

TOO SOON. TOO LITTLE.

An early eviction to a spectrum reservation that is too small; how Ofcom's plans still threaten the future of the Programme Making and Special Events (PMSE) sector.

If Ofcom award UHF spectrum as proposed, there will be far too little spectrum available for PMSE in the run-up to and post Digital Switchover (DSO) and it will be far too fragmented. Evicting PMSE users as soon as DSO takes place in each region will not give the PMSE sector sufficient time to adjust and re-equip. Although this additional time for adjustment will help the equipment development issue, it will not help significantly with the spectrum availability issue.

If Ofcom proceeds as planned, it will be disastrous for the PMSE industry and the cultural life of the UK.

Note: since this document was drafted, Ofcom has published two further consultations relating to the Digital Dividend Review: one on the award of the cleared spectrum and the other on the award of the geographic interleaved. While this document does not address these consultations directly and was written before they were published, the arguments and evidence contained within it have been bolstered by them. We thought that the outlook for the PMSE sector was grim prior to publication of these consultations; it is now significantly worse.

The PMSE sector

The Programme Making and Special Events (PMSE) sector is a disparate, diverse and diffuse community of content producers, manufacturers, rental organisations and freelance engineers. The PMSE sector is responsible for both content production and content delivery for live and recorded entertainment. It plays a critical role in the ongoing success of the £15 billion pa British Entertainment Industry. The PMSE sector is critical to the production of content for live entertainment of all genres. This sector extensively utilises wireless equipment such as Wireless Microphones, Wireless In-Ear Monitor Systems, Wireless Talk Back Systems and Wireless Instrument Systems.

For over fifty years wireless products have been used in the entertainment industry. In the past thirty years there have been vast improvements in production value and safety levels as a result of advances in wireless technology. The PMSE sector currently relies on the spectrum interleaved between existing TV Broadcast channels to enable the use of Radio Microphones, In-Ear Devices and other short-range wireless devices. This equipment is an essential component of the British Entertainment Industry.

On a daily basis this sector is responsible for the production of content that has received world-wide acclaim and continues to attract a global audience. A vast array of organisations are reliant on radio spectrum for the production of content for **Performing Arts, Broadcasting, News Gathering, Independent Film and TV Production, Corporate Events, Concerts, Night Venues and Sports Events**. In addition, other sectors that utilise the current UHF spectrum include the Health Service, Education, Local Government, Political Programming and Conferencing.

Wireless equipment and the spectrum it operates on are now crucial to the British Entertainment Industry. **All parts of this important industry have a major impact on the daily lives of the entire UK population.**

Just one example of this contribution would be the UK's theatre industry. However this is only one facet of the much broader contribution that the PMSE sector makes every year to the unusually diverse British Entertainment Industry. A study by Dominic Shellard, of the University of Sheffield, published as recently

as April 2004 (Theatre Impact on UK Economy - Economic Impact Study of UK Theatre), highlighted the considerable social and economic value of the theatre market alone:

Theatre has a huge economic impact: £2.6bn annually. This is a conservative figure. It does not include, for instance, the impact of touring theatre companies or non building-based theatre activity.

Theatre makes a considerable contribution to local economies, both in terms of direct spending on goods and services and in terms of visitor spending.

Theatre activity outside London has an economic impact of £1.1bn annually. By attracting audience members who undertake spending on food, transport and childcare, theatres make a significant contribution to their local economies. Audience members spend an average of £7.77 per person on food, transport and childcare when they visit a UK theatre outside the West End.

The economic importance of West End theatre to the UK is clear – it contributes £1.5bn pa. Audience members spend an average of £53.77 per person on food, transport and childcare when they visit a West End theatre.

Employment

A sample of 259 UK based theatres showed that they employ 6,274 people on a full-time basis and offer 5,700 part-time contracts.

Theatre is a popular area for volunteering. There are at least 16,000 volunteers working in UK theatres.

During the 21 years since the PMSE sector first had regulated access to spectrum, the requirement for use of wireless microphone, in-ear monitor and other short-range wireless devices has increased dramatically. For instance, large scale musicals and live music events today require use of over 60 radio devices and therefore access to over 60 MHz of interference-free spectrum, which is a three-fold increase in the past twenty years. Any future arrangement will require continuation of at least this level of access nationwide, and additional spectrum availability to cope with a level of future expansion.

Executive Summary

- ***If Ofcom's current proposals are adopted Large scale musicals and live music productions will not be possible in certain prime locations across the UK, potentially resulting in the closure of a number of major theatres and long term cultural and employment loss in those regions, and within the industry in general.***

Ofcom-generated and approved data, freely available from the JFMG website, shows that, post-Digital Switchover (DSO), there will be insufficient spectrum available in order to operate sufficient quantities of PMSE equipment for large-scale musical productions to be staged at certain prime venues across the UK¹. Analysis of the data clearly demonstrates that musicals such as *Mary Poppins*, *Chitty Chitty Bang Bang*, *The Lion King*, *Spamalot*, *Miss Saigon*, *Phantom of the Opera*, *Les Miserables* and *Oliver* will be impossible to stage to current production standards at the major theatres in Edinburgh, Nottingham, Bradford, Southend and Woking.

The country's largest touring theatres rely for over 50% of their annual output on musical productions. In the event that *through the loss of spectrum* it becomes impossible to stage these shows at certain theatres, the theatres would have to close. Many of these large theatres are unsuitable for the staging of Drama and it is highly unlikely in any event that the supply of Drama would or could increase to fill the gap left by the absence of musicals.

Action: more UHF spectrum must be awarded to the band manager with PMSE obligations for use of wireless microphones and in-ear monitor systems post-DSO.

¹ Working on the basis that a large-scale production requires over 50 MHz of interference free spectrum to operate its wireless microphones, in-ear monitor systems and wireless communications

- **Many touring productions may be rendered financially unviable**
 - a. **As a consequence of insufficient spectrum availability at some venues**

If the size of the touring *theatre* circuit were reduced by the closure of some theatres resulting from lack of spectrum coverage, the loss of major venues from a national tour would make many tours financially unviable to produce *and, as a consequence, could cause the closure of more theatres than just those directly affected.*

Action: more UHF spectrum must be awarded to the band manager with PMSE obligations for use of wireless microphones and in-ear monitor systems post-DSO.

