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IMPACT ASSESSMENT

Accompanying the document

Commission Implementing Decision

**on harmonised technical conditions for radio spectrum use by wireless audio
programme making and special events equipment in the Union**

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Executive Summary Sheet

Impact assessment accompanying a proposal on "harmonised technical conditions of radio spectrum use by wireless audio programme making and special equipment in the Union"

A. Need for action

Problem definition

UHF (ultra-high frequency) spectrum in the 470-862 MHz spectrum range is most valuable due to its technical characteristics. It is licensed for broadcasting and mobile services whose networks leave some portions of spectrum unused ('white spaces'). These are used by programme making and special events (PMSE) applications, mainly wireless microphones. Wireless audio PMSE users are not protected from harmful interference and there is no guarantee for a minimum amount of available, usable spectrum.

All three services' spectrum demand is growing. Broadcasting technologies have evolved and reduced white spaces and wireless broadband was introduced in the 800 MHz band leaving only an unused part of spectrum (duplex gap) available to PMSE. The growing possibility of extension of wireless broadband below 790 MHz and likely further densification of broadcasting networks will reduce spectrum availability for wireless audio PMSE even further. No common core band for wireless audio PMSE is harmonised throughout the EU. Consequently, this sector lacks economies of scale for manufacturing, and R&D.

Objectives

This policy initiative aims to:

- Ensure a long-term adequate amount of spectrum to meet average daily needs of wireless audio PMSE;
- Strengthen the single market for wireless audio PMSE equipment and use, leading to economies of scale and encouraging research and innovation to improve efficient use of spectrum;
- Ensure an acceptable interference-free operation of PMSE applications in the assigned spectrum;
- Avoid reservation of spectrum that might be left unused so as to use spectrum efficiently.

Value added of action at the EU level

EU action would identify a core band to meet some of the wireless audio PMSE needs with spectrum currently underused. This band would be common, so the same equipment can be used Union-wide, leading to economies of scale and fostering research and development. Equipment operating on this band would be sufficient for users with small spectrum needs. An EU measure would provide clarity and long-term certainty of a baseline amount of available spectrum.

B. Solutions

Legislative and non-legislative policy options considered and preferred choice

Option 1: baseline scenario/no regulatory change

Facing the reduction of 'white spaces', users will incur costs to replace their equipment without the certainty of a sustainable solution. Member States' uncoordinated solutions will lead to further fragmentation in spectrum use for wireless audio PMSE outside the UHF band.

Option 2: Common tuning ranges

Member States will be requested to make available at least 60 MHz of spectrum for wireless audio PMSE within specific tuning ranges aligned to a non-binding recommendation by the European Conference of Postal and Telecommunications Administration (CEPT). There is no guarantee of a common Union-wide core band, thus neither economies of scale nor research and development are promoted.

Option 3: Harmonised Spectrum availability added to tuning ranges

The Commission will harmonise 29 MHz of core bands (the 800 MHz and 1800 MHz duplex gaps) for wireless audio PMSE use. Member States will have to make available another 30 MHz within specific tuning ranges, aligned with the recommendation by CEPT.

Option 3.1: Harmonised Spectrum availability added to tuning ranges available based on demand

Option 3.1 addresses the concerns on the usability of the duplex gaps thus providing more value to the harmonised bands. An additional 30 MHz will only have to be made available based on demand to the extent required, preferably in the 470-790 MHz range.

Option 3.1 is the preferred option because it:

- ensures an Union-wide, sustainable core harmonised band facilitating economies of scale and research and development;
- provides users with additional spectrum – if needed – preferably in the UHF band;

- addresses the usability of the duplex gaps;
- facilitates Union-wide usability of equipment and hence cross-country equipment sales and PMSE operations;
- offers flexibility to Member States and thus respects proportionality and subsidiarity.

Who supports which option

Based on extensive stakeholder consultation, a contracted study and other studies:

- Users question the amount of spectrum left available in the UHF band and its usability, they demand not to be completely squeezed out of their current use;
- Manufacturers clearly express a need for harmonised spectrum to benefit from economies of scale;
- Member States were consulted via the VVA study and the Radio Spectrum Committee. Initially expressing preference for tuning ranges (option 2), over half support the approach of option 3.1.

C. Impacts of the preferred option

Costs and benefits of the preferred option

The cost of the baseline in a timeframe of 5-10 years, is calculated at 496 million euros for the users (mainly unavoidable equipment renewal costs), due to the on-going changes in spectrum use in the UHF band. Costs for manufacturers are 11 million euros. The preferred option 3.1 will reduce those costs by:

Option value compared to no action at an EU-level (option 1)	Users	Manufacturers	Regulators	Total
Option 3.1 (<i>Harmonised frequencies and additional spectrum;</i>) amounts in euros	64 million	14 million	4 thousand	78 million

It should be noted that the full benefits of this option will be higher when considering the cultural and social benefits which result from being able to maintain the quality of performances due to a long-term accessibility of sustainable spectrum for their equipment. This benefit is not quantifiable due to lack of market data.

How will businesses, SMEs and micro-enterprises be affected

The majority of multinational manufacturers and distributors of audio PMSE equipment, active on both wired and wireless PMSE equipment, are SMEs or a division of larger electronics manufacturers. This measure will provide manufacturers with long-term frequencies to focus their R&D efforts and will generate economies of scale, thus lowering production costs and prices for users (especially non-intensive users).

Many professional users in the content and cultural sector are SMEs and micro-enterprises which will benefit from an assurance of sufficient and usable spectrum to meet their average daily needs. Larger users in critical indoor scenarios might run the risk of interference from LTE emissions in nearby bands. This risk can be tackled through several options based on size, budget, location, physical characteristics and creative choices.

Impacts on national budgets and administrations

The calculated effects (mainly licensing costs) vary between 5,000 and 20,000 euros for all Member States. Collecting data on spectrum demand and actual use is already a requirement under Decision 2013/195/EU on the spectrum inventory.

Other significant impacts

A single European market could have spill-over effects and lead other countries to adopt the European frequencies, thus becoming effectively part of the same market from the manufacturers' viewpoint.

D. Follow up

Policy review

Very limited data exists on this market in terms of units, revenue, spectrum access demand etc. so the Commission proposes to monitor the impact of the proposed measures through continued stakeholder consultation and potentially review these measures if new developments in this dynamic sector were to change the situation. The Commission proposes an evaluation of this initiative 3 years after its adoption.

1. INTRODUCTION

The term programme making and special events (PMSE) covers a wide variety of audio and video applications which support broadcast content making and special events - 30% and 70% of PMSE usage respectively¹. The use of PMSE equipment is essential for the production of programs like news coverage as well as the performance and documentation of social and cultural events such as theatrical performances. There is a wide range of events supported by PMSE equipment, varying from local to Union-wide touring events and run by both professional and non-professional users. Practical examples of PMSE equipment use can be found across many different activities: TV and radio production including news coverage; sports coverage, political and other national events; business conferences, industrial shows and exhibitions; schools and universities, live music and performances; theatres and other stage performances; concerts and musicals as well as small non-professional uses such as local associations and religious gathering, education and training institutions and amateur production (see Annex 11.8 for an example of professional user categories). Beyond the immediate scope of the wireless audio PMSE sector (manufacturers and users), there is a broader cultural and social field which represents significant economic turnover and high employment.

Such productions and events are supported by wired and/or wireless PMSE systems. In terms of type of applications, wireless audio and video PMSE applications are distinct, because wireless audio uses narrow portions of spectrum in lower frequency bands, while video uses broader portions in higher frequency ranges. Wireless audio PMSE applications include wireless microphones and associated systems like in-ear monitors (IEMs), talk-back systems and audio links².

This Impact Assessment focuses on the wireless audio PMSE while the full assessment of the wireless video applications market will require further studies and stakeholder consultation.

Figure 1 – Functioning of PMSE equipment



Source: Joint Research Centre, *PMSE System Operation in the 800 MHz LTE duplex gap* (2014)

¹ (CEPT Report 32, 2009), p. 6.

² An intercom system used in recording studios to enable personnel to communicate with people in the recording area and an audio connection of two different points.

A wireless audio PMSE equipment set is composed of a microphone, a transmitter, and a receiver as illustrated in Figure 1. The microphone captures the sound, converts it to a radio signal and sends it to the transmitter (often found in the body of the microphone) which then broadcasts this signal over radio frequencies, through an antenna. Wireless transmitters require a battery to operate just like any other wireless equipment. The receiver then ‘picks up’ the signal from the radio frequencies and changes it back into an audio signal that is then heard. Each wireless system used at a particular location (a theatre or school, for example) must operate on a different frequency to avoid interference with other systems operating nearby. If two performers at one location try to use the same frequency at the same time, neither one will have a clear signal, i.e. there will be interference.

The requirements of wireless audio PMSE users vary greatly across different times and locations mostly depending on the type and the scale of the event or program. Also, the wireless audio PMSE needs for spectrum in different Member States will differ due to different size and density of population and the extent of social and cultural activities. Therefore, PMSE use of spectrum has historically been managed by Member States on a case-by-case basis at the national or local level by making frequencies available to wireless audio PMSE users.

Wireless audio PMSE applications in most of the Member States predominantly use parts of the ultra high frequency (UHF) band in the 470-862 MHz spectrum range³ for technical and operational reasons which make this band the ideal spectrum location for many applications. Wireless audio PMSE applications historically operate in the ‘white spaces’ of the UHF band. These ‘white spaces’ are portions of spectrum which TV broadcasting, the licensed user in most of the UHF band, leaves unused in a certain location or timeframe for technical reasons. Of the overall UHF band which amounts to 392 MHz only the ‘TV white spaces’ are available to wireless audio PMSE users on ‘non protection - non-interference’ basis⁴. The locations of the white spaces differ between different geographical locations (see Annex 11.2).

Spectrum availability for wireless audio PMSE users is expected to reduce significantly in the UHF band due to growing requirements of all services currently using this band. Audio-visual and broadband services are licensed services in the UHF band and in particular the latter pay significant fees to access spectrum. On the other hand, PMSE use in Member States is licence-free (licence exempt or general authorisations) or based on coordinated access to spectrum with no or minimal fees.

With this proposal for a harmonisation the Commission aims to provide a baseline of available spectrum for wireless audio PMSE requirements for the benefit of social and cultural events and hence cultural diversity, create the conditions for a single market to generate economies of scale, and improve efficient use of spectrum. Given the temporary and locally variable nature of wireless audio PMSE spectrum requirements, not all users will be affected in the same way so the aim of this initiative is not to satisfy all audio PMSE spectrum requirements. In line with the principles of proportionality and subsidiarity, this initiative aims to address the daily ordinary events.

³ In this document ultra high frequency (UHF) band is intended as the range from 470 to 862 MHz, which is the common usage of this term in European spectrum policy.

⁴ Their usage cannot cause harmful interference to authorised users of that spectrum and they have no guarantee of protection from harmful interference from other users, licensed or not.

2. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

2.1. Identification

This Staff Working Paper presents the impact assessment accompanying the Commission's proposal on "the harmonised technical conditions for radio spectrum use by wireless microphones and associated applications for programme making and special events (wireless audio PMSE equipment) in the Union". The main aim of this document is to assess the impact of the potential introduction of such Union-wide harmonised spectrum on users, manufacturers and Member States.

This Staff Working Paper was prepared by the unit 'Spectrum' of Directorate B 'Electronic Communications Networks and Services' of Directorate General 'Communications Networks, Content and Technology'.

The RWP reference of this initiative is 2012/CNECT/012.

2.2. Organisation and timing

Other services of the Commission with a policy interest in the subject have been associated in the development of this analysis. The Impact Assessment Steering Group was drawn from the existing Spectrum Inter-Service Group and the invitation was sent to several units of DG CONNECT as well as the Legal Service, the Secretariat General, DG ENTR, DG EAC, DG SANCO, DG RTD, DG COMP and the Joint Research Centre (JRC).

The Impact Assessment Steering Group met for the first time on the 7th June 2013 to discuss a draft version of the impact assessment. Other units in DG CONNECT, namely Converging Media and Content (G1) and Knowledge Sharing (02) as well as the Secretariat General were represented at the meeting and provided their input and comments.

A second Impact Assessment Steering Group meeting took place on the 12th July 2013 during which the Commission services discussed the proposed options and the additional testing required to evaluate the potential interference from electronic communications to wireless audio PMSE applications.

A third and final Impact Assessment Steering Group took place on the 9th December 2013 to discuss the tests conducted by the JRC and the latest questions and comments before the impact assessment was finalised. Further comments were received by DG CNECT 02, SEC GEN, DG ENTR and DG EAC.

2.3. Impact Assessment Board

A first draft was discussed at the impact assessment board meeting of 5 February 2014. The Impact Assessment Board issued a negative opinion; their recommendations were to clarify the problem and the options with less technical language and provide more detail on the assessment of options. These general recommendations as well as more punctual comments were reviewed carefully and the impacts were presented for the non-expert reader. Finally, the value of harmonisation and how option 3.1 is appropriate to address the needs of the different stakeholders and prevent fragmentation of the internal market was explained more clearly. The impact table was modified to better reflect these

clarifications and a revised version was submitted to the Impact Assessment Board on 1 April 2014.

The revised impact assessment received a positive opinion from the Impact Assessment Board, who provided some additional comments. The main recommendations were to further sharpen the problem definition, improve the presentation of the options and the assessment of the impacts. Table 1 was revised to better differentiate problems, drivers and consequences. The presentation of the options was further clarified to avoid repetition with the impacts section. Finally the impact analysis was strengthened with a visual representation of all dimensions being considered and a more clear explanation of the benefits of option 3.1.

2.4. Consultation and expertise

2.4.1. External expertise used

The European Commission sought for external expertise on the technical field as well as on the socio-economic impacts of a possible spectrum harmonisation regarding wireless microphones (Annex 11.3).

The European Commission issued mandates to the European Conference of Postal and Telecommunications Administrations (CEPT) in April 2008⁵ and December 2011⁶ requesting for a recommendation for a sustainable solution for existing PMSE services operating in the UHF band (470-862 MHz) concerning technical conditions and spectrum harmonisation options for wireless microphones respectively. In March 2013 CEPT presented Report 50, which concludes that the bands 821-832 MHz and 1785-1805 MHz (800 MHz and 1800 MHz duplex gaps) are appropriate for the development of harmonized technical and operational conditions for PMSE audio applications in Europe. The report concluded that the operation of wireless microphones in the 'duplex gaps', would generally not be constrained by interference but that interference-free operation may not be guaranteed in all PMSE usage scenarios, e.g. indoor. Therefore it was noted the usability of the bands under consideration for wireless radio microphones requires further study. An Addendum to CEPT Report 50 concluded that setup procedures (spectrum management) are required for interference-free operation of wireless microphones and in-ear monitor links. The risk that the PMSE channel in use may not remain free of interference throughout the event was noted. Also, separation is required between wireless audio PMSE and MFCN (Mobile and Fixed electronic Communications Networks) applications, in particular when MFCN picocells⁷ and user equipment (smart phones) using frequency bands close to those in use by the PMSE receiver operate in close vicinity to one another (e.g. same room scenario).

These CEPT conclusions and concerns regarding the usability of both duplex gaps expressed by stakeholders' in several instances of the consultation process, led the

⁵ Second Mandate to CEPT on technical considerations regarding harmonisation options for the digital dividend in the European Union, RSCOM08-06 final.

⁶ Mandate to CEPT on technical conditions regarding spectrum harmonisation options for wireless radio microphones and cordless video-cameras (PMSE equipment); adopted at RSC#38 on 15 December 2011, RSCOM11-59 final

⁷ A picocell is a small cellular base station typically covering a small area, such as in-building. In cellular networks, picocells are typically used to extend coverage to indoor areas where outdoor signals do not reach well, or to add network capacity in areas with very dense phone usage.

Commission to ask DG Joint Research Centre to perform technical tests on PMSE-MFCN coexistence in particular when using LTE⁸ technology. The JRC testing focused on using small cells in indoor social and cultural locations, such as theatres, live performances and musicals, to redirect smart phone services from the 800 MHz and 1800 MHz duplex gaps to higher frequency bands (e.g. 2.1 and 2.6 GHz). These technical tests were conducted by the JRC in collaboration with stakeholders from the PMSE sector represented by Association of Professional Wireless Production Technologies (APWPT) and the mobile industry represented by the GSM Association⁹. In summary the result of the test indicated that:

- Potential interference to PMSE equipment from LTE technology, identified in previous measurements¹⁰, was confirmed;
- Deployment of LTE picocells to redirect traffic to frequency bands other than the 800 MHz and 1800 MHz bands can avoid or reduce interference from active LTE user equipment (smart phones) to PMSE if appropriate set-up procedures and technical arrangements are observed.

Beside the technical external expertise the Commission contracted a study on the "Assessment of socio-economic impact of spectrum harmonisation regarding wireless microphones and cordless video-cameras (PMSE equipment)" (SMART 2012/0019). The study was conducted by Valdani Vicari Associates (VVA) and was aimed to assess the socio-economic impact of different policy options taken into consideration. It should be noted that the objective of this study was not to estimate the total value of PMSE (and/or compare it to other industries), but to determine whether a Commission's proposal would have a positive impact (i.e. to conduct a cost-benefit analysis, not a net present value analysis) relative to the likely developments in the absence of such an intervention. Further details on this study as well as the link where the final report can be accessed are provided in Annexes 11.3 and 11.9.

2.4.2. Stakeholder consultations

The Commission has consulted stakeholders on the issue of PMSE applications since 2010. The main sectorial associations, the Association of Professional Wireless Production Technologies (APWPT) and the Performing Arts Employers' Associations League Europe (Pearle) have been consulted and invited to express their opinions and participate in different events.

Workshops with stakeholders were held in October 2010 (on "A long term approach to radio spectrum for PMSE in Europe"), June 2013 (on the "Study on socio-economic aspects of spectrum harmonisation for PMSE equipment") and February 2014 ("PMSE Stakeholders Workshop"). The outcomes and conclusion of those workshops are described in Annex 11.3.

⁸ Long Term Evolution, is a standard for wireless communication of high-speed data for mobile phones and data terminals (commonly referred to as "4G" as it builds upon the GSM/EDGE ("2G") and UMTS/HSPA ("3G") generations of network technologies

⁹ The GSM Association is an association of mobile operators and related companies devoted to supporting the standardising, deployment and promotion of the GSM mobile telephone system

¹⁰ IRT, APWPR/DKE, BNetzA, Ofcom UK, the Norwegian Post and Telecommunications Authority

A public consultation was held from May to August 2012 in order to collect stakeholders' views on the potential introduction of Union-wide harmonisation of spectrum and the conditions for making it available. In addition to the explanations regarding the Commission's views on this policy subject, the call contains a questionnaire for the collection of socio-economic information and views from all interested parties in the field of PMSE equipment. In line with the Commission's minimum standards, the public consultation was published on the DG INFSO (now CONNECT) webpage and was brought to the attention of the Radio Spectrum Committee (RSC) and the Radio Spectrum Policy Group (RSPG) Members as well as to the attention of CEPT (FMWG PT51¹¹). The call was open to all interested stakeholders from 24 May to 21 August 2012; responses received up to 24 August were included in the outcomes, so for a total of over 13 weeks. The call included a summary of the context, scope and objectives of the consultation, including a description of the specific issues open for discussion or questions with particular importance for the Commission. The call clearly indicated details and deadlines. The purpose of the call included references to the impact assessment and to the CEPT Mandate on PMSE. In Annex 11.3 details on the outcomes of this public consultation are provided.

2.4.3. Radio Spectrum Committee

The Commission presented the information obtained from the consultation process described above to Member States and observers in several RSC¹² meetings. Representatives of APWPT and Pearle presented their views in the RSC#37 and Member States were invited to express their views with regard to the out-of-band interference problems.

A potential Commission Implementing Decision would be adopted via a comitology procedure so such preliminary discussions with Member States aim to reach an agreement on the initial concept of such a measure. The Commission presented the preliminary elements of a potential Implementing Decision based on option 3.1 at RSC#46. Member States were asked to respond in writing to such a proposal. 18 Member States replied in writing of which 16 indicated to be supportive of an EU measure providing a core band with a total of 29 MHz for wireless audio PMSE use. Five Member States indicated their reluctance to provide 30 MHz based on the extent of demand in addition to the harmonised core band.

The Commission consulted the RSC on the preliminary elements of its preferred option at RSC#46 and RSC#47. Following the approval of this impact assessment, the Commission will propose a draft decision to the RSC aiming for a positive outcome of the examination procedure under comitology rules.

¹¹ A Project Team of the Working Group Frequency Management of CEPT, mandated to study PMSE issues.

¹² The issue has been discussed in the RSC meetings on 8 July 2010 (RSC#32), 5 October 2011 (RSC#37), 20 March 2013 (RSC#43), 9 July 2013 (RSC#44), 9 October 2013 (RSC#45), 12 December (RSC#46) and 19 March 2014 (RSC#47).

3. CONTEXT

3.1. Legal context

Decision 676/2002/EC¹³ on a regulatory framework for radio spectrum policy in the European Community (Radio Spectrum Decision), and in particular Article 4 thereof, provides the legal basis to harmonise the technical conditions for the availability and use of certain frequency bands for a specific application at EU level. Decision 2012/243/EU¹⁴ establishing a multiannual radio spectrum policy programme (RSPP) specifies that such harmonisation measures are expected to ensure more efficient use of spectrum and enhance the internal market.

This initiative is an integral part of the RSPP. Article 6.6 of the RSPP states that Member States shall examine ways and, where appropriate take technical and regulatory measures, to ensure that the freeing of the 800 MHz does not adversely affect PMSE users. Article 8.5 of the RSPP states that Member States shall, in cooperation with the Commission, seek to ensure the necessary frequency bands for PMSE, in accordance with the Union's objectives to improve the integration of the internal market and access to culture. The use of certain frequency bands for a specific application, creating a common usage at European level with common technical requirements, is expected to foster the internal market. EU Implementing Decisions under the Radio Spectrum Decision are legally binding for all Member States.

The RSPP identified, amongst other policy objectives, the need to encourage the efficient management and use of spectrum to best meet the increasing demand for use of frequencies reflecting the important social, cultural and economic value of spectrum; to allocate sufficient and appropriate spectrum in a timely manner to support EU policy objectives; to maintain and develop effective competition, reduce the fragmentation and fully exploit the potential of the internal market, avoid harmful interference, and foster accessibility to new consumer products and technologies.

