Reserving the band 2500–2690 MHz for the London 2012 Games

Statement on the extension of Ofcom's Spectrum Plan for London 2012

Statement

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Section 1

Executive Summary

1.1 The London 2012 Games take place between 27 July and 9 September 2012. During this period, and immediately before and after the Games, the demand for access to spectrum suited to wireless camera technologies will be exceptionally high. The Government has guaranteed to the International Olympic Committee that sufficient spectrum will be made available for the organisation of the Games. Since 2006 Ofcom has been developing a spectrum plan to match the significant spectrum needs of the Games with appropriate frequencies. With this in mind we consulted on 23 August 2010 about whether we should reserve spectrum within the 2500-2690 MHz range (the '**2.6 GHz band**') for use by wireless cameras at the London 2012 Games. This consultation closed on 17 September 2010.

1.2 The responses to the consultation raised points about alternative uses for the 2.6 GHz band in 2012. We published an update to the spectrum plan for the London 2012 Games on 18 October 2010. This stated that we would seek additional information in order to undertake a further assessment of any opportunity cost or consumer harm from:

- restricting the availability of the 2.6 GHz band for new mobile services like Long Term Evolution (LTE) and WiMAX[1] or
- restricting the availability of the 2.6 GHz band for wireless cameras at and around London 2012 Games venues.

We have now undertaken that further assessment.

1.3 The responses also raised a question about the impact of airborne wireless cameras on radars that use the 2700-2900 MHz band. We have therefore undertaken a technical assessment of this question.

Conclusions

2.6 GHz reservation

1.4 An alternative to using the 2.6 GHz band for wireless cameras for London 2012 Games would be using it for new mobile service trials or services. These new services will have significant value, but will not be available until new licences have been awarded (currently forecast for Q2 2012) and the radar remediation project is completed (which will be after the Games has ended). However we have received no evidence of a significant opportunity cost or of resulting harm to consumers from our proposal to reserve the 2.6 GHz band for Games use during the summer of 2012. We have received confidential evidence from the London Organising Committee of the Olympic Games and Paralympic Games Limited (LOCOG) of the importance of access to the 2.6 GHz band for wireless cameras – including new spectrum demand information from the Olympic Broadcasting Services (OBS). The confidential evidence from LOCOG and OBS indicates the importance of access to the 2.6 GHz band to enable wireless camera coverage of the Games and in

[1] See for example: http://www.wimaxforum.org/

particular airborne wireless camera coverage, which is not possible in many alternative bands.

1.5 In the absence of evidence that there is any material opportunity cost of reserving the 2.6 GHz band for the London 2012 Games, or of harm to consumers, we will proceed with the reservation of the whole 2500-2690 MHz band for wireless cameras between 28 June and 23 September 2012.

1.6 It may be possible to grant licences for non-operational trials and tests of new mobile or broadband data services in the 2.6 GHz band if these are carefully co-ordinated. The provision of London 2012 Games services will take precedence over other uses of the spectrum during the Games, but we will endeavour to coordinate other uses (where possible) in order to facilitate the development of new services to citizens and consumers.

1.7 Our reservation of the 2.6 GHz band for the London 2012 Games does not require us to revoke or vary existing spectrum licences to meet Games requirements.

Effect of wireless cameras on 2700-2900 MHz

1.8 We have carefully considered how it will be possible to permit airborne wireless cameras in the 2.6 GHz band while prohibiting the deployment of LTE networks and devices because of the potential for interference to radars operating in the 2700-2900 MHz band.

1.9 Our assessment refelects the absence of reported interference from existing airborne wireless camera use in the 2.6 GHz band to Air Traffic Control (ATC) radars operating in the 2700-2900 MHz band. The main reason for this is the low transmit powers deployed in practice by airborne wireless cameras, the small numbers in use and the mobile and transient nature of this application.

1.10 We conclude that by adopting power limits for airborne wireless camera use, harmful interference will not result from airborne wireless camera use to ATC radars. Our previous conclusions[2,3,4] on the potential for harmful interference from LTE base-stations on unmitigated radars systems remain unaffected.

[2] http://stakeholders.ofcom.org.uk/binaries/spectrum/spectrum-awards/awards-in-preparation/757738/Ofcom_presentation_slid1.pdf
[3] http://stakeholders.ofcom.org.uk/binaries/consultations/2ghzawards/annexes/masonresearch.pdf
[4] http://stakeholders.ofcom.org.uk/binaries/spectrum/spectrum-awards/awards-in-preparation/infoupdate.pdf

Section 2

Introduction

The consultation

2.1 The consultation on reserving the 2.6 GHz band for the London 2012 Games[5] closed on 17 September 2010. Responses supporting the proposal were received from JFMG Ltd and Everything Everywhere. A confidential response, which does not support the proposal, was also received. Two further responses were received after the closing date: one from the BBC and one other confidential response. Both of these responses support the reservation of the 2.6 GHz band for PMSE use to facilitate the numerous wireless cameras that will be present at the London 2012 Games.

