Ofcom make many references to efficiency of spectrum usage in this consultation, with strong and somewhat discourteous implications that the PMSE sector can operate more efficiently with spectrum. With more information, Ofcom would soon realise that significant proportions of the PMSE sector are extremely efficient with the spectrum they have licenced. For example, the National Theatre licences entire 8MHz bands as part of its annual schedule, and Ofcom doesn't actually receive any information on how many radio mics are in use in each 8MHz channel.

The analogue IEMs have been efficiently calculated so that they do not interfere with each other, factoring in the need for some of them to move interference-free between different spaces within the building. Where there is no expected movement of the IEMs and where they are separated physically in the building, it has been possible to be even more efficient with spectrum, by ignoring their interference characteristics entirely and therefore squeezing more IEMs into a band than would otherwise be possible.

Ofcom is also using the PMSE sector's past technological achievements in manufacturing (which became a requirement when PMSE lost access to the 800 and 700MHz bands) to incorrectly predict the potential further efficiencies of future technology. The technology has reached its limit of efficiency, so further improvements will not be significant. For example, WMAS is quoted by Ofcom as more spectrally efficient, with no acknowledgement of the degradation of audio quality and latency required to achieve 64 audio channels. In actual fact, like for-like comparison of Sennheiser's 6000 and WMAS systems running at high audio quality and low latency reveals that only a similar channel count is possible in a single 8MHz channel. Taking a look at Sennheiser's Spectera, Ofcom needs to acknowledge that there is a massive difference between delivering 8 radio mic channels of RAW PCM audio with 1ms delay and delivering the maximum number of radio mic channels using a lossy codec with a delay of 15.2ms (https://docs.cloud.sennheiser.com/en-us/spectera-solution/spectera/specifications-system.html). The latter isn't likely to be acceptable for some professional applications, meaning that a non-WMAS system is just as efficient for the high-quality content being generated.

Ofcom must acknowledge that the 7.1% compound annual growth in microphone and IEM assignments in Table 4 of the consultation, measured between 2018 and 2024, indicates a likely future increased demand for more spectrum by the PMSE sector. Any additional technological improvement in equipment will be saturated by this growth, which is borne from greater expectations by those for whom the content is created. What is Ofcom's projection for the number of PMSE microphone and IEM assignments for 2034, when Digital Terrestrial Television licences are up for renewal? How much spectrum will the PMSE sector need to deliver the content that Ofcom's other stakeholders expect in 2034 and going forward? Why does Ofcom seem to expect the PMSE sector to deliver a growing demand for wireless audio and video content production with less spectrum, when it doesn't expect the mobile sector to grow and deliver faster data and phone platforms with less spectrum?

Ofcom must acknowledge that the 9.2% compound annual growth in video assignments in Table 4 of the consultation, measured between 2018 and 2024, indicates a likely future increased demand for more spectrum by the PMSE sector. Any additional technological improvement in equipment will be saturated by this growth, which is borne from greater expectations by those for whom the content is created. What is Ofcom's projection for the number of PMSE video assignments for 2034, when Digital Terrestrial Television licences are up for renewal? How much spectrum will the PMSE sector need to deliver the content that Ofcom's other stakeholders expect in 2034 and going forward? Why

does Ofcom seem to expect the PMSE sector to deliver a growing demand for wireless audio and video content production with less spectrum, when it doesn't expect the mobile sector to grow and deliver faster data and phone platforms with less spectrum?

How does Ofcom calculate radio mic and IEM assignments shown in Table 7? For example, the National Theatre is only slightly below the 10th-rated location/event in the table with approximately 222 channels of radio equipment, nearly all of which are used every single day. Does Ofcom know that this is the number at the National Theatre, carefully optimised for efficient and practical use within the building? How many other PMSE licence-holders have a greater number of assignments than Ofcom realises, due to more efficient spectrum usage than Ofcom realises.

Question	Your response
Section 3 –Spectrum use by the PMSE sector in the UK **Question 1**: What are your views on how our processes work - for example our online booking system, turnaround times, and event coordination. Do you think the current approach works well? How could we improve it?	Confidential? –N PMSE users require a direct licensing relationship with Ofcom, which is the current setup. The online booking website would benefit from an upgrade, though most users have now probably got used to its nuances. Other than that, bookings are easy to make reasonably quickly and with sufficient information on potential known interference issues. It's worth noting that sharing has existed between Terrestrial Television and PMSE for decades and has been an excellent partnership and efficient use of spectrum. The National Theatre cautions against referencing Coleago's report as an accurate reflection of PMSE's use of the band, PMSE working practices, and broader UK PMSE spectrum policy. Ofcom needs to acknowledge that the UHF band, as defined by Coleago, does **not** currently support Mobile Communications in the UK, contrary to the report by Coleago. Coleago advocate for spectrum sharing via 'dynamic allocation mechanisms' but does not provide viable explanation of how it would be achieved.