3.2. Regulatory context

Spectrum access for PMSE varies widely across Europe. Availability and technical conditions for PMSE usage (wireless audio and video links) are recommended by CEPT via the European Communications Committee (ECC)¹⁵. Most Member States are following the non-legally binding CEPT Recommendations as shown in Table 1 and make available at least some of the bands indicated for audio PMSE. The tuning ranges identified by the CEPT Recommendations are indicated in the first row while the following ones illustrate which Member States make available which tuning ranges (in green if available without restrictions, in yellow if available with restrictions). It is important to note that the green colour does not mean that the entire tuning range would

¹³ O.J. L 108, 24.4.2002, p. 1–6

¹⁴ O.J. L 81, 21.3.2012, p. 7–17

¹⁵ The European Communications Committee is part of the CEPT. It recommends the availability and technical conditions for PMSE usage in Recommendation 70-03 Annex 10 and Recommendation 25-10 Annex 2.

be available. Each Member State can choose what amount of spectrum to make available and in which specific frequency bands - within the CEPT tuning ranges or otherwise¹⁶.

Some Member States indicated that at least 100 MHz of 'white spaces' in the 470-790 MHz range is available for wireless audio PMSE in most locations in their country. Wireless audio PMSE applications can also operate in the duplex gaps of the 800 MHz and 1800 MHz bands which are gaps necessary to separate the uplink and downlink spectrum parts in use by electronic communications systems for wireless broadband. The CEPT (Report 50 and its addendum) indicates that these gaps would be appropriate for harmonised use by wireless audio PMSE equipment under specific conditions.

The 800 MHz gap is currently made available to wireless audio PMSE by 20 Member States (of which 4 Member States limit its use according to certain restrictions). 19 Member States make available the 1785-1800 MHz band. An additional 7 Member States either make the band available with some restrictions or are planning to make it available in the near future. Currently 7 Member States also made available the 1800-1805 MHz for wireless audio PMSE use.

Spectrum management is a Member State competence, which should however be exercised in compliance with EU law. In terms of licences, which is a Member State competence, some Member States make the frequency ranges available licence-exempt or with a general authorisation regime,¹⁷ which means they can be used by wireless audio PMSE users at any time and place on a 'non protection - non-interference' basis. Only a few Member States have a dedicated PMSE spectrum management authority which receives spectrum usage requests and assigns specific spectrum for each event thus offering some guarantee that once this spectrum is assigned it will in fact be available in the foreseen time and location.

In practice wireless audio PMSE users will generally verify if a specific portion of spectrum is available for interference-free use at the location of interest. This is done by tuning the available frequency ranges manually with the equipment shortly before the event is due to take place, i.e. trial and error. More advanced equipment is also available using cognitive radio systems¹⁸, which can scan spectrum interference-free availability during operation and tune to the best frequencies.

¹⁶ For example the UK made available the band 53-60 MHz for PMSE use.

¹⁷ A regime whereby users have a general authorisation to use spectrum for wireless audio PMSE equipment but this is not specific to a time and place.

¹⁸ A cognitive radio system automatically detects available frequencies and changes its transmission or reception parameters according to allow more concurrent wireless communications in a given spectrum band at one location

Table 1 – Frequency ranges available potential for audio PMSE equipment across Member States compared to CEPT Recommendations

ERC 70-03, 25-10 tuning ranges (MHz)	29.7- 47.0	White spaces in 174-216	White spaces in 470-786	786-789	Duplex gap 800 MHz band			1492-1518	Duplex gap 1800 MHz band			Other
					823-826	826-832	863-865		1785-1795	1795-1800	1800-1805	
Member States												
AT											pln	
BE				pln							pln	
BG											n.i	
CY												
CZ											n.i.	
DE												
DK											pln	
EE											pln	
EL											n.i.	
ES									pln	pln	pln	
FI												
FR											pln	
HR											n.i.	
HU											n.i.	
IE												
IT						pln	pln			pln	pln	
LT											n.i.	
LU												
LV												
MT										pln	pln	
NL											pln	
PL											n.i.	
PT												

RO												n.i.	
SE													
SI												n.i.	
SK												n.i.	
UK					pln	pln							

	Available in the Member State
	Available in the Member State partially or with some restrictions
	Not available in the Member State
pln	Planned to be made available by the Member State
n.i.	No info
	Also made available for wireless audio PMSE in the Member State beyond CEPT Recommendation
	Depends on migration of digital terrestrial TV
	Band was recently identified by CEPT for wireless audio PMSE; not available yet in the Member States

Source: ECC, ERC Recommendation 70-03, 9 October 2013, ERC Recommendation 25-10, 11 February 2003, responses to a CEPT questionnaire on PMSE (CEPT/ ECC, 2012) and responses on the questionnaire added to Document RSCOM13-39 rev1.

4. PROBLEM DEFINITION

The main problems observed in regard to the wireless audio PMSE applications are presented in Table 2 together with their relevant drivers and potential consequences.

Regarding the issue of acquiring information on available spectrum and access conditions, which was initially identified, the problem was not addressed in any of the objectives or options. This is because during the course of the drafting of this document in 2013, the European Communications Office (ECO) has taken the initiative to set up an information system which will provide information on the national contact points useful for PMSE users in all CEPT Member States (which include all EU Member States). This initiative is a form of self-regulation which should help users to identify the relevant national authorities and hence access the information concerning which frequencies are available for wireless audio PMSE and under which access conditions in each Member State.

Table 2 – Driver-problem-consequence

Drivers	Problem	Possible consequences
<p>Changes in the UHF band mean less ‘white spaces’; No guarantee of a minimum amount of specific spectrum for wireless audio PMSE users; UHF spectrum offers optimal technical characteristics.</p>	<p>Insufficient availability of usable ¹⁹ spectrum for wireless audio PMSE.</p>	<p>Reduced usable spectrum means a reduction in production or documentation possibilities and/or of quality of service ; Migration of wireless audio PMSE applications to other technologies and/or bands.</p>
<p>More equipment used in more events; Higher quality applications.</p>	<p>Growing demand for spectrum.</p>	<p>Reduction of production or documentation possibilities and/or of quality of service.</p>
<p>Harmful interference caused by LTE technology in nearby bands, where wireless audio PMSE operates on a non protection and non-interference basis; Quality of service for professional cultural and social events requires harmful interference free use of spectrum.</p>	<p>Wireless audio PMSE equipment users have growing difficulty to find spectrum without harmful interference.</p>	<p>Coexistence difficulties with users other than broadcasting; Risk of harmful interference might make the spectrum unusable for PMSE use, in particular for professional users.</p>
<p>Recommended tuning ranges do not legally binding; Variable availability of local frequencies within tuning ranges and white spaces within and between Member States; Lack of sustainable Union-wide common frequencies.</p>	<p>Fragmented market.</p>	<p>Multiple and/or more expensive equipment is required to tune in the different frequency ranges available at different locations; Higher equipment costs owing to lack of economies of scale due to multiple small markets, which leads to higher production costs; Barriers for research and development that aim to achieve more efficient use of spectrum; Users‘ reticence to invest in equipment that could improve efficient use of spectrum.</p>

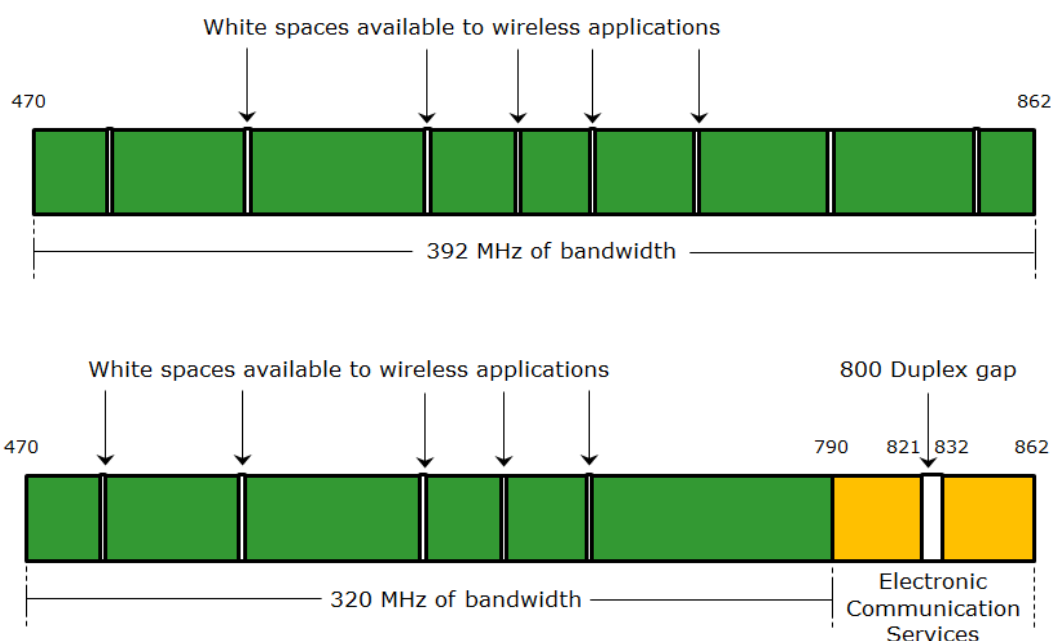
¹⁹ With an acceptable risk of harmful interference

4.1. Insufficient availability of usable spectrum for wireless audio PMSE

As concluded by CEPT Report 32, PMSE users are facing significant changes and their historic use of the 470-862 MHz will need to evolve. The possibilities of shared use and coexistence with new services are reduced and finding spectrum on an ad-hoc basis has become more difficult, as confirmed by the responses to the Commission's public consultation from 2012.

Figure 2 illustrates the loss of spectrum available to wireless audio PMSE users in the UHF band (470-862 MHz), where audio PMSE users can use the 'white spaces'. It is important to note that the exact location of the 'white space' might be different in different locations, even within a single Member State, so those indicated in Figure 2 are merely illustrative (see Annex 11.2 for maps from the Netherlands of 'white spaces' availability in different parts of the country indoor and outdoor).

Figure 2 – Reallocation of the 800 MHz band to Electronic Communication Services



Source: Created by European Commission Services

The 790-862 MHz range ("800 MHz band") was reallocated to electronic communication services in the EU in 2010 pursuant to what is called the digital dividend (digitisation of previously analogue television broadcasting allowed more efficient use of spectrum, and part of this "dividend" was therefore freed from broadcasting and allocated to electronic communication services). The RSPP established that the 800 MHz band should be assigned for electronic communications (wireless broadband) by 1 January 2013, subject to derogations, and this band is currently being assigned by EU Member States: 21 Member States have assigned at least part of this frequency band to wireless broadband but not all of this spectrum is in fact already in use. Since wireless broadband networks do not have 'white space' (see Annex 11.4), wireless audio PMSE applications now have to use the 'white spaces' in a reduced portion of the UHF band amounting to 320 MHz – compared to 392 MHz previously, which represents a reduction of over 15%.

The RSPG (Radio Spectrum Policy Group) noted in its Opinion on Strategic Challenges facing Europe in addressing the Growing Spectrum Demand for Wireless Broadband (Radio Spectrum Policy Group, 2013, Annex 2) that for the 470-790 MHz band, PMSE

services are likely to lose significant spectrum capacity and have to migrate to other technologies/or bands in the long-term. The opinion also noted that it is unlikely that PMSE services can continue in the 700 MHz sub-band if it is used for mobile broadband. This aspect was confirmed during the ‘2014 PMSE stakeholders’ workshop’.

In addition, the densification of broadcasting networks (a more efficient use of spectrum) implies a reduction of ‘white spaces’ available for wireless audio PMSE usage even in the remaining broadcasting part of the UHF band. See Annex 11.4 for additional technical details on ‘white spaces’ and their availability in different types of networks. The underutilisation of the 1785-1805 MHz band to date might be an indication that the current spectrum made available to wireless audio PMSE users has been sufficient up to now for average daily needs, but this does not necessarily hold for the future as ‘white spaces’ come under further pressure.

The growing possibility of extension of wireless broadband below 790 MHz and the likely further densification of broadcasting networks will reduce spectrum availability for wireless audio PMSE even further.

From the stakeholders’ survey, spectrum (un)availability is cited as the main factor leading to a potential reduction in usage. In the VVA study survey, regulatory uncertainty about future spectrum availability was mentioned as the most worrisome concern for both users and manufacturers.

4.2. Growing demand for spectrum

Based on the information provided by stakeholders in the public consultation and other sources, the wireless audio PMSE needs in the UHF band vary from about 15 MHz to 96 MHz for ordinary daily events to over 250 MHz for extraordinary ones such as the Eurovision Song Contest. See Annex 11.6 for details of the sources of wireless audio PMSE daily spectrum needs. Future needs and demand for spectrum including for PMSE are expected to grow. The most conservative of such estimates indicates a growth in wireless audio equipment use of around 5 per cent annually. See Annex 11.7 for additional details on the different estimates of growth by the different sources.

To operate at high quality in the UHF band, wireless microphones require about 600 kHz per equipment²⁰ unless there are more restrictive power limits which can increase the number of sets that can be used (see Annex 11.6 for more details on the spectrum requirements of wireless audio PMSE equipment). A UHF channel of 8 MHz can allow the operation of 8 to 12 analogue wireless microphones, with a non-linear progression, i.e. double the microphones will require more than double the spectrum.

Hence, applying a 5 per cent compound annual growth would lead to 27 per cent increase in just 5 years. And, as just mentioned, a 27 per cent increase in equipment being used would lead to a more than linear increase in spectrum needs (the exact figure depends on the amount of equipment as shown in section 11.5). Such increasing requirements cannot be met by increasing demand for spectrum only, but also require technical improvements in equipment which will make a more efficient use of spectrum. As mentioned in paragraph 4.1, this was indicated by the RSPG in the context of its Opinion on Strategic Challenges facing Europe (2013).

²⁰ 200 kHz for the use of the wireless microphone and a 200 kHz ‘guard band’ on each side is required to prevent interference between microphones close to each other.

4.3. Growing difficulties using spectrum without harmful interference

In response to the public consultation, 60% of users expressed doubts as to the usefulness of the spectrum in the duplex gaps due to fears of possible interference caused by LTE technology use in adjacent bands. In 2012 and 2013 a number of studies were conducted with the objective to identify potential interference conditions and to quantify protection criteria for PMSE systems.²¹ While all studies concluded that a potential for interference from LTE technology to PMSE systems exists, originating particularly from LTE user equipment (smart phones), there was no consensus on the severity of the interference and the resulting protection criteria, owing to the lack of agreeable assumptions.

As noted in section 2.4.1, CEPT addressed the problem of possible interference risks caused by LTE technology in CEPT Report 50 and its Addendum (2013). If unacceptable levels of harmful interference were to become frequent, wireless audio PMSE users would have to find alternative solutions. In this context it should be noted that in particular professional social and cultural events like live performances require continuous interference-free availability (no disturbance of the quality of service is acceptable). A sustainable alternative solution is more desirable than unreliable spectrum. Modern professional systems can operate above 1 GHz with some restrictions. PMSE manufacturers indicated that equipment using this spectrum is more expensive, which makes this band less attractive than UHF spectrum. This is one reason why, although the 1785-1800 MHz band is opened for radio microphones, in-ear monitoring and portable audio links; there is hardly any use in this band (European Broadcasting Union, p.5). This was confirmed by the Commission's public consultation mid-2012.

Wireless audio PMSE users operate on a 'non protection - non-interference' basis and they have no guarantee of a minimum amount of spectrum to be made available to them. They are hence the 'weakest' user, in particular the UHF band with no defined rights to preserve their current use.

4.4. Fragmented market

The absence of clarity as to the future sustainable availability of spectrum and the specific frequencies that might be made available negatively affects the PMSE equipment market as it reduces users' willingness to invest in upgrading, replacing or purchasing additional equipment and reduces manufacturer incentives to invest in R&D to develop new technologies and products.

International touring operations are limited compared to the national use of wireless audio PMSE equipment because of national orientation of cultural events. Manufacturers, suppliers and distributors of PMSE equipment indicated in their responses to the public consultation that the equipment is mainly used at local and national level as cross-border use is difficult due to the national licensing regimes which vary between the Member States. Moreover, users of wireless radio microphones touring in multiple countries need to use equipment that can operate in different frequency ranges in each of the Member States and will thus be more likely to have to buy more expensive equipment with wider tuning ranges, to rent equipment locally or to rely on the venue's organisation to ensure

²¹ Measurements were conducted by the German Institute für Rundfunktechnik (IRT, 20913), the Association of Professional Wireless Production Technologies (APWPT, 2012), the Norwegian Post and Telecommunications Authority (2012), the German Bundesnetzagentur (BNetzA, 2013), United Kingdom's Ofcom (2012) and JRC (2014)

their operability. Although two thirds of the users responding to the VVA online survey stated that they do not need to use their equipment in other EU Member States (Valdani Vicari Associates, 2013, p.30), over 20 per cent indicated they would consider working in more Member States if harmonised bands were adopted and would be more inclined to purchase instead of rent wireless microphones (Valdani Vicari Associates 2013, p.46).

Equipment that can use the same frequencies Union-wide will foster mobility of equipment across borders and create economies of scale for the manufacturers. "Manufacturers indicated that their equipment was tuneable across most or all of the European Union. However, uncertainty about availability of spectrum and lack of consumer confidence are seen as key barriers to growth" (Valdani Vicari Associates. 2013, p.49). Using equipment with limited tuning ranges²² to cover the full range of available tuning ranges in the Member States would require the use of different sets of equipment, noting that equipment covering broader tuning ranges is subject to quality constraints compared with equipment operating in narrower frequency ranges,

At the national level larger users can have difficulty to find enough spectrum for their needs in the 'white spaces' of the UHF band and will therefore either need sophisticated multiple equipment which can tune into the wider range of frequencies. There is a large range of equipment available in the market with retail prices ranging from little under € 100 for a simple hand-held transmitter and receiver set which can tune into a single or very limited range, over € 1000 for multi-channel systems within the UHF band, and over €5000 for sophisticated tailored professional equipment.

Regulators' responses confirmed an overall lack of coordination among European countries regarding PMSE spectrum. 4 regulatory authorities responding to the VVA study indicated market fragmentation as a major barrier to PMSE (Valdani Vicari Associates. 2013, p.52), notwithstanding that many Member States apply CEPT Recommendations as explained in section 3.1.

4.5. Who is affected, in what ways, and to what extent

As can be seen from the context and issues presented above, the availability of spectrum for wireless audio PMSE applications will affect both users and manufacturers of the relevant equipment which will turn to national regulatory authorities in search of appropriate solutions.

In particular the professional wireless audio PMSE users claim they need spectrum in the UHF band due to its technical characteristics such as the propagation of the signal and the battery life as confirmed by responses to a European Communications Committee (ECC) questionnaire (CEPT/ECC, 2012), by the European Commission's public consultation (see Annex 11.3) and by CEPT Report 32, 2009. Users (APWPT²³) also request that about 100 MHz of spectrum be made available in the UHF band to continue their operations.

Small users (e.g. churches, meeting organisers using only a few wireless microphones) are likely to be the least affected since they are likely to need a small amount of spectrum

²² Radio microphones can be tenable in a range of 24 MHz up to over 200 MHz, however usually there exists a trade-off between different system parameters; a larger range might result in a decreased susceptibility to interference and/or a lower battery life time.

²³ Study on audio PMSE spectrum usage, DK AK 731.0.8 (DIN/VDE), 2014.

for their operations – professional or not – which will, at least partly, remain available via the ‘white spaces’ in the UHF band. They will probably continue to use their current equipment for some time but will face uncertainty when they will have to replace it as indicated in the public consultation. As an example, based on the responses from 111 German theatres to a survey organised by Pearle in 2010, it appeared that 26% of those theatres are still using devices that use frequencies between 790 and 862 MHz.²⁴

The very large professional users with large needs will have to address their requests at the national level to find tailored solutions. They will need multiple equipment and/or equipment that can tune into a wider range of frequencies.

Manufacturers, which are mainly SMEs in this sector, are affected by the fragmentation of the market and the need to adapt each model to the specific frequencies made available in the different Member States. This sector is a niche market with specialised manufacturers that have limited resources for R&D. Innovative digital equipment developments will only occur if economies of scale can be achieved in some bands.

There is evidence that the pressure on the UHF band availability has led national regulators to find alternative solutions to the needs of the wireless audio PMSE users. The evidence suggests that such efforts are nationally focused leading to increased differences in the frequencies made available. The RSPG noted this in its Report on Strategic Sectorial Spectrum Needs (Radio Spectrum Policy Group, 2013) indicating that industry is moving towards equipment with wider tuning ranges in line with the national differences in spectrum used.

The evidence also suggests that the solutions found are potentially of a temporary nature, like the 1492-1518 MHz frequency band was recently added to Annex 10 of ERC Recommendation 70-03. Its use for audio PMSE equipment is restricted to indoor locations and an individual licence will be required. This additional band aims to alleviate congestion but this same frequency band is being considered by CEPT as a potential candidate for wireless broadband service expansion in preparation for the ITU World Radiocommunications Conference in 2015 (WRC-15)²⁵. Hence, wireless audio PMSE users might find this band hardly usable in the future.

Similarly, CEPT concluded in its ECC Report 188 (CEPT / ECC, 2013), that the most appropriate regulatory framework for the future use of the 1452-1492 MHz band in CEPT countries is the harmonisation of this band for mobile broadband/mobile downlink, while allowing individual countries to adapt to special national circumstances in part of the band for terrestrial broadcasting and other terrestrial applications. This last category could include PMSE applications. However by ECC Decision (13)03 this spectrum is now allocated to mobile supplemental downlink which may compromise usability for PMSE users. This uncertainty is making manufacturers reticent to produce equipment for this band since users are also not inclined to invest in equipment of which the usability is highly uncertain.

Quantifying the socio-economic impact of changes in spectrum availability proved difficult because of a general lack of public data on this market to establish a baseline.

²⁴ 98 theatres indicated that they used the 800 MHz band in the past, before its reallocation.

²⁵ A meeting held in Geneva between members of the International Telecommunication Union which included the region Europe, Africa and the Middle-East including Iran,

The reasons for this lack of data include that wireless audio PMSE equipment is used in a variety of sectors and scales, that there is no systematic record of this use, that it is only one of the many contributors to the activities which it supports and that manufacturers are not providing information due to confidentiality as they claim this is an extremely competitive market. These elements are explained in more detail in Annex 11.9.

