Award of available spectrum: 2500-2690 MHz, 2010-2025 MHz and 2290-2300 MHz

The BBC welcomes the opportunity to respond to this consultation. We will first address a number of issues that are not directly covered in the questions in the consultation and then will answer the questions directly.

The Importance of These Bands to Broadcasters and Other Programme-Makers

The future of these frequency bands is of great importance to the BBC. The 2500-2690 MHz band is currently heavily used by Programme Making and Special Events (i.e. PMSE - in this band the main PMSE usage is digital radio cameras and links) – Ofcom served notice to quit on this usage by the end of 2006 but has since granted a 3 month rolling extension so that the spectrum does not lie fallow. The two other smaller blocks are also very significant because they lie adjacent to two remaining PMSE allocations that are heavily used for digital radio cameras.

How broadcasters can continue to operate digital radio camera equipment going forward is an issue of considerable concern to the BBC. We need to continue to have access to sufficient spectrum to enable us to make programmes, whether live news reports or sports events in the same way and with the same immediacy as other broadcasters around the world. This means that we need digital radio cameras that have low delay, that allow operation both in urban canyons and dense urban areas and which do not suffer from network contention issues that can occur with systems such as 3G or WiMax (that is, delay increases and picture quality decreases as the number of users rises, such as in emergency situations, currently meaning that digital radio cameras using WiMax links would not be effective for broadcasting purposes).

Digital radio cameras are crucially important to programme making and a move back to wired operation would be a step back into the 20th century. Wireless operation gives access where it would never previously have been practicable e.g. at the State Opening of Parliament, inside Buckingham Palace or for mobile newsgathering options. Some of the more recent major news stories could not have been reported with wired cameras e.g. the 7/7 bombings, the Boscastle floods. Also many sporting occasions can only be covered with wireless cameras e.g. on the touchline or for live action from vehicles at motor sports events. Wireless cameras also allow us to address safety concerns over long and heavy trailing cables.

There are significant challenges caused by the impending loss of the 2.5-2.69 GHz band to digital radio cameras. This is mainly due to the reduction in capacity this will mean for bands for which equipment is currently available at reasonable prices (and bands at lower frequencies for which such equipment is available are more prone to interference from services in adjacent channels) but also because there is currently considerable uncertainty over the availability of spectrum at higher frequencies which could potentially be used by wireless cameras. This subject is discussed in more detail later in our response.

The Challenges of the 2012 London Olympics

There is a national expectation that broadcasters will cater for the requirements of the 2012 London Olympics. It is important that the definitive spectrum requirements for the Games are co-ordinated with the Host Broadcaster for 2012 (OBS), combining both Host Broadcaster and Rights-Holding Broadcaster requirements (including the BBC as UK domestic rights-holder).

We are aware that, although not directly addressed in this consultation, Ofcom recognise the spectrum requirements for PMSE usage (including radio cameras and radio microphones) for the 2012 Olympics and the commitments made by the Secretary of State for Trade and Industry with regards to such requirements in Sections 15.8 and 15.9 of the UK's Candidate File and, as such, are planning on holding a consultation on 2012 Olympic PMSE needs in Summer this year. Ofcom has suggested in its stakeholder event for the award of this spectrum that successful bidders may need to vacate the 2500-2690MHz band during the period of the London Olympics. Our experience of trying to use the ISM band during the Manchester Commonwealth Games in 2002 suggests that imposing such restrictions on consumer devices is virtually impossible. If the licenses are awarded to CDMA operators, they will need to disable phone services in East London and other parts of the country where events are taking place during the Olympic Games period which seems very difficult to envisage.

To meet the extremely high demand for additional spectrum generated by events such as the Olympics, Ofcom has previously made available additional blocks of spectrum close to existing PMSE spectrum (often primarily allocated to the MoD).

This means that it will probably be necessary for Ofcom to ensure that broadcasters continue to have access (on reasonable terms and conditions) to frequencies compatible with PMSE equipment that is currently available on the market or equipment that is freely available to the market at the time of the 2012 Olympics.