2.2 We have published the responses from JFMG Ltd, Everything Everywhere and the BBC[6]. We have not published the two confidential responses.

2.3 The respondent who did not support the proposal to reserve the band solely for the Games suggested that we consider partitioning the band (e.g. by dividing it into two equal blocks with guard bands) to accommodate the needs of at least some mobile operators together with the London 2012 Games broadcasters. The respondent presented three main arguments:

- it will be ready to offer LTE-based services in London in 2012 and is already in the process of building LTE capability into base stations being deployed in the Olympic Park and elsewhere; and that LTE services using the 2.6 GHz band are being launched in other countries. The respondent argues that there will therefore be the infrastructure and users to support a commercial service. The opportunity cost to the respondent is not “very low or zero” as we had suggested in our consultation;

- the 2.7 GHz radar remediation programme[7] could be prioritised to allow mobile services to be deployed in the 2.6 GHz band in 2012; and

- the earlier that the launch of LTE services can be facilitated the better. The respondent argues that the London 2012 Games are an ideal opportunity to show-case services like HD video and gaming, thus stimulating customer interest and accelerating the take up of LTE in the UK.

2.4 In our update to the spectrum plan[8] for the London 2012 Games we said that we did not have sufficient information in relation to the opportunity cost of reserving the 2.6 GHz band for the London 2012 Games either in part or as a whole; and that we would seek the necessary additional information and undertake a further assessment of that opportunity cost.

[5] http://stakeholders.ofcom.org.uk/consultations/band-2500-2690-london-2012-games/
[6] http://stakeholders.ofcom.org.uk/consultations/band-2500-2690-london-2012-games/?showResponses=true
[7] http://stakeholders.ofcom.org.uk/binaries/spectrum/spectrum-awards/awards-in-preparation/infoupdate.pdf
[8] http://stakeholders.ofcom.org.uk/consultations/london2012/london2012-spectrum-plan-update/

2.5 In Section 3 we set out our conclusion on reserving some or all of the 2.6 GHz band for the London 2012 Games by restricting the availability of the band for new mobile services like Long Term Evolution (LTE) and WiMAX[9].

2.6 In its response to our consultation, Everything Everywhere asked why it will be possible to permit airborne wireless cameras in the 2.6 GHz band but necessary to prohibit the deployment of LTE equipment and devices because of the danger to radars operating in the 2700-2900 MHz band.

2.7 In the update to our spectrum plan[10] we said that the technical issue raised in Everything Everywhere's response required further consideration and that we would undertake an assessment of the impact of airborne wireless camera use for the London 2012 Games on radars operating in the band 2700-2900 MHz.

2.8 In Section 4 we set out our analysis of the impact of wireless camera use for the London 2012 Games (including airborne camera use) on radars operating in the band 2700-2900 MHz.

[9] See for example: http://www.wimaxforum.org/
[10] http://stakeholders.ofcom.org.uk/consultations/london2012/london2012-spectrum-plan-update/

Section 3

Reserving 2.6 GHz for the London 2012 Games

Background to the 2.6 GHz Award

3.1 On 4 April 2008 Ofcom announced a decision to award spectrum in the 2.6 GHz band. In that announcement we indicated that we expected the application date for the award to be in July 2008[11]. That decision was eventually withdrawn following litigation by various stakeholders and interaction with the Government's Digital Britain project.

3.2 In January 2009, the Government published its interim Digital Britain report setting out a series of proposed actions designed to ensure the UK maximised the opportunities for all in the digital age. In that report, the Government identified a complex set of challenges that were hindering the release and use of additional spectrum that could support the deployment of next generation broadband services. Subsequently the Government announced the appointment of an Independent Spectrum Broker to examine whether a solution could be found to overcome the challenges.

3.3 The Independent Spectrum Broker's report was published in May 2009[12] and the Government's response to it formed part of the Digital Britain final report published in June 2009[13]. Following the Independent Spectrum Broker's final report, the Government decided that the proposals represented a basis for further action and that it would seek to do this through a formal Direction to Ofcom on the release of the 2.6 GHz band among other matters. Subsequently, the Government issued a consultation document on the proposed Direction and this was published on 16 October 2009, with a closing date for responses of 8 January 2010.

3.4 On 27 July 2010, the Government laid a draft Direction in Parliament, superseding a draft which had been previously laid on 23 March 2010. The new draft includes the requirement for Ofcom to hold an auction of these frequencies as soon as possible after carrying out a competition assessment in relation to mobile electronic communication services markets following the auction.