Given these methodological difficulties, the VVA study, which included an extensive desk research, proposed three value-levels:

1. The primary value of PMSE includes directly involved stakeholders: manufacturers, suppliers and distributors of the equipment, the users whose business activities involve the use of PMSE equipment, and the regulatory authorities. The estimated EU market information is:
 - 8 million users operating on 10 million channels per day.
 - Sales of wireless audio PMSE equipment in the EU is estimated at about 260 000 units/year corresponding to €170 million (2011 sales)
2. The secondary value of PMSE includes the economic, cultural and social activities which contribute to a broader benefit for society and consumers. These include activities related to the cultural and creative sectors, notably the programs made or documented with wireless audio PMSE applications and live performances or sporting events. In the Communication promoting cultural and creative sectors for growth and jobs in the EU (EUROPEAN COMMISSION, 2012), the European Commission recognised that the cultural and creative sectors are one of Europe's most dynamic economic sectors and are essential drivers of cultural diversity in Europe. These sectors, which include notably audio-visual (such as film, television, video games and multimedia), cultural heritage, design, festivals, music, performing arts, radio and visual arts– represent 4.5% of EU GDP which amounts to about 580 billion euros, but there is no indication as to the part that can be attribute to wireless audio PMSE.
3. The tertiary value is not related directly to the use of wireless audio PMSE equipment, but is closely related to the second level. Examples would include a proportion of the merchandising purchases from events and shows, as well revenues of hotels and restaurants used by audiences as a consequence of their presence in a specific location because of the cultural activity they are attending.

The cost-benefit analysis was run on the primary value of wireless audio PMSE as this was the only level where some market information combined with some extrapolation allowed for quantitative estimates of the baseline. This quantitative analysis was supplemented by qualitative information concerning the secondary and tertiary levels where possible. More details on the secondary and tertiary levels are provided in Annex 11.10. The economic benefit of the harmonisation options to the core PMSE industry is considered as the sales revenue of manufacturers, the sales revenue of users (attributable to wireless technology), licensing revenues to regulators, set against equipment costs for users and manufacturers and administrative costs for regulators.

It is beyond any doubt that use of wireless audio PMSE equipment is essential for the documentation of social and cultural events and hence offers crucial support to content providers which make these events available to the public but it should be noted that the objective of the impact assessment is neither to estimate the complete socio-economic

(and the contribution to the cultural) value of wireless audio PMSE nor to compare it to other industries using spectrum but rather to assess the socio-economic impacts of policy options on spectrum harmonisation measures being considered. In other words the VVA study carried out a cost-benefit analysis of the effects of harmonisation at EU level and qualified the social and cultural benefits of radio microphones' (and cordless video-cameras) use in the EU, and not a net present value analysis.

4.6. How would the problem evolve, all things being equal

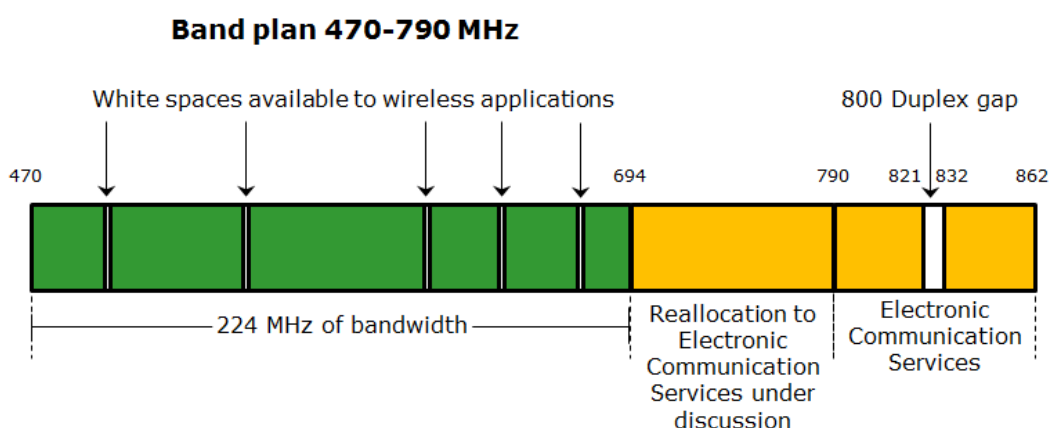
As illustrated in section 4.2, demand for spectrum for wireless audio PMSE use is expected to continue to increase over the medium term even accounting for technological developments which may provide more efficient equipment. A linear projection of annual growth rates around 5 per cent would be impossible to accommodate with additional spectrum, and even more so in the UHF band, given its limited size and the multiple claims on this 'premium' spectrum.

Users are concerned that the 'white spaces' in the UHF band will become less available, due to access of electronic communication systems in UHF spectrum as confirmed by Member States in the RSPG "Opinion on Strategic Challenges facing Europe in addressing the Growing Spectrum Demand for Wireless Broadband" as noted in paragraph 4.1. The densification of broadcasting networks would have a similar negative effect on the availability of 'white spaces' available for wireless audio PMSE.

The availability of spectrum for wireless audio PMSE use in the UHF band is likely to decrease further due to decisions taken at a world-wide level in the context of the next World Radiocommunications Conference (WRC15). At WRC-15, participating countries are expected to confirm the co-allocation of the 694-790 MHz frequency range to broadcasting and mobile electronic communication as decided at WRC-12 with a potential to achieve worldwide harmonisation in this range. In preparation for WRC15, the Commission issued a Mandate to CEPT to "develop harmonised technical conditions for the 694-790 MHz ("700 MHz") frequency band in the EU for the provision of wireless broadband electronic communications services and other uses in support of EU spectrum policy priorities". The Commission also issued a request for Opinion to the RSPG on developing a long-term strategy for the UHF band and set-up a High Level Group of industry representatives to provide a strategic advice to the Commission on the future use of the UHF band. There is hence a growing possibility that availability of spectrum for wireless audio PMSE use in the UHF band will decrease further due these ITU decisions and to subsequent decisions by certain Member States if not at Union level.

The reallocation of the 700 MHz band, if realised, would further decrease the portion of UHF band used by broadcasting to 224 MHz, meaning a further 30 percent reduction. In the survey organised by Pearle in 2010 on wireless audio PMSE equipment use in German theatres, 42 of the 111 respondents indicated they use wireless audio PMSE equipment in the 700 MHz range (694-790 MHz); meaning about 40 per cent of respondents would be affected by a reallocation of the 700 MHz spectrum.

Figure 3 – Potential reallocation of the 700 MHz band to Electronic Communication Services



Source: Created by European Commission Services

In particular the professional wireless audio PMSE users could be constrained in their operations by a lack of available spectrum in the UHF band and the sector will face one or a combination of the following consequences:

- Move wireless audio PMSE operation – or part of it – to other bands which could be made available (in an uncoordinated way) in the different Member States;
- Reduce the usage of wireless audio PMSE equipment and/or replace some wireless usage with wired usage;
- Accept more risk of harmful interference for some wireless audio applications;
- Develop mitigation techniques and more efficient equipment that requires less spectrum providing the same quality of service.

The full impact is impossible to quantify or to qualify owing to very variable local conditions. Lack of sufficient spectrum for wireless audio PMSE usage is expected to be more serious in urban areas than in rural ones. Users have expressed their concern with regards to all of the above possibilities which of course would all imply a cost and/or a loss of quality for their operations.

The frequencies available for wireless audio PMSE users across the EU will continue to be fragmented within probably increased and broader tuning ranges indicated by ERC Recommendations, however with likely decreasing availability of usable spectrum within the Member States. Such fragmentation may in fact increase due to different Member States having to find alternatives to the further reduction of available spectrum in the UHF band. As explained above, there is already evidence of uncoordinated solutions.

Manufacturers are also likely to react to such a situation by looking for alternative technologies or bands on which wireless audio PMSE applications could be used. They will be faced with increasing small market requirements to cater for which will dilute their efforts.

5. GENERAL AND SPECIFIC POLICY OBJECTIVES

In line with the objectives set in the Radio Spectrum Policy Programme (243/2012/EU) and considering the framework of the Radio Spectrum Decision (676/2002/EC), this

policy initiative aims to ensure access to spectrum for PMSE, in accordance with the Union's objectives to improve the integration of the internal market and access to culture.

This general objective has been detailed with the following specific objectives:

- Ensure that sufficient spectrum is available to meet the daily ordinary needs of wireless audio PMSE users;
- Establish a sustainable common core band Union-wide to foster economies of scale and encourage research and innovation;
- Provide certainty that spectrum identified will be sustainable
 - Foster long-term usability of equipment in that spectrum, including new equipment;
 - Encourage R&D to develop technical solutions for more efficient use of spectrum;
- Foster a satisfactory operation of PMSE applications in the assigned spectrum;
- Maintenance of national flexibility of spectrum use to avoid reservation of spectrum that might at certain times and locations be left unused.

The Commission has identified the following operational objectives:

- Reduce manufacturing costs of wireless audio PMSE equipment;
- Increase manufacturers' R&D in wireless audio PMSE applications;
- Meet wireless audio PMSE daily ordinary needs;
- Identify and foster solutions solving harmful interference to and from wireless audio PMSE equipment;
- Foster efficient use of spectrum.

6. POLICY OPTIONS

6.1. Possible options for meeting the objectives

Three identified policy options with regard to spectrum access for wireless audio PMSE equipment were considered in the VVA study: (1) no EU regulatory measure, (2) a general approach based on tuning ranges and (3) a technical harmonisation measure for a set of core frequency bands in the EU. The VVA study compared these options and estimated the cost-benefit effects of tuning ranges and of a harmonisation measure as compared to the baseline scenario identified as option 1.

Option 1: Baseline scenario/No EU intervention

This scenario consists of no action at EU level in regard to the spectrum needs for wireless audio PMSE usage and a projection of the current framework into the future.

The situation would evolve as described in section 4.6. Spectrum availability for audio PMSE use is expected to decrease further due to the reduction of 'white spaces' in the UHF band. In addition wireless audio PMSE use is expected to grow.

Users will be “squeezed” in their use of the UHF band and will have to find a solution amongst the ones mentioned in section 4.6. Users will have to use different equipment: wired equipment or wireless equipment able to operate in other bands or that can handle broader tuning ranges. All these options will generate equipment costs - in some cases just after having recently replaced equipment in response to the 800 MHz reallocation.

It is likely that Member States will continue taking decisions at the national level to address wireless audio PMSE spectrum needs in their market. However, evidence shows that initial efforts are uncoordinated and do not guarantee a long-term availability at a multi-country/European level. This will reinforce regulatory uncertainty in the short to medium term and market fragmentation in the longer term.

Therefore, users will be less prone to buy new equipment or replace existing one because of the uncertainty surrounding the reallocation of the UHF spectrum. Manufacturers will dilute their R&D efforts in different bands as well as experience higher production costs due to lack of economies of scale.

Member States will continue to choose whether to align to CEPT Recommendations which is broadening its recommended tuning ranges outside the UHF spectrum and consequently disperse potential spectrum availability. Member States will also maintain the ability to change these available frequencies and their relevant technical conditions unilaterally. Finally, Member States will maintain their discretion concerning the access conditions for PMSE use from a licence perspective, as this is a national competence. None of these aspects will be affected by the Telecom Single Market initiative which was recently proposed by the Commission (applicable only to spectrum harmonised for wireless broadband).

In this option, the amount of spectrum and the bands made available for wireless audio PMSE will differ between Member States as will the legislative framework of access to spectrum.

Option 2: Tuning Ranges

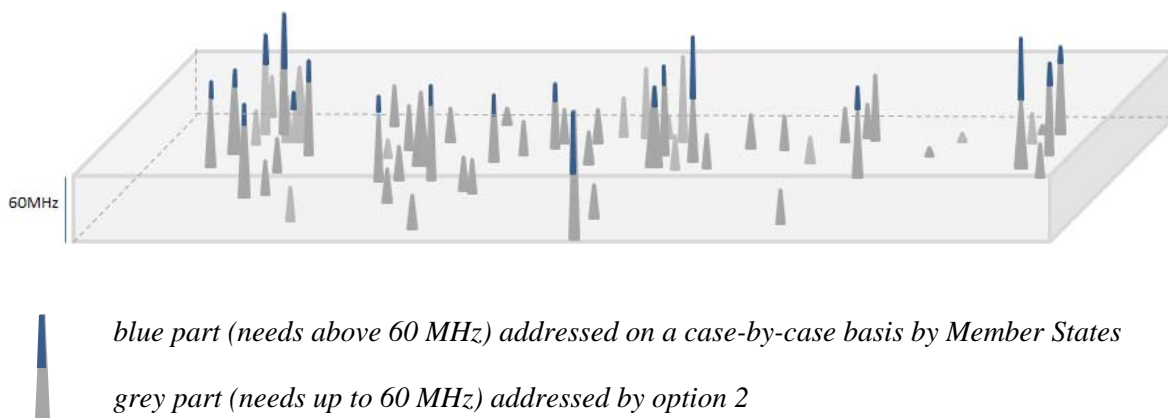
This scenario is focusing on specific Union-wide tuning ranges within which at least 60 MHz are to be made available as a baseline to meet average daily needs of non-professional use as well as most small and medium professional events such as theatre, concerts, press coverage, and to some extent TV productions. These tuning ranges would be in line with CEPT Recommendations and would provide for wireless audio PMSE equipment to share their use with other users as is currently the practice. The tuning ranges in question are listed below:

29.7-68 MHz,
174-216 MHz,
470-790 MHz,
823-832 MHz,
863-865 MHz, and
1785-1805 MHz

Figure 4 shows how the baseline of 60 MHz would be useful in meeting ordinary daily spectrum needs.

The grey base represents a given geographical area in which events will occur at specific times and places. At any given moment there will be several wireless audio PMSE events requiring different amounts of spectrum for their operation. Each cone represents one such event and its height the amount of spectrum it requires at a specific location in time. The grey portion of the cones meets the baseline amount equal to or below 60 MHz. The blue parts represent needs of an event beyond 60 MHz and these would be addressed at the discretion of the Member States at the national level through case-by-case solutions.

Figure 4 – A single point in time of option 2 in a given geographical area, where the intensity of PMSE spectrum needs differs at different locations and will vary in time and location



Source: Created by European Commission Services

From the identified tuning ranges Member States will make available 60 MHz for wireless audio PMSE users on a ‘non protection - non-interference’ basis with regard to licensed users, with the flexibility to identify the exact frequencies available within the tuning ranges. Member States can make available spectrum beyond the 60 MHz in the same frequency ranges or in others.

Option 3: Harmonised spectrum availability added to tuning ranges

In this scenario, harmonised core frequency bands are combined with identified tuning ranges.

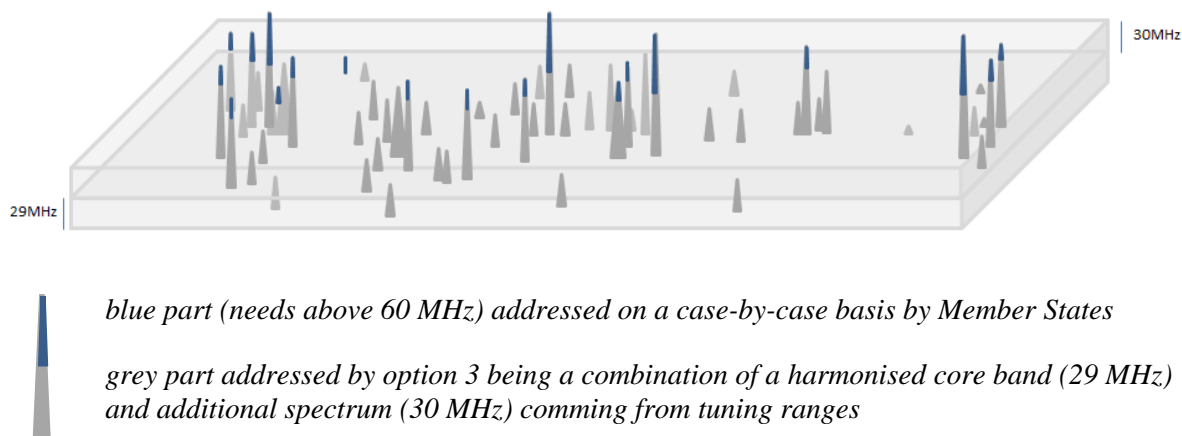
Harmonised technical conditions would apply to core frequency bands 823-832 MHz and 1785-1805 MHz, the ‘duplex gaps’ in the 800 MHz and 1800 MHz spectrum, amounting to 29 MHz of spectrum. Member States will be required to make the ‘duplex gaps’ available for wireless audio PMSE use.

Member States will also be required to make available an additional 30 MHz within the tuning ranges listed below:

- 29.7-68 MHz,
- 174-216 MHz,
- 470-790 MHz, and
- 863-865 MHz

Figure 5 shows how the harmonised bands amounting to 29 MHz and the additional 30MHz in tuning ranges contribute to a baseline of 59 MHz aimed at meeting ordinary daily spectrum needs similarly to Figure 4.

Figure 5 – A single point in time of option 3 in a given geographical area, where the intensity of PMSE spectrum needs differs at different locations and will vary in time and location



Source: Created by European Commission Services

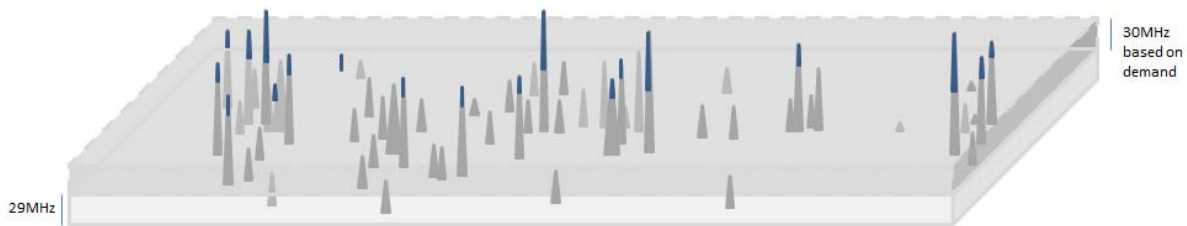
Also in this option Member States remain free to make spectrum available in addition to the 59 MHz provided by this option either in the same frequency ranges or in others.

Option 3.1: Harmonised spectrum availability added to additional spectrum based on demand

Option 3.1 is a variant of option 3 which takes into account stakeholders' comments on the options identified in the VVA study. Just like option 3, this option provides for harmonisation of the appropriate technical conditions in the frequency bands 823-832 MHz and 1785-1805 MHz to be designated and made available for the use of wireless audio PMSE equipment. This option would thus also provide 29 MHz of harmonised spectrum Union-wide.

As pointed out before, an additional 30 MHz would meet average daily requirements. However, option 3.1 does not require Member States to make available the entire additional 30 MHz in case there are no requirements coming from PMSE users. Such fine-tuning of option 3 took into account comments from Member States during RSC discussions, some of which insisted that the additional 30 MHz should not have to be made available in times and places where it is not needed. Further, these additional 30 MHz are to be made available from tuning ranges, preferably in the range 470-790 MHz. This was based on stakeholder feedback that it is very important for users to have as much spectrum as possible available in the UHF band – subject, of course, to the important shifts taking place in broadcasting activity in this band.

Figure 6 – Graph illustrating a single point in time of option 3.1 in a given geographical area, where the intensity of PMSE spectrum needs differs at different locations and will vary in time and location



blue part (needs above 60 MHz) addressed on a case-by-case basis by Member States

grey part addressed by option 3.1 being a combination of a harmonised core band (29 MHz) and additional spectrum on demand to the extent required (30 MHz) by PMSE users

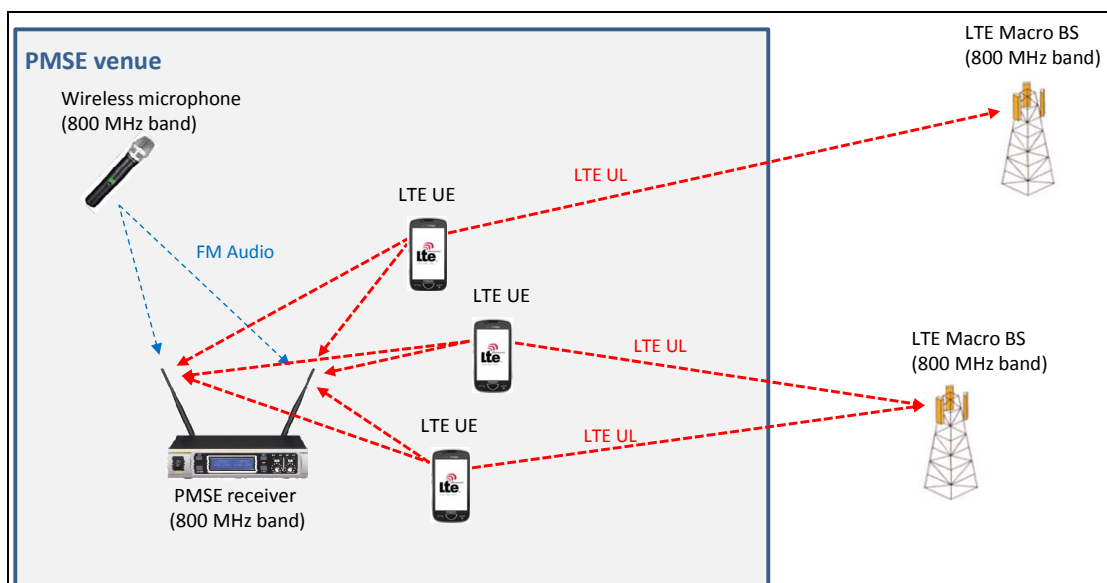
Source: Created by European Commission Services

Further, in response to users’ concerns on the usability of the ‘duplex gaps’ for wireless audio PMSE use due to risks of harmful interference caused by LTE technology in adjacent bands, option 3.1 enhances the usability of the proposed harmonised core bands. Several mitigation solutions – operational or technical – are possible to lower the risk of harmful interference and are outlined below.

From a technical perspective, as was pointed out in the Addendum to CEPT Report 50, the harmful interference from mobile electronic communications in the 800 MHz and 1800 MHz duplex gaps will occur when the receiver part of the wireless audio PMSE equipment in the indoor scenario is in close proximity of transmitting picocells using the frequency bands adjacent to those used by the PMSE receiver. Also MFCN user equipment (smart phones) close to PMSE receivers can cause harmful interference. The additional studies and analysis concluded that set-up procedures²⁶ are required between PMSE and wireless communication networks to ensure the needed quality of service for PMSE, where this quality will depend on the usage scenarios. However the high quality of service has to be maintained for the duration of the performance and it is noted that it is unclear how this would be achieved especially considering the mobility of LTE user equipment (smart phones).