Question	Your response
Section 4 – PMSE historic trends **Question 2**: Do you have any comments on how we have analysed and characterised wireless microphone and IEM demand, or suggestions for alternative ways of characterising this demand?	Confidential? – N Ofcom must acknowledge that the 7.1% compound annual growth in microphone and IEM assignments in Table 4, measured between 2018 and 2024, indicates a likely future increased demand for more spectrum by the PMSE sector. Any additional technological improvement in equipment will be saturated by this growth, which is borne from greater expectations by those for whom the content is created. What is Ofcom's projection for the number of PMSE microphone and IEM assignments for 2034, when Digital Terrestrial Television licences are up for renewal? How much spectrum will the PMSE sector need to deliver the content that Ofcom's other stakeholders expect in 2034 and going forward? Why does Ofcom seem to expect the PMSE sector to deliver a growing demand for wireless audio and video content production with less spectrum, when it doesn't expect the mobile sector to grow and deliver faster data and phone platforms with less spectrum? PMSE has enjoyed a position of relative protection provided by DTT (and ATT before) for many years but the constant pressure and demands on spectrum requirements from a growing number of applications, including MNOs, create significant disruption and concern for the future stability of our sector and our ability to deliver worldclass content and everyday events. Contrary to the Coleago report, Ofcom needs to acknowledge that any technological innovation in audio PMSE equipment leads to greater use of spectrum through creative innovation. Ofcom should also note that the efficiencies in PMSE working practices advocated by Coleago are already employed by PMSE users, so no efficiency of spectrum is possible there. PMSE has incumbent status in the 470-694 MHz range and this must be reflected in any decision to allow new users of this spectrum.

Question 3: Do you have any comments on how we have analysed and characterised wireless video demand, or suggestions for alternative ways of characterising wireless video demand?	Confidential? – N Ofcom must acknowledge that the 9.2% compound annual growth in video assignments in Table 4, measured between 2018 and 2024, indicates a likely future increased demand for more spectrum by the PMSE sector. Any additional technological improvement in equipment will be saturated by this growth, which is borne from greater expectations by those for whom the content is created. What is Ofcom's projection for the number of PMSE video assignments for 2034, when Digital Terrestrial Television licences are up for renewal? How much spectrum will the PMSE sector need to deliver the content that Ofcom's other stakeholders expect in 2034

Question	Your response
	and going forward? Why does Ofcom seem to expect the PMSE sector to deliver a growing demand for wireless audio and video content production with less spectrum, when it doesn't expect the mobile sector to grow and deliver faster data and phone platforms with less spectrum?

Question	Your response
Section 5 – Future trends and opportunities Wireless audio Drivers of demand **Question 4:** What factors have driven changes in the demand for audio PMSE applications, specifically for: a) the increased use of coordinated wireless microphones and IEMs, particularly the peak number of simultaneous assignments used at the largest events? b) the slight decline in the number of national wireless microphone licences (UHF channel 38 and VHF)? Has the extent of use of these licences changed, and if so why? c) the declines in talkback, fixed audio links and ADS licences?	Confidential? – N a) Over the last 12 years, the PMSE sector has seen its access to spectrum reduce dramatically. In parallel with this, the industry has improved spectral efficiency and equipment agility. Demand and scale of productions are growing and even with technological advances, PMSE still requires a significant amount of spectrum. Contrary to the Coleago report, Ofcom needs to acknowledge that technological innovation in audio PMSE equipment will often lead to greater use of spectrum through creative innovation. The National Theatre can demonstrate an increase in reliance on wireless technology due to innovations in the theatre industry if required. b) Ofcom should consider an increase in unlicenced use of the channel 38 band as a possible contributor to the slight decline in licenced use. As the 700MHz clearance took place between 2017 and 2020, there may have been an increase in licenced use of channel 38, as users took advantage of the compensation scheme. As the spectrum allocation appeared to stabilise, perhaps some users decided to risk unlicenced use of channel 38. Another possibility is the absorption/amalgamation of small organisations into bigger organisations, reducing the number of channel 38 licences needed. c) Between 2017 and 2021, the National Theatre migrated most talkback users from analogue simplex and duplex radio channels to a dynamically assigned digital system and DECT, which is much more spectrally efficient, resulting in fewer assignments for this stakeholder. To evidence this, please see the National Theatre's response to "Statementon-strategic-review-of-UHF-Band-1-and-Band-2" and also this stakeholder's historical annual licences dating between 2017 and 2021.