However, in doing so, it will be important for Ofcom to keep in mind that if any of the frequencies at which wireless cameras currently operate are auctioned in the near future, such that cameras which operate at these frequencies have to be written off, broadcasters will not suddenly be able to take such cameras out of storage in 2012 and use them for the Olympics: manufacturers will have no incentive to produce spares for repairs and maintenance, etc between now and 2012 and in any case most current radio cameras are not HD capable. For the reasons stated above, it is difficult to see how manufacturers would produce compatible kit for use by broadcasters over a two week period of the Olympics and for no other period.

The Current Uncertainty Regarding Potential Substitutes

There is also uncertainty as to the future availability of spectrum more generally in other bands in which wireless cameras could potentially be operated, and there are perhaps more potential substitutes for wireless cameras than for other uses of the bands that are the subject of this consultation.

There is currently a PMSE allocation at 3.5 GHz, although it is difficult to gain the UK-wide access in this band that is needed for newsgathering. However this is not currently heavily used because of uncertainty regarding the long term availability of this band, given the pressures for 3G and WiMax expansion. Clarity on Ofcom's longer term plans for this band would enable broadcasters and other programme-makers to make a better evaluation of the business case for investing in new PMSE equipment to work in this band.

We note that some digital radio cameras are becoming available in the US to work around 7 GHz. They would need further development to work in the frequencies available in the UK and it is not certain that equipment will become available for a UK market. Clearly this is more likely to occur the greater Ofcom gives a steer on the likely long term availability of spectrum for PMSE usage at these frequencies. It is also worth stressing that at these frequencies (and above), the performance of the digital radio camera link is significantly

lower than is possible at 2.5 GHz so further work is required to investigate the viability of this technology at these higher frequencies.

There is currently no digital radio camera equipment on the market that operates in the 10 GHz band. It is also unclear whether or not there will be in the near future, particularly in the UK, given the uncertainty regarding the availability of spectrum in this band that would allow any significant PMSE operation. Ofcom has packaged the spectrum it is proposing to auction at 10 GHz in such a way as to permit PMSE use, but there is no guarantee that any bids by PMSE users would prevail at auction.

Even if Ofcom were to make available (on reasonable terms and conditions) access to spectrum at 10 GHz for wireless cameras for the period of the 2012 London Olympics, it is questionable whether anyone would invest the substantial resources in R&D that would be required to try to ensure that wireless cameras could operate at this frequency (assuming that this can be done), particularly in the knowledge that broadcasters, at most, may only be able to use this for about 2 weeks - the business case just wouldn't stack up.

Question 1: *Do you agree with these proposals for the awards of the three bands or have any other comments on the contents of this document?*

We believe that the 2010 and 2290 MHz bands should **not** be auctioned but instead should be allocated to JFMG for PMSE (digital radio camera) usage. Ofcom's analysis has shown that the 2290 MHz block of spectrum is likely to have little alternative commercially viable use because of stringent interference constraints. Any use other than PMSE, in either of these two bands is likely either to cause interference to the existing PMSE usage in the two directly adjacent bands (2025-2110 MHz and 2200-2290 MHz) or be heavily constrained in achievable coverage.

The availability of 2010-2025 MHz could potentially support two radio camera channels, assuming 2025-2030MHz can be licensed from the JFMG. If this band were to be awarded for 3G TDD base station applications, it would be likely to cause interference to PMSE receivers operating in the existing 2025-2110MHz band and vice versa (see Mason's report P53).

Given this interference, and hence the little alternative commercially viable use of the 2010 and 2290 MHz bands, awarding these bands by auction would seem to be creating considerable additional costs for bidders for no discernible gain. The BBC would therefore urge Ofcom to allocate these two bands to JFMG for digital radio camera use.

Other more detailed concerns around the proposals are included in our answers to the following questions.

Question 2: *Do you agree with the analysis in section 5 or have any comments on adjacent interference issues?*

The analysis presented in the Mason's report is based on theoretical parameters and takes no account of the real performance of receivers in practice. Nevertheless, it highlights serious interoperability issues between different technologies sharing a common band. The mitigation methods suggested are not practical, particularly for mobile equipment. Filters delivering the necessary performance are costly and bulky to implement, which questions the practicality of technology neutral licensing for these bands.

As an example of the problems that can arise with a technology neutral licensing approach, the BBC has already experienced severe technical interference issues when working adjacent to UMTS services in existing bands used by radio cameras.

It is unclear if the restrictions set out in section 5.24 will provide adequate protection for the PMSE channel between 2490-2500MHz. This is the most useful channel in the 2450-2500MHz PMSE band. The remainder of the spectrum is subject to co-channel interference from unlicensed ISM devices, including IEEE 802.11x (WLAN) and IEEE 802.14.1 (Bluetooth) devices. Any loss of 2490-2500MHz would compound the problems created for broadcasters and other programme-makers by the loss of spectrum between 2500 to 2690MHz, putting more pressure on the remaining PMSE bands of 2025-2110MHz and 2200-2290MHz.

The interference potential of new services between 2500-2690MHz to existing WLAN equipment operating between 2450-2483MHz is understated in section 5.25. Previously these devices only needed to contend with interference from sparse PMSE services which typically operated at +20dBm output power. Much higher transmitted powers would be permitted under Ofcom's Spectrum Usage Rights (SUR) guidelines and this could easily cause interference to consumer WLAN devices. Although there is no obligation to protect ISM band devices, these devices are becoming increasingly widespread and hence it seems likely that rendering ineffective the use of this band would be very unpopular with consumers. A technical study characterising WLAN receivers and their performance in the presence of adjacent channel interference is needed to assess the threat to these devices.

We believe that the interference potential of Air Traffic Control (ATC) radars operating at 2.7–3.1 GHz into the award band discussed in section 5.40 is understated. There is significant power radiated into the top channels of the 2.6GHz band and this is a known problem to current usage of radio cameras in certain geographical locations. Real time services, such as PMSE video links require low latency and do not have the interleaving necessary to protect the data from high amplitude, low duty cycle pulses generated by radar systems. As a consequence, these channels have been avoided when licensing PMSE spectrum in certain parts of the country where ATC interference is likely. It is probable that the paired spectrum near the top of the band will be significantly less useful than the channels nearer the centre of the band.

This means that, under Ofcom's proposals, since spectrum allocations are determined by top-up bids during the final phase of the auction, a successful bidder could easily be awarded less useful spectrum with only a single chance to secure the more valuable spectrum nearer the centre of the band through the final assignment, which is proposed to be an uncapped, single round, sealed bid. This could be a serious problem for some bidders, as allocation of frequencies is dependent on top up bids and a bidder could easily end up with a polluted channel if they were outbid at this stage of the auction.

We are aware that Ofcom has said that it is not concerned by the ATC problem, claiming that there is considerable 'white space' between radar pulses. Technologies other than PMSE would still need to be immune to this type of interference. PMSE applications suffer a complete loss of signal at the instant of the radar pulse. That said, PMSE usage requires unpaired spectrum. Under the proposed auction packaging, unpaired spectrum will be a variable length block in the middle of the band and the highest available channel will be channel 23 (2610MHz). ATC interference is becoming less of a problem at these lower frequencies (typically 20dB lower than at 2685MHz) so PMSE usage, if implemented in this band would be unlikely to be affected by ATC not because of a lack of vulnerability (it is vulnerable to interference), but because likely channels would be those inherently less vulnerable to interference.

With reference to Section 5.5, it should be noted that it is unlikely that the PMSE band 2025-2110MHz will be re-planned as this would require expensive modifications to existing equipment. Users of equipment in this band are already suffering from adjacent channel blocking caused by