²⁶ This procedure needs to be performed before the PMSE user can go online and during the use of the equipment; spectrum is to be scanned and frequencies for operation are indicated

Figure 7 – Potential interference scenario in case of LTE user equipment – PMSE receiver proximity



Source: Joint Research Centre, *PMSE System Operation in the 800 MHz LTE duplex gap* (2014)

Legend: BS = base station, UL = uplink, UE = user equipment

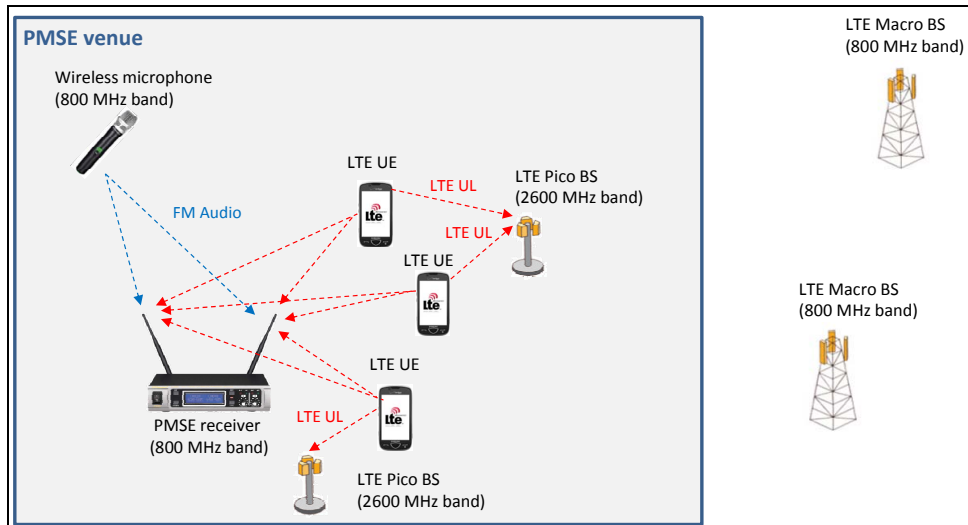
Therefore, the Commission has proposed to examine a possible technical solution and requested the Commissions’ Joint Research Centre (JRC) to perform testing on the LTE-PMSE coexistence as indicated in section 2.4 and detailed in Annex 11.3. The tests were conducted in collaboration with stakeholders from the wireless audio PMSE and mobile industry. This mitigation solution will be relevant to indoor social and cultural locations, such as theatres and concert halls. The usability of the 800 MHz duplex gaps was tested while electronic wireless traffic was redirected to the 2.6 GHz frequency band by using small cells or picocells²⁷ which are higher frequencies than used by the PMSE receiver in the duplex gap. The outcome of this mitigation testing indicates that such redirection of traffic avoids or reduces interference from smart phones to wireless microphone if appropriate set-up procedures and technical arrangements are observed (see Figure 8). It is hypothesized that this conclusion will also hold for the 1800 MHz duplex gap and redirection to the 2.1 GHz frequency band.

Thus stakeholders (i.e. premises using PMSE equipment and mobile operators, particularly the operator using the block adjacent to the duplex gap) could be encouraged to enter into commercial agreements so that social and cultural premises could be equipped with small cells and picocells using other frequencies than the 800 MHz and 1800 MHz bands. 4G traffic would be diverted to higher frequencies which are ideal for geographically limited areas with large capacity demand and the lower frequencies (i.e. 800 and 1800 MHz) would be freed and hence usable without out-of-band interference

²⁷ ‘Small cells’ is an umbrella term for low-powered radio access points operating in licensed or unlicensed spectrum. Small cells include femtocells, picocells, metro cells and microcells – broadly increasing in size. A small cell is typically a low cost, small (typically the size of a Wi-Fi router), reasonably simple unit. They are also typically subject to less cumbersome authorisation procedures than macro-cells and are thus easier to install. Small cells typically have a range from 10 metres to several hundred metres and they provide improved cellular coverage and capacity when integrated in a wireless cellular network.

for wireless audio PMSE. Such an environment of coexistence would reduce the users' concerns on the possible interference threats in the 800 and 1800 duplex gaps.

Figure 8 – Potential future PMSE-LTE technology coexistence scenario



Source: Joint Research Centre, *PMSE System Operation in the 800 MHz LTE duplex gap* (2014)

From an operational perspective, each organiser of social and cultural event who wants to reduce risks of harmful interference when using the 800 MHz and 1800 MHz duplex gaps can choose one or a combination of the options mentioned below. The choice will be based on the specific characteristics of the venue and event, like size, location, physical characteristics (for example distance from the stage to the audience), availability of a fixed line connection, artistic choices, and the level of acceptable risk.

- Replace part of the wireless audio PMSE equipment with wired equipment, thus reducing the amount of channels necessary for the operation of the wireless equipment.
- Ensure that all mobile phones are switched off, or using flight mode or distribute a signal blocking bag (priced at about 5 euros a piece) to avoid traffic on the 800 MHz and 1800 MHz duplex gaps at the social or cultural venues. Venues could make efforts to enforce more strictly the common request of switching off mobile phones while in the premises when these are not necessary as is the case in innovative ‘interactive’ shows.
- Taking measures such as the ones for an interference-free operation of wireless microphone and in-ear monitor links defined in Annex 2 of the Addendum to CEPT Report 50 (setup procedures).
- For small venues that expect an audience of less than 100 people, organisers can benefit from commercial offers available from mobile operators. These are priced between 80 and 120 euros and consist of the mobile operator providing a picocell that is integrated in its networks and that operates on frequencies above 2 GHz, thus alleviating traffic on the 800 MHz and 1800 MHz duplex gaps.
- Larger venues that expect larger audiences would experience more traffic but could also experience less risk if interference as the distance from the audience to the PMSE receiver is higher. Small cells solutions similar to the commercial ones

described above would have to be agreed between the venue and a mobile operator on a case-by-case basis. Cost will be highly dependent on the individual circumstances and the requirements of the equipment. In case of high traffic volumes in these venues, mobile operators might have a general business case to install picocells to improve wireless broadband capacity. There might also be specific agreements between the mobile operator and the venue manager to specifically address the interference problem with a similar picocell solution but the added characteristics of shifting traffic to higher frequencies.

6.2. Discarded options

The option of letting the sector self-regulate their access to spectrum has been discarded because PMSE users have hardly any regulated rights on the spectrum that they require for their operations. Access conditions differ considerably between the Member States, where in those Member States using a general licensing or licence-exempt regime the sector is left to itself finding access to available spectrum. In other Member States they hence need to have the spectrum they need made available by the relevant spectrum manager at Member State level. In addition, since the UHF band is ‘premium’ spectrum – below 1 GHz – other licensed services claim their right to use this spectrum. It is therefore the role of spectrum managers to evaluate how to best share this limited public resource to achieve optimal economic and social benefit.

The option of identifying only harmonised core frequency band in both 800 MHz and 1800 MHz duplex gaps (without any additional amount of spectrum to be made available within tuning ranges) has been discarded because the 29 MHz available in the ‘duplex gaps’ are not sufficient to meet average daily needs of the sector. This was indicated by stakeholders in the public consultation, who underlined that the proposed harmonised frequency bands are too narrow and will not be suitable for professional use because of the envisaged interference problems from adjacent bands especially from LTE technology.

Some PMSE users and manufacturers (among others APWPT and broadcasting organisations) have indicated that EU measures should take into account the needs of specific geographical areas, such as content production areas or theatre districts or large-scale extraordinary events like sport World Cups, the Olympic Games or the yearly Eurovision song contest. Such events require specific and detailed spectrum planning and often include the need to temporarily use spectrum that is normally used by other applications. However, the option of addressing all wireless audio PMSE needs was discarded because such needs only occur restricted locally or a few times per year in limited geographical locations and are hence best addressed on a case-by-case basis by the Member States. Making available more spectrum than average daily wireless audio PMSE needs, would unnecessarily ‘reserve’ spectrum in times and places in which it is not needed, thus reducing the efficiency of spectrum use.

Also PMSE users and manufacturers (among others APWPT) indicated that the spectrum requirements for wireless audio PMSE should be set at 96 MHz to be made available in the UHF broadcasting band. However such a claim seems to be disproportionate, given the total of 320 MHz (470 – 790 MHz) currently available in that band – and which may itself change.

It was noted that spectrum needs for wireless audio PMSE in urban areas are significantly higher (over 100 MHz) than those in rural areas (8 to 12 MHz, see Annex 11.6). The option of differentiating the amount of spectrum that has to be made available

in areas with different densities was discarded because no appropriate approach to take this fact into account was considered operationally feasible. Taking into account that measures should be enforceable, no appropriate legal framework could set a clear line between urban and rural areas to distinguish the spectrum needs for those areas.

Respondents to the public consultation suggested that besides focusing on spectrum harmonisation for PMSE use, it would be useful to consider a pan-European harmonisation of licensing regimes for PMSE use since these currently differ amongst Member States. The different available bands and the different regimes reinforce a short- to medium-term uncertainty as to the frequencies that are available and which are the relevant conditions of access and a further uncertainty as to how the individual Member States' situations might evolve in the long term, potentially towards further fragmentation. The options do not consider the harmonisation of the licensing regimes in the Member States because this need has not been sufficiently demonstrated, given the fact that the overall wireless audio PMSE needs in Member States vary and are highly dependent on national circumstances e.g. size of population and its density. Moreover a harmonisation of the licensing regime is out of the scope of the Radio Spectrum Decision (676/2002/EC).

In the public consultation it was suggested by respondents to introduce an EU geo-location data base to provide information on the local availability of spectrum and which would also be useful to monitor PMSE demand and usage. The local aspect of the needs of wireless audio PMSE applications would justify the use of geo-location databases and such an approach would be in line with the Mandate from the Commission to the European Telecommunications Standards Institute (ETSI) to standardise the information with respect to cognitive radio systems (Reconfigurable Radio Systems). However such a geo-location database could require registration of the users, which is not practised in those Member States using general licence or licence-exempt access. Legal introduction of a geo-location database at EU level for the benefit of PMSE usage could require amendment of the legislative framework of Member States. However, the provision of information via a geo-location database does not by itself provide wireless audio PMSE users with particularly useful information on how to find usable spectrum, as it is necessary to carry out a technical analysis of this information using the appropriate technical parameters and local knowledge in order to obtain an accurate picture of the potentially usable spectrum. Regulatory authorities of Member States indicated that the benefit of such geo-location databases would be low compared to the administrative burden for the establishment, maintenance and operation. The general comments by the Member States are that the administrative and financial burdens will outweigh the advantages. Moreover, operating the database requires a continuous update to check that channels and powers given by the database are still valid, whereas PMSE usage can be extremely mobile and of short duration at a specific location.

7. ANALYSIS OF IMPACTS

7.1. Key issues considered in the impact analysis

As indicated in section 4.5, the VVA study methodology has identified three levels of socio-economic value of PMSE.

Table 3 below lists the key issues considered in the VVA used to estimate the economic impact of the options.

Table 3 – Economic impacts

Economic Impacts	Key Issues
Functioning of the internal market and competition	Expected impact (positive and negative) of the considered options in respect to equipment costs and competition by the manufacturers; PMSE user behaviour and regulators' opinions.
Competitiveness, trade and investment flows	Expectations on investment, sales and expanding into EU markets the next 10 years.
Operating costs and conduct of business	Impact of the options on the cost of production in the next 5-10 years including expected replacement necessary to respond to the options. Expectations on the turnover. Future business plans.
Administrative burdens on business	Cost involved with harmonisation measures.
Public authorities	Budgetary consequences for Member States' spectrum regulators.
Innovation and research	Expectation on investment in Research and Development.
Art, culture and creative industry	The average needs for spectrum for the benefit of a "typical event" and future expectations on the use of wireless audio PMSE equipment.

Source: Created by European Commission Services

No environmental impact in reference to this issue could be identified.

The VVA study team evaluated the impact of the harmonisation options separately for each category: users, manufacturers and regulators over the next 5-10 years (Valdani Vicari Associates, 2013, section 6).

- For users, costs and benefits refer to changes in equipment costs and in licensing under each scenario. These are calculated on the basis of the cost of the equipment, the number of times the equipment is used daily and three different types of events depending on their size and the frequency at which they occur.
- Costs and benefits for manufacturers refer to their opinion on the changes in production costs or revenue likely to materialise under each scenario.
- For regulators, costs and benefits refer to their opinion on the changes in licensing revenue and regulatory costs under each scenario.

The social impacts included in Table 4 below have been considered; however no direct cost-benefit analysis is feasible as mentioned above; they have hence been considered on a qualitative basis.

Table 4 – Social impacts

Social Impacts	Key issue
Employment and labour markets	Europe’s cultural and creative sectors are considerable. Based on the NACE ²⁸ code analysis in Annex 11.10 an overestimate of the employment in cultural sectors supported by audio PMSE use can be established at 610 thousand employees Union-wide with a turnover of 580 billion euros.
Public health and safety	The use of wireless audio PMSE equipment is required during performances to prevent dangerous situations due to multiple wired PMSE equipment.
Cultural diversity	The use of audio PMSE is a key facility for most social and cultural events supporting cultural diversity. It is difficult to determine if and under which conditions wireless PMSE equipment could be replaceable by wired systems given the show’s artistic quality requirements.
Consumers and households	The quality of social and cultural events will contribute to an overall quality of life for the EU citizens.

Source: Created by European Commission Services

7.2. Impact of the options

Table 5 provides the calculation of the costs in a time frame of 5-10 years by VVA due to the reallocation of the spectrum in the UHF band, considering the equipment costs and licence cost for the users, the existing cost and sales figures for the PMSE manufacturers and cost of regulating PMSE spectrum and licensing revenues of the regulators. **It should be noted that these costs are not related to any of the potential change options (2, 3 and 3.1), but rather stem from the on-going changes in the use of the UHF band by broadcasters and mobile operators aimed at more efficient spectrum use.** The cost of the broader scope of the social and cultural events is also not included in these calculations, due to the lack of a reliable financial instrument to quantify that cost.

Table 5 – Calculated cost by VVA due to changes in spectrum use in particular the UHF band

Baseline - no EU action	Users	Manufacturers	Regulators	Total
Estimated cost (euros)	<i>496 million</i>	<i>11 million</i>	<i>5 thousand</i>	<i>507 million</i>

Source: VVA, (2013, p.68)

²⁸ European industrial activity classification, a pan-European classification system which groups organisations according to their business activities

The impacts have been calculated taking into account the cost-benefits of each option. The net benefit of each option compared to the baseline is presented in Table 6. It should be noted that none of the options is able to compensate fully the costs resulting from the on-going changes in spectrum use.

Table 6 – The net benefits (reduction of cost) of the options compared with the baseline of no EU intervention measures

Option values compared to the base line (euros)	Users	Manufacturers	Regulators	Total <i>(reduction of the costs in table 5)</i>
Option 2 (<i>tuning ranges</i>)	<i>65 million</i>	<i>11 million</i>	<i>-18 thousand (increase of costs)</i>	<i>76 million</i>
Option 3 (<i>harmonised frequencies + tuning ranges</i>)	<i>31 million</i>	<i>14 million</i>	<i>4 thousand</i>	<i>45 million</i>
Option 3.1 (<i>harmonised frequencies + additional spectrum</i>)	<i>64 million</i>	<i>14 million</i>	<i>4 thousand</i>	<i>78 million</i>

Source: VVA, (2013) and created by European Commission Services

Details on the sources of the estimated negative impacts are provided in the text below for each option.

Option 1: Baseline scenario/No EU intervention

As indicated in paragraph 6.1 this option refers to a case where no specific action is taken at EU level to secure a long-term certainty for PMSE spectrum access given the on-going changes in use of spectrum in the UHF band.

Stakeholder consultation showed a large diversity of opinions. Some users stated that a lack of EU intervention would not have a large impact on their business in terms of wireless audio PMSE equipment used per event, overall cost per event and licensing costs. This is probably due to the fact that not all users expect additional impacts to the ones already experienced as a consequence of the 800 MHz reallocation.²⁹ Nevertheless, the majority of consulted users would like to see some EU-level intervention. Wireless audio PMSE users clearly expressed that they need sufficient spectrum in the UHF band and they needed clarity and long-term assurance with regards to the frequencies that will be made available.

A number of users pointed out the pressure on availability of white spaces in the UHF band and hence expect an increase risk of harmful interference and its negative impact on the quality of cultural output and hence on cultural diversity across Europe. Ofcom

²⁹ As noted before, a non-representative Pearle survey from 2010 showed that 98 of 111 German theatres responding used the frequency band 790-862 MHz before the reallocation of the 800 MHz band. Of those 98 theatres 30 continued to use wireless microphones in those frequency bands (of which 16 in the 800 MHz duplex gap) so over half the theatres were affected by the 800 MHz band reallocation. 42 of 111 theatres indicated use of the 694 to 790 MHz range and would hence be concerned by a possible reallocation of the 700 MHz band. Some might not be affected as they might continue to use this band similarly to the 800 MHz band.

conducted an analysis of UK events which they presented at the 2014 ‘PMSE stakeholders’ workshop’ and identified that events could be severely impacted by the release of the 700 MHz band.³⁰

Manufacturers expressed quite diverse opinions on the evolution of the market if no EU level action is undertaken. This may be partly due to the different national contexts. Some manufacturers indicated for instance that their production costs would decrease (perhaps as a result of reduced investment in product development under this option) whereas others thought they would increase due to lack of economies of scale. Most manufacturers thought their sales would decrease significantly (more than 10%) if no action is undertaken at EU level.

Densely populated Member States are likely to be more affected as they use spectrum more intensively in specific areas. As an illustration, Pearle has provided non-comprehensive data on theatres and music hall numbers (see Annex 11.13) from which it is clear that the countries with the highest concentration of venues using wireless audio PMSE are the UK, France, Germany, Spain and Italy.

Finally, regulators see lack of spectrum as the key concern, followed by uncertainty about future regulation. Member States are also reticent to reserve spectrum for wireless audio PMSE because of its temporary and local nature which might imply that spectrum is reserved but not used at specific times and locations. Licensing costs, market fragmentation and information regarding demand for spectrum are seen as less important barriers to the industry. All regulators provide very low licencing revenue figures, mainly because licencing is free in most countries.

Option 2: Common Tuning Ranges

This option refers to the identification of tuning ranges in all Member States with at least 60 MHz of available spectrum for wireless audio PMSE equipment. The amount of 60 MHz is identified by several sources as detailed in Annex 11.6.

This option does not provide a guarantee to users or manufacturers that any specific frequencies would be available neither throughout a single Member State nor Union-wide. Although a baseline of available spectrum is set by this option, fragmentation would persist, albeit limited to those frequencies in the identified tuning ranges.

In the VVA study workshop³¹, stakeholders expressed concerns that the identified tuning ranges differ significantly in terms of their usability for wireless audio PMSE usage³². Users expressed a strong preference to use the UHF band (470-790 MHz) because of its technical characteristics. About 40 per cent of users indicated that option 2 would require the purchase of devices and increase usage of wireless microphones. The source of the cost for users is the equipment cost as indicated in Table 5. This option provides the benefit of more clarity for the users than the baseline option and 40 per cent of the users expect an increased use of wireless microphones, compared with about 50 per cent who

³⁰ Strategic review of spectrum access for programme making and special events, 18 February 2012; <https://ec.europa.eu/digital-agenda/en/news/announcement-pmse-stakeholders-workshop>

³¹ Held on 21 June 2013

³² In particular they noted that the 28.7-69 MHz range is not usable due to man-made noise and the required antenna length (too long) and that the 174-216 MHz range has limitations

expect no change. About 45 per cent of users expected no change in the cost of wireless microphones for a typical event and about an equal share expected an increase. Moreover, respondents also indicated that this EU intervention would require them to update their equipment due to the loss of access to some of the currently used frequency bands (not only the reallocated 800 MHz band) and that they would thus incur additional costs. Two thirds of the user respondents expected no change in the licensing costs. The total positive effect for the users is estimated at a net benefit of 65 million euros compared with the baseline option, due to the increased use of equipment during events.

Under this option manufacturers are expecting a combination of rising production costs and rising sales (users are expected willing to invest in new equipment). This option will have a limited impact on the integration of the internal market because the specific frequencies made available within the identified tuning ranges could differ between Member States. Hence, this option does not meet the objective of generating economies of scale as there would be no guarantee that the identical frequencies would be identified by each Member State.

Regulators' responses were aligned in saying that option 2 would not lead to greater coordination across Member States; it would not increase registration/licensing of PMSE applications or lead to more accurate monitoring of demand and supply. In addition, most regulators do not foresee any particular change in terms of licencing revenues or regulatory costs.

Option 3: Harmonised spectrum availability added to tuning ranges

This option refers to a combination of harmonized bands amounting to 29 MHz of spectrum (duplex gaps in the 800 and 1800 MHz bands, i.e. 823-832 MHz and 1785-1805 MHz). This option ensures that 29 MHz of spectrum is harmonised by its technical conditions³³ and made available Union-wide in the long-term. In practice, this means that the same wireless audio PMSE equipment can operate in the duplex gaps frequencies within and across every EU Member State.

Since average daily requirements for social and cultural events exceed the amount of the harmonised spectrum in the duplex gaps in the 800 and 1800 MHz bands, an additional 30 MHz would be available within tuning ranges to meet average daily requirements as identified in Annex 11.6. The main difference with respect to option 2 is that the baseline is made up by a combination of a harmonised core band part to meet users and manufacturers' perspectives and a tuning ranges part taking into account the wish for flexibility by Member States regulatory authorities.

This option combines the availability of a limited amount of spectrum Union-wide for wireless audio PMSE use and a baseline to meet average daily needs of non-professional use as well as most small and medium professional events such as theatre, concerts, press coverage, and to some extent TV productions. The core band of 29 MHz could facilitate 15 to 25 wireless microphones, although this is highly dependent on the local conditions and the specific usage conditions. The very numerous community and very small-scale professional users are likely to find that equipment focused on these harmonised core bands would be adequate for their needs (in the event that they feel compelled to change

³³ The CEPT studied the technical conditions of the core bands identified for harmonisation for wireless audio PMSE usage, as noted in paragraph 2.4.1.

current equipment adapted for UHF white spaces), which therefore contributes to an Union-wide market for equipment addressing this segment.

Harmonisation of the duplex gaps would be most useful to generate economies of scale for 'basic' equipment, i.e. for use by the large numbers of users who do not require very high-fidelity professional sound reproduction and whose needs (along with those of others operating in their vicinity) would be adequately met by the channel capacity of the 29 MHz harmonised core band. Users can benefit from such economies of scale when they need to purchase or replace equipment. The workshop held in 2010 on "A long-term approach to radio spectrum for PMSE in Europe" confirmed that core harmonised frequency bands at EU level would be one of the key strategic initiatives which would have wide support among stakeholders. Similarly, about 60% of respondents to the public consultation, held mid-2012, indicated support for harmonisation of spectrum for the use of wireless microphones, including in-ear and control systems. Respondents indicated that such a harmonisation measure would provide clarity for consumers and provide advantages of economy of scale and for "touring" events operating across multiple Member States.