3.5 Subject to the Government Direction being made in the next few weeks, and subject to the necessary consultation processes, we can now set out our plans for the timetable.[14] It is clearly subject to risks, but we are seeking to minimise their potential impact as far as possible.

- We aim to publish a consultation setting out our detailed proposals for how to award the 2.6GHz and 800MHz spectrum by the end of February 2011.
- We then expect to publish a statement on future competition and details of the combined auction, together with draft auction regulations, in early autumn of 2011.

[11] http://stakeholders.ofcom.org.uk/spectrum/spectrum-awards/awards-in-preparation/award_2010/
[12] Report from the Independent Spectrum Broker : findings and policy proposals
[13] Digital Britain, Final Report, June 2009 URN 09/1026
[14] http://media.ofcom.org.uk/2010/11/16/ft-world-telecoms-conference/

- This would lead to the final auction regulations being in place before the end of 2011 and the award process starting in the Q1 2012.

- We would then complete the award and issue licences in Q2 2012.

- We expect the 2.6 GHz spectrum to be available for new mobile uses once the radar remediation programme is complete. We expect this to take place during 2013.

Background to the Spectrum Plan for the London 2012 Games

3.6 Ofcom is responsible for organising a full spectrum plan for the London 2012 Games, for arranging all the licences in good time in support of the plan and for ensuring all key wireless services are kept free from harmful interference.

3.7 In May 2009 we consulted[15] on a draft spectrum plan to meet the Government's spectrum guarantees[16] to the International Olympic Committee (IOC) with minimum disruption to other users. On 19 October 2009 we published our Statement on the spectrum plan for the London 2012 Games[17], which included our high-level approaches to licensing and interference management. The October 2009 Statement was updated on 18 October 2010[18]. Responses to our May 2009 consultation indicated that there would be a high level of demand for spectrum in the 2 GHz to 4 GHz range for use by wireless cameras, and that Ofcom should seek access to more spectrum in this range.

3.8 The 2.6 GHz band is used at present by wireless cameras, co-ordinated through the Programme Making and Special Events (PMSE) processes managed on Ofcom's behalf by JFMG Limited[19]. Ofcom has revoked the rolling PMSE licences in this band, and has replaced them with short term licences. PMSE licensees will be given three months' notice of the spectrum becoming unavailable for PMSE use. The band is also used for Test and Development applications, with licences granted on a non-interference and un-protected basis.

3.9 Our May 2009 consultation included an assessment of the demand for spectrum for video links including wireless cameras[20]. The October 2009 Statement, confirmed a preference to use spectrum in bands below 4 GHz for wireless cameras, because the propagation characteristics of these bands make them suitable for supporting the coverage of events taking place over wide areas such as the marathon, rowing, and sailing events and because the broadcasters already have (or can readily hire) wireless camera equipment that operates in this frequency range.

3.10 Although we have made an allowance for growth in the use of high definition (HD) technology in our spectrum plan and we have encouraged those that are able to do so to use frequencies above 7 GHz, experience passed to us from the Vancouver 2010 Games and confidential information on the demand for wireless cameras from LOCOG (including the demand for airborne television coverage) confirms that the demand for wireless camera channels below 4 GHz will be greater than we had predicted.

[15] http://stakeholders.ofcom.org.uk/consultations/band-2500-2690-london-2012-games/
[16] http://stakeholders.ofcom.org.uk/binaries/consultations/london2012/summary/london2012.pdf
[17] http://stakeholders.ofcom.org.uk/consultations/london2012/statement/
[18] http://stakeholders.ofcom.org.uk/consultations/london2012/statement/
[19] http://www.jfmg.co.uk/
[20] See Section 7: http://stakeholders.ofcom.org.uk/binaries/consultations/london2012/summary/london2012.pdf

Impact Assessment

3.11 Impact Assessments (IAs) provide a valuable way of assessing different options for regulation and showing why the preferred option was chosen. They form part of best practice in policy-making. This is reflected in Section 7 of the Communications Act 2003, which states that we generally have to carry out IAs where our proposals would be likely to have a significant effect on businesses or the general public or when there is a major change in Ofcom's activities. As a matter of policy, Ofcom is committed to carrying out and publishing impact assessments in relation to the great majority of our policy decisions. For further information about our approach to IAs, see the guidelines Better Policy-Making[21].

3.12 In our consultation on reserving the 2.6 GHz band for the London 2012 Games we gave a qualitative assessment of the effects of our proposal and sought confirmation from stakeholders that doing so would not impose any significant opportunity cost to UK citizens and consumers, for example by restricting the deployment of new mobile or broadband data services to UK citizens and consumers.