Question 5: What factors could drive further changes in the demand for audio PMSE applications in the future, and what will this mean for future demand, specifically for:	Confidential? –N Over the last 12 years, the PMSE sector has seen its access to spectrum reduce dramatically. In parallel with this, the industry has improved spectral efficiency and equipment agility. Demand and scale of productions are growing and even with technological advances, PMSE still requires a significant amount of spectrum. Contrary to

Question	Your response

a) coordinated wireless microphones and IEMs, particularly the peak number of simultaneous assignments used at the largest events? b) national wireless microphone licences (UHF channel 38 and VHF)? c) talkback, fixed audio links and ADS licences?	the Coleago report, Ofcom needs to acknowledge that technological innovation in audio PMSE equipment will often lead to greater use of spectrum through creative innovation. The National Theatre can demonstrate an increase in reliance on wireless technology due to innovations in the theatre industry. The largest events show that innovative ideas result in an increase in demand: see "BEIRG - Spectrum Report Rev1.2 Final March 24th 2025" Ofcom must acknowledge that the 7.1% compound annual growth in microphone and IEM assignments in Table 4, measured between 2018 and 2024, indicates a likely future increased demand for more spectrum by the PMSE sector. Any additional technological improvement in equipment will be saturated by this growth, which is borne from greater expectations by those for whom the content is created. What is Ofcom's projection for the number of PMSE microphone and IEM assignments for 2034, when Digital Terrestrial Television licences are up for renewal? How much spectrum will the PMSE sector need to deliver the content that Ofcom's other stakeholders expect in 2034 and going forward? Why does Ofcom seem to expect the PMSE sector to deliver a growing demand for wireless audio and video content production with less spectrum, when it doesn't expect the mobile sector to grow and deliver faster data and phone platforms with less spectrum? The most significant factor in demand for spectrum will be any further reduction in available spectrum for the PMSE sector, which is disparate and diverse. As spectrum continues to be reduced, demand for what is usable will naturally increase, probably beyond what is available. See "BEIRG - Spectrum Report Rev1.2 Final March 24th 2025" which shows the effect of reduced spectrum on largescale events and reflects the likely effect on the National Theatre which has over 200 radio assignments in use continuously throughout the year. How does Ofcom calculate radio mic and IEM assignments shown in Table 7? For example, the National Theatre is only slightly below the 10th-rated location/event in the table with approximately 222 channels of radio equipment, nearly all of which are used every single day. Does Ofcom know that this is the number at the National Theatre, carefully optimised for efficient and practical use within the building? How many other PMSE licence-holders have a greater number of assignments that Ofcom realises.

Question	**Your response**

Question 6: Do you agree that, given the trends, we are right to focus on wireless microphones/IEMs?	Confidential? – N Ofcom is right to be most concerned about the absence of usable spectrum for wireless microphones and IEMs, but should also be considering PMSE video applications too, which is also rising, as demonstrated in Ofcom's own consultation in Table 4. All PMSE users need to have their spectrum protected from any further reduction. Both PMSE audio and video have shown an increase in assignments between 2018 and 2024, which Ofcom should assume will continue to rise in the future. Ofcom needs to use these figures to make a projection of how may PMSE audio and video assignments there will be in 2034 when the DTT is up for renewal and beyond.
Changes in the take-up of bands already available **Question 7:** What factors have driven the take-up of different bands for wireless audio? What are the barriers to greater use of the DME band?	Confidential? –N Improvements in DECT wireless communication technology resulted in a migration to it by the National Theatre around 2004 for production communications. Further improvements in the DECT systems available allowed near-building-wide adoption in 2016, but this was also driven by innovation demands in theatre production requiring more wireless communications users. Most of the National Theatre's remaining PMSE talkback users exist on a spectrally efficient, dynamically allocated digital system. These systems are not suitable for radio microphones. Ofcom needs to acknowledge that only **part** of the 960 – 1164 MHz band was made available to low power audio PMSE in the UK to complement the 470 – 694 MHz band, not replace it. The 960 – 1164 MHz band would not mitigate another loss of spectrum for PMSE in the 600 MHz band. Accounting for the guard bands to protect aeronautical radionavigation services at 1030 and 1090 MHz, and GNSS above 1164 MHz, it effectively comprises 3 sub-bands (961 – 1015MHz; 1045 – 1075 MHz; and 1105 – 1154 MHz).
Question 8: What actions could enable greater takeup of the DME, DECT and licence exempt bands in the future?	Confidential? – N The National Theatre is already using DECT for production communications and talkback. Therefore no significant reduction in PMSE spectrum usage is likely for these talkback services for this stakeholder. These systems are not suitable for radio microphones. Most of this stakeholder's remaining PMSE talkback users exist on a spectrally efficient, dynamically allocated digital system. Licence exempt bands have been tried by this stakeholder for non-critical applications but with poor results.