As indicated in section 4.3, concerns were raised on the usability of the duplex gaps due to possible harmful interference caused by LTE technology operating in adjacent bands. These concerns are reflected in the outcome of the indicated net benefit value of option 3 where user responses only indicated a 31 million euros value, 34 million less than option 2. In particular, the professional wireless audio PMSE users do not value a harmonisation of the duplex gaps due to the risk of interference and thus consider that option 3 only provides for 30 MHz of usable (i.e. interference-free) spectrum which they consider as insufficient. This was confirmed at the 2014 "PMSE Stakeholders' Workshop" where stakeholders mentioned that the duplex gaps would be useful for small users such as community gatherings, uses in educational establishments while the risk of interference would be too high for professional users to accept. Nevertheless, from the qualitative perspective a harmonisation of bands is best ranked by the users.

From the manufacturers' perspective, option 3 creates an opportunity for an Union-wide market for wireless audio PMSE equipment through the harmonised core bands. Manufacturers expect a rise in sales in line with user responses. Manufacturers' preference is for a harmonisation measure as this provides the basis for economies of scale. Owing to the harmonised core frequencies this scenario would generate economies of scale by providing manufacturers with a single European market, in particular for equipment using only the harmonised core bands, or using such bands plus those most commonly made available in addition by Member States. Research and innovation could focus on those harmonised bands. The wireless audio PMSE is a competitive market as confirmed by APWPT reporting the reticence of manufacturers to reveal their data and by the rather long list of well-known manufacturers (mainly SMEs or divisions of larger electronics group) provided in Annex 11.12. Also, as many other electronic devices, this market experiences strong price competition from Asian countries, especially in the 'basic' equipment segment aimed at non-professional users.

The additional 30 MHz of spectrum to be made available does not in itself lead to economies of scale as already outlined in Option 2, but it increases the amount of spectrum available for wireless audio PMSE users and thus caters for larger users. The objective of reducing fragmentation is achieved for smaller users via the harmonised bands and larger users, who are likely to have more expensive equipment anyway and thus will experience fewer issues in tuning to different ranges as already explained

earlier. The CEPT Recommendations are being, at least partially, followed by all Member States so that the Commission does not see the need to mandate the tuning ranges in addition to the harmonised bands and a further harmonisation would be disproportionate given the concerns in respect to more specific local and temporary needs of larger, non-frequent events.

Member States will maintain the desired flexibility by identifying the additional 30 MHz from tuning ranges at the national level in line with CEPT Recommendations and would hence provide for the use of these ranges for wireless audio PMSE equipment on a ‘non protection - non-interference’ basis with the authorised users as is currently the practice. Some regulators expressed concern that this option would lead to less efficient spectrum allocation because Member States would be bound to make available 60 MHz even if PMSE demand were lower in specific locations and time frames. This option also restricts the flexibility of Member States to offer appropriate local solutions for example by making spectrum available in ranges other than the ones indicated above. Option 3 would not dramatically change licencing revenues, while some regulators commented that this solution would reduce their regulatory costs and have a positive impact on PMSE use.

Option 3.1: Harmonised spectrum availability added to additional spectrum based on demand

This option is a variant of option 3, taking into account comments from stakeholders and Member States regulatory authorities on the previous options. This option maintains the benefits of option 3. The harmonisation of the ‘duplex gaps’ would be most useful to a single market thus generating economies of scale for ‘basic’ equipment and for research and development efforts just like in option 3. Also, the additional 30 MHz of spectrum in tuning ranges contribute to the baseline amount of 59 MHz needed to meet average daily requirements. In addition to option 3, option 3.1 considers interference risk mitigation solutions and a provision by Member States to make available at least 30 MHz of additional spectrum (on demand to the extent required) from the tuning ranges of their choice thus avoiding an inefficient reservation of spectrum.

APWPT argued, at the 2014 ‘PMSE stakeholders’ workshop’, that the wireless audio PMSE industry needs a minimum of 96 MHz in the UHF band. Nevertheless, stakeholders emphasised that any European Commission initiative that would give the industry certainty was welcomed.

In relation to stakeholders’ concerns on the usability of the ‘duplex gaps’, the quantitative impact estimations confirm those concerns as described in option 3. Option 2 provides for 60 MHz of spectrum from tuning ranges and has an impact of 65 million (about 1.08 million per MHz) while option 3 provides for the harmonisation of 29 MHz in the ‘duplex gaps’ and 30 MHz of additional spectrum and is valued at 31 million (about average of 1.06 million per MHz). The Commission thus based itself on the estimate of options 2 and 3 to estimate the impact of option 3.1 and specifically to attribute a value to the harmonised portion of the spectrum. From a user perspective the value of 59 MHz of usable spectrum would be proportional to the 60 MHz provided in option 2, i.e. 59 MHz valued at 1.08 million/MHz amount to about 64 million.³⁴ From

³⁴ This is the maximum achievable impact based on all the 29 MHz of harmonised spectrum being considered usable. The usability of the bands for each venue will depend on the individual choices that venue will make to reduce the risk of interference, see section 5.1 for further details

manufacturers' perspective this option is equivalent to option 3 as only the harmonised bands contribute to generating economies of scale. Hence the Commission considers that the impact for manufacturers of option 3.1 would be equal to that of option 3.

The technical feasibility of coexistence between wireless audio PMSE use and LTE technology was successfully demonstrated by the JRC tests, but the operational details would benefit from practical experience. It is thus not currently possible to estimate the implementation costs due to the different criteria that would need to be considered on a case-by-case basis for each venue. Also, the exact cost of installing small cells and of integrating them in the existing network of mobile network operators would have to be estimated based on the size of the venue, its characteristics in terms of position, the amount of people likely to attend events and the characteristics of the specific network. This issue was discussed at the 2014 'PMSE stakeholders' workshop'. Many participants from mobile operators, PMSE users and regulators regarded this as an interesting option to explore further without being currently able to determine the exact costs it would imply. It should also be noted that at the Mobile World Congress 2014 in Barcelona, several large vendors displayed small cell solutions that are capable of handling 10 to 500³⁵ subscribers in an indoor environment. A competitive offering of small cell solutions can therefore be assumed.

Member States noted a preference for option 3.1 as opposed to option 3 because the former avoids the reservation of spectrum when and where it is not needed and does not specify tuning ranges thus leaving more flexibility for Member States to choose which frequency bands will be made available to wireless audio PMSE users. These positions were discussed in more detail at the RSC#47 meeting where the Commission and Member States agreed on the need for a decision on wireless audio PMSE.

7.3. Assessment of administrative burden

The outcome of the study shows that the impact on the administrative burden of all three options is negligible. The three options do not create any additional administrative burden as the licencing regimes are left at the discretion of MS so no change with respect to today.

7.4. Uncertainties and sensitivity analysis

Sensitivity testing was conducted by the contractor of the study to investigate how changes in model assumptions could influence the outcome of the analysis.

VVA analysed the effects of changing the coding of the survey replies to quantitative impact (Valdani Vicari Associates, 2013, Table 1). This means changing the estimated effect on costs and revenues estimates based on the responses provided by the stakeholders. The ranking of the preferred options by manufacturers and users does not change. For regulators the preferred option changes from option 3 to option 1, although the financial effect is negligible. VVA also tested the set of assumptions taken to estimate manufacturers' baseline data. Although the assumptions used to arrive at market size estimates will have an impact on the total magnitude of the impacts, they will not affect the ranking of the options in terms of cost-effectiveness.

³⁵ A number of 1000 subscribers per macro sector are expected by 2018.

7.5. Effect on other spectrum users

The intended harmonised spectrum in the 800 MHz and 1800 MHz ‘duplex gaps’ is spectrum which separates the uplink and down link traffic of electronic communications services in order to prevent harmful interference between both traffic flows. It is therefore available for other services. Most Member States indicated that both duplex gaps are available for wireless audio PMSE use. If this use is based on ‘non-protection and non-interference’ existing users will not be affected when wireless audio PMSE applications use those gaps. As noted there is a need for PMSE-LTE technology coexistence, which requires mitigation solutions and, where feasible and necessary agreements between mobile network operators and PMSE users. The provision of the additional 30 MHz of spectrum on demand to the extent required provides legal certainty based on an already existing practice regarding PMSE spectrum use and sustains it into the future.

7.6. Impacts in the EU and outside the EU

Impacts outside the EU are not included in the study. Although European manufacturers of audio PMSE equipment are represented among companies operating worldwide, it should be noted that outside the EU different frequency bands and tuning ranges could be assigned for wireless audio PMSE use.³⁶ Some economy of scale effects can be expected in case of an Union-wide harmonisation, in particular supporting research and development when sustainable availability of spectrum is provided.

An additional impact of this initiative could be that if the EU forms a single market for this type of equipment, other small countries in the region might identify the same frequencies for this type of application. European manufacturers could hence export their equipment to these markets with no adjustment required to their equipment.

7.7. Potential obstacles to compliance

Use in highly professional cultural settings requires full interference-free availability of spectrum, given the required quality of the performances. Currently such requirements are feasible in shared use in those frequency bands operated by broadcasting in the UHF broadcasting band (470-790 MHz). To provide and guarantee full interference-free use of spectrum will become more difficult in the future owing to the increased use of the spectrum by both broadcasting and other services. Solutions are not possible by regulation only and require also a technical approach. In that respect research and development and appropriate standardisation measures will be essential in the short term. Moreover such requires enforceability measures and could involve costs at social and cultural locations.

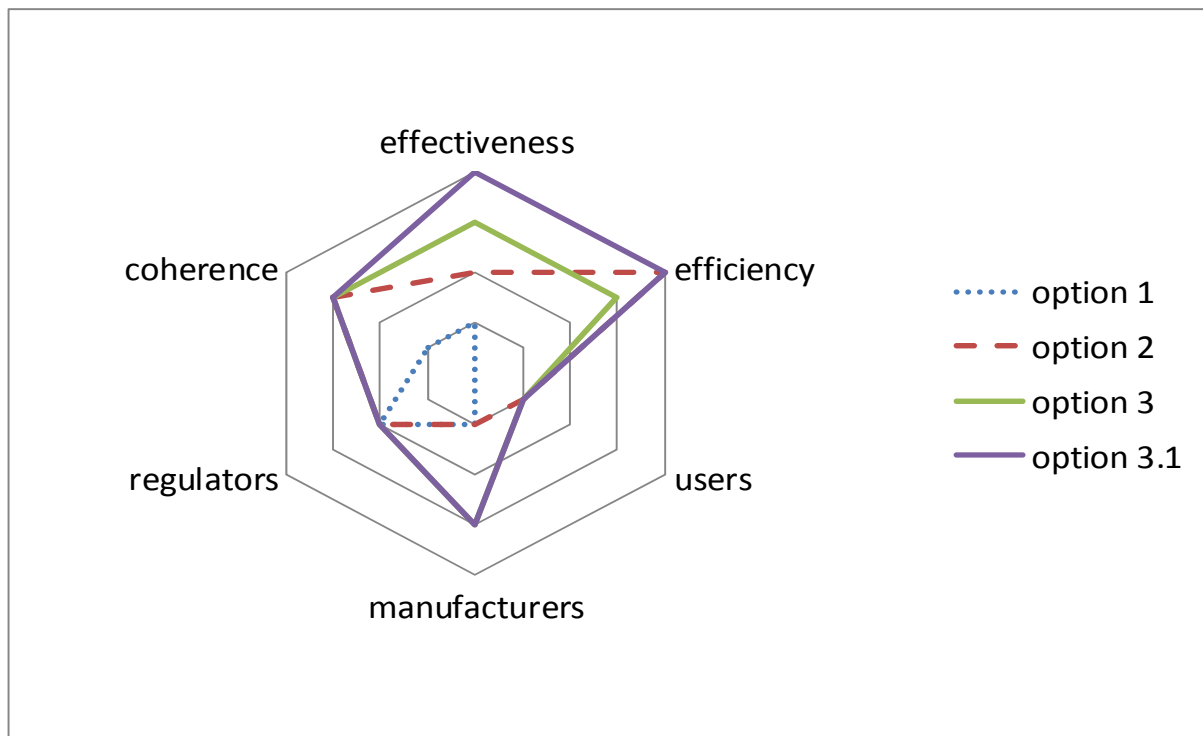
8. COMPARING THE OPTIONS

Section 7.1 presented a summary of the quantitative and qualitative analysis for each option and for different stakeholder groups.

³⁶ In the USA the frequencies 169.445, 169.505, 170.245, 170.305, 171.045, 171.105, 171.845 and 171.905 MHz are available for wireless microphone operations on a secondary basis. In the bands 54-72 MHz, 76-88 MHz, 174-216 MHz, 470-608 MHz and 614-698 MHz, wireless microphone and wireless assist video devices may be authorized on a non-interference basis. (source FCC)

Table 7 gives an appreciation of each option compared to the policy objectives in the effectiveness column, provides the socio-economic impact of each option in the efficiency column and then provides a summary of stakeholders' views and a view of the coherence with other elements of EU policy in the respectively named columns. Each column has been represented in Figure 9 below to provide an immediately visual appreciation of the different options. In its overall performance, Option 3.1 exceeds the other options, as it is equivalent or superior in each area.

Figure 9 – Diagram of all dimensions considered to compare the options



In terms of comparing the options, the following criteria have been considered:

- 60 per cent of manufacturers and users expressed support in principle for a harmonisation measure at EU level;
- The elements of a potential Commission Decision based on option 3.1 were discussed with Member States most of which support the need for a decision;
- Option 3.1 has the highest aggregate impact, while user impact, which is by far larger than manufacturers' and regulators' impact, is proportionally the same as in option 2;
- The outcome of the public consultation showed that users hardly use equipment for the 1785-1805 MHz range (although this band has been recommended by CEPT for wireless audio PMSE since a few years already) which means PMSE users will have to invest in equipment to use this band. Evidence shows that in the long-term many professional users would have to change equipment in any case due to the shrinkage of available UHF 'white spaces'. Therefore the 1785-1805 MHz range can provide a basis for long-term replacement planning on the part of users. It also means the use of this band will be promoted thus speeding up the required migration path and making the equipment as cost-effective as possible via economies of scale.

Table 7 – Impact table

For option 1 the efficiency values indicated are the **costs effects** of the on-going changes in spectrum use in the UHF band in the next 5-10 years.

Option	Effectiveness versus objectives <i>(- negative; 0 neutral; +positive)</i>	Efficiency (euros)	Stakeholders' views <i>(- negative; 0 neutral; +positive)</i>	Coherence
Option 1 - Base line; no EU intervention	<p><u>Users (-):</u> Ordinary daily needs under continuing increasing pressure; No common Union-wide band; No certainty on long-term availability of specific spectrum; No protection from harmful interference.</p> <p><u>Manufacturers (-):</u> No common Union-wide band and further fragmentation is likely; No certainty on long-term availability of specific spectrum; R&D will concentrate on (more expensive) sophisticated simultaneous equipment and could neglect the required technical aspects of efficient use of spectrum.</p> <p><u>Regulators (+):</u> No spectrum reservation and full national flexibility.</p>	<p><u>Users</u> : 496 M</p> <p><u>Manufacturers</u> : 11 M</p> <p><u>Regulators</u>: 5 K</p> <p>TOTAL COST EFFECTS : 507 M</p>	<p><u>Users (- -):</u> Replacement of equipment will be necessary for some users with lack of certainty on recoup of the investments because lack of certainty on availability of specific spectrum.</p> <p><u>Manufacturers (-):</u> No economies of scale; Dilution of R&D efforts.</p> <p><u>Regulators (0):</u> Regulators need to adapt to changing use of the UHF band.</p>	Will not fulfil RSPP Art. 8(5) 'to ensure the necessary frequency bands for PMSE in accordance with the Union's objectives to improve the integration of the internal market and access to culture'.

For options 2, 3 and 3.1 the efficiency values indicated are the cost/benefit estimates of each option (and for each stakeholder category) in the next 5-10 years.

Option	Effectiveness versus objectives <i>(- negative; 0 neutral; +positive)</i>	Efficiency (euros)	Stakeholders' views <i>(- negative; 0 neutral; +positive)</i>	Coherence
Option 2 - Common tuning ranges	<p><u>Users (+)</u> Meets ordinary daily needs; No common Union-wide band; Provides certainty on long-term amount of available spectrum; No protection from harmful interference.</p> <p><u>Manufacturers (0):</u> No common Union-wide core band and therefore no economy of scale; Limited certainty on long-term availability of specific spectrum.</p> <p><u>Regulators (0)</u> No core band spectrum reservation and national flexibility within the tuning ranges.</p>	<p><u>Users</u> : 65 M</p> <p><u>Manufacturers</u> : 11 M</p> <p><u>Regulators</u>: 18 K</p> <p>COST/BENEFIT: 76 M ³⁷</p>	<p><u>Users (-):</u> Replacement of equipment will be necessary for some users with limited guarantee of long-term sustainability of in case of limited band equipment. Professional users are indicating higher daily spectrum needs up to 96 MHz in UHF spectrum</p> <p><u>Manufacturers (-):</u> No economies of scale; Dilution of R&D efforts.</p> <p><u>Regulators (0):</u> Common tuning ranges aligned to majority of Member States' practices and flexibility to identify specific frequencies within the identified tuning ranges, however concerns on the efficient use of spectrum because temporary use in time and location which vary between 8 MHz up to over 100 MHz is inadequate reflected by the provision of 60 MHz</p>	Provides a baseline of available spectrum supporting cultural activities but only marginally helps decrease fragmentation of the market with reference to RSPP Art. 8(5) 'to ensure the necessary frequency bands for PMSE in accordance with the Union's objectives to improve the integration of the internal market and access to culture'.

³⁷ Remaining costs in euros due to spectrum reallocation: users 431 M; manufacturers 0; regulators 23 K ; in total 431 M

<p>Option 3 - Harmonised spectrum availability added to tuning ranges</p>	<p><u>Users (+):</u> Meets ordinary daily needs; Common Union-wide core band Provides certainty on long-term availability of a core band and amount of spectrum; No protection from harmful interference.</p> <p><u>Manufacturers (++)</u> Common Union-wide band, economies of scale for sizable equipment; Provides certainty on long-term availability of specific spectrum; Intention for R&D to focus on efficient use of spectrum.</p> <p><u>Regulators (-)</u> Transposition of harmonisation measure; Spectrum reservation.</p>	<p><u>Users</u> : 31 M</p> <p><u>Manufacturers</u> : 14 M</p> <p><u>Regulators</u>: 4 K</p> <p>COST/BENEFIT: 45 M³⁸</p>	<p><u>Users (-):</u> Long-term availability of bands will provide more confidence on the sustainable use of equipment replaced; Availability of some sustainable spectrum is provided; Harmonisation appropriate for small users; Due to concerns on the usability of the duplex gaps, lack of professional users' support who prefer 96 MHz of UHF spectrum; 60 per cent of respondents give support to harmonisation in the public consultation; 40 per cent of users ranked this best option in the VVA study.</p> <p><u>Manufacturers (+):</u> Will foster Economies of scale; Will focus R&D efforts;</p> <p><u>Regulators (0):</u> Low implementation costs as the harmonised bands are already made available for most Member States; Member States' concerns on the efficient use of spectrum because temporary use in time and location which vary between 8 MHz up to over 100 MHz is inadequate reflected by the provision of 60 MHz</p>	<p>Fulfil RSPP Art. 8(5) 'to ensure the necessary frequency bands for PMSE in accordance with the Union's objectives to improve the integration of the internal market and access to culture'.</p> <p>Aligned with CEPT Report 50 which recommends the availability of the 823-832 MHz and 1785-1805 MHz band under harmonised and operational conditions.</p>
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³⁸ Remaining costs in euros due to spectrum reallocation: users 465 M; manufacturers reduction of the costs by 3 M; regulators 1 K; in total 462 M

<p>Option 3.1 - Harmonised spectrum availability added to additional spectrum based on demand</p>	<p><u>Users (++):</u> Meets ordinary daily needs; Common Union-wide core band; Provides certainty on long-term availability of a core band and amount of spectrum; Includes interference mitigation solutions in the harmonised bands.</p> <p><u>Manufacturers (++)</u> Common Union-wide band, economies of scale for sizeable equipment; Provides certainty on long-term for some spectrum; Intention for R&D to focus on efficient use of spectrum.</p> <p><u>Regulators (0)</u> Transposition of harmonisation measure; No unnecessary spectrum reservation for smaller Member States; Spectrum reservation with still room for flexibility.</p>	<p><u>Users</u> : 64 M</p> <p><u>Manufacturers</u> : 14 M</p> <p><u>Regulators</u>: 4 K</p>	<p><u>Users (-):</u> Long-term availability of bands will provide more confidence on the sustainable use of equipment replaced; Any initiative giving wireless audio PMSE users some sustainable access to spectrum is welcome; Harmonisation appropriate for small users; Due to concerns on the usability of the duplex gaps, lack of professional users' support who prefer 96 MHz of UHF spectrum; 60 per cent of respondents give support to harmonisation in the public consultation; A Mitigation solution for reducing the risk of harmful interference in the duplex gaps is considered interesting for further deployment.</p> <p><u>Manufacturers (+):</u> Will foster economies of scale; Will focus R&D efforts.</p> <p><u>Regulators (0):</u> Low implementation costs as the harmonised bands are already made available by most Member States; Provides flexibility to identify the exact frequencies (preferably in the UHF band); Some Member States doubt the usefulness of an additional 30 MHz based on demand,</p>	<p>Fulfil RSPP Art. 8(5) 'to ensure the necessary frequency bands for PMSE in accordance with the Union's objectives to improve the integration of the internal market and access to culture'.</p> <p>Aligned with CEPT Report 50 which recommends the availability of the 823-832 MHz and 1785-1805 MHz band under harmonized and operational conditions.</p>
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³⁹ Remaining costs in euros due to spectrum reallocation: users 432 M; manufacturers reduction of the costs by 3 M; regulators 1 K; in total 429 M

		COST/BENEFIT: 78 M ³⁹	preferring full flexibility.	
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8.1. Added value of EU action

The benefits of a binding EU-harmonisation measure for wireless audio PMSE equipment should be balanced against the intrinsic flexibility needed to find solutions for wireless audio PMSE services which have local and temporary characteristics.

In all Member States wireless audio PMSE users have access to radio spectrum, whereas the conditions of such access differ due to difference in population, the extent of social and cultural activities, the existing use of the spectrum, the existing (if any) licence conditions for wireless audio PMSE, etc.