3.13 Since the consultation closed we have had further dialogue with the respondent who opposed reserving the band for wireless cameras to establish the extent of any opportunity cost (and therefore consumer harm) arising from our reserving the band. The respondent has not provided any such evidence of opportunity cost or consumer harm. The respondent expressly acknowledged that any LTE system that it does run at Games time will need to co-ordinate with the spectrum requirements of wireless cameras for the Games.

3.14 We also received confidential evidence from the London Organising Committee of the Olympic Games and Paralympic Games Limited (LOCOG) of the importance of access to the 2.6 GHz band for wireless cameras. This includes new spectrum demand information from the Olympic Broadcasting Services (OBS) which indicates significant demand for airborne wireless camera channels in addition to substantial ground-based demand. LOCOG believes that these facilities are vital to achieve excellent coverage of the Games for the world's broadcasters.

3.15 On this basis we do not have evidence of any material opportunity cost of reserving the 2.6 GHz band for the Games, or any resulting harm to consumers from our proposal to do so.

Analysis and policy options

3.16 We believe there are two realistic policy options – to reserve all the band for wireless cameras or to partition the band for new mobile services. We also consider whether we can reserve the band for wireless cameras but allow co-ordination with trials and operational testing of new services.

Option 1: Reserving all the 2.6 GHz band for wireless cameras

3.17 The draft Government Direction laid before Parliament on 27 July 2010 requires Ofcom to hold an auction for licences to use, amongst other things, the 2.6 GHz band as soon as possible after carrying out a competition assessment in relation to mobile electronic communications services markets following the auction. There are significant complexities in preparing for the auction and our expectation is that an

[21] http://www.ofcom.org.uk/consult/policy making/guidelines.pdf.

award of the 2.6 GHz band will take place in Q2 2012, no more than six months before the end of the Games.

3.18 On 11 December 2009 Ofcom published information on the coexistence of S Band radar systems and adjacent future services[22]. This provided a further update on the emerging implications of the sensitivity of existing radars in the S Band (2.7-3.1 GHz) to transmissions in the two adjacent bands (the 2.6 GHz band and, potentially, the 3.4-3.8 GHz band). The indicative timelines for the programme of remediation of radars are set out in the Government's relevant Digital Britain consultation[23]. The remediation timetable indicates that there is now unlikely to be the capability to launch new services in the 2.6 GHz band in 2012.

3.19 Ofcom's view is that there is a low prospect of any significant deployment of next-generation wireless data technologies such as LTE and WiMAX before the end of the Games, suggesting a very low opportunity cost of reserving the band for the Games. This option will deliver the maximum capacity for wireless cameras at Games time.

3.20 Reserving the band for wireless cameras during the period of the Games will not prevent Ofcom from proceeding with the auction and granting new licences to the winners. But the terms and conditions of the award and the subsequent licences can enable Ofcom to grant concurrent licences to other users. The period during which such concurrent licences would be granted would be from 28 June 2012 to 23 September 2012 (i.e., a month before the Olympic Games opening ceremony until two weeks after the closing ceremony of the Paralympic Games). Geographically they would be for some or all of the London 2012 Games venues and the co-ordination zones around them (including, ,venues used to stage events both in and outside of London).

Option 2: Partitioning the band for new mobile services

3.21 In this option the 2.6 GHz band would be divided into two equal blocks (with guard bands) to accommodate the needs of at least some mobile operators together with the London 2012 Games broadcasters. For example one (or more than one sharing) mobile operator could use 2x10 MHz or 2x20MHz for 4G services.

3.22 This option would require guard bands between wireless camera and 4G use if implemented in the same geographic area. We calculate that, depending on the channel bandwidths used for wireless cameras up to three guard channels would be needed to provide adequate protection between these uses. This would sterilise a third of the whole band.

3.23 This option would reduce the availability of 1-3 GHz wireless camera spectrum during the London 2012 Games and would have a significant impact on LOCOG and OBS's ability to deliver broadcast coverage of the Games.

Coordination with trials and non-operational testing

3.24 The consultation proposed that the provision of services to the Olympic Family would take precedence over other uses of the spectrum during Games-time. Nevertheless it may be possible to share the band with other uses if these are carefully co-ordinated.

[22] http://stakeholders.ofcom.org.uk/binaries/spectrum/spectrum-awards/awards-in-preparation/infoupdate.pdf
[23] http://www.bis.gov.uk/files/file53061.pdf

3.25 Wireless cameras using the 2.6 GHz band are normally administered and co-ordinated by JFMG. As part of the licensing and assignment process for the Games, Ofcom is developing the technical means to co-ordinate Games use with other users nearby, including the ability to coordinate assignments so that interference is minimised and optimal use is made of the available spectrum. This will also include the technical means to co-ordinate Games use with other uses of the 2.6 GHz band during the Games. This option retains the potential for trials and early services to be deployed in 2012 so long as they are co-ordinated with wireless camera use. This is likely to be feasible outside the M25 area (or other locations of especially high demand for wireless cameras for the Games).

