. In particular, the strategy to identifying solutions for audio PMSE frequency use should be considered, taken into consideration aspects such as:

- Potential for widespread adoption on a global level (in order to achieve economies of scale)
- Sub 2 GHz (suitable for audio PMSE)
- The request from the PMSE community for Long term stability and regulatory certainty).

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Video PMSE

This section of the RSPG Opinion covers PMSE applications where video signals are transmitted. The most commonly used applications are wireless cameras and video transmissions in terms of portable, mobile or temporary point to point radio links.

Growth in video PMSE at the largest events has been steady, but as the technology matures users are taking advantage of increasing reliability and more affordable prices of wireless cameras.

Televised live sport currently drives demand for video PMSE and these events usually see the highest simultaneous number of wireless video devices (mainly wireless cameras) in use. Almost all broadcast sport crucially relies on offering the viewer a 'ringside seat' that wireless video can offer, and this now being the established norm, viewers' expectations for this 'first-person' or 'point of view' content have been set, driving future demand.

Sport is forecast to act as a driver for growth over the next decade but there are also new production formats and trends which are appearing in the area of light entertainment. One example is 'cross over shows' which increase the requirement for content capture.

In all cases, high definition video is supported today, with a high probability that Ultra-High Definition (UHD with '4k' or higher) radio cameras will be required within the next decade.

Technological development

Wireless camera equipment is being developed which will be more spectrally efficient and should be available within the next few years, with codec technology improving roughly in step with the demand for increasing resolution. In addition, tuning ranges for wireless camera equipment are typically far broader than for audio PMSE and often offer tuning ranges between 500 – 700 MHz. This means that video PMSE equipment is in general able to operate in several core tuning ranges made available across the Member States.

Frequency demand

Commission Implementing Decision 2016/339/EU harmonises the 2010 - 2025 MHz frequency band for video PMSE. RSPG confirms that this EC decision does not need to be modified in response to the national needs. Due to the local and temporary nature of PMSE demand, RSPG believes that requirements beyond this harmonised spectrum are best addressed on a case-by-case basis on a national level using the "tuning range concept" developed by CEPT. Further harmonisation work on EU level is not necessary.

The harmonised frequency bands and tuning ranges identified in different CEPT deliverables, including frequency bands assigned to SRD and RLAN/WAS, satisfy the demand and capacity for most kind of applications. Having also in mind, that video PMSE equipment used at peak demand events is typically low volume niche market

products, RSPG believes that further mandatory harmonisation measures are not necessary. Current equipment often operate over large tuning ranges which are typically wide enough to adapt to various situations in Member States. In order to have enough flexibility to meet peak demand RSPG encourages to use equipment with larger tuning ranges.

If further needs are identified by Member States, after successful studies within CEPT in the future additional bands may be added to the CEPT deliverables in order to encourage manufactures to develop equipment and to promote availability of frequencies of these bands for PMSE.

Initial discussion in CEPT consider the frequency tuning ranges identified in ERC Recommendation 25-10 for cordless cameras, portable video links and mobile video as one possibility for Unmanned Aircraft Systems (UAS) video downlinks. The feasibility of this option and the potentially considerable impact on PMSE in the use of spectrum in future will be analysed by CEPT in more detail.

In some Member States certain sub bands within the 2 GHz range could be subject to some evolution of use at national level. In these Member States there may be a need to maintain national flexibility enabling continued use of video PMSE to respond to spectrum demand in this core frequency range. They can also take into account the CEPT technical studies and guidelines on sharing between video PMSE and the different incumbent usage.

One part of the long term solution to manage the PMSE video frequency demand could be to consider greater use of higher frequency bands on a national level. ERC REC 25-10 includes several larger bands above 7 GHz (in particular in the 7-11 GHz range) that may be (or are already) made available for PMSE. Peak demand events place significant stress on spectrum in the core video PMSE bands in the 2 GHz range and this demand may be difficult to meet. Due to propagation characteristics some use cases require sub 3 GHz frequencies²⁸, but for other use cases with line of sight (LOS) or short distance the usage of higher bands would be possible. This would require investments in new equipment, but for PMSE users this could be an attractive solution to have easy access to large bandwidths for some of their communication needs. One example of this is Formula One (Grand Prix) motor racing, which represents one instance of peak demand. Decisions taken by the organisers to develop equipment which operates in higher frequencies above 7 GHz, is expected to ease pressure on the core video PMSE bands.