Question	Your response
Changes in spectrum availability **Question 9:** Which potential additional bands might be suitable for wireless audio applications, particularly microphones and IEMs at the largest events and venues?	Confidential? – N Access to spectrum is the fundamental requirement for audio PMSE, and given the environment of use, this has to be below 2 GHz (as recognised by Ofcom in 2015 when consulting on new spectrum for audio PMSE. None of the options proposed would be appropriate replacements for existing PMSE spectrum, but a few would serve as additional areas for specific geographical events, particularly interleaved with DAB and 406-430 MHz. Sharing with mobile technology is not recommended by this stakeholder. If the 700MHz duplex gap was available for PMSE then we could use it, if we still had any equipment that tuned to it – but it has all been surrendered as part of the 700MHz clearance! Given the time that has passed since award of the 700Mhz band to mobile operators, can Ofcom show that these MNOs are now using their spectrum efficiently? Whenever the NT does a scan of the 700MHz band when the scanned area is heavily populated with mobile technology, there are distinct gaps where parts of the 700MHz band seem to be unused.
Question 10: To what extent do the characteristics of different audio applications drive their requirements for spectrum – for example particular requirements for latency, resilience or capacity?	Confidential? – N Key reasons PMSE requires the UHF spectrum include: Superior Signal Characteristics: UHF frequencies offer excellent propagation, allowing wireless microphones and in-ear monitors (IEMs) to operate reliably across large, complex venues and outdoor spaces. Low Latency & High Reliability: Live performances, broadcasting, and theatre require near-zero latency for audio, which is best achieved in this specific, consistent spectrum range. High-Density Audio Needs: Major events and productions require massive amounts of spectrum for dozens, sometimes hundreds, of microphones and IEMs simultaneously, necessitating large, contiguous blocks of UHF bandwidth. Critical Infrastructure & Safety: PMSE equipment, including wireless intercoms and talkback systems, is critical for safety and management in theatre, broadcasting, and sports, requiring highly reliable, dedicated spectrum. Interleaved Spectrum Availability: PMSE has historically and effectively utilized "White Spaces"—unused spectrum between digital

Question	Your response
	television transmitters—making this band a heavily developed, mature ecosystem for professional audio gear. Please note that WMAS products don't improve spectral efficiency significantly when using the current latency and audio quality settings required for live professional PMSE radio microphone applications.

Changes in efficiency of spectrum use **Question 11:** What changes in spectrum use (technology, working practices, different bands, etc) have enabled audio wireless growth to be accommodated to date, particularly the increased use of wireless microphones and IEMs at the largest events and venues in the context of reduced UHF spectrum availability?	Confidential? – N While innovation in the industry delivers efficiency gains in spectrum use, it also unlocks creative innovation which increases demand. This increased demand is shown clearly, and is supported by many studies, by the fact that the PMSE industry continues to grow as events and productions become more complex and sophisticated to satisfy consumer and audience expectations. Innovations in the industry (and a lot of hard work) allow these events to take place within the available spectrum, albeit recognising that in some cases even today some production ambitions are constrained by a lack of spectrum. Consequently, even with continued innovation in technology, the industry would be severely impacted by further loss of spectrum access. The PMSE sector has also already demonstrated significant increases in spectral efficiency and agility through the technological developments provided by the transition to digital systems or more efficient narrow-band analogue systems. These developments have all enabled the sector to successfully adapt to the reduction in spectrum created by the 700MHz clearance, which demonstrates our proactive and pragmatic approach to accommodating previous changes in the spectrum landscape. In broad terms, much of today's equipment can be deployed with over twice the number of channels per MHz than just over ten years ago. Whilst all these developments are positive and help the sector to continue to operate, there are several key factors to highlight: ● Regardless of these developments PMSE still requires access to sufficient quality and quantity of radio spectrum. ● Innovation alone cannot be relied upon to mitigate further loss of spectrum. ● The recent announcements of WMAS-based systems further demonstrates the industry's commitment to finding innovative solutions. However, WMAS products don't improve spectral efficiency significantly when using the current latency and audio quality settings required for live professional PMSE radio microphone applications. ● Latency, range, interoperability with existing narrowband equip-ment, price factors and international regulatory variances, all must be considered if we are to take a balanced view of its current benefits.

	It is vital that regulators do not require or expect long-term solutions to be delivered solely by technological change. Ofcom needs

Question	Your response
	to acknowledge that the growing number of PMSE audio assignments will continue to increase, which will mean a requirement for more spectrum, not less. Ofcom has noted that analogue systems are still widely in use in the PMSE sector. Sometimes the choice to use them is not borne from cost but due to high-profile artists liking the sound and demanding a specific analogue product to be used. Therefore, these analogue devices and their associated intermodulation characteristics have to be factored into large-scale events to accommodate the requirements of the artist. Ofcom has proposed a theoretical doubling of spectrum efficiency for Glastonbury without perhaps considering the many conflicting requirements that have to be met for such a large-scale and multiartist event. Given that Ofcom is directly involved in the RF plan for Glastonbury, Ofcom should demonstrate that its theoretical models to reduce the current spectrum usage by 50% are achievable in reality. It will quickly be found that in terms of PMSE spectrum usage, Glastonbury is already very close to its maximum efficiency.