3.26 The evidence provided by respondents acknowledges that co-ordination will be adequate for the trials and services they have in mind for 2012. Ofcom is therefore of the view that the opportunity cost to the Games arising from non-operational licensing for trials and testing purposes in the 2.6 GHz band will be very low or zero.

Conclusions

3.27 In the absence of any evidence of a material opportunity cost of reserving the 2.6 GHz band for the London 2012 Games or evidence of resulting harm to consumers we will proceed with the reservation of the whole 2500-2690 MHz band for wireless cameras between 28 June and 23 September 2012 within the M25 areas and at other locations depending on the demand for wireless cameras which may emerge nearer the time.

3.28 It may be possible to grant licences for non-operational trials and tests of new mobile or broadband data services if these are carefully co-ordinated. The provision of services to the Olympic Family will take precedence over other uses of the spectrum during the Games, but it may be possible to coordinate other uses in order to promote opportunities for new services to citizens and consumers.

3.29 Our reservation of the 2.6 GHz band for the London 2012 Games does not require us to revoke or vary existing spectrum licences to meet the requirements of the London 2012 Games.

Section 4

Airborne wireless cameras and radar

4.1 In this section we examine the impact of airborne wireless camera use for the London 2012 Games on radars operating in the 2700-2900 MHz Band. Annex 1 provides more detailed information on our analysis.

Minimum coupling distances for the onset of interference.

4.2 In our analysis we have identified the number of assignments that have been made within the 2.6 GHz band over the past four years. We have identified from these assignments the technical characteristics needed for an assessment of the minimum coupling distances for the onset of interference from airborne wireless cameras to radar stations operating in the adjacent 2700-2900 MHz band.

4.3 The transmit power level for the majority of the airborne wireless camera assignments identified is 0 dBW ERP, which equates to approximately 2.1 dBW EIRP assuming ERP is referenced to the gain of a dipole antenna. The Mason study[24] for Ofcom on use in the 2500-2690 MHz, 2010-2025 MHz and 2290-2302 MHz bands assumed a power level of 7dBW EIRP for aeronautical PMSE use. The usual transmitter power of airborne wireless cameras is below this threshold; and is also significantly lower than the maximum 20 dBW ERP in a maximum bandwidth of 20 MHz specified within UK Interface Requirement 2038 for temporary point-to-point, mobile & portable digital wireless cameras use.[25]

4.4 Some helicopter-borne wireless camera operations have been identified that use transmit powers of around 10 dBW EIRP and fixed-wing aircraft-borne wireless camera transmit powers are typically higher - around 21 dBW EIRP.

Modern ATC radar

4.5 To estimate the potential for interference from airborne PMSE use into modern categories of S-band radars, a link budget analysis is undertaken. Assuming a 10 dBW EIRP, a radar receiver blocking level of around -50 dBW and no antenna discrimination between the radar and airborne camera because of its elevated height above ground level (e.g. direct coupling and a resulting maximum radar antenna gain of around 33 dBi toward the wireless camera transmission); the minimum coupling loss to avoid the onset of blocking at the radar is calculated as approximately 93 dB, which equates to approximately 400m separation distance based on free space path loss conditions. Consideration of polarisation discrimination will further reduce the calculated minimum coupling loss and hence reduce the separation distance. Annex 1 contains a more detailed technical assessment of the potential for interference from airborne wireless camera transmissions into radars.

Conclusion

4.6 We conclude that by adopting a maximum power limit of 10 dBW EIRP for airborne wireless camera transmissions operating around the London 2012 Games venues

[24] http://stakeholders.ofcom.org.uk/binaries/consultations/2ghzawards/annexes/masonresearch.pdf
[25] http://stakeholders.ofcom.org.uk/binaries/spectrum/spectrum-policy-area/spectrum-management/research-guidelines-tech-info/interface-requirements/ir2038.pdf

no harmful interference (blocking) will result to modern Air Traffic Control (ATC) radars, such as those deployed at Heathrow.

Older ATC radars

4.7 To assess the potential for blocking to older ATC radars (e.g. Watchman radars), we assume that the maximum level measured for the onset of blocking is around -41 dBm. This will increase the estimated free space path loss distances to approximately 4.4km for a 10 dBW airborne wireless camera transmission. We note that this estimate does not take into account any further discrimination arising from polarisation mismatch and frequency selectivity at the radar antenna prior to the receiver to transmissions below 2690 MHz which will further reduce this estimated minimum coupling loss distance.

Older Radar deployments

4.8 We understand a Watchman radar is currently deployed at London Stansted airport operated by National Air Traffic Services and that this radar is in the process of being replaced with a modern radar having a better selectivity. However, it is not known whether the replacement will occur prior to the London 2012 Games taking place. If the Watchman radar is replaced prior to the Games then the estimated minimum coupling distance for the onset of blocking will be reduced from around 4.4km to around 400m. We note also that the Ministry of Defence has a Watchman radar deployed at Northolt.