To meet specific short-term peak demand, RSPG recommends that Member States should continue to supplement video PMSE use possibilities with spectrum not designated to PMSE on a national level, where possible and appropriate.

²⁸ Applications where the transmission path is longer or may be liable to obstruction by trees or buildings, for example, video links from helicopters and from motorbikes or other moving vehicles.

RSPG recommendations

The RSPG confirms its previous analysis (see RSPG report on sectoral needs and RSPG Opinion on RSPP) and developed additional recommendations on top of these deliverables.

In assessing the spectrum requirement for PMSE, it must be borne in mind that PMSE demand is mainly time and location specific. Meeting peak demand becomes especially difficult at large events where spectrum is required simultaneously by many users both at the same time and location. As well as large events, peak demand may also be experienced in certain locations such as studio complexes or where there is a high density of production venues (such as for example theatres²⁹). We expect to see a continuing growth in wireless use for both audio and video in general. Given the growing demand for wireless PMSE in general, this does not necessarily mean that spectrum demand is increasing to the same extent. This assumes that technological evolution, more efficient usage of spectrum and/or better planning and coordination on a national level, are also implemented, to mitigate the increase spectrum demand. Therefore, this opinion provides punctual information, which can be used in isolation or in combination to respond to the peak demand at national level.

RSPG welcomes the current trend that PMSE equipment is capable of being operated within larger tuning ranges, which provides flexibility for operation in different countries and ensures a more efficient local planning at national level. RSPG encourages users to use this kind of equipment especially for peak demand events.

In general, RSPG is of the view, that technology advances will contribute meeting the peak spectrum demand for both audio and video PMSE. It will also improve the spectrum efficiency of PMSE and enable more efficient sharing with a wider range of users, technologies and applications. RSPG encourages the PMSE industry to continue its development of more advanced and spectrally efficient technologies, including digital ones, to better use the available spectrum and to implement these technologies in ETSI harmonised standards which may benefit from R&D funding of PMSE related industries development. RSPG invites manufactures and academia to put more effort in research and development in more efficient techniques for audio (and video) PMSE. Possibilities could be included in programmes such as the Horizon 2020 Programme³⁰ or subsequent ones). RSPG also believes that especially in case of peak demand events operational advances such as more detailed planning, better on-site coordination and assistance by Member States coupled with the adoption by PMSE users of more efficient working practices can be used successfully to achieve high density spectrum usage with minimal impact on the quality of production. In

²⁹ for example of where there is a high density of theatres e.g. Berlin, Paris, Vienna or West End, London

³⁰ see also <https://ec.europa.eu/digital-single-market/information-communication-technologies-horizon-2020>

order to support improved working practices and use of spectrum resources, RSPG recommends Member States to continue to contribute information to the current CEPT Portal³¹. RSPG further encourages greater prominence of detailed information of frequency bands, contact points and authorisation, which are available at national level for PMSE and best practices on meeting national peak demands in special cases.

The RSPG recognizes that long-term regulatory certainty and visibility on spectrum access is desired by PMSE manufacturers and users in order to decide on investment and is a consideration in product development and improvement.

5G may be able to technically support PMSE use cases. Therefore, RSPG recommends exploring the development of 5G and its potential for PMSE.

Audio PMSE

Commission Implementing Decision for audio PMSE (2014/641/EU) harmonises “at Union level the availability of a baseline of about 60 MHz of sustainable spectrum to meet recurring ordinary needs for wireless audio PMSE equipment users, even if this would not cover all possible requirements which may occur”. It further concludes that spectrum requirements beyond this baseline are best addressed on a case-by-case basis on a national level. RSPG confirms these conclusions and recommends to use the “tuning range concept” developed by CEPT for this purpose.