Question 12: What technologies are currently available or are being developed which can improve audio spectrum efficiency in the future, particularly in the use of wireless microphones and IEMs at the largest events and venues?	Confidential? – N Modern PMSE equipment is very spectrally efficient, particularly when considering the requirements of the audio channel and its use, for example, audio quality, latency, equipment size, battery life, challenging RF environment with moving performers and scenery etc creating deep fades, body absorption (of the RF signal), and the operational requirement of zero failure for any live event. Audio PMSE manufacturers continue to innovate to meet the growing demands and expectations of content creators and consumers within an already spectrum-constrained environment. PMSE equipment is close to the limit of what is technically and economically achievable given the performance demands of audio PMSE, e.g. high audio quality, and low latency. In addition to developments in equipment, users have developed their working methods and workflows to maximise the use of spectrum. Even with these innovations, today some events and productions are constrained by spectrum availability as events grow and become more sophisticated. Manufacturers have developed Wireless Multichannel Audio Systems (WMAS) that leverage the benefits of multiple access communication techniques to support multiple audio channels within a single wideband RF channel. Though WMAS has the potential to improve spectral efficiency for certain applications, like for-like comparison of Sennheiser's 6000 and WMAS systems running at high

Question	Your response
	audio quality and low latency reveals that a similar channel count is possible in a single 8MHz channel. Taking a look at Sennheiser's Spectera, Ofcom needs to acknowledge that there is a massive difference between delivering 8 radio mic channels of RAW PCM audio with 1ms delay and delivering the maximum number of radio mic channels using a lossy codec with a delay of 15.2ms. The latter isn't likely to be acceptable for some professional applications, meaning that a non-WMAS system is just as efficient for the highquality content being generated.

Question 13: Are there any barriers to adopting more efficient technologies for audio applications, particularly for wireless microphones and IEMs at the largest events and venues? What could industry do and what could Ofcom do to facilitate greater use of those technologies?	Confidential? – N The PMSE sector has also already demonstrated significant increases in spectral efficiency and agility through the technological developments provided by the transition to digital systems or more efficient narrow-band analogue systems. Even with continued innovation in technology, the industry would be severely impacted by further loss of spectrum access. PMSE equipment is close to the limit of what is technically and economically achievable given the performance demands of audio PMSE, e.g. high audio quality, and low latency. In addition to developments in equipment, users have developed their working methods and workflows to maximise the use of spectrum. For example, as mentioned in this stakeholder's opening summary, the National Theatre promotes spectral efficiency with a minimum of 23 radio microphones per 8MHz channel and with clever management of the fixed-location IEM frequencies, all of which are used every day of the year. Even with these innovations, today some events and productions are constrained by spectrum availability as events grow and become more sophisticated. Manufacturers have developed Wireless Multichannel Audio Systems (WMAS) that leverage the benefits of multiple access communication techniques to support multiple audio channels within a single wideband RF channel. Though WMAS has the potential to improve spectral efficiency for certain applications, like for-like comparison of Sennheiser's 6000 and WMAS systems running at high audio quality and low latency reveals that a similar channel count is possible in a single 8MHz channel. Taking a look at Sennheiser's Spectera, Ofcom needs to acknowledge that there is a massive difference between delivering 8 radio mic channels of RAW PCM audio with 1ms delay and delivering the maximum number of radio mic channels using a lossy codec with a delay of 15.2ms. The latter isn't likely to be acceptable for some professional applications,