Conclusion

4.9 Given the relatively modest free space path loss distances, the mobile and transient nature of airborne wireless camera use and likely additional factors (such as polarisation discrimination and additional selectivity) that will reduce the minimum coupling loss estimates, harmful interference in terms of blocking effects to existing Watchman radars from 10 dBW airborne wireless cameras should not occur.

Radar remediation programme

4.10 On 11 December 2009 Ofcom published information on the coexistence of S Band radar systems and adjacent future services[26]. This provided a further update on the emerging implications of the sensitivity of existing radars in the S Band (2.7-3.1 GHz) to transmissions in the two adjacent bands (the 2.6 GHz band and, potentially, the 3.4-3.8 GHz band). The indicative timelines for the programme of remediation of radars[27] are set out in the Government's relevant Digital Britain consultation[28]. The remediation timetable indicates that there is now unlikely to be the capability to launch new services in the 2.6 GHz band in 2012.

[26] http://stakeholders.ofcom.org.uk/binaries/spectrum/spectrum-awards/awards-in-preparation/infoupdate.pdf
[27] Remediation is not required for City Airport.
[28] http://www.bis.gov.uk/files/file53061.pdf

Annex 1

Technical assessment of 2.6 GHz and PMSE use

Current use of wireless cameras in the 2.6 GHz band

A1.1 The JFMG register[29] indicates within the 2550-2610 MHz and 2630-2670 MHz airborne PMSE use is permitted with the following restrictions:

i) Maximum power of 23dBW ERP for analogue modulation and 20dBW for digital modulation.

ii) Maximum height of 5,000 feet above ground level.

iii) Airborne use prohibited within 5km of Ministry of Defence (MOD) sites at Bude and Menwith Hill, and within 16km to a maximum height of 2,500ft at Bude and Menwith Hill.

iv) Some channels have additional restrictions in maximum powers in parts of south-east England within 150km of France, Belgium, Netherlands and Ireland.

A1.2 Ofcom's licensing records identify that 37 wireless camera 2.6 GHz airborne licences were issued by JFMG during 2007-2009.

A1.3 The transmission power levels permitted are shown in table A1.1 below.

Table A1.1 Airborne power levels for wireless cameras

	ERP (dBW)			
Year	-10	0	6-10	23
2007		9	1	
2008		3	2	
2009	3	16	2	

Wireless camera link budget calculation

A1.4 Ofcom understands from discussions in 2008 with PMSE users related to the 2.6 GHz consultation that airborne PMSE use is typically based on the use of a 5W High Power Amplifier (HPA) coupled to either a 3 dBi antenna for helicopter use, or 14 dBi antenna for fixed-wing aircraft use.

A1.5 Assuming negligible feeder link loss between the HPA and the antenna, the typical airborne wireless camera EIRP is as estimated in table A1.2 below.

[29] http://www.jfmg.co.uk/pages/freq/air/2_4ghz.htm

Table A1.2 EIRP levels of typical airborne wireless cameras

	Helicopter	Aircraft	
High Power Amplifier output	5	5	W
TX antenna	3	14	dBi
EIRP	40.0	51.0	dBm

A1.6 The minimum typical operational height for a helicopter is 1000ft above ground level (AGL). At this height, it is assumed there would be no significant antenna discrimination of the radar antenna to the airborne wireless camera transmission. Typical minimum height of wireless cameras deployed in fixed-wing aircraft can be assumed to be significantly greater than 1000ft.

A1.7 The 2.6 GHz Information update document published by Ofcom in December 2009[30] contains indicative coordination threshold levels for different ATC radar types. These are given in table A1.3 below.

Table A1.3 Indicative coordination threshold levels for different ATC radars

	Maximum 2.6 GHz field strength incident at a radar antenna for circular polarisation transmissions	Maximum 2.6 GHz field strength incident at a radar antenna for linear polarisation transmissions
Radar Category A	65 dB(μV/m)	68 dB(μV/m)
Radar Category B	79 dB(μV/m)	82 dB(μV/m)

A1.8 These indicative levels were agreed following extensive discussion with the CAA and MOD, and were based on adjacent terrestrial transmission (i.e., factor in some antenna discrimination from the radar to the adjacent transmission).

A1.9 The agreed propagation modelling parameters associated with the transitional arrangements are listed in table A1.4 below.