- b. **As a consequence of the greatly increased fragmentation of spectrum availability post DSO and therefore, an increased level of equipment will be required in the venues where staging productions is still possible**

Currently, certain combinations of adjacent bands are available for PMSE use on a near-nationwide basis. This allows travelling productions to use the same equipment at all tour venues. However, in the wake of DSO, spectrum available for PMSE will become so sparse and so fragmented that multiple sets of equipment will be required². BEIRG's latest models suggest that equipment costs for touring theatre will increase by a minimum of 100% post-DSO.

Action: in addition to channel 69, more spectrum must be awarded to the band manager with PMSE obligations for use of wireless microphones and in-ear monitors on nationwide basis post-DSO. This must have sufficient bandwidth to be useable for professional PMSE productions. To this end, BEIRG would like to refer Ofcom to the PMSE Pro User Group's 2007 submission in which it recommended that channels 67 and 68 be held back for PMSE use. Furthermore, to prevent disruption to touring theatre earlier than necessary, users of wireless microphone and in-ear monitor systems must retain access to all of the cleared spectrum until after DSO is completed nationwide or post Olympics, whichever is the latter,

- **Millions of pounds worth of wireless microphone and in-ear monitor systems will be either rendered redundant or require expensive modification**

Since the frequencies used for DTT will change from those used for analogue terrestrial television, the pattern of interleaved spectrum will also change. As a consequence, PMSE users of equipment operating in interleaved spectrum are likely to find it necessary to retune, modify or replace that equipment in order to use new frequencies after DSO. The PMSE Pro User Group estimated that equipment that will become redundant as a result of the DDR is worth well in excess of £30 million. Ofcom initially disputed this but has since valued the affected equipment at around £35 million.

In place of current proposals, the PMSE sector must be granted sufficient time that would allow them to amortize the value of current equipment that will inevitably become redundant under current plans.

Action: Users of wireless microphone and in-ear monitor systems must retain access to the cleared spectrum until DSO is completed nationwide and the Olympics have taken place in 2012 irrespective of when auctions for the 'cleared' spectrum take place and licenses are awarded. For instance, Ofcom could make clear in the licence conditions for channels 31-40 (excluding channel 38) and 61-68 that rights of usage do not start until September 2012

If this is not the case then owners of equipment affected by DDR/DSO must be paid appropriate compensation.

- **Expensive new equipment that operates in the 'digital interleaved' will have to be developed, manufactured and purchased by users and rental companies**

² Indeed, equipment costs for every large-scale professional PMSE user will increase due to the change in pattern of spectrum availability

Following the transition to DTT broadcasting and the change in the pattern of interleaved spectrum availability, the PMSE sector will have no option but to re-equip. There is at present an inadequate stock of PMSE equipment for use solely in the 'digital interleaved' spectrum. It is, therefore, essential that the industry begins to build up stocks of 'digital interleaved compatible' equipment. This will take a considerable period of time – see PMSE Pro User Group response to the DDR.

Action: Users of wireless microphone and in-ear monitor systems must retain access to the cleared spectrum until DSO is completed nationwide and the Olympics have taken place in 2012 irrespective of when auctions for the 'cleared' spectrum take place and licenses are awarded. For instance, Ofcom could make clear in the licence conditions for channels 31-40 (excluding channel 38) and 61-68 that rights of usage do not start until September 2012

However, without guarantees of security of tenure in the digital interleaved areas of spectrum, there will be no commercial imperative for suitable equipment to be developed. The PMSE sector requires certainty of spectrum access over a reasonable period of time in order for expensive new PMSE equipment development to make economic sense. Furthermore, the PMSE sector, after having been forced to re-equip by the reorganisation of spectrum associated with DSO and DDR in 2012, may have to do so again in 2018.

Action: PMSE protected access to the 'digital interleaved' spectrum must continue to 2026 rather than 2018.

Conclusion

In this document, BEIRG demonstrates the devastating effect that Ofcom's current plans for the release of UHF spectrum currently used for wireless microphones, in-ear monitor systems and other short-range wireless devices will have on the PMSE sector.

If medium and large scale live events are going to be able to continue at current levels, then Ofcom must award more UHF spectrum to the band manager with PMSE obligations than it is currently planning to. If this does not happen, then, for instance, medium to large scale live events from musicals to conferences will not be able to take place in certain prime locations across the UK, certain theatres will have to close and many productions will not tour the UK. The cultural and economic consequences will be disastrous.

Introduction

Ofcom currently plans to sell off much of the spectrum currently used for wireless microphones and in-ear monitor systems. The remaining digital interleaved spectrum due to be allocated to the band manager with PMSE obligations will be too scarce and too fragmented.

Practical and financial consequences of UHF spectrum reorganisation and release for the PMSE sector:

1. Large-scale musicals and live music productions will not be possible in certain prime locations across the UK. The trickle-down effect of the loss of product will result in significant drops in employment levels.
2. Many touring productions may be rendered financially unviable or be restricted to certain venues. Again, the trickle-down effect of the loss of product will result in significant drops in employment levels
3. Millions of pounds worth of wireless microphone and in-ear monitor systems will be either rendered redundant or require expensive and significant modification
4. New equipment that operates in the 'digital interleaved' (the frequencies that will be awarded to the band manager with PMSE obligations are still not certain) have to be developed, manufactured and purchased by users and rental companies
5. Increased equipment will be required post-Digital Switchover (DSO) to achieve current results, thus resulting in further cost increases

Suggested solutions

1. Users of wireless microphone and in-ear monitor systems must retain access to the cleared spectrum until DSO is completed nationwide and the Olympics have taken place in 2012
2. More spectrum must be set aside for PMSE use post-DSO
3. In addition to channel 69, more spectrum must be available for professional PMSE use on a nationwide basis

Preamble

Ofcom's 'white space' maps, illustrating PMSE access to interleaved spectrum post-DSO were published in a regulatory statement on 16th January 2008. The data used to produce the 'white space' maps has been used to generate an on-line database containing detailed information on the channels in interleaved spectrum that will be available for indoor and outdoor wireless-microphone use at any given location in the UK post-DSO. The on-line database is available on the JFMG website³. BEIRG's arguments and conclusions outlined in this document are based entirely on this on-line database and therefore on Ofcom-generated and approved data.