Question	**Your response**

	meaning that a non-WMAS system is just as efficient for the highquality content being generated. As an adjunct to the technological development insight above, there is a further significant factor to consider and that is the R&D cycles and timelines required by manufacturers to innovate and develop and a further time period required for the industry to adopt, invest and deploy new technologies as well. Using WMAS as an example, the initial regulatory discussions took place in 2013, and product development around six years ago, and by the time products are being shipped and utilised significantly, probably still a further one year from now. With this in mind, the issues that are perceived as medium to long-term require short-term consideration to ensure sufficient development and deployment time.
Question 14: What changes to working practices and spectrum planning could improve audio spectrum efficiency in the future, particularly in the use of wireless microphones and IEMs at the largest events and venues?	Confidential? – N Regardless of changes to working practices and spectrum planning, PMSE still requires access to sufficient quality and quantity of radio spectrum. Ofcom must acknowledge that the 7.1% compound annual growth in microphone and IEM assignments in Table 4, measured between 2018 and 2024, indicates a likely future increased demand for more spectrum by the PMSE sector. Any additional technological improvement in equipment will be saturated by this growth, which is borne from greater expectations by those for whom the content is created. What is Ofcom's projection for the number of PMSE microphone and IEM assignments for 2034, when Digital Terrestrial Television licences are up for renewal? How much spectrum will the PMSE sector need to deliver the content that Ofcom's other stakeholders expect in 2034 and going forward? Why does Ofcom seem to expect the PMSE sector to deliver a growing demand for wireless audio and video content production with less spectrum, when it doesn't expect the mobile sector to grow and deliver faster data and phone platforms with less spectrum?
Question 15: Are there any barriers to adopting working practices that could enable more efficient use of spectrum by audio applications, particularly for wireless microphones and IEMs	Confidential? – N The PMSE sector has also already demonstrated significant increases in spectral efficiency and agility through the technological developments provided by the transition to digital systems or more

Question	Your response
at the largest events and venues? What could industry do and what could Ofcom do to facilitate those efficiencies?	efficient narrow-band analogue systems. Even with continued innovation in technology, the industry would be severely impacted by further loss of spectrum access. PMSE equipment is close to the limit of what is technically and economically achievable given the performance demands of audio PMSE, e.g. high audio quality, and low latency. In addition to developments in equipment, users have developed their working methods and workflows to maximise the use of spectrum. Even with these innovations, today some events and productions are constrained by spectrum availability as events grow and become more sophisticated. As an adjunct to the technological development insight above, there is a further significant factor to consider and that is the R&D cycles and timelines required by manufacturers to innovate and develop and a further time period required for the industry to adopt, invest and deploy new technologies as well. Using WMAS as an example, the initial regulatory discussions took place in 2013, and product development around six years ago, and by the time products are being shipped and utilised significantly, probably still a further one year from now. With this in mind, the issues that are perceived as medium to long-term require short-term consideration to ensure sufficient development and deployment time. Please note that WMAS products don't improve spectral efficiency significantly when using the current latency and audio quality settings required for live professional PMSE radio microphone applications.

Question	Your response

Wireless video Drivers of demand **Question 16:** What factors (such as more complex events and use of higher resolution equipment) have driven the demand for wireless video bandwidth, in particular for: a) the increased bandwidth required for the largest sporting events such as Formula 1 at Silverstone and The Open Championship? b) the bandwidth required for nationally important state events such as The Coronation? c) the slow growth or decline in bandwidth used at horse racing fixtures?	Confidential? – N While innovation in the industry delivers efficiency gains in spectrum use, it also unlocks creative innovation which increases demand. This increased demand is shown clearly, and is supported by many studies, by the fact that the PMSE industry continues to grow as events and productions become more complex and sophisticated to satisfy consumer and audience expectations. Innovations in the industry (and a lot of hard work) allow these events to take place within the available spectrum, albeit recognising that in some cases even today some production ambitions are constrained by a lack of spectrum. Consequently, even with continued innovation in technology, the industry would be severely impacted by further loss of spectrum access. Higher resolution equipment, which is expected by consumers when viewing the content, is also a factor.

Question 17: What factors could drive further changes in the demand for wireless video bandwidth in the future, and what will this mean for future demand, in particular for: a) the bandwidth required for the largest sporting events like Formula 1 at Silverstone and The Open Championship?	Confidential? – N Ofcom must acknowledge that the 9.2% compound annual growth in video assignments in Table 4, measured between 2018 and 2024, indicates a likely future increased demand for more spectrum by the PMSE sector. Any additional technological improvement in equipment will be saturated by this growth, which is borne from greater expectations by those for whom the content is created. What is Ofcom's projection for the number of PMSE video assignments for 2034, when Digital Terrestrial Television licences are up for renewal? How much spectrum will the PMSE sector need to deliver the content that Ofcom's other stakeholders expect in 2034 and going forward? Why does Ofcom seem to expect the PMSE sector to deliver a growing demand for wireless audio and video con-

Question	Your response
b) the bandwidth required for nationally important state events such as The Coronation? c) the bandwidth used at horse racing fixtures and other major sporting events?	tent production with less spectrum, when it doesn't expect the mobile sector to grow and deliver faster data and phone platforms with less spectrum?
Potential news bands **Question 18:** What factors have influenced the degree of take-up of existing bands used by wireless video applications, particularly the growth in take-up of the 7 GHz band?	Confidential? – N Narrower band transmission (like COFDM in 7MHz) allows for higher channel density, enabling more transmitters to operate in the same area without interference. Ofcom is separately consulting on the eviction of PMSE video from some of the 6Mhz and 7Mhz spectrum currently being used! Why isn't this mentioned as a factor in this consultation?
Question 19: Which potential additional bands might be suitable for video PMSE applications, particularly at the largest events and venues?	Confidential? – N Ofcom is separately consulting on the eviction of PMSE video from some of the 6Mhz and 7Mhz spectrum currently being used! Why isn't this mentioned as a factor in this consultation?