The mass-market PMSE equipment is typically not used in the events where the peak bandwidth demands occurs, and the conclusion is that the harmonised frequency bands and tuning ranges identified in different CEPT deliverables, including frequency bands assigned to SRD and RLAN/WAS, satisfy the demand and capacity for this kind of applications.

The frequency bands often used today to meet the peak demand are mainly the UHF-band and, according to national variations, also the VHF band and, occasionally the 1800 MHz band.

The RSPG expects that the use of digital wireless microphones will become more widespread, but analogue technology remains attractive for some time for certain PMSE use. Main improvements in spectrum efficiency are expected for digital audio PMSE but also analogue audio PMSE will be subject to further improvements.

The RSPG recognises that the removal of PMSE use in parts of the 700 MHz band and the re-planning and evolution of DTT in countries may influence the amount of spectrum for shared PMSE use in different local areas in the UHF band. Availability of spectrum in the UHF band across Member States will depend largely on a nation’s individual approach to DTT re-planning and, by extension, how much usage

³¹ <http://cept.org/ecc/topics/programme-making-and-special-events-applications-pmse>

possibilities are available for PMSE. According to Article 5 of DECISION (EU) 2017/899³² OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2017 on the use of the 470-790 MHz frequency band in the Union Member States shall adopt and make available their 'national roadmap' for re-planning of DTT in the UHF band by 30 June 2018.

The frequency band 470-694 MHz will, in accordance with Article 4 of DECISION (EU) 2017/899, continue at least until 2030 to be an important frequency band for audio PMSE. The long term strategy for the band 470-694 MHz is addressed in the RSPG opinion on a long-term strategy on the future use of the UHF band (470-790 MHz) in the European Union and needs to be subject to review according to the Lamy Report³³ by 2025. In this review the positioning of PMSE needs to be considered carefully.

There are different national views whether UHF spectrum available on a national level post 2020 is enough to meet the future peak demands for audio PMSE. In a timeframe after 2020, having in mind the other developments in the UHF band, the current national availability of the tuning ranges mentioned in CEPT deliverables and the future technical advances and varying availability of frequency bands, there could be a need to identify further spectrum within CEPT for audio PMSE on a shared basis.

Taking into account the review of the situation of the UHF band according to Decision (EU) 2017/899, RSPG recommends that the situation for PMSE should be reviewed around 2025. This should take into account further information with regards to the existing users of the bands, consider the progress of PMSE technology as projected in this Opinion (i.e. wider set of tuning ranges, increase of efficiency and flexibility in sharing, cognitive capabilities, impact of 5G etc.) as well as demand evolutions including the need for maintaining or identifying relevant spectrum for PMSE. In particular, the strategy to identifying solutions for audio PMSE frequency use should be considered, taken into consideration aspects such as:

- Potential for widespread adoption on a global level (in order to achieve economies of scale)
- Sub 2 GHz (suitable for audio PMSE)
- The request from the PMSE community for Long term stability and regulatory certainty).

³² DECISION (EU) 2017/899 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2017 on the use of the 470-790 MHz frequency band in the Union - <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017D0899&from=EN>

³³ Reference to Lamy Report - http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=8423

Video PMSE

Commission Implementing Decision for video PMSE (2016/339/EU) harmonises the frequency band 2010-2025 MHz for video PMSE on an EU level. RSPG confirms that this EC decision does not need to be modified in response to national needs. Due to the local and temporary nature of PMSE demand, RSPG believes that requirements beyond this harmonised spectrum are best addressed on a case-by-case basis on a national level using the “tuning range concept” developed by CEPT.

To meet specific short-term peak demand, RSPG recommends that Member States should continue to supplement video PMSE usage possibilities with spectrum not designated to PMSE on a national level, where possible and appropriate.

The harmonised frequency bands and tuning ranges identified in different CEPT deliverables, including frequency bands assigned to SRD and RLAN/WAS, satisfy the demand and capacity for most kind of applications. RSPG therefore believes that further mandatory harmonisation measures are not necessary since the current equipment often operate over tuning ranges which are typically wide enough to adapt to various situations in Member States. In order to have enough flexibility to meet peak demand RSPG encourages that the tuning range of future equipment should be further increased.