[30] http://stakeholders.ofcom.org.uk/spectrum/spectrum-awards/awards-in-preparation/award_2010/

Table A1.4 Propagation parameters

	Modelling parameters (see note 1 below)
Propagation model	Rec P.452-12 or later
Propagation modelling interference time percentage setting	0.10%
Propagation modelling short term enhancements selected	Clear air effects: Multipath & Focusing Effects, Tropospheric Scatter and Ducting / Layer Reflection
Other modelling requirements	Use of 50m terrain database with coverage limited 200km of adjacent radar.

A1.10 Note 1. Short-term propagation effects are factored into account in determining the protection afforded to radars from adjacent band signals.

A1.11 Radar protection levels are specified in terms of the maximum field strength that is permissible at the face of the radar antenna. These are derived on the basis of various link budget allowance assumptions such as *inter alia* the estimated receive antenna gain in the direction of the adjacent channel signal, multiple interferer allowances, etc.

A1.12 Table A1.5 below details the derivation of the maximum field strength protection values for ATC radars to avoid the potential for blocking to different radars operating above 2700 MHz from transmissions in the 2.6 GHz band.

Table A1.5

	Radar Category A	Radar Category B	
Maximum adjacent channel receive power at radar receiver input	-41	-27	**dBm**
Feeder loss	2	2	**dB**
Pre- low noise amplifier (LNA) filter loss at 2690MHz	0	0	**dB**
Antenna gain to horizon (with respect to an omni-directional antenna)	28	28	**dBi**
Antenna cross-polarisation factor	3	3	**dB**
Multiple interference allowance	6	6	**dB**
antenna pattern and sitting variation	2	2	**dB**
Additional margin (apportionment of interference)	6	6	**dB**
Maximum power at radar face	-78	-64	**dBm**
Maximum field strength incident at a radar antenna during the application of interim coordination arrangements	68	82	**dB (μV/m)**

A1.13 If these arrangements are applied to airborne wireless cameras use there is unlikely to be any significant antenna discrimination at the radar to airborne transmissions. Consequently, the maximum antenna gain of between 33 dBi and 34 dBi in direction of the airborne wireless cameras will need to be assumed. In contrast, a multiple interference allowance of 6 dB will not apply due to the low spatial density of airborne wireless cameras; an assumption that remains valid for use during the London 2012 Games use because of the geometry of the sharing and re-use arrangements for airborne wireless cameras. The adjusted threshold requirements are presented in table A1.6 below.

Table A1.6 Interference thresholds to airborne wireless cameras

	Radar Category A	Radar Category B	
Assumed Maximum field strength incident at a radar antenna for comparison with PMSE usage	70 – 71	84 - 85	**dB (µV/m)**

A worked example

A1.14 For a 10W transmitter at 300m (helicopter-based wireless camera), the coordination distances for maximum field strengths of 70 dBµV/m (Type A / Southend radar) and 84 dBµV/m (type B / Heathrow radar) and assuming 0.1% propagation time percentage have been estimated and are illustrated in Figures A1.1 and A1.2 below.

Figure A1.1 Estimated 12km coordination area for Type A radar

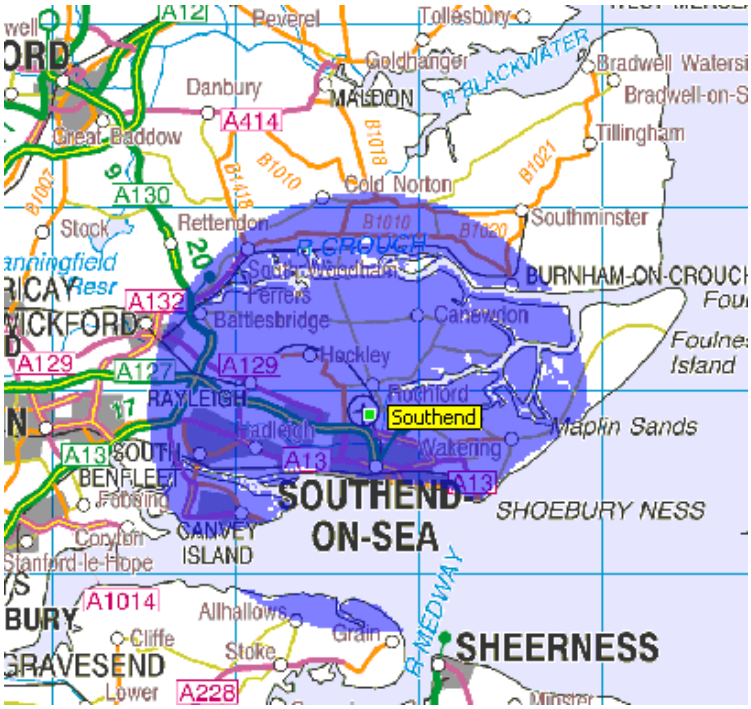
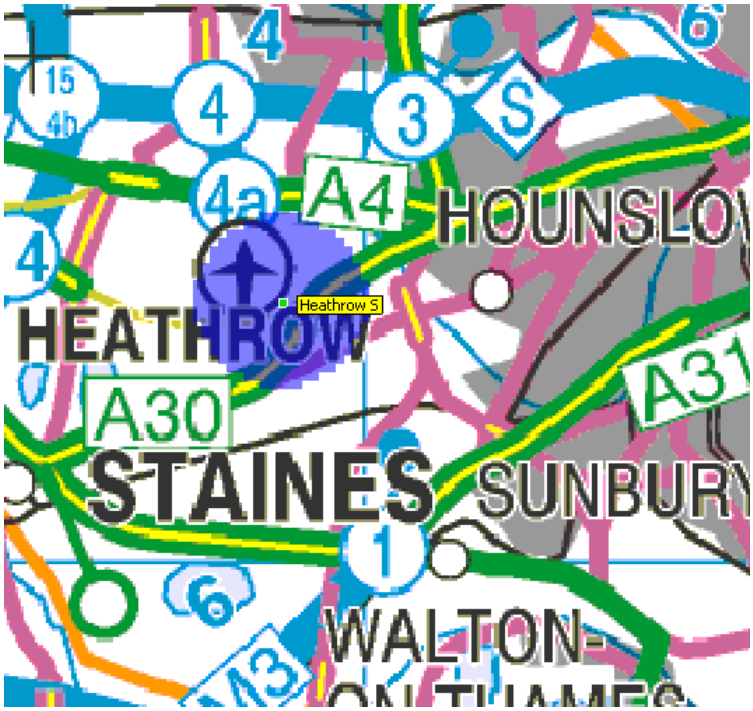