BEIRG has been told by Ofcom officials on several occasions that the white space maps and JFMG on-line database is pessimistic due to the conservative methodology used in their production⁴. BEIRG hopes that this is the case, but without updated 'white space' maps showing certain increased availability of interleaved spectrum, this 'reassurance' is of little comfort to the PMSE sector.

The 'white space' maps produced by Ofcom using data generated by Sagentia are based on theory only.

³ <http://www.jfmg.co.uk/jfmgcamera/wireless/public/microphonedso.aspx>

⁴ Sagentia:

'These results indicate that, based on 2005 demand, there are a few locations where may be a constraint on capacity for PMSE users. However there are a number of situations where the modelling approach produces overly cautious estimates:

- These results are based on outdoor channel availability only. It is highly likely that a large proportion of these licensees require indoor use only and therefore will have more channels available to them;*
- These results are based on excluding channels where incoming DTT interference limits radio microphone minimum estimated operating range to below 100m. In situations where a lower operating range is acceptable the channel availability is often higher. The estimated operating range for radio microphones in channels limited by incoming DTT interference is provided in the online database at www.jfmg.co.uk.*
- We protect all broadcast TV services that are predicted to be receivable post DSO. It is possible that in locations where a number of transmitter service areas overlap there are some TV services being protected which are not being used by a large number of households. The adoption of the DPSA protection model would increase the availability of spectrum for PMSE use.'*

Within this document, BEIRG concentrates on large and medium-scale PMSE events such as theatre productions since these will be the hardest hit by the reduction in UHF spectrum (in certain geographical locations) available for PMSE post-DSO.

1. INSUFFICIENT SPECTRUM POST-DSO: large scale theatrical and musical productions will not be possible in certain prime venues across the UK

1.1. CSMG, Ofcom's consultants, recently stated the following:

'Digital switchover will be complete in the UK in 2012. As a result, 14 channels in UHF Bands IV and V will be nationally cleared of terrestrial television -- and Channel 36 of aeronautical radar -- and made available for new uses. Wireless microphone, IEM and talkback users of these bands will be affected by both a reduced availability of spectrum interleaved with digital terrestrial television and changes to the pattern of its availability.'

This is correct but does not represent the scale of the problem. Following the Digital Switchover (DSO) and the Digital Dividend (DDR), the significant decrease in spectrum available to the PMSE sector in certain geographical locations will render large musicals and live music productions impossible in certain prime locations across the UK, regardless of the substantial financial impact of equipment redundancy and reinvestment.

- 1.2. In a report commissioned by Ofcom, Sagentia used figures from 2005⁵ to assess PMSE UHF spectrum demand relative to availability post-DSO. Sagentia also noted that 'PMSE demand could increase in some locations between 2005 and DSO in 2012'. This is misleading; the fact is that demand for wireless microphones and in-ear monitors in professional productions is increasing and will continue to increase up until 2012 and thereafter.
- 1.3. Sagentia and Ofcom's analyses are based on a poor understanding of how the PMSE sector operates. The most popular musicals and live events do not tour every year, do not tour at the same times, they do not play at the same venues and vary in how long they spend at each location. Basing analysis on PMSE demand data solely from 2005 totally misrepresents how DSO/DDR will affect the PMSE sector.
- 1.4. The PMSE sector currently works on the basis that 8 wireless microphones can be used interference-free in a standard 8 MHz TV band⁶ in complex multi-channel set-ups. This is therefore the practical operating maximum in the context of large-scale productions. Using these figures, BEIRG has taken a sample of upcoming tour venues to assess the extent to which Ofcom's plans threaten the future of large-scale PMSE productions outside London to illustrate the severity of the problem.
- 1.5. The critical distinction here is between equipment availability and spectrum availability. Equipment issues will be addressed later in this document. Even if a sufficient volume of sufficiently spectrally agile equipment existed, there will be insufficient spectrum availability to cater for large-scale musicals and live events in certain prime locations across the UK post-DSO.

⁵ Ofcom: '5.2 Sagentia identified locations where peak demand for channels for wireless microphones before DSO exceeds the number of channels that can be expected to be available for PMSE after DSO. Figures for 2005 were used as the last year for which full demand data were available. 5.4 Where we identified significant reductions in channel availability, we used licensing information from JFMG to calculate the peak use of spectrum for wireless microphones during 2005. We compared this in each location with channel availability to assess whether there are likely to be constraints after DSO.'

⁶ JFMG data incorporates buffers of 600 KHz between 8 MHz TV channels pre-DSO, thus reducing available bandwidth within a full 8 MHz to 7.4 MHz. Their post-DSO data reduces these buffers to 200 KHz. At an absolute maximum, 12 wireless microphones can fit into channel 69. However, if channel 68 is auctioned, then interference from new neighbouring users is likely to increase. Therefore, it will be more difficult to fit the same number of wireless microphones into channel 69 after DSO/DDR than before.

- 1.6. Most major musicals and theatre productions staged in the West-End in the past five years required between 40 and 60 MHz in the UHF spectrum for use of essential wireless microphone and in-ear monitor systems. West-End musicals frequently tour the UK, and when they do their spectrum requirements for use of wireless microphones, In-ear monitor systems or talkback are either replicated or increase. This is in part because audience expectations increase as time goes on.
- 1.7. To illustrate the magnitude of the problem, BEIRG has taken a sample of three upcoming touring musical productions (for 2008 and 2009) and examined the venues at which they are due to be staged. These productions cannot be named due to commercial sensitivity. These three productions are due to be staged at 6, 14 and 19 venues respectively across the UK, several of which are due to host more than one of the musicals in question. The venues examined by BEIRG are the usual hosts for shows of this kind in the cities/towns in question.