The current co-ordination of the internal market in wireless audio PMSE equipment relies on the non-legally binding CEPT Recommendations as explained in section 3.1. A standardisation of the equipment would not be useful as a stand-alone measure as this standardised equipment has no sustainable access to the same frequencies Union-wide in order to operate. Hence, the Commission services suggest that a harmonisation measure be proposed to Member States in the Radio Spectrum Committee (comitology decision). The added-value of such a measure would be to provide a portion of common Union-wide frequencies and a legal certainty on the amount of spectrum to be made available for wireless audio PMSE users. There is a high potential for such an EU measure to achieve more efficient use of radio spectrum because it will:

- provide access to the 800 MHz and 1800 MHz duplex gaps of which the last is effectively underutilised
- allow a common baseline of 29 MHz to be available Union-wide which means
 - small users can operate with standard equipment in the same spectrum Union-wide and will experience reduced administrative burden in finding available frequencies at any location domestically or in other EU Member States
 - manufacturers can benefit from economies of scale, especially but not exclusively for more basic equipment, and certainty in frequency bands designated across the EU
 - manufacturers can focus their R&D effort on those bands to develop more efficient technologies for the use of the duplex gaps, including that of the 1800 MHz band
- ensure access to spectrum in particular for professional users that will benefit from an additional 30 MHz being made available based on demand
- ensure clarity and sustainability to the wireless audio PMSE sector which has been (and will be) affected by the reallocations and changes in intensity of use of the UHF band and which currently has limited rights
- maintain the required flexibility of Member States to address the very large users in the way that is most suitable at the specific time and location of the event
- foster the cross-border and Union-wide deployment of equipment

The added value of any EU initiative does not lie in making sufficient spectrum available to meet all the needs of wireless audio PMSE users in all circumstances. The value of this EU measure lies in its tiered approach which aims to address the different objectives in a way that fully takes into account subsidiarity and proportionality as well as efficiency of spectrum use.

8.2. Preferred option

Based on the options presented to stakeholders by the VVA study and on their respective benefits and shortcomings, the Commission services, after taking into account stakeholder views in the context of the study questionnaire, the subsequent study workshop, and the discussions within the RSC meetings, have designed option 3.1 as the preferred option as it better meets the policy objectives and addresses stakeholders' comments. Option 3.1 contains the following elements:

- Harmonisation of the appropriate technical conditions of the frequency bands 823-832 MHz and 1785-1805 MHz to be designated and made available for the use of wireless audio PMSE equipment. With this measure the Commission intends to provide an Union-wide core band contributing to a baseline for wireless audio PMSE use.
- In addition to the harmonised frequency bands mentioned above, Member States should make available at least 30 MHz of additional radio spectrum to the extent where and when there is demand from social and cultural events organisers. Member States can provide this spectrum in frequency ranges of their choice, although preferably in the 470-790 MHz band.
- Any additional spectrum requirements beyond the 59 MHz indicated above will be addressed at the discretion of the Member States through national case-by-case solutions.

The advantage of option 3.1 is that it combines harmonised bands (and the subsequent advantages already described) with a provision for additional spectrum based explicitly on demand to reach an amount of 59 MHz for wireless audio PMSE use.

Harmonised spectrum alone would only amount to 29 MHz. Option 3.1 hence explicitly avoids the reservation of the additional spectrum everywhere when and where wireless audio PMSE needs are not present and thus deals with the concern expressed by some Member States that option 3 would lead to less efficient spectrum allocation because they would be bound to make available 60 MHz even if PMSE demand were lower in specific locations and time frames.

Option 3.1 also helps to maintain Member States' flexibility in light of their respective allocation tables while encouraging them to provide PMSE users with spectrum from the UHF broadcasting band which is strongly requested by this sector. A harmonisation of all identified bands would restrict the desired flexibility for the Member States to offer appropriate local solutions and 'reserve' spectrum in times or places where it would not necessarily be needed.

Only encouraging (and not obliging) Member States to make available the additional 30 MHz in the UHF band could lead to different national situations and possibly lack of spectrum for PMSE users in the UHF band at national level, in particular if broadcasters were to use the existing spectrum more efficiently (e.g. single frequency networks). However, Member States are aligned to CEPT Recommendations as already mentioned and there is no indication that any Member State would be diverging from them where, noting that the recommended tuning ranges are increasing. Also, from Member States' comments during the RSC meetings, this appears to be the maximum that can currently be done at EU level in favour of PMSE users in light of the highly coveted UHF band (which is the subject of more far-reaching reflections currently discussed at various EU and international levels and to which discussions the Commission continues to fully associate the PMSE sector), and the circumstances and intensity of use of the UHF band which varies considerably across Member States.

To prevent the risk of possible harmful interference caused by out of band emissions, Member States shall encourage to improve the coexistence between PMSE users and mobile electronic communications network operators through e.g. the deployment of small cells that will shift traffic to

the 2.1 GHz and 2.6 GHz band at the appropriate social and cultural locations, in particular in indoor scenarios (e.g. theatres, music halls, opera houses). This will avoid the use of the 800 MHz and 1800 MHz bands by mobile devices in the vicinity of wireless audio PMSE equipment present at those locations and thus improve the usability conditions of the harmonised bands for wireless audio PMSE equipment and hence increase the value to users of the harmonised duplex gaps.

In summary, this option meets all the set policy objectives: it ensures the sustainable and sufficient provision of frequencies for wireless audio PMSE use without reserving unused spectrum and without excessively limiting the desired Member States' flexibility or the future evolution of the UHF band. It provides an assurance of core harmonised bands where wireless audio PMSE users would benefit from reduced risk of harmful interference and in which manufacturers can concentrate production and benefit from economies of scale. Moreover, it is expected that this option will stimulate research and development in the 1785 to 1805 MHz range, thus encouraging the sector to use these available frequencies which are likely to be required for the challenges that PMSE users will face in the future.

Option 3.1 set out as the preferred option, includes the identification of harmonised core bands for wireless audio PMSE. Based on the provisions of the Radio Spectrum Decision (2002/676/EC), and taking into account the report from CEPT completed pursuant to a mandate of the Commission under the Radio Spectrum Decision, such harmonisation measures under the form of an implementing decision will be subject to the opinion of the relevant committee, in this case the Radio Spectrum Committee. The European Commission will hence submit to the RSC a proposal for a Draft implementing Decision including the elements of option 3.1.

9. MONITORING AND EVALUATION

9.1. Indicators of progress towards meeting the objectives

Table 8 below outlines the indicators of progress that will be monitored to evaluate whether the objectives of this initiative are being met through option 3.1. In line with the 'better regulation' policy of the Commission and in order to reduce administrative burden, the preference should be for light reporting obligations, building on existing tools. However, as noted in this Impact Assessment, there is a lack of useful market data on production and use of wireless audio PMSE equipment at the EU level. This could be compensated with information to be received from various sources including Commissions missions carried out in Member States, analysis of national implementing measures, market data received from national regulatory authorities and surveys commissioned on price developments. These are existing processes that the Commission proposes to exploit more effectively. There is hence no additional obligation being imposed in the context of this measure.

Given the objectives indicated above, the indicators of progress should focus on the development of wireless audio PMSE equipment which can be Union-wide, fostering research and development resulting in investment and innovation of equipment which is able to use spectrum more efficiently and in higher bands and stimulation of competition.

Table 8 – Indicators of progress

Objectives	Core indicators
Ensure that sufficient spectrum is available to meet the daily ordinary needs of wireless audio PMSE users	Number of demands for spectrum for wireless audio PMSE users that cannot be met
Reduce manufacturing costs of wireless audio PMSE equipment	Price reduction of wholesale and retail pricing of the equipment
Increase manufacturers R&D in wireless audio PMSE applications	<p>Increasing of the budget for R&D by the manufacturers</p> <p>Increasing of equipment which is able to use spectrum more efficient</p>
Foster mitigation solutions and coexistence in spectrum use resulting in a fit operation of PMSE applications in the assigned spectrum	<p>The coming of agreements between wireless audio PMSE users and mobile electronic communications networks operators on installing LTE picocells to redirect LTE traffic away from the PMSE use in the 800 MHz and 1800 MHz duplex gaps</p> <p>Number of cases of interference to and from wireless audio PMSE equipment</p> <p>Degree of interference observed and impact on the events</p>
Maintenance of national flexibility of spectrum to avoid reservation of spectrum that might in certain times and locations be left unused	Utilisation of spectrum bands made available to wireless audio PMSE users

Source: Created by European Commission Services

Member States should monitor the demand and usage of wireless audio PMSE to ensure efficient use of the bands where there will be a need for constant review of the Commission Implementing Decision to cover new developments, however without affecting the long-term certainty on the availability and access conditions of spectrum for wireless audio PMSE users. Regular reports could therefore provide a tool for monitoring and evaluating the implementation of the regulatory framework. Data collection and monitoring should be developed in order to better assess the effects of this regulation in a dynamic sector. The Commission proposes to evaluate the Decision three years after it is adopted

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11. ANNEXES – LIST OF ANNEXES

- 11.1. List of Acronyms
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11.1. List of Acronyms

APWPT : Association of Professional Wireless Production Technologies

CEPT : European Conference of Postal and Telecommunications Administrations, an organisation in which 48 European countries cooperate to regulate posts, radio spectrum and communications networks

EBU : European Broadcasting Union

ECC: Electronic Communications Committee

ECO : The European Communications Office

ENG : Electronic News Gathering

ERC : European Radiocommunications Committee

ETSI : European Telecommunications Standards Institute

HDTV : High-Definition television

Horeca : the food service industry sector

IEMs : in-ear monitors

MFCN : Mobile and Fixed electronic Communications Networks

OB : Outside Broadcasting

Pearle : Performing Arts Employers' Associations League Europe

PMSE : programme making and special events

RSC : Radio Spectrum Committee, a Committee which assists the Commission, which procedures and functioning is recorded in Articles 3 and 4 of the Radio Spectrum Decision (676/2002/EC)

RSPG : Radio Spectrum Policy Group

RSPP : Radio Spectrum Policy Programme

SFNs : Single Frequency Networks

UHF band : Ultra high frequency band, intended in this document as the frequency range 470-862 MHz

VVA : Valdani Vicari Associates

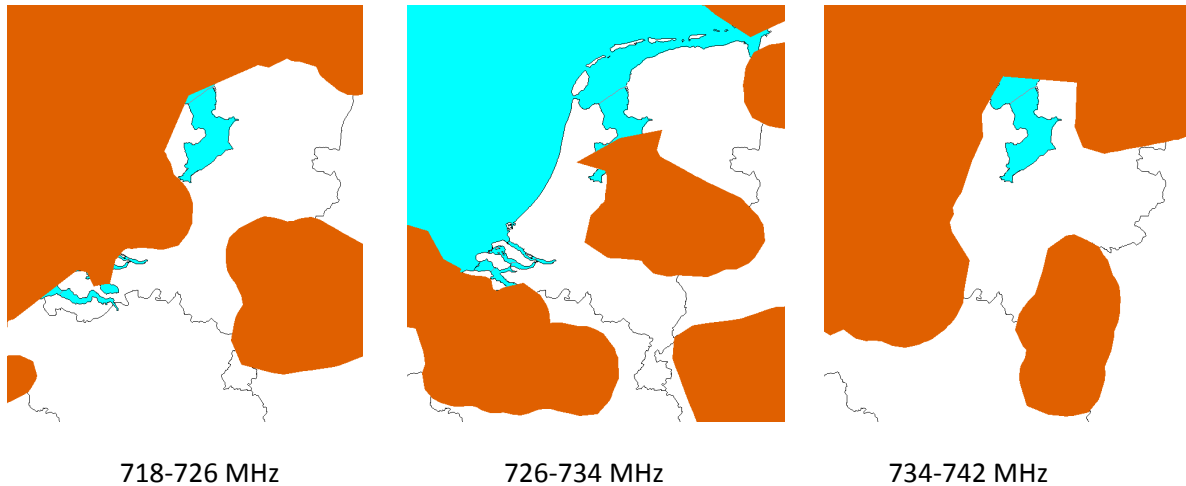
WRC : World Radiocommunications Conference

11.2. White spaces

The availability of the white spaces in the UHF band (470-790 MHz) is often in blocks of 8 MHz.

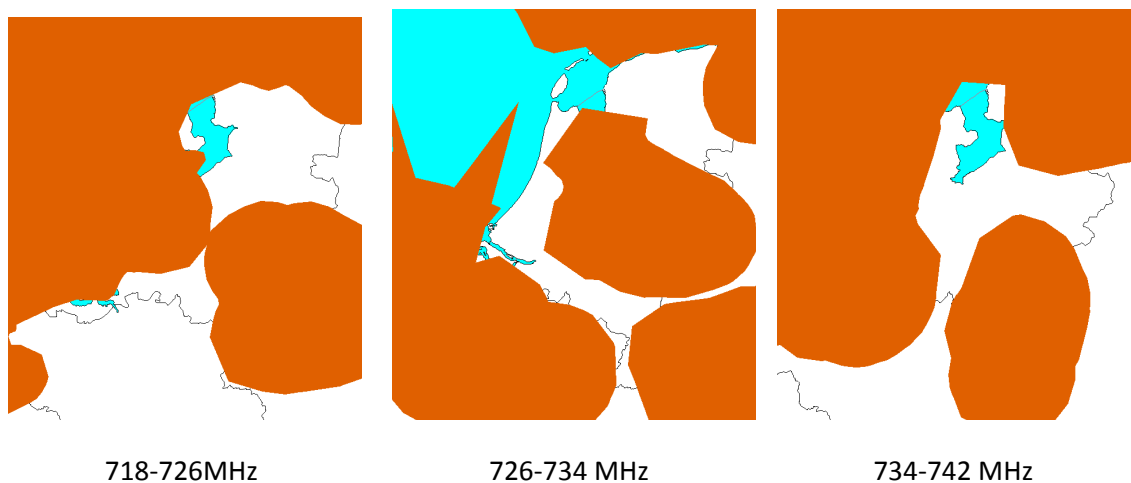
The figures below show some of the white spaces available in the Netherlands for **indoor** wireless audio PMSE use, for example in the frequency range 718 – 742 MHz. The coloured parts are used by broadcasting networks while the white parts would be available to PMSE users.

An example of some of the white space available in the Netherlands for *indoor* wireless audio PMSE



The figures below show some of the white spaces available in the Netherlands for **outdoor** wireless audio PMSE use in the same frequency range as above 718 – 742 MHz .

An example of some of the white space available in the Netherlands for *outdoor* wireless audio PMSE



More ‘white spaces’ are available indoor than outdoor because buildings prevent some of the broadcasting signal from entering thus leaving more spectrum ‘free’.

Source: <http://www.agentschaptelecom.nl/sites/default/files/effecten-vrijmaken-digitaal-dividend-op-pmse-rapport.pdf>

11.3. Consultation and expertise

Mandates to the European Conference of Postal and Telecommunications Administrations (CEPT)

In April 2008 the European Commission issued the "Second Mandate on the technical considerations regarding harmonisation option for the digital dividend⁴⁰ in the European Union"⁴¹ and requested CEPT, inter alia, to recommend a sustainable solution for existing PMSE services operating in the UHF band (470-862 MHz). In October 2009 CEPT published the "Recommendation on the best approach to ensure the continuation of existing Program Making and Special Events services operating in the UHF band, including the assessment of the advantage of an EU-level approach" (CEPT Report 32, 2009).

In December 2011 the Commission issued a Mandate to CEPT concerning technical conditions and spectrum harmonisation options for wireless microphones and cordless video-cameras (PMSE equipment)⁴². In March 2013 CEPT presented Report 50 in response to the Mandate on the 'Technical conditions for the use of the bands 821-832 MHz and 1785-1805 MHz for wireless microphones in the EU'. It "concludes that the bands under consideration are appropriate for the development of harmonized technical and operational conditions for PMSE audio applications in Europe, but that additional studies are required to determine which wireless audio applications are appropriate, and to what extent these bands will provide additional capacity for wireless audio applications." The report also recommends considering the band 821-823 MHz as a guard band because of adjacent band compatibility issues (CEPT Report 50, 2013). In November 2013 CEPT approved the addendum to Report 50 with regard to the usability of the bands 821-832 and 1785-1805 MHz for wireless radio microphones identifying the most critical case if a PMSE receiver is located close to a transmitting MFCN (Mobile and Fixed electronic Communication Network) picocell, which uses frequency bands adjacent to those used by the PMSE receiver. Also MFCN user equipment (smart phones) close to PMSE receivers can cause harmful interference. Studies show that a set-up procedure (planning of the frequencies in use) is required to ensure the quality of service needed for wireless audio PMSE use. However, there is no guarantee that a PMSE channel will remain free of harmful interference throughout the event.

Joint Research Centre testing

Stakeholders expressed concerns regarding the usability of the 'duplex gaps' in the 800 MHz and 1800 MHz bands in several instances of the consultation process. This was clearly reflected in the socio-economic impact estimated by VVA for options 2 and 3 where the harmonised bands were considered as having no value. In response to these concerns, the Commission asked JRC to perform technical test on LTE-PMSE coexistence by using small cells for redirection of traffic using LTE technology away from the 800 MHz and 1800 MHz duplex gaps to higher frequency bands (e.g. 2.1 GHz and 2.6 GHz) to be used in indoor social and cultural locations, such as theatres, musical halls and sporting venues. These small cells will automatically (i.e. without user

⁴⁰ Spectrum in the 800 MHz band which became available by switching from analogue to digital broadcast technology which enables broadcasters to provide the same services with less spectrum

⁴¹ Adopted at the Radio Spectrum Committee meeting #23 on 3 April 2008, RSCOM08-06 final

⁴² Adopted at the Radio Spectrum Committee meeting #38 on 15 December 2011, RSCOM11-59 final

intervention) connect handsets using LTE technology to the higher frequencies thus avoiding interference to PMSE equipment in the ‘duplex gaps’.

The technical testing was conducted by the JRC in collaboration with stakeholders from the PMSE sector represented by APWPT and the mobile industry represented by the GSMA Association (GSMA). The testing focused on the 800 MHz duplex gap with a handover to 2.6 GHz picocells and a distant 800 MHz macro cell. It is assumed that the conclusions will also hold for the 1800 MHz duplex gap. In summary the results of the tests indicate that the potential interference from LTE to PMSE identified in previous measurements⁴³ was confirmed.

The working document is available on the following webpage:

<https://ec.europa.eu/digital-agenda/en/news/announcement-pmse-stakeholders-workshop>

Study on the "Assessment of socio-economic impact of spectrum harmonisation regarding wireless microphones and cordless video-cameras (PMSE equipment)"

The Commission contracted a study on the "Assessment of socio-economic impact of spectrum harmonisation regarding wireless microphones and cordless video-cameras (PMSE equipment)" (SMART 2012/0019). The study was conducted by Valdani Vicari Associates (VVA) and was aimed to assess the socio-economic impacts of different policy options taken into consideration to provide a long-term sustainable solution to spectrum access for PMSE equipment.

In order to assess the impacts of different policy options, it is necessary to have a conceptual understanding of the socio-economic value of PMSE which the policy options may affect. In terms of scope the report identifies three levels at which PMSE creates socio-economic value:

- primary value of PMSE (i.e. economic value to manufacturers, users and regulators of PMSE equipment);
- secondary value of PMSE (i.e. economic and social value that accrues as a direct result of different types of PMSE equipment use, such as the value of event quality and frequency for audiences); and
- tertiary value of PMSE (i.e. economic and social value experienced by stakeholders who are not directly using PMSE equipment, e.g. hotels and restaurants next to theatres, the societal “value of culture”, etc.)

Given the scarcity of publicly available information on the wireless audio PMSE market, the study team had to extrapolate a value for the European market from existing literature. Based on this estimate of the market, the study considered three options and assessed their impact for each category: users, manufacturers and regulators over the next 5-10 years based on a stakeholder survey and interviews with several stakeholders.

For users, costs and benefits refer to expected costs of equipment and changes in licensing under each scenario. Costs and benefits for manufacturers refer to changes in production costs or revenue (e.g. market size) that manufacturers think would materialise under each scenario. For regulators, costs and benefits refer to changes in licensing revenue and regulatory costs under each scenario.

⁴³ IRT, APWPT/DKE, BNetzA, Ofcom UK, the Norwegian Post and Telecommunications Authority

The study was published and is available by following this link:

<http://bookshop.europa.eu/en/assessment-of-socio-economic-aspects-of-spectrum-harmonisation-regarding-wireless-microphones-and-cordless-video-cameras-pmse-equipment--pbKK0313217/>

"A long term approach to radio spectrum for PMSE in Europe" workshop (2010)

In line with the digital dividend Communication (Commission of the European Communities, 2009), covering amongst other things wireless microphones and similar applications, the Commission organised a stakeholders' workshop on "A long term approach to radio spectrum for Programme Making and Special Events in Europe", which took place on 26 October 2010 (European Commission, 26 October 2010). The workshop was open to all stakeholders and interested participants, which resulted in about eighty-five participants attending this workshop. In this process, the Commission has consulted, inter alia, the main sectorial associations: the Association of Professional Wireless Production Technologies (APWPT) and the Performing Arts Employers' Associations League Europe (Pearle).

Professional users' representatives stressed the need for having access to spectrum offering a predictable quality of service. As regards to EU harmonisation, several speakers called for a flexible strategy: on one hand, harmonisation should facilitate cross-border transportability of equipment, foster economies of scale and increase competition. On the other hand, it may cause inefficiencies due to the complexity of an EU spectrum re-farming process, and create possible confusion in the market if there were no clear delineation any longer between national and EU responsibilities.

Public consultation (2012)

A public consultation was held from May to August 2012 in order to collect stakeholders' views on the potential introduction of EU wide harmonisation of spectrum and the conditions for making it available on https://ec.europa.eu/digital-agenda/sites/digital-agenda/files/public_consultation_pmse_20120524.pdf. In addition to the explanations regarding the Commission's views on this policy subject, the call contains a questionnaire for the collection of socio-economic information and views from all interested parties in the field of PMSE equipment.

In total 39 different contributions were received to the public consultation including 3 from national administrations of Finland, France and Germany, 16 from manufacturers, suppliers and distributors of PMSE equipment (including Sennheiser, Shure and Audio Technica) and 69 from users (including broadcasters such as Canal+, ARD/ZDF/SRG and the European Broadcasting Union (EBU), live performers such as theatres and opera houses, and individual companies and private persons whose business activities involve the use of PMSE equipment).

The contributions to the questionnaire can be summarised as follow:

- Manufacturers, suppliers and distributors of PMSE equipment indicate that wireless microphone equipment mainly operates in the UHF band and that this spectrum provides the best quality of services for wireless microphones.
- Respondents suggest that the equipment is mainly used at local and national level.
- It is suggested that a harmonisation of licensing regimes could facilitate cross border use of equipment.