Question 20: To what extent do the characteristics of different video applications drive their requirements for spectrum – for example particular requirements for resilience or capacity?	Confidential? – N The choice of band(s) may be made based on the need for low latency; superior performance in non-line-of-sight or long-range environments; or robustness against interference; or to fit within an existing radio band plan.

Question	Your response
Changes in efficiency of spectrum use **Question 21:** What technologies are currently available or are being developed which can improve wireless video spectrum efficiency in the future?	Confidential? – N Triband & Intelligent Switching: Newer systems, which use 2.4GHz, 5GHz, and 6GHz, can dynamically adjust data across bands to ensure stability. Some of them use AI to do this.
Question 22: Are there any barriers to adopting more efficient technologies for wireless video? What could industry do and what could Ofcom do to facilitate greater use of those technologies?	Confidential? – N The PMSE sector has also already demonstrated significant increases in spectral efficiency and agility through the technological developments provided by the transition to digital systems or more efficient narrow-band analogue systems. Even with continued innovation in technology, the industry would be severely impacted by further loss of spectrum access.
Question 23: What types of video demand could realistically be supported by private (for example 5G) networks?	Confidential? – N There are already devices that aggregate up to 12+ connections (3G/4G/5G) for reliable, long-distance remote production with subsecond latency.

Question 24: What changes to working practices and spectrum planning could improve video spectrum efficiency in the future, particularly in the use of wireless microphones and IEMs at the largest events and venues?	Confidential? – N
Question 25: Are there any barriers to adopting working practices that could enable more efficient use of spectrum by wireless video? What could industry do and what could Ofcom	Confidential? – N The PMSE sector has also already demonstrated significant increases in spectral efficiency and agility through the technological developments provided by the transition to digital systems or more efficient narrow-band analogue systems. Even with continued innovation in technology, the industry would be severely impacted by further loss of spectrum access.

Question	Your response
do to facilitate those efficiencies?	The R&D cycles and timelines required by manufacturers to innovate and develop and a further time period required for the industry to adopt, invest and deploy new technologies as well. Using WMAS as an example, the initial regulatory discussions took place in 2013, and product development around six years ago, and by the time products are being shipped and utilised significantly, probably still a further one year from now. With this in mind, the issues that are perceived as medium to long-term require short-term consideration to ensure sufficient development and deployment time.

Other comments

Question 26: Do you have any other comments or views on the issues raised in this document?

Confidential? – N

This stakeholder's response is intended to be in line with BEIRG. The National Theatre fully supports BEIRG in their representation of PMSE needs.

Ofcom make many references to efficiency of spectrum usage in this consultation, with strong and somewhat discourteous implications that the PMSE sector can operate more efficiently with spectrum. With more information, Ofcom would soon realise that significant proportions of the PMSE sector are extremely efficient with the spectrum they have licenced. For example, the National Theatre licences entire 8MHz bands as part of its annual schedule, and Ofcom doesn't actually receive any information on how many radio mics are in use in each 8MHz channel. The table below (which should be kept confidential, please) shows that, for our radio microphones, each 8MHz channel has at least 23 digital radio microphones occupying it.

20	462.000 - 470.000	**Talkback & Digital Radio Mics (64 dynamically allocated Digital 2way Talkback channels, 4 2way Analogue Talkback Channels, and 4 Digital Radio Mics.)**
21	470.000 - 478.000	
22	478.000 - 486.000	DTV mux - ARQ A
23	486.000 - 494.000	DTV mux - BBC A
24	494.000 - 502.000	**23 Digital Radio Mic Frequencies**
25	502.000 - 510.000	DTV mux - SDN
26	510.000 - 518.000	DTV mux - D3&4
27	518.000 - 526.000	**23 Digital Radio Mic Frequencies**
28	526.000 - 534.000	DTV mux - ARQ B
29	534.000 - 542.000	**23 Digital Radio Mic Frequencies**
30	542.000 - 550.000	DTV mux - BBC B HD
31	550.000 - 558.000	**23 Digital Radio Mic Frequencies**
32	558.000 - 566.000	**23 Digital Radio Mic Frequencies**
33	566.000 - 574.000	**23 Digital Radio Mic Frequencies**
34	574.000 - 582.000	**23 Digital Radio Mic Frequencies**
35	582.000 - 590.000	DTV mux - L-LON
36	590.000 - 598.000	Available for Hired Equipment
37	598.000 - 606.000	Available for Hired Equipment (Higher noise floor)
38	606.000 - 614.000	**33 Digital Radio Mic Frequencies (various uses and locations)**
39	614.000 - 622.000	Used by others nearby
40	622.000 - 630.000	Used by others nearby
41	630.000 - 638.000	**9 Analogue IEM Frequencies**
42	638.000 - 646.000	Used by others nearby
43	646.000 - 654.000	**12 Analogue IEM Frequencies**
44	654.000 - 662.000	NT Cabled Digital HD Theatre Channel
45	662.000 - 670.000	**7 Analogue IEM Frequencies**
46	670.000 - 678.000	NT Cabled Digital HD Theatre Channel
47	678.000 - 686.000	NT Cabled Digital HD Theatre Channel
48	686.000 - 694.000	NT Cabled Digital HD Theatre Channel
49	694.000 - 702.000	**Highest** Available RM Channel after May 1st 2020