Of those venues examined from the three sample touring productions, the following will not be able to host large scale musical productions such as The Lion King, Spamalot, Miss Saigon, The Phantom of the Opera, Les Miserables, Mary Poppins, Chitty Chitty Bang Bang, My Fair Lady, Oliver and Beauty and the Beast post-DSO⁷:

Edinburgh: Festival Theatre⁸
 Edinburgh: Playhouse Theatre⁹
 Woking: New Victoria Theatre¹⁰
 Stoke: Regent Theatre¹¹
 Nottingham: Royal Albert Hall¹², Theatre Royal
 Southend: Cliffe Pavilion¹³
 Bradford: Alhambra Theatre¹⁴

This is just the tip of the iceberg, and merely illustrates the immense threat to large-scale PMSE productions across the UK. The threat to the viability of the Edinburgh Festival is a particular worry. Firstly, there is simply insufficient spectrum to host large-scale musicals or live music events. Secondly, the number of productions taking place at the same time and the same place increases the chance of interference and further reduces spectrum availability (especially outdoors where there is no RF screening). Thirdly, many of the productions at the Festival are low-budget and could not afford to buy new equipment subsequent to their current equipment being rendered redundant by DSO.

If large-scale musicals are to be seen again in the cities and venues listed above (along with many others) post-DSO, then more spectrum must be reserved for the PMSE industry.

2. Many touring productions may be rendered financially unviable or be restricted to certain venues

- 2.1. Touring theatre and musical productions need to use the same wireless microphone and in-ear monitor systems as they travel around the country. This is for both practical and financial reasons. The alternative to using the same equipment would be to 'swap out' equipment every time the production moved to a different location and the pattern of spectrum availability changed. This would involve transport costs (and time), extra personnel and time. But more importantly, it would entail considerable additional expense in rental costs since the rental

⁷ Channel 69 has been incorporated into this analysis – it was assumed that it could be used for 8 wireless microphones. 50 MHz of UHF spectrum has been taken as the standard bandwidth requirement for large-scale professional PMSE theatre and musical productions.

⁸ 33.4 MHz bandwidth available for PMSE in UHF post-DSO, including channel 69

⁹ 33.4 MHz bandwidth available for PMSE in UHF post-DSO, including channel 69

¹⁰ 21.8 MHz bandwidth available for PMSE in UHF post-DSO, including channel 69

¹¹ 47.0 MHz bandwidth available for PMSE in UHF post-DSO, including channel 69

¹² 48.6 MHz bandwidth available for PMSE in UHF post-DSO, including channel 69

¹³ 38.16 MHz bandwidth available for PMSE in UHF post-DSO, including channel 69

¹⁴ 37.0 MHz bandwidth available for PMSE in UHF post-DSO, including channel 69

company would require a larger and more mobile inventory, costs which would be passed on to users.

- 2.2. Sagentia and Ofcom have presented the information on interleaved availability post-DSO by referring to each location in isolation. However, the PMSE industry relies on a UK pool of equipment that through careful planning and logistics operates on a countrywide basis.
- 2.3. All PMSE equipment has a finite 'window' through which it accesses spectrum. The width of this window, i.e. how much spectrum can be accessed, is defined as the equipment's 'tuning range'. On individual systems, the tuning range is fixed; the window cannot be moved up and down the frequency scale. It follows that, as they move around the UK, touring theatre and musical productions can only use the same equipment if there is sufficient available spectrum within the bands accessible by the production's equipment at each venue on the tour. Those responsible for planning equipment requirements and deployment have the difficult job of finding a viable 'pathway through the patchwork' of available and non-available spectrum.
- 2.4. An average-size musical production needs to access at least 32 MHz of interference-free UHF spectrum per venue¹⁵, which may not be contiguous. High-spec professional wireless microphone systems used to satisfy the requirements of these productions commonly have components with a tuning range or 'window' of 24 MHz. As things currently stand, a normal production will typically tour with a system that uses three different components that each have the ability to access a different 24 MHz of UHF spectrum. Currently (i.e. pre-DSO), this arrangement results in the full 32 MHz production requirement being fulfilled 99% of the time. Ofcom's 'white space' maps show that, post-DSO, three components with a 24 MHz window are much less likely to be able to cater for a 32 MHz production due to the reduction and dispersion of available bands.
- 2.5. However, the question is less about whether components that access three different 24 MHz windows of spectrum can fulfil the 32 MHz requirement at each venue, but which three 24 MHz windows of spectrum can be used to fulfil the 32 MHz requirement at every venue hosting the production. This is the difference between using the same three components (that access a different 24 MHz) at each and every venue (i.e. the same equipment) and, in the most extreme scenario, three different components (that access a different 24 MHz) at each and every venue. The difference in cost between these two scenarios is considerable; for instance, if totally different components have to be used at every venue on a 6-venue tour, it will cost the production approximately 6-times more than it would to use the same components at every venue. This is because the rental company will require a much larger inventory of equipment and the transfer of equipment will require additional time and staff for transport, setup and rehearsal.
- 2.6. At a conservative estimate, it costs an average-sized touring production around £1000 per week to rent its radio microphones and in-ear monitor systems equipment. Ofcom's 'white space' maps and the corresponding data available on the JFMG website suggest that, post-DSO, this cost will increase by at least a factor of 2, which in itself will render a large proportion of tours unviable.

Examples

To illustrate the severity of the considerable increase in equipment costs in the wake of DSO, BEIRG has selected two real-life average-sized theatrical productions that are due to be touring the UK in 2008 and 2009. For each production, BEIRG has calculated UHF spectrum availability for PMSE before and after DSO at each venue (using the tool on the JFMG website). Using this data, BEIRG has produced a spectrum availability spreadsheet for each production¹⁶ which clearly shows the extent to which the

¹⁵ It is possible to fit 6 wireless microphones comfortably into a standard 8 MHz TV band and 8 at the very most. Channel 69 can accommodate 8 wireless microphones comfortably and 12 is the maximum. The average touring theatre production requires between 32 and 40 wireless microphones and in-ear monitors. This is why at least 32 MHz of interference-free UHF spectrum is required at each venue.