- 60% of the respondents gave support for Union-wide frequency harmonisation of the 821-832 MHz and 1785-1805 MHz spectrum for the use of wireless microphones, including in-ear and control systems.
- Respondents suggested that a harmonisation for audio PMSE will provide clarity for consumers and through specific standardisation measures on specific bands it can contribute to long term assurances which will result in investments by manufacturers in new designs and technologies in the field of wireless microphones and will provide the advantages of economy of scale.
- Respondents highlighted that PMSE users are most experienced in spectrum sharing. Sharing spectrum with a primary (licensed) user requires enough spaces for the secondary (e.g. PMSE) user to deploy its services and avoid conflicts in operation in view of harmful interference.

The outcomes of the public consultation as well as the individual responses (unless otherwise requested by the respondent) were published on DG INFSO website on the 1 October 2012, the link to this document is available on https://ec.europa.eu/digital-agenda/sites/digital-agenda/files/20121001_PC_PMSE_summary_v2.pdf

The outcome of the public consultation regarding the options for harmonisation of spectrum available for PMSE equipment presents a substantial input to the Commission's current work on analysing options for possible harmonisation conditions with the objective to maximise socio-economic benefits and ensure efficient use of spectrum. All contributions and comments received provided valuable information on the measures under consideration by the Commission as well as possible alternative options.

Workshop to discuss the 'Study on socio-economic aspects of spectrum harmonization for PMSE equipment' (2013)

The results of the study on the socio-economic aspects of spectrum harmonisation regarding wireless PMSE equipment, both audio and video were discussed with the stakeholders in a workshop held on 21 June 2013. The open workshop was attended by thirty stakeholders, representing the sectorial associations, broadcasting, manufacturers of PMSE equipment, organisations, companies and private persons whose business activities involves the use of equipment for the PMSE and representatives of national administrations.

Stakeholders were critical about the used questionnaire by the study team and expressed their opinion that many of the assumptions and calculations were based on incorrect data. Some were of the opinion that the questions in the questionnaire used by the study team were biased. These concerns had already been expressed when the survey was published and both the Commission and the study team had repeatedly invited stakeholders to one-to-one interviews, to provide their own reliable market data and information on the wireless audio and cordless video-camera PMSE to the study team. Unfortunately, stakeholders, and in particular manufacturers, have chosen, due to business confidentiality, not to provide any data neither on an individual nor on an aggregate basis through their associations. The study team's market size and cost estimates were hence based on the spare publicly available data of a single PMSE manufacturer.

Comments from stakeholders also expressed that the choices presented in the questionnaire did not reflect the technical and physical characteristics of the different potential and available frequency bands and that more interference-free spectrum should

be made available for PMSE than is being considered in the options evaluated in the study.

PMSE Stakeholders' Workshop (2014)

44 participants attended the "PMSE stakeholders' workshop" held on 18 February 2014. They were representatives of broadcasting and live performances (Pearle), manufacturers of wireless microphones and users (APWPT), the mobile industry and its representative organisation (GMSA) and national authorities of some Member States.

During the event, the JRC presented the outcome of the LTE-PMSE coexistence tests performed in Ispra 13-15 November 2013. The testing outcomes were discussed with the participants. The concept of redirecting mobile traffic away from the frequencies in the duplex gaps was found of being an interesting initiative while noting that further testing would be required in real-life situations and more clarity on its potential implementation and costs would be needed.

Ofcom UK shared their experiences in the field of spectrum use by PMSE applications and views on the potential impact of the 700 MHz band release.

The Commission services presented some preliminary elements for a draft Commission decision based on the preferred option 3.1. Some stakeholders were concerned about the status of the PMSE operations with regard to the licensed users in the additional 30 MHz band. Some national authorities' representatives raised doubts as to the need for the 30 MHz in addition to the harmonised spectrum in the 'duplex gaps'.

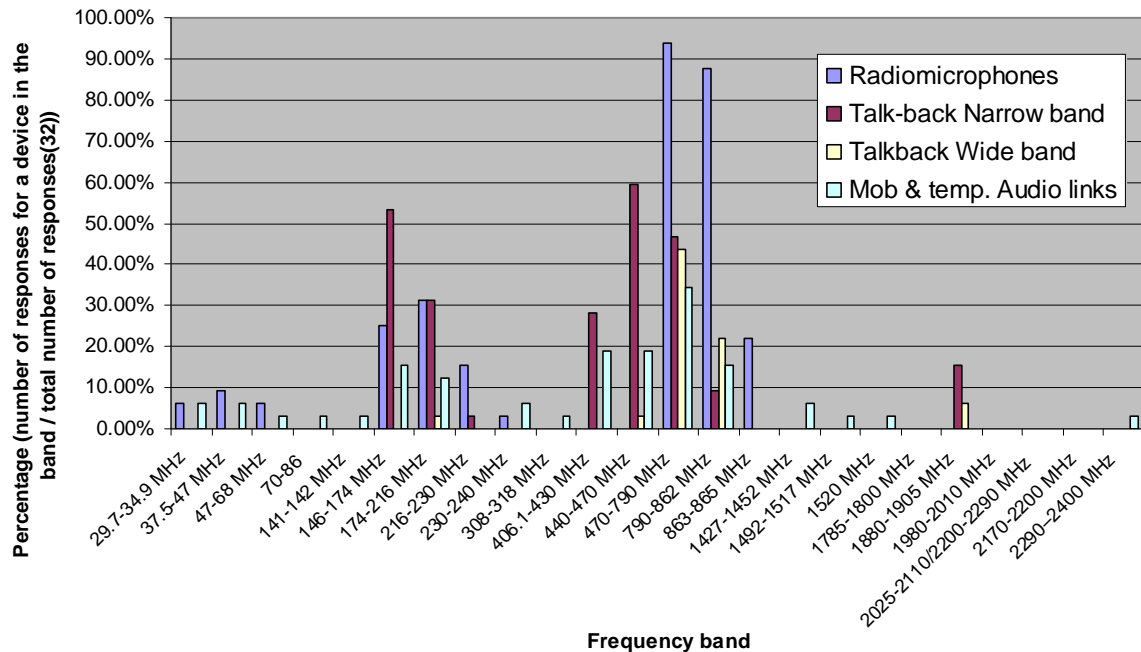
The Commission services concluded on the positive technical outcome of the JRC testing and noted that it considers the PMSE industry should be given some certainty that sustainable and sufficient spectrum will be made available to meet their daily needs in spite of the on-going changes in spectrum use, particularly in the UHF band.

11.4. Spectrum access conditions for PMSE users

Wireless audio PMSE equipment uses predominantly "white spaces"⁴⁴ in the 470-862 MHz range (the UHF band) left unused in some areas by the licenced user.

The following figure is extracted from a survey of PMSE broadcasting applications used in the bands from 29.7 MHz to 2400 MHz.

Use of PMSE broadcasting applications in the bands 29.7 MHz to 2.4 GHz



Source: EBU Technical Report 001, p.5, February 2009 and CEPT Report 32, p.6

These 'white spaces' are there to prevent harmful interference between TV channels. Such shared use of spectrum ranges resulting in coexistence is only possible when harmful interference, which could affect the quality of service, can be prevented. To ensure a good quality of service, spectrum sharing requires a 'reliable' primary user⁴⁵ which leaves enough 'white space' for the co-user (also called secondary user) of the spectrum to deploy its services. However, the spectrum use of wireless audio PMSE equipment is based on 'non protection - non-interference' conditions. The PMSE sector has a long experience in spectrum sharing with TV broadcasting services in the UHF band and in sharing spectrum mutually among users of PMSE applications.

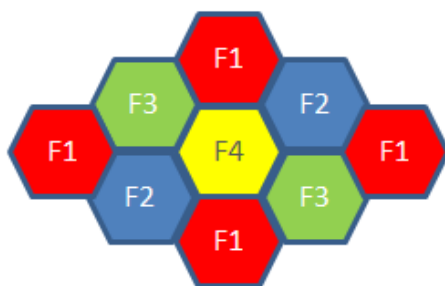
The figure below illustrates the concept of 'white spaces'. The areas labelled as F1 use the same frequency range. The different areas using the F1 frequency range have to be separated by areas in which different frequency ranges are used in order to prevent harmful interference. Hence the areas labelled F2, F3 and F4 will use different frequencies than area F1.

⁴⁴ The term "white spaces" refers to segments of spectrum which are not used by the licensed user (also called the primary user) in a geographical area.

⁴⁵ When the use of the spectrum is predictable in time and location as well as the level of interference, which makes it possible for spectrum management to plan interference-free spectrum use.

When area F1 is in use by TV broadcasting on a specific frequency range, PMSE will be able to use the same frequency range, F1, in the other areas F2, F3 and F4 using different frequencies ranges. The use can only be partial because PMSE use in the areas just next to the F1 area will be subject to harmful interference. So, in fact, it is the most central parts of other areas that can be used more successfully while the bordering areas are subject to more interference. Likewise, in the F1 areas, PMSE could partially use the frequencies used by TV broadcasting in the areas F2, F3 and F4.

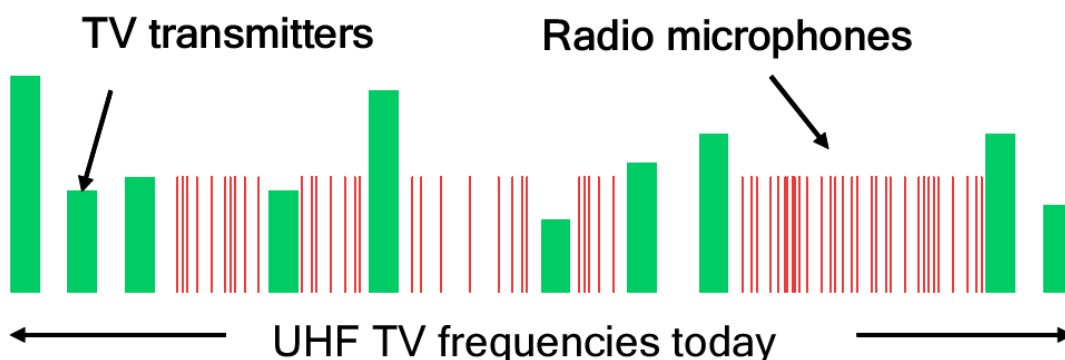
Multiple frequency cellular network



Source: Created by European Commission Service

This situation can be visualised as follows (copied from ETSI TR 102 546)⁴⁶

UHF TV frequencies in 2007



Source: ETSI TR 102 546 V1.1.1 (2007-02)

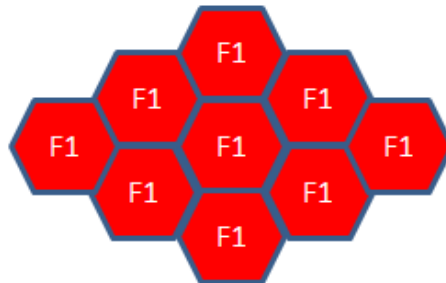
The introduction of cellular networks offering 3G and 4G wireless services⁴⁷ in the 800 MHz band leave no room for "white spaces" due to the denser deployment of base stations. The whole area in the figure below (F1, F2, F3 and F4) will be covered by a single cellular network using the whole range of spectrum, which does not leave stable "white spaces".

⁴⁶ (ETSI, 2007), p.13.

⁴⁷ Third and Fourth generation mobile services using UMTS (Universal Mobile Telecommunications Systems), HSDPA (High-Speed Digital Packets Access) or LTE (Long Term Evolution) technology.

The amount of such ‘white spaces’ available is reducing due to the transition from analogue to digital broadcasting and the introduction of wireless broadband services in the UHF band, both of which rely on networks that have much fewer ‘white spaces’.

Single frequency cellular network

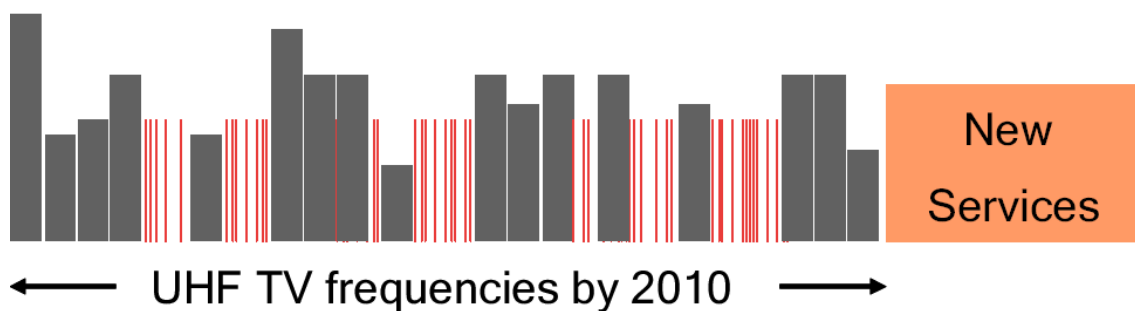


Source: Created by European Commission Service

LTE technology applications can vary rapidly in location, time and power limits which cause interference problems depending on the number of its users and applications, making shared spectrum use with wireless audio PMSE impossible. The reallocation to wireless broadband communications in the 800 MHz spectrum (790-862 MHz) reduces the potential available spectrum in that part of the UHF band for wireless audio PMSE applications. Should a decision be taken in the future to possibly reallocate the 700 MHz band (694-790 MHz) for the use of wireless broadband communications, which moreover could intensify the use of broadcast technology in the remaining UHF spectrum (470-694 MHz), it is to be expected that the access and availability of spectrum for wireless audio PMSE applications will diminish further.

This is illustrated as follows:

UHF TV frequencies in 2010



Source: ETSI TR 102 546 V1.1.1 (2007-02)

The vast majority of spectrum demand at each location comes from a small number of professional users and broadcasters. As an example, there are estimates that 13 per cent of PMSE spectrum use in the UK is generated by the BBC alone and 70 per cent of

PMSE assignments can be attributed to just 3.7 per cent of the user base⁴⁸. It has also been estimated that 50 per cent of UK assignments occur at only 4 per cent of the locations⁴⁹. However, cultural and broadcasting events are also moving to different locations as part of their normal operation, e.g. touring shows or sporting circuits.

The use of spectrum in lower or higher bands for wireless audio PMSE use is possible but affects some of the parameters: quality, more costly equipment, battery life etc., depending on the specific application. The use of higher bands for example would cause a loss of quality of service for body worn applications. Spectrum ranges in the 28.7-47 MHz and 174-216 MHz suffer from man-made noise and require longer antennas. Tuning ranges above 1GHz do not provide propagation characteristics equivalent to those of the UHF band (ETSI, 2007) with the currently available equipment.

⁴⁸ Supply and demand of spectrum for Programme Making and Special Events in the UK, Quotient Associates, Dec 2006, p. 19

⁴⁹ From the "*Final report on assessment of socio-economic aspects of spectrum harmonisation regarding wireless microphones and cordless video-cameras (PMSE equipment)*", VVA Europe, July 2013, p.32.

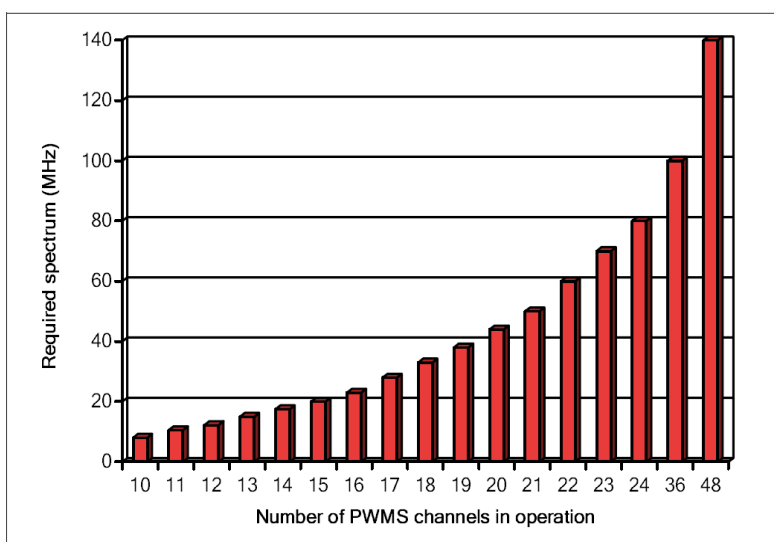
11.5. Wireless audio PMSE equipment's spectrum requirements

There are 2 MHz of harmonised spectrum in the 863-865 MHz range available, amongst other users, to wireless audio PMSE applications. The power levels in this band are set at a maximum of 10 mW e.r.p., which is lower than in other frequency bands⁵⁰ which could limit the operational radius of this equipment compared to other frequency bands.

To enable high quality sound wireless audio PMSE applications normally operate, in the UHF band, in a channel, i.e. a spectrum amount of 200 kHz. A guard bandwidth of at least 400 kHz between two neighbouring wireless microphones channels is required to prevent intermodulation⁵¹ with surrounding microphones. In the 1785-1805 MHz band channel spacing per wireless microphone up to 400 kHz, is required.⁵²

In a UHF TV channel of 8 MHz 8 to 12 analogue wireless microphones are able to operate, however this number proportionally decreases when the bandwidth increases owing to intermodulation.

Required spectrum (MHz) versus numbers of channels in intermodulation free operation



Source: ETSI TR 102 546 V1.1.1 (2007-02), p.19

Spectrum requirements for analogue wireless audio PMSE are progressive and not linear in comparison to the number of channels. Double the amount of spectrum will less than double the amount of microphones that can be operated.

⁵⁰ miliWatt, effective radiated power; ETSI EN 300 422-2 V1.3.1. (2011-08) Harmonized European Standard; Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless microphones in the 25 MHz to 3 GHz frequency range; Part 2: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive, p.6

⁵¹ Interference between equipment in adjacent channels operating non-linear signals

⁵² ETSI TR 102 546 TR V1.1.1. (2007-02) p.12

11.6. Spectrum requirement for daily needs of wireless audio PMSE equipment

CEPT Report 32 indicates a daily/every day need for radio microphones and in-ear monitors of 12 up to 98 channels (or simultaneous sets in operation) corresponding to 8 MHz to 144 MHz⁵³. The report indicates that large-scale theatrical and musical productions can require the use of up to 60 wireless microphones at a single show. To avoid intermodulation no more than eight microphones are used in an 8 MHz TV channel, where smaller productions have a practical limit of 12 microphones per 8 MHz TV channel.

Moreover Annex 3 of CEPT Report 32 provides different data by PMSE manufacturers indicating needs ranging from 30 to 60 'frequencies' (with a maximum of 80 'frequencies') for average musical shows, media production in studios and live performance of musicals, theatres and sport events. Large events are ranked from 120 up to 800 'frequencies'. However no indication on the needs in MHz are provided, but given the information provided that 55 'frequencies' equals 72 MHz and 80 'frequencies' require 150 MHz the needs for the "average" social and cultural event (excluding annual and special events) apparently vary from 40 MHz to 90 MHz.⁵⁴

ETSI TR 102 546 V1.1.1 (2007-01)⁵⁵ indicates more demanding outcomes, indicating that 10 professional wireless microphone systems (PWMS) channels requires about 8 MHz, but that 140 MHz can only facilitate 48 PWMS channels in operation.

A slightly different approach has been taken in a study by the Technische Universität Braunschweig and the Institut für Nachrichtentechnik (Technische Universität Braunschweig and Institut für Nachrichtentechnik, January 2013) where the requirements for PMSE systems are expressed in channels in the UHF band. This study indicate that 50 PMSE channels are required for standard uses, e.g. for theatrical productions, musicals, concerts and conferences as well as in universities, churches, hotel, schools, etc. Examples are given which vary from 32 UHF PMSE channels up to 82 UHF PMSE channels, indicating large-scale events up to 150 PMSE channels and more for special events like elections and the Eurovision Song Contest. Although the report does not convert those needs into MHz requirements it notes that at least 64 MHz will be required in the UHF band for events.

The Institut für Hochfrequenztechnik und Funkssysteme and the Leibniz Universität Hanover (Institut für Hochfrequenztechnik und Funkssysteme, 2008) also reported on the frequency resource requirements for PWMS in urban areas and concluded that calculations resulted in a frequency resource requirement of 12 TV channels for a

⁵³ (CEPT Report 32, 2009), Annex 4, p.26

⁵⁴ 55 'frequencies' equals 72 MHz, each 'frequency' is the equivalent of 1,3 MHz and 80 'frequencies' equals 150 MHz, each 'frequency' equals 1,9 MHz (more MHz are required due to the problem of intermodulation). By extrapolation, 30 'frequencies' equals about 40 MHz and 60 'frequencies' equals about 90 MHz.

⁵⁵ Electromagnetic compatibility and Radio spectrum Matters (ERM); Technical characteristics for Professional Wireless Microphone Systems (PWMS); System Reference Document.

simultaneous usage of 96 PWMS, which would equal to 96 MHz of shared use with DVB-T⁵⁶ (Institut für Hochfrequenztechnik und Funkssysteme, 2008).

This need for a minimum of 96 MHz in the UHF band is also indicated by APWPT, supported by a study on audio PMSE spectrum usage (DKE AK 731.0.8.(DIN/VDE) (2014). In this study 33 PMSE usages are monitored during events since 2007 in Austria, Finland, Germany and Switzerland, brought forward as typical events from sports to exhibitions, political reports such as elections, international music productions, open air theatre, etc. The recorded spectrum (in a 600 kHz grid) varies from 17.4 MHz up to 86.6 MHz⁵⁷ of which 24 events used spectrum blow an amount per event of 60 MHz (which is 70 per cent of the monitored events). However the report noted that this estimated spectrum demand does not represent the real spectrum demand of PMSE because the real spectrum demand is significant higher while in-ear monitor transmitters combined to a single antenna cannot be operated in a linear channel grid.

In the Final report of the VVA Study the amount of required spectrum varies from 12 MHz (village countryside (<500 people/sqkm) up to more than 130 MHz in a capital city (>2500 people/sqkm).⁵⁸

Amount of PMSE equipment used and spectrum requirements

PMSE	Number of systems	Spectrum requirement
Village countryside (<500 people/sqkm)	12	>12Mhz
Village countryside (<500 people/sqkm, 1 small event)	38	>40Mhz
Town (500-1000 people/sqkm)	56	>80Mhz
City (1000-2500 people/sqkm)	>102	>100Mhz
Capital city (>2500 people / sqkm)	>200	>130Mhz

Source: VVA Report, input by Dutchview

An "ordinary" need for spectrum for the use of wireless microphones (audio PMSE equipment) is dependent from the size of the event and differs between rural and urban situations as well as amongst Member States.

This is consistent with data made available by one of the Member States which indicates available spectrum for the use of wireless audio PMSE vary from 8 MHz in less populated areas up to 80 MHz in the capital and spread availability in other areas in the country from 16 MHz to 63 MHz.