The analogue IEMs have been efficiently calculated so that they do not interfere with each other, factoring in the need for some of them to move interference-free between different spaces within the building. Where there is no expected movement of the IEMs and where they are separated physically in the building, it has been possible to be even more efficient with spectrum, by ignoring their

	interference characteristics entirely and therefore squeezing more IEMs into a band than would otherwise be possible. Ofcom is also using the PMSE sector's past technological achievements in manufacturing (which became a requirement when PMSE lost access to the 800 and 700MHz bands) to incorrectly predict the potential further efficiencies of future technology. The technology has reached its limit of efficiency, so further improvements will not be significant. For example, WMAS is quoted by Ofcom as more spectrally efficient, with no acknowledgement of the degradation of audio quality and latency required to achieve 64 audio channels. In actual fact, like for-like comparison of Sennheiser's 6000 and WMAS systems running at high audio quality and low latency reveals that only a similar channel count is possible in a single 8MHz channel. Taking a look at Sennheiser's Spectera, Ofcom needs to acknowledge that there is a massive difference between delivering 8 radio mic channels of RAW PCM audio with 1ms delay and delivering the maximum number of radio mic channels using a lossy codec with a delay of 15.2ms (https://docs.cloud.sennheiser.com/enus/spectera-solution/spectera/specifications-system.html). The latter isn't likely to be acceptable for some professional applications, meaning that a non-WMAS system is just as efficient for the highquality content being generated. Ofcom must acknowledge that the 7.1% compound annual growth in microphone and IEM assignments in Table 4 of the consultation, measured between 2018 and 2024, indicates a likely future increased demand for more spectrum by the PMSE sector. Any additional technological improvement in equipment will be saturated by this growth, which is borne from greater expectations by those for whom the content is created. What is Ofcom's projection for the number of PMSE microphone and IEM assignments for 2034, when Digital Terrestrial Television licences are up for renewal? How much spectrum will the PMSE sector need to deliver the content that Ofcom's other stakeholders expect in 2034 and going forward? Why does Ofcom seem to expect the PMSE sector to deliver a growing demand for wireless audio and video content production with less spectrum, when it doesn't expect the mobile sector to grow and deliver faster data and phone platforms with less spectrum? Ofcom must acknowledge that the 9.2% compound annual growth in video assignments in Table 4 of the consultation, measured between 2018 and 2024, indicates a likely future increased demand for more spectrum by the PMSE sector. Any additional technological improvement in equipment will be saturated by this growth,

Question	Your response
	which is borne from greater expectations by those for whom the content is created. What is Ofcom's projection for the number of PMSE video assignments for 2034, when Digital Terrestrial Television licences are up for renewal? How much spectrum will the PMSE sector need to deliver the content that Ofcom's other stakeholders expect in 2034 and going forward? Why does Ofcom seem to expect the PMSE sector to deliver a growing demand for wireless audio and video content production with less spectrum, when it doesn't expect the mobile sector to grow and deliver faster data and phone platforms with less spectrum? How does Ofcom calculate radio mic and IEM assignments shown in Table 7? For example, the National Theatre is only slightly below the 10th-rated location/event in the table with approximately 222 channels of radio equipment, nearly all of which are used every single day. Does Ofcom know that this is the number at the National Theatre, carefully optimised for efficient and practical use within the building? How many other PMSE licence-holders have a greater number of assignments than Ofcom realises, due to more efficient spectrum usage than Ofcom realises.

Please tell us how you came across about this consultation.

- ☐ Email from Ofcom
- Y Saw it on social media
- ☐ Found it on Ofcom's website
- ☐ Found it on another website
- ☐ Heard about it on TV or radio
- ☐ Read about it in a newspaper or magazine
- ☐ Heard about it at an event
- Y Somebody told me or shared it with me
- ☐ Other (please specify)

Please complete this form in full and return to liz.hall@ofcom.org.uk.