¹⁶ See annexes A, B and C for productions A, B and C respectively

same three sets of equipment with a 'window' of 24 MHz can be used at each venue. The results do not make encouraging reading.

Assumptions:

- 1) There will be sufficient volumes of wireless microphones and in-ear monitor systems that operate anywhere in the 'digital interleaved' spectrum due to be awarded to the band manager with PMSE obligations
- (2) Each component of the systems used by all of the productions in question has a 'window' of 24 MHz¹⁷
- (3) Each production requires a minimum of 32 MHz of interference-free spectrum¹⁸ (i.e. total bandwidth) at each venue before and after DSO (i.e. not necessarily contiguous)
- (4) A full 8 MHz channel accommodates as many wireless microphones after DSO as before¹⁹ and comprises 8 MHz of available spectrum both before and after DSO

Touring theatre production example A:

Production A is due to take place at the following 6 UK venues in 2008:

1. Empire Theatre, Liverpool
2. Playhouse Theatre, Edinburgh
3. New Victoria Theatre, Woking
4. Grand Theatre and Opera, Leeds
5. King's Theatre, Glasgow
6. Regent Theatre, Stoke

¹⁷ The equivalent of 3 standard 8 MHz TV bands – this is a standard high-spec tuning range used by professional PMSE users – equipment with a larger tuning range is hugely expensive whereas a smaller tuning range is insufficiently flexible

¹⁸ Working on the further assumption that the ratio of wireless mics to available bandwidth (MHz) in UHF spectrum is approx 1:1 (maximum efficiency)

¹⁹ For the purposes of this model, a free 8 MHz TV band is designated with an available bandwidth of 8 MHz both before and after DSO. This is to (1) make the explanation clearer and (2) because BEIRG disagrees with Sagentia's assessment of the guard band required to protect digital as opposed to analogue TV broadcasts; due to the pattern of an analogue signal, PMSE applications can overlap with analogue broadcasts, unlike digital broadcasts.

Sagentia has stated that '*Digital TV has negative protection ratios throughout most of the adjacent channel compared with the significant protection required for analogue TV reception. This in itself means that more of the adjacent channel to a Digital TV broadcast is usable for PMSE than the channel adjacent to an analogue TV broadcast.*'

The upshot of this is that, as represented on the JFMG website, a full 8 MHz band pre-DSO (i.e. interleaved with analogue broadcasts) 7.4 MHz because of the perceived requisite guard band. As the adjacent channels digital broadcasts are perceived to be more useable for PMSE than analogue, the buffer has been reduced to 200 KHz and so an available 8 MHz band is increased to 7.8 MHz post-DSO. However, these details do not affect the clear demonstration that currently, touring productions can use 3 sets of equipment with a 24 MHz window whereas much more equipment will be required post-DSO.

It is also unclear how the following analysis from Sagentia aligns with the 200 KHz buffer or 'guard band' designated to protect DTT on the JFMG website:

'The DTT channel bandwidth is 8MHz. However real DTT receivers have intermediate frequency (IF) bandwidths that are greater than the 8MHz TV channel. This means that signals from beyond the 8MHz bandwidth are able to enter a DTT receiver and interfere with wanted signals in adjacent channels. Operation of PMSE equipment within this wider bandwidth i.e. at the edge of the adjacent channel, is likely to give rise to interference within a DTT receiver. The question is how big the guard band needs to be in order to protect receivers in the adjacent channel. We conducted a brief survey of IF filters made for DTT receivers. This suggests that they have significant attenuation beyond 5MHz from their centre frequency. Protecting a guard band of 1MHz each side of the used TV channel should give adequate protection from PMSE use. We believe that a 1MHz guard band should be adopted until it is demonstrated that a narrower guard band is safe.'

Pre-DSO situation:

'Window' of equipment (TV bands)	Minimum bandwidth available at every venue ²⁰
67 – 69	16 MHz
61 - 63	8 MHz
34 - 36	16 MHz
41 - 43	16 MHz
54 - 56	16 MHz

The table shows that a system with three components, each which accesses a different 24 MHz window of spectrum, will be able to fulfil the 32 MHz requirement of touring production 'A' pre-DSO (16 X 3 = 48 MHz); indeed, several combinations of equipment with different 24 MHz tuning ranges are possible. Pre-DSO, the same set of equipment (with the same three components) can be used at every venue.

Post-DSO situation

Production A will not be possible at the New Victoria Theatre in Woking post-DSO.

Production A will require a minimum of 5 different components each with a 24 MHz spectrum window to take place in Edinburgh²¹

Production A will be able to use the same components in Leeds²² as it did in Edinburgh

Production A will be able to use the same components in Glasgow²³ as it did in Edinburgh and Leeds

In addition to the components used in Edinburgh²⁴, Glasgow and Leeds, production A will require a minimum of two more components²⁵, each with a different 24 MHz spectrum window, so it can take place in Liverpool²⁶ and Stoke²⁷

²¹ (1) **TV 29-31** encompasses 5.8 MHz (543.100-548.900 MHz); (2) **TV 37-39** encompasses a full 8 MHz band (TV38); (3) **TV 48-50** encompasses 5.8 MHz (687.100-692.900 MHz); (4) **TV 55-57** encompasses 5.8 MHz (751.100-756.900 MHz) and (5) **TV 67-69** encompasses a full 8 MHz band (TV69)

(5.8 + 8 + 5.8 + 5.8 + 8 = 33.4 MHz)

²² Edinburgh equipment encompasses the following available frequencies (MHz) in Leeds: 535.100-540.900; 696.100-701.900; 702.100-708.900; 751.100-757.900; 758.100-764.900 and TV69