⁵⁶ Report on the frequency resource requirements of Professional Wireless Microphone Systems in urban areas with respect to changing broadcasting allocation concepts, dated 29 October 2008; Institut für Hochfrequenztechnik und Funkssysteme and Leibniz Universität Hannover.

⁵⁷ The coordinated bandwidth of the links varied from 27.6 GHz up to 199.8 MHz, however for 14 events no coordination figures are available.

⁵⁸ Source Dutchview, the Netherlands.

Also, the radio microphone spectrum requirements of different West End productions in London 2013 are reported in the VVA report: these vary from 12 MHz to 95 MHz with an average of 45 MHz for 31 shows, where more than 90 per cent of the shows are covered in the range of 12 MHz to 60 MHz and half of the shows are covered in the range of 30 MHz to 60 MHz needs.

In response to the public consultation held mid-2012 stakeholders indicated spectrum needs in a range of 15 MHz up to 75 MHz for live performance and theatres and from 24 MHz to 96 MHz for daily productions (Berlin). An organisation representing the entertainment industry indicated needs ranging from 96 (minimum for daily production) up to 300 MHz (large and special events).

11.7. PMSE spectrum demand

The Analysys Mason (Analysys Mason, 2013) study estimates that the demand for PMSE spectrum will grow in the short term (2012-2014) between 10 per cent (conservative) and 29 per cent (aggressive) per annum. (Analysys Mason, 2013, p.179) CEPT Report 32 indicated a yearly average 5 per cent increase in demand in the coming 10 years based on information from PMSE manufacturers (CEPT Report 32, 2009, Annex 3, p.25). In particular, the usage of wireless audio PMSE systems is growing due to mobility needs on stage and generally in indoor locations (e.g. musicals, conferences).

Spectrum-demand drivers for PMSE and impact on spectrum usage

PMSE	Short term	Medium term	Long term
Type and number of events	+	+	+
Type of equipment and growth	+	+	+
Increase in the amount of equipment per event	+	+	++
Adoption of HD and 3D cameras	+	+	++
OVERALL ASSESSMENT	+	+	+ / ++

Source: Analysys Mason, Report on the analysis of technology trends, future needs and demand for spectrum in line with Art.9 of the RSPP, 5 June 2013, Ref: 35427-223

The VVA study estimates the annual market growth as being currently around 4-7 per cent per year (Valdani Vicari Associates, 2013, p.4 and 32).

A report by Arqiva, licencing database from the UK, especially prepared for the Commission in the context of this impact assessment indicates a compound annual growth 2006-2012 for wireless microphones of about 11 per cent. The table below indicates the number of frequency allocations made against each equipment category over each selected year.

Number of frequency allocations by equipment category by year

Equipment Type	2006	2008	2010	2011	2012
Audio Distribution Service	125	155	137	132	139
Audio Link	1,699	1,703	1,800	1,828	1,870
Data and Telemetry	1,532	1,738	1,960	2,378	2,340
Talkback	29,247	36,026	38,579	41,576	59,592
Wireless Mic/IEM	38,222	44,832	49,051	56,835	72,189
Vision Link	4,453	6,341	8,370	9,649	13,535
Total No of individual frequencies	75,278	90,795	99,897	112,399	149,666
*Est. Average daily rate of Frequency Applications.	25	33	38	43	45

*Application – Customer request for one or more frequencies.

Source: (Arqiva, 2013)

Although efficiency gains in spectrum use owing to technical developments of wireless audio PMSE equipment could decrease spectrum requirements to some extent, the increase of desired quality and the increased use of equipment per event would neutralise the potential gains from technological changes. Moreover, the current state of digital microphones technology presents some challenges: they are not widely available at competitive prices, there is no clear timeline for that availability to become widespread, there is a 'latency'⁵⁹ problem⁶⁰ which makes digital microphones inappropriate for live shows and digital microphones are not necessarily more spectrally efficient than analogue ones unless they have large blocks of continuous spectrum to operate in – as opposed to several small blocks separated by other uses.

⁵⁹ Latency is the time delay that digital equipment needs to convert sound into a digital signal. The current latency is not compatible with the quality requirements of live performances for example in the music industry. The time delay for a performing artist should be less than 20 micro seconds (ms) for wireless microphones applications, and as low as 5 ms for a two-way delay, while the typical current values are around 300 ms as reported in ETSI, 2007, p.16 and in Fischer.

⁶⁰ As pointed out by professional users in the "A long term approach to radio spectrum for PMSE in Europe" workshop (2010)

11.8. Categories of professional users

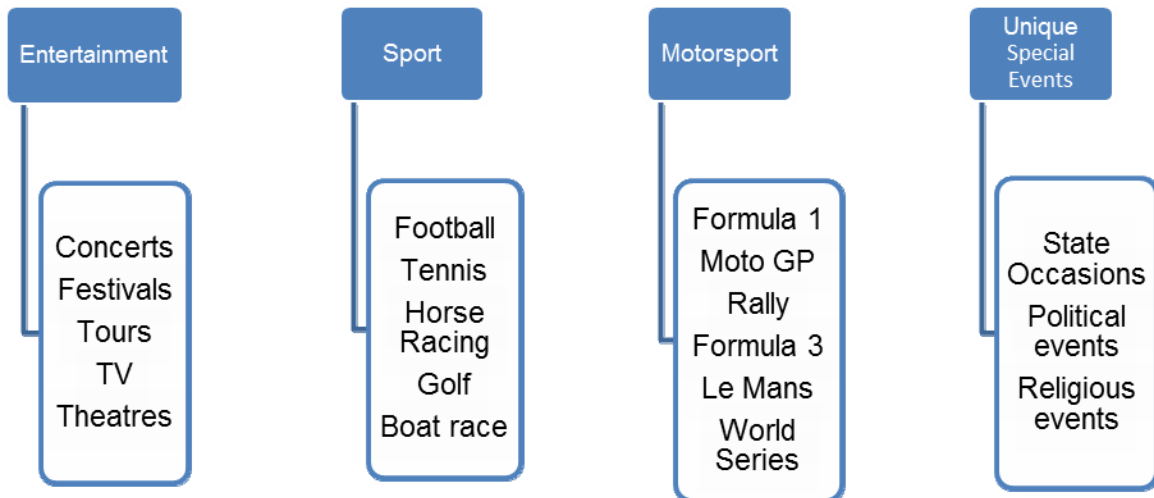
Categories of professional users

TV/Radio Broadcasting stations: Media productions including film, video and DVDs
TV/Radio productions: Electronic News Gathering and Outside Broadcast
Musical/Theatre productions; fixed installations; conference venues/universities
PA Rentals: companies who rent audio equipment to professional touring bands or artists and to large corporate and political events
Other professional users, such as touring bands or artists who own their own audio equipment

Source: ETSI TR 102 546 V1.1.1. (2007-02), p.12

An alternative way of categorizing is focussing on the environments in which professional users are operating.

Categories of professional users



Source: (Arqiva, 2013)

11.9. VVA study – primary level and socio-economic impact

Quantifying the effects of any changes of spectrum availability on socio-economic impact proved difficult because of a general lack of public data on this market. The reasons for this lack of data include:

- The applications are used by many different companies and organisations in many different sectors and on a variety of scales which makes it difficult to quantify their volume and usage patterns;
- The non-professional use – and sometimes the professional one – is not recorded - and is rarely attributed an economic or socio-cultural value in studies (e.g. PMSE use in community gatherings);
- Wireless audio PMSE applications contribute to the feasibility and quality of many business and cultural activities but the value generated specifically by these applications cannot be quantified because it is only one of several inputs which contribute to the overall value;
- The cultural and social value linked to PMSE use contributes to some extent to turnover in tertiary markets such as Horeca⁶¹ which can be linked to tourism motivated by cultural events but again it is not possible to quantify this effect as it is only one of many contributors;
- PMSE activities can rely on wired or wireless equipment without a clear indication of when wireless equipment could be substituted by wired one and without clarity as to the possible consequence of such replacements for the socio-economic value of the event.

The VVA study methodology has identified three levels of socio-economic value of PMSE. The quantified socio-economic impact is based on the direct economic impacts of the options considered as estimated by the VVA study team based on the stakeholders' survey responses and individual interviews. Stakeholders were asked to provide a response in terms of their expectation as to the decrease, increase or no change of their costs and revenues as a consequence of the options presented. These survey responses were then coded ('translated') into a percentage positive or negative change to the baseline market situation.

Although the study confirmed that the second and third level undeniably generate social-economic value in the European Union internal market, the impact of any spectrum harmonisation measure is difficult to determine on the secondary and tertiary levels, i.e. the quality of cultural and social events and its indirect effects on other sectors such as tourism or Horeca. Economic, social and cultural values are generated by events using audio PMSE equipment, wired (not effected by a harmonisation measure) and wireless (which could be effected by a harmonisation measure). The assessment of the impact of spectrum harmonisation measures for wireless audio PMSE use on the values of the second and tertiary levels could theoretically be expedient, however would be a disproportionate exercise since no objective indicators have been set or are available in scientific sources. To determine the impact on the primary level has proved to be a difficult exercise already since there is limited data which varies widely and hence a number of assumptions had to be made.

⁶¹ Horeca is the sector of the food service industry that consists of establishments which prepare and serve food and beverages. The term is a syllabic abbreviation of the words Hotel/Restaurant/Catering

By considering only the primary level in calculating the socio-economic impact the bar for the Impact Assessment has been set as high as possible. A policy option passes the cost-benefit test only if it leads to a more beneficial outcome than would individual Member States' actions to ensure spectrum availability in their jurisdictions. A limitation to the primary level means that the impacts of policy options will have to be positive even in the absence of the secondary and tertiary level analysis, which is expected to have an aggregate effect on the valued outcomes. This conception of the impact analysis is fully within the spirit of the subsidiarity requirements and it ensures that EU intervention only takes place if it presents real added value over national action focusing on the functioning of the internal market.

The respondents of the public consultation referring to PAMA's (Professional Audio Manufacturers' Alliance) wholesale figures 2011 of 164.000 units/systems in EU key markets; however from another source (ETSI, 2007). PAMA is also quoted for an estimated total of 1.9 million wireless microphones unit shipments for the European Union in the period 2003-2006.

Wireless microphone turnover in largest EU markets

Market	Turnover	Units/systems
Germany	€36m	61,000
UK	€41m	37,000
France	€15m	33,000
Italy	€8m	22,000
Spain	€6.8m	11,000
Total	€106.8m	164,000

Source: PAMA quoted in the Robert Bosch GmbH response to the European Commission public consultation on options for the possible harmonisation of spectrum available for wireless microphones and cordless video-cameras (PMSE equipment).

11.10. Second and third level values and data on the cultural sector in the EU

The VVA study proposed three value-levels. The secondary and tertiary levels are described below.

The secondary value of PMSE includes the economic, cultural and social activities which contribute to a broader benefit for society and consumers. These include activities related to the cultural and creative sectors, notably the programs made or documented with PMSE applications and live performances or sporting events which are dependant, amongst other requirements, on the use of wireless audio PMSE equipment.

In the Communication promoting cultural and creative sectors for growth and jobs in the EU (EUROPEAN COMMISSION, 2012), the European Commission recognised that the cultural and creative sectors are one of Europe's most dynamic economic sectors and are essential drivers of cultural diversity in Europe. These sectors, which include notably audio-visual (such as film, television, video games and multimedia), cultural heritage, design, festivals, music, performing arts, radio and visual arts– represent 4.5% of EU GDP which amounts to about 580 billion euros. Of this wide cultural sector, some sectors are supported by PMSE use. Motion pictures, TV production, music and broadcasting activities represent 98.4 billion euros in turnover and over 450 thousand employees (Eurostat). Activities relating to creative, arts and entertainment activities (R90); libraries, archives, museums and other cultural activities (R91); and gambling and betting activities are only available at an aggregate level and represent a gross value added of 90 billion euros. In terms of employment the figures for the categories are available and categories R90 and R91 represent around 160 thousand employees (Eurostat).

In addition to their economic value there is the economic and social value that accrues as a direct result of different types of PMSE equipment use, such as the value of event quality and appreciation by audiences. This impact to the broader cultural and social field is clear and represents additional economic turnover and employment but no methodology exists to our knowledge of how that impact can be estimated in quantitative terms.

There is also an economic and social impact provided by wireless equipment in terms of safety. Given the increase in the amount of equipment per event and the added freedom of movement offered, wireless PMSE is often the only option that ensures the necessary health and safety provisions are met, at least in performing arts. However, no information is available to estimate to what extent wired systems could replace wireless systems in case of spectrum shortage.

In this context, it should be noted that according to Article 167 of the Treaty on the Functioning of the European Union "The Union shall take cultural aspects into account in its action under other provisions of the Treaties, in particular in order to respect and to promote the diversity of its cultures". Facilitating the wireless audio PMSE industry and its users has effects reaching far beyond its core industry, and will affect in a much broader sense the social, cultural and sport-related activities of European citizens, with a direct impact on cultural diversity.

As regards to the cultural sector, the European Commission estimates that the entire sector represents 4.5% of EU GDP which represents about 580 billion euros. By looking at NACE sectors, of this wide cultural sector some classes are relevant to PMSE use (see Figure 7 below for an overview, more details are available in the full Structure and

Explanatory Notes text⁶²). NACE is the “statistical classification of economic activities in the European Community”.

The three classes 59.11, 59.20 and 60.20 represent 98.4 billion in turnover and over 450 thousand employees.⁶³

The five classes 90.01, 90.02, 90.04, 91.02 and 91.03 are unfortunately not covered separately. The only quantification available is a gross value added figure of 90 billion euros for the entire 90, 91 and 92 categories. In terms of employment, again the categories are not covered individually; the 90 and 91 categories represent around 160 thousand employees.⁶⁴

NACE Divisions 59, 60, 90 and 91

Division	Group	Class	n.e.c. : not elsewhere classified	* part of ISIC Rev. 4
59			Motion picture, video and television programme production, sound recording and music publishing activities	
	59.1		Motion picture, video and television programme activities	
		59.11	Motion picture, video and television programme production activities	5911
		59.12	Motion picture, video and television programme post-production activities	5912
		59.13	Motion picture, video and television programme distribution activities	5913
	59.2	59.14	Motion picture projection activities	5914
			Sound recording and music publishing activities	
59.20		Sound recording and music publishing activities	5920	
60			Programming and broadcasting activities	
	60.1		Radio broadcasting	
		60.10	Radio broadcasting	6010
	60.2		Television programming and broadcasting activities	
60.20		Television programming and broadcasting activities	6020	
90	90.0		Creative, arts and entertainment activities	
			Creative, arts and entertainment activities	
		90.01	Performing arts	9000*
		90.02	Support activities to performing arts	9000*
		90.03	Artistic creation	9000*
	90.04	Operation of arts facilities	9000*	
91	91.0		Libraries, archives, museums and other cultural activities	
			Libraries, archives, museums and other cultural activities	
		91.01	Library and archives activities	9101
		91.02	Museums activities	9102*
		91.03	Operation of historical sites and buildings and similar visitor attractions	9102*
	91.04	Botanical and zoological gardens and nature reserves activities	9103	

Source: Eurostat, NACE Rev. 2 – Structure and explanatory notes

3) The tertiary value is not related directly to the use of wireless audio PMSE equipment, but is closely related to the second level. Examples would include a proportion of the merchandising from events and shows as well as from hotels and restaurants used by audiences as a consequence of their presence in a specific location because of the cultural activity they are attending. There are two components, a domestic one which is comprised of domestic tourists and residents as well as an international component of inbound tourists. Unfortunately, there are no estimates available to determine which portion of these expenses can be attributed to PMSE. In Annex 11.10 an indication of the

⁶² Eurostat, NACE Rev. 2 – Structure and explanatory notes
http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-07-015/EN/KS-RA-07-015-EN.PDF

⁶³ Structural Business Statistics SBS, Eurostat

⁶⁴ Labour Market survey, Eurostat

available data is provided. The economic attribution of a portion of the value of these tertiary markets to the quality of cultural events and then in turn to the use of wireless audio PMSE equipment in these events is an exercise that entails too many unknowns to expect any meaningful results. The PMSE stakeholders expressed the opinion that this linkage should be taken further (see Annex 11.11) but neither a methodology nor any analysis of actual data were proposed to produce reliable estimates.

It is beyond any doubt that use of wireless audio PMSE equipment is essential for the documentation of social and cultural events and hence offers crucial support to content providers which make these events available to the public but it should be noted that the objective of the impact assessment is neither to estimate the complete socio-economic (and the contribution to the cultural) value of wireless audio PMSE nor to compare it to other industries using spectrum but rather to assess the socio-economic impacts of policy options on spectrum harmonisation measures being considered. In other words the VVA study carried out a cost-benefit analysis for harmonisation at EU level and qualified the social and cultural benefits of radio microphones' (and cordless video-cameras) use in the EU, and not a net present value analysis.

We have found no data that was helpful to quantify this causality so an analysis has been run for the tourism sector where detailed data on tourists' expenditure can provide some insight as to this phenomenon. Eurostat does not provide statistics for internal tourism (domestic + inbound); it concentrates on national tourism (domestic and outbound).

Hence, the following example from the UK Office of National Statistics serves as an illustration of the causal links from PMSE to HORECA and accommodation. Tourists' spending on cultural activities and sports and recreational activities in the UK amounts to just over 5 billion and 3 billion pounds respectively. Only a portion of expenditure can be attributed to events or locations that use PMSE equipment (unfortunately no quantification is available here) and only a subset of this expenditure would be lost if PMSE equipment was no longer being used (again there is no quantification available).

In terms of HORECA and other accommodation, there is a marked disparity between domestic and inbound tourists' expenditure. The domestic tourists spend 5 billion and 2.9 billion pounds on cultural activities and sporting events respectively. Inbound tourists spend 176 million and 146 million pounds respectively on cultural activities and sporting events respectively. Within the domestic tourists, excursionists (same-day visitors) spend 4 billion and 2.4 billion pounds on cultural activities and sporting events respectively. This means that 78% of cultural activities and 80% of sporting and recreational events expenditure is generated by domestic excursionists thus limiting the impact on HORECA and other accommodation⁶⁵.

Again from the UK, we have found that London welcomes over 14 million tourist visits yearly and surveys indicate that a large percentage of theatre goers in London were overseas tourists.⁶⁶

⁶⁵ Tourism Satellite Accounts 2009, Office for National Statistics, 2012

⁶⁶ London Pass and VVA Consulting

International tourism consumption by products

Products	Internal Tourism Expenditure (£ million)		Internal Tourism Expenditure	Other components of tourism consumption (£m)	Internal Tourism Consumption (£m)
	Inbound tourism expenditure	Domestic tourism expenditure			
Accommodation services for visitors	4,368	8,476	12,844	-	12,844
Food and beverage serving services	2,983	24,376	27,358	-	27,358
Railway passenger transport services	434	3,274	3,708	-	3,708
Road passenger transport services	425	2,240	2,665	-	2,665
Water passenger transport services	192	800	992	-	992
Air passenger transport services	2,519	13,202	15,721	-	15,721
Transport equipment rental services	103	654	758	-	758
Travel agencies and other reservation services	86	2,055	2,141	-	2,141
Cultural activities	176	5,000	5,176	-	5,176
Sport and recreation activities	147	2,887	3,034	-	3,034
Exhibitions & Conferences etc.	102	313	416	-	416
Other consumption products	7,818	27,579	35,397	2,994	38,391
<i>services associated with vacation home ownership</i>	-	-	-	2,994	2,994
TOTAL	19,354	90,857	110,211	2,994	113,205

Note: the average exchange rate for 2009 was 1 GBP = 1.122460 EUR

Source: (Office of National Statistics, UK, 2009)

11.11. Listing full socio-economic value of PMSE according the sector

In a letter dated 4 July 2013 the sector (APWPT) indicated the following list to grasp the full socio-economic value of PMSE, by taking into account at least a part of the revenues made by productions using PMSE equipment:

- Direct sales of PMSE equipment
- Direct ticket sales of concerts, sport events and other venues
- Direct revenues of rental companies on the PMSE equipment
- The advertisement coming from all the events
- The spin-off of these events (like tourism, hotels, taxis, restaurant and catering)
- Indirect revenues from SMS services linked to events (in all Member States)
- Indirect revenues of IMT providers on the traffic during events
- Indirect revenues of recorded material of the events (DVD, Blue Ray etc.)

Moreover is brought under the attention the social and cultural cohesion within the European Union which is supported by events, the freedom of speech and newsgathering for which production PMSE is an essential tool.

11.12. List of manufacturers of wireless audio PMSE equipment

AKG	Austria
Audio Technica	Japan
Audix	USA
Azden Corporation	USA
Beyerdynamic	Germany
ElectroVoice/ Bosch	Germany
HME	USA
Lectrosonics	USA
Nady Systems	USA
Panasonic	Japan
Samson Wireless	USA
Sennheiser	Germany
Shure	USA
Sony	Japan
Telex (Bosch)	Germany
Voco Pro	USA

11.13. Non comprehensive overview of theatre and concert halls in European countries

	opera & music theatre	orchestras & instrumental ensembles	music (other)	dance	theatre	festivals	venues
Austria	19	63	82	25	36	88	41
Belgium	5	30	35	21	50	43	66
Bulgaria	10	12	22	7	40	13	6
Croatia	4	14	18	6	25	22	3
Cyprus	1	2	3	0	5	7	11
Czech Republic	21	32	53	30	60	84	40
Denmark	3	15	18	16	26	19	35
Estonia	2	10	12	3	15	27	13
Finland	15	30	45	35	57	89	48
France	34	59	93	60	133	204	293
Germany	94	205	299	111	236	210	248
Greece	1	9	10	20	67	18	14
Hungary	9	21	30	25	49	35	23
Iceland	1	5	6	1	5	9	9
Ireland	3	8	11	9	20	19	39
Italy	20	55	75	46	209	147	187
Latvia	1	24	25	4	13	30	15
Lithuania	3	28	31	5	26	22	21
Luxembourg	1	3	4	2	4	5	8
Malta	0	1	1	0	0	1	3
Netherlands	5	39	44	28	29	28	81
Norway	5	20	25	15	35	27	26
Poland	19	32	51	17	93	86	38
Portugal	3	9	12	8	40	29	33
Romania	11	27	38	12	47	8	2
Slovak Republic	6	15	21	9	28	26	6
Slovenia	2	6	8	8	14	21	6
Spain	14	53	67	56	131	164	189
Sweden	13	26	39	20	43	32	29
Switzerland	9	34	43	34	35	48	45
United Kingdom	34	101	135	78	150	100	360
TOTAL per column	0	988	1356	711	1721	1661	1938

Source: PAYE Performing arts Yearbook Europe (2012)