Figure A1.2 Estimated 1.5km coordination area for Type B radar.



A1.15 The estimated coordination areas shown in figures A1.1 and A1.2 above are based on the application of short term propagation effects. However, these short term effects only apply for small time percentages and are more applicable for the case of fixed transmissions in determining the potential for interference to radar. For the case of mobile transmissions such as airborne wireless cameras, due to the varying path geometries it is considered appropriate these anomalous propagation effects are discounted to estimate the separation distances under which interference may result for medium (50%) time percentages.

A1.16 The minimum coupling loss separation distance for a 10 dBW EIRP airborne wireless camera transmission to avoid the blocking of radars based on free space path loss are estimated to be approximately 3.2km for Type A radars and 0.3km for Type B radars as shown in table A1.7 below.

Table A1.7

	Type A	Type B	
PMSE	40	40	**dBm**
Blocking level assumed	-41	-20*	**dBm**
Radar antenna gain	34	34	**dBi**
Feeder link loss	-2	-2	**dB**
Polarisation discrimination	-2	-2	**dB**
Pre-low noise amplifier loss	0	-1	**dB**
Minimum coupling loss	111	89	**dB**
Estimated free space path distance	3.2	0.3	**km**

A1.17 We note that these estimates assume a slightly higher blocking level of -20 dBm for Type B radars than -27 dBm (which was set lower to account for potential for intermediate frequency (IF) amplifier blocking effects in radars). This potential for IF interference was attributed to fixed transmission at 2690 MHz, which is not considered to be applicable for airborne transmissions which may well operate in parts of the 2500-2690 MHz band.

Conclusions

A1.18 The analysis presented supports the lack of reported interference from existing airborne wireless camera use in the 2.6 GHz band to ATC radars operating in the 2700-2900 MHz band. The main reason for this is the use of significantly lower transmit powers deployed in practice.

A1.19 Given the small minimum separation distances calculated to avoid the potential for interference (approximately 0.3km for Type B radars and 3.2km for Type A radar when discounting anomalous propagation effects), and considering the mobile and temporary nature of airborne wireless cameras, harmful interference to ATC radars should not occur.

Annex 2

Glossary of Abbreviations

4G	**Fourth generation mobile services**
AGL	**Above ground level**
ATC	**Air Traffic Control**
dBµV/m	**Decibels relative to one microvolt per metre**
dBi	**Gain relative to an isotropic antenna**
dBm	**Decibels relative to one milliwatt**
dBW	**Decibels relative to one Watt**
EIRP	**Equivalent Isotropic Radiated Power**
ERP	**Effective Radiated Power**
GHz	**Gigahertz**
HD	**High definition**
HPA	**High Power Amplifier**
IA	**Impact Assessment**
kHz	**Kilohertz**
LNA	**Low Noise Amplifier**
LOCOG	**London Organising Committee of the Olympic Games and Paralympic Games**
LTE	**Long Term Evolution**
MHz	**Megahertz**
OBS	**Olympic Broadcasting Services**
PMSE	**Programme-making and special events**
S Band	**A band of radio frequencies extending from 1550 MHz to 5200 MHz**

Tx Transmitter