(5.8 + 5.8 + 6.8 + 6.8 + 6.8 + 8 = 40 MHz)

²³ Edinburgh equipment encompasses the following available frequencies (MHz) in Glasgow: 535.100-541.900; 542.100-548.900; TV38; 695.100-700.900; 751.100-756.900 and TV69

(6.8 + 6.8 + 8 + 5.8 + 5.8 + 8 = 41.2 MHz)

²⁴ Edinburgh equipment encompasses the following available frequencies (MHz) in Liverpool: 543.100-548.900; 703.100-708.900; 759.100-764.900; TV69

(5.8 + 5.8 + 5.8 + 8 = 25.4 MHz)

Edinburgh equipment encompasses the following available frequencies (MHz) in Stoke: 535.100-540.900; 759.100-764.900; TV69

(5.8 + 5.8 + 8 = 19.6 MHz)

²⁵ (6) **TV 51-53** encompasses 727.100-732.900 MHz in Liverpool and 711.100-717.900 MHz, TV52 and 726.100-732.900 MHz in Stoke

(7) **TV 42-44** encompasses 647.100-653.900 MHz and 654.100-660.900 MHz in Liverpool

²⁶ 25.4 + 5.8 + 6.8 + 6.8 = 44.8 MHz

²⁷ 19.6 + 6.8 + 8 + 6.8 = 41.2 MHz

Summary of production A

Prior to DSO, production A can use a set of equipment with the same 3 components, each of which accesses a different 24 MHz of UHF spectrum, at all 6 tour venues (rental cost approx £1000 p/w)
 Post-DSO, production A will require a minimum of 7 components, each of which accesses a different 24 MHz of UHF spectrum, in order for the production to take place at 5 of the 6 tour venues (rental cost approx £2300 p/w)

Post-DSO, production A will not be possible at one of the tour venues

This model serves to demonstrate that, as a result of DSO and DDR, PMSE equipment rental costs for touring theatre will increase: in this case by 130%

Touring theatre production example B

Production B is due to take place at the following UK venues in 2009 (this is just a sample section but will take place at a number of other venues with similar problems):

1. Theatre Royal, Nottingham
2. Empire Theatre, Liverpool
3. Hippodrome Theatre, Birmingham
4. Derngate Theatre, Northampton
5. Cliffe Pavilion, Southend
6. Orchard Theatre, Dartford

Pre-DSO situation

'Window' of equipment (TV bands)	Minimum bandwidth available at every venue ²⁸
67 - 69	16 MHz
58 - 60	10.2 MHz
36 - 38	8 MHz
29 – 31	9.2 MHz

The table shows that a system with three components, each of which accesses a different 24 MHz window of UHF spectrum, will be able to fulfil the 32 MHz requirement of touring production 'B' pre-DSO (16 + 10.2 + 9.2 = 35.4 MHz). Pre-DSO, the same system (with the same three components) can be used at every venue.

Post-DSO situation

Production B will require a minimum of 5 different components each with a 24 MHz spectrum window in order for the production to take place in Southend²⁹

Production B can use the same components in Liverpool³⁰ as in Southend

Production B can use the same components in Northampton³¹ as in Southend and Liverpool

²⁹ (1) **TV 21-23** encompasses 5.8 MHz (471.100 – 476.900 MHz); (2) **TV 26-28** encompasses 5.8 MHz (519.100- 524.900); (3) **TV 37-39** encompasses a full 8 MHz band; (4) **TV 42-44** encompasses 5.8 MHz (639.100-644.900) and (5) **TV 69** encompasses a full 8 MHz band

³⁰ Southend equipment encompasses the following available frequencies (MHz) in Liverpool: 471.100-476.900; 519.100-524.900; 647.100-653.900; 654.100-660.900; TV69 (5.8 + 5.8 + 6.8 + 6.8 + 8 = 33.2 MHz)

Production B can use the same components in Dartford³² as in Southend, Liverpool and Northampton. In addition to the 5 components used in Southend³³, Liverpool, Northampton and Dartford, production B will require a minimum of one component³⁴ with a different 24 MHz spectrum window in order for the production to take place in Nottingham³⁵ and Birmingham³⁶.

Summary of production B

Prior to DSO, production B can use one system with the same three components (each with a different 24 MHz spectrum window) at its first 6 tour venues (rental cost approx £1000 p/w)

Post-DSO, production B requires a minimum of 6 components (each with a different 24 MHz spectrum window) in order for the production to take place at the same 6 tour venues (rental cost approx £2000 p/w)

This model serves to demonstrate that, as a result of DSO and DDR, PMSE equipment rental costs for touring theatre will increase: in this case by 100%

Summary of section 2

BEIRG has used two sample touring productions to illustrate the negative cost implications of the Digital Switchover and the Digital Dividend on medium-scale touring productions if Ofcom proceeds as planned.

Medium-scale touring theatre and musical productions generally take place at many more than six venues around the UK, but a sample of only six was used in each of the models outlined above. This is because spectrum available for PMSE post-DSO will be so scarce, so dispersed and so varied from venue to venue that it is very difficult to ascertain the minimum amount of equipment that is required to cater for the entire tour. However, it is certain that additional equipment will be required to cater for the production to take place at further venues.

There will not be sufficient spectrum available for PMSE post-DSO in certain geographical locations to allow productions to continue at current levels. Furthermore, the spectrum that will be available for PMSE is highly fragmented, dispersed and the pattern of fragmentation varies significantly between locations, which will have a negative impact on both touring and static productions.

The consequences of DSO/DDR for the touring theatre industry are potentially disastrous. As we have demonstrated, equipment costs will increase by a minimum of a factor of 2³⁷.

3. Millions of pounds worth of wireless microphone and in-ear monitor systems will be rendered redundant or require significant expensive modification

³¹ Southend equipment encompasses the following available frequencies (MHz) in Northampton: 479.100-485.900; 486.100-492.900; 510.100-516.900; 527.100-533.900; TV38; 655.100-660.900; TV69

(6.8 + 6.8 + 6.8 + 6.8 + 8 + 5.8 + 8 = 49 MHz)

³² Southend equipment encompasses the following available frequencies (MHz) in Dartford: TV38; TV42-44; TV69

(8 + 8 + 8 + 8 + 8 = 40 MHz)

³³ Southend equipment encompasses the following available frequencies (MHz) in Nottingham: 487.100-492.900; 511.100-516.900; 655.100-660.900; TV69

(5.8 + 5.8 + 5.8 + 8 = 25.4 MHz)

Southend equipment encompasses the following available frequencies in Birmingham (MHz): 479.100-484.900; 527.100-532.900; 655.100-660.900; TV69

(5.8 + 5.8 + 5.8 + 8 = 25.4 MHz)

³⁴ (6) **TV 58-60** encompasses 775.100-781.900 MHz and 782.100-788.900 MHz in Nottingham and 775.100-781.900 MHz and 782.100-788.900 MHz in Birmingham

³⁵ 25.4 + 6.8 + 6.8 = 39 MHz

³⁶ 25.4 + 6.8 + 6.8 = 39 MHz

³⁷ BEIRG does not accept any argument that these figures exaggerate the problem because not all touring productions use equipment that is restricted to a 'window' of 24 MHz. This is because, generally speaking, the cost of the equipment is proportionate to the amount of spectrum it can access due to higher development and manufacturing costs. If more spectrally agile equipment is required in large quantities (i.e. that with larger tuning range), then the rental organisations will have to buy it, and then pass on the large costs to the users. Furthermore, many touring PMSE productions use equipment that has a tuning range of less than 24 MHz, thus making it even more difficult to use the same equipment across different venues post-DSO.

- 3.1. Ofcom has rightly stated³⁸ that *'PMSE equipment operating in channels 21-30 or 41-62 is likely to be affected by DSO. This is because the frequencies used for DTT will change from those used for analogue terrestrial television, and so the pattern of interleaved spectrum will also change. As a consequence, PMSE users of equipment operating in interleaved spectrum are likely to find it necessary to retune, modify or replace that equipment in order to use new frequencies after DSO.'*
- 3.2. Sagentia have stated that *'PMSE users may need to migrate to a different frequency for one of three reasons: (1) DSO; (2) Their channel is no longer available for PMSE use as a result of the DDR. This applies to channels 31-40, 61 – 68; (3) The number of channels (and therefore radio microphone frequencies) available for PMSE use at any given location is lower than the demand for PMSE channels. These locations are referred to as "pinch points".'*
- 3.3. In its submission to Ofcom's consultation on the Digital Dividend Review, the PMSE Pro-User Group stated that the value of equipment that would become redundant as a result of the DDR was well in excess of £30 million and that Ofcom estimates of equipment currently held by the PMSE industry were 'wildly inaccurate'. Ofcom has since admitted that the 'total value of relevant PMSE equipment' is 'around £35 million'³⁹.
- 3.4. BEIRG's view is that compensation must be paid to owners of PMSE equipment that will be rendered redundant or require expensive modification as a result of DSO/DDR.
- 3.5. When considering this course of action, it is important to remember some of Ofcom's explicit DDR objectives:
- 3.5.1. 'Encourage more efficient use of spectrum'
 - 3.5.2. 'Help the PMSE industry adapt to 'full market mechanisms''
 - 3.5.3. 'Minimise disruption to the PMSE industry'
 - 3.5.4. 'Avoid the risk of market failure'.
- 3.6. If appropriate compensation were paid to owners of PMSE equipment that will be rendered redundant or require expensive modification as a result of the DDR then this would help fulfil all of these objectives.
- 3.7. Compensation would help minimise disruption to the PMSE sector and help avoid market failure because it would ease the financial burden on those who will have to invest in an entire inventory of new equipment following the DDR, especially those who have not yet amortized the cost of their existing equipment. As BEIRG has said before, Ofcom also needs to acknowledge that equipment for which full depreciation has taken place continues to hold value within the industry because of the longevity of the equipment itself and its rental value within the PMSE sector. This means that equipment filters down through the industry. As things stand, DSO/DDR will abruptly end the life cycle of this equipment by making it entirely redundant.
- 3.8. Compensation would allow these companies to invest in spectrally agile equipment.
- 3.9. The example below illustrates the disastrous financial implications of DSO/DDR for professional PMSE users that have invested in good faith:

The Arena and Convention Centre in Liverpool (ACCL) currently holds licenses for thirty-six 200 KHz frequencies that range from TV43 – TV60. This building hosted the launch of Liverpool as the 'European City of Culture' and the recent Liberal Democrat conference, for which all 36 channels were used plus another 20 from the soon-to-be unavailable 800 MHz band.

Just prior to the conversion of the 'white space' maps to useable form on the JFMG website, ACCL bought a large stock of expensive new radio microphone equipment. Those involved took all possible steps to 'future proof' this equipment and so purchased radio microphones which

³⁸ 2.5, DDR statement 13th December 2007

³⁹ A3.151: annex to December DDR Regulatory Statement

operate in exclusively in the 'digital interleaved' rather than those frequencies being released as part of the DDR.

The equipment purchased by the ACCL was specifically manufactured to work in their licensed frequencies in the 'digital interleaved'. However, the ACCL recently received a letter from Ofcom informing them that of these 36 licensed frequencies, only 10 are 'likely to be available' post-DSO. This means that the ACCL's new equipment will either become largely redundant or require expensive modification if it is to be useable post-DSO.

Furthermore, the frequencies that are 'likely to be available' post-DSO might not be. According to Ofcom, *'some of the frequencies identified could be identified for separate award under the DDR, and so availability would not be guaranteed for PMSE'*. This means that any new radio microphone and IEM systems purchased up until Ofcom's regulatory statement (which could be delayed until 20th December 2008) might not work post-DSO.

There are potentially thousands of users in the same or worse position as ACCL across the country; (i.e. those who have recently invested in new equipment that will not work after DSO has taken place or require expensive modification). It is not sufficient for Ofcom to advise PMSE users to 'check availability of spectrum with JFMG before retuning, modifying or replacing equipment'. This is because all frequencies in the digital interleaved are still only 'likely to be available', subject to consultation. In view of this uncertainty, it is impossible to plan events.

4. Expensive new equipment that operates in the 'digital interleaved' will have to be developed, manufactured and purchased by users and rental companies

4.1. As outlined above, the consequence of the reduction and change in pattern of available PMSE spectrum post-DSO is that the vast majority of PMSE equipment currently in the marketplace (with a value in excess of £30 million) will be rendered redundant or require significant modification.

The PMSE sector will have to re-equip. However, this is currently very difficult as it is still uncertain as to how DSO and the DDR will affect the pattern of availability.

5. A larger volume of equipment or (more expensive) spectrally agile equipment will be required post-DSO to achieve current results, the consequence of which will be further increases in cost

5.1. The huge reduction and the change in pattern of PMSE spectrum availability post-DSO will mean that every large-scale professional PMSE user will have to spend much more on wireless microphones and in-ear monitor systems to achieve current results, whether it be for increased equipment or higher levels of (expensive) spectrally agile equipment.

5.2. In this regard, Sagentia correctly recognises that 'the number of available frequencies at many locations is reduced'. Sagentia suggests that as a result, 'a number of existing users' will have to 'migrate to one or more different frequencies'. This is somewhat of an understatement, as this document demonstrates.

5.3. The examples of Cliffee Pavilion in Southend and the Edinburgh Playhouse described above in section 2 illustrate the problem effectively. In both cases, three sets of equipment with a tuning range of 24 MHz could easily cater for a medium-scale production pre-DSO. However, post-DSO, five sets of equipment with a tuning range of 24 MHz will be required to cater for the same event at these venues. This is due to the reduction of available bands and the considerable fragmentation of those which are available. The spreadsheets attached to this document further illustrate this point.

Conclusion: too soon too little – the PMSE sector needs more spectrum after DSO and more time to adapt to the changes

Ofcom currently plans to sell off much of the spectrum currently used for wireless microphones and in-ear monitor systems. The remaining digital interleaved spectrum due to be allocated to the band manager with PMSE obligations will be too scarce and too fragmented:

More importantly, Ofcom is on course to fail the PMSE sector⁴⁰.

Potential solutions

1. Users of wireless microphone and in-ear monitor systems must retain access to the cleared spectrum until DSO is completed nationwide and the Olympics have taken place in 2012⁴¹

- 1.1. This will provide the much needed time for manufacturers to develop and produce the new equipment capable of operating in the digital interleaved.
- 1.2. This will allow users and rental companies the much needed time to assess their needs and re-tune, modify or replace their affected equipment.
- 1.3. This will provide more time for users and rental companies to re-coup their investments in equipment which will become redundant or require extensive modification.
- 1.4. This will save touring productions from having to swap equipment as they move around the UK and they pass into areas which are due to release the cleared spectrum before 2012
- 1.5. It is extremely doubtful that phased termination of PMSE access and phased availability of channels 31-40 and 61-68 will be appropriate for the new operators of these bands. The new licensees will, in all probability, be intending to run their new services nationwide (telecommunications companies for example). As nationwide use of these bands will not be possible until London has switched over to digital broadcasting in 2012, it would have no value to evict PMSE users from channels 31-40 and 61-68 until this date⁴².
- 1.6. This will help to ensure that there is sufficient spectrum and sufficient equipment to cater for the immense demands of the London 2012 Olympics⁴³.

⁴⁰ Estimated annual turnover of Musical and other productions using radio equipment in TMA theatres; £250 million.. Employment of performers, musicians and technicians by these productions gives about 66,000 days of employment p.a. Theatre based employment of administration, marketing, box office, technicians and support staff: provides about 75,000 days employment p.a. Producers head office staff and freelance technicians and others in prepping and running shows: provides about 312,000 days employment p.a. Dependant external trades (scene shops/sound & lighting shops/printers/catering etc): provides between 1000 - 5000 jobs, equating to a minimum of 312,000 days of annual employment. In the larger theatres in Major cities circa 50% of productions are musicals - without this component these theatres do not have a viable operating year. Altogether a minimum of about 765,000 days employment per year

⁴¹ ...irrespective of when auctions for the 'cleared' spectrum take place and licenses are awarded. For instance, Ofcom could make clear in the licence conditions for channels 31-40 and 61-68 that rights of usage do not start until September 2012

⁴² One of Ofcom's explicit objectives is to 'minimise disruption to the PMSE industry'. Eviction of the PMSE sector from the spectrum in which it currently operates will cause massive disruption; this should not be exacerbated needlessly.

⁴³ On the supply side, both equipment and spectrum availability are set to radically fall (due to the phased termination of PMSE access to cleared spectrum ending in London before the Games and LOCOG's technology freeze). On the demand side, both equipment and spectrum requirement are set to radically rise (due to the Games themselves, Cultural Olympiad and increase in normal demand).

2. More spectrum must be set aside for PMSE use post-DSO⁴⁴, ideally available on a nationwide basis between 470 and 862 MHz

- 2.1. This will mean that large-scale PMSE productions will be able to continue to take place across the UK
- 2.2. This would potentially reduce the amount of equipment required to achieve current results post-DSO if the spectrum was located between 470 and 862 MHz
- 2.3. In addition to channel 69, more spectrum must be available for professional PMSE use on a nationwide basis. This would be the most effective way of solving the problems posed to the touring theatre industry by DSO/DDR. As we have seen, for the same equipment to be useable across each tour venue then there must be spectrum available across the same range of TV channels. If this is not the case then multiple sets of equipment must be used, costs skyrocket and many touring productions become financially unviable.
- 2.4. In its submission to Ofcom's original DDR consultation, the PMSE Pro User Group strongly urged Ofcom to retain TV channels 67–69 for nationwide PMSE use. Ofcom has ignored this and decided to sell channels 67 and 68 anyway.

⁴⁴ i.e. awarded to the commercial band manager with PMSE obligations