If further needs are identified by Member States, additional bands may, after successful studies within CEPT, be added to the voluntary framework in CEPT deliverables in order to encourage manufactures to develop equipment and to promote availability of frequencies of these bands for PMSE. Further harmonisation work on EU level is not necessary.

In some Member States certain sub bands within the 2 GHz range could be subject to some evolution of usage at national level. In these Member States there may be a need to maintain national flexibility enabling continued usage of video PMSE to respond to spectrum demand in this core frequency range. They can also take into account the CEPT technical studies and guidelines on sharing between video PMSE and the different incumbent uses.

For certain video PMSE applications if required on a national level, RSPG encourages the utilisation of the additional tuning ranges of higher frequencies above the current core video PMSE bands in the 2 GHz range (in particular from around 7 GHz and above). This would reduce the demand on the core video PMSE bands in the 2 GHz range.

ANNEX 1 - List of References

- [1] 2014/641/EU: Harmonised technical conditions of radio spectrum use by wireless audio programme making and special events equipment in the Union
- [2] 2016/339/EU: The harmonisation of the 2 010-2 025 MHz frequency band for portable or mobile wireless video links and cordless cameras used for programme making and special events
- [3] 2016/687: Harmonisation of the 694-790 MHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services and for flexible national use in the Union
- [4] RSPG Opinion on the Radio Spectrum Policy Programme
- [5] RSPG Report on Strategic Sectoral Spectrum Needs
- [6] CEPT Report 51: Technical conditions for ensuring the sustainable operation of cordless video-cameras.
- [7] ERC/REC 25-10: Frequency ranges for the use of terrestrial audio and video Programme Making and Special Events (PMSE) applications
- [8] ERC/REC 70-03 Relating to the use of Short Range Devices (SRD)
- [9] ECC Report 44: In response to the EC Permanent Mandate on the "Annual update of the technical annex of the Commission Decision on the technical harmonisation of radio spectrum for use by short range devices
- [10] ECC Report 204: Spectrum use and future requirements for PMSE
- [11] RSPG Opinion on a long-term strategy on the future use of the UHF band (470-790 MHz) in the European Union
- [12] DECISION (EU) 2017/899 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2017 on the use of the 470-790 MHz frequency band in the Union
- [13] Lamy Report: Report of Mr Pascal Lamy

ANNEX 2 - LIST OF ABBREVIATIONS

Abbreviation	Explanation
4G	4 th generation mobile networks
5G	5th generation mobile networks or 5th generation wireless systems
CEPT	European Conference of Postal and Telecommunications Administrations
C-PMSE	Cognitive - Programme Making and Special
DAB/DAB+	Digital Audio Broadcasting
DTT	Digital Terrestrial Television
EC	European Commission
ECS	Electronic Communication Systems
EFIS	ECO Frequency Information System
ENG	Electronic News Gathering
ETSI STF 259	Task Force 259 extension (TC ERM / TG 35) on “Measurement uncertainties and Test methodologies 1 GHz to 40 GHz
IEM	In Ear Monitor
IMT	International Mobile Telecommunications
ISM	Industrial, Scientific and Medical applications
LTE	Long Term Evolution
PMSE	Programme Making and Special Events
PMR	Private/ Professional Land Mobile Radio
QoS	Quality of Service
RLAN /WAS	Radio Local Area Networks / Wireless Access Systems
RSPG	Radio Spectrum Policy Group
SAB	Services Ancillary to Broadcasting

SAP	Services Ancillary to Programme making
SNG	Satellite News Gathering
SRD	Short Range Devices
UHF	Ultra High Frequency
UHD	Ultra-High Definition
VHF	Very High Frequency
WGFM	Working Group Frequency Management of CEPT/ECC
WMAS	Wideband Multichannel Audio Systems

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ANNEX 3 - Summary of results – Public Consultation

... [to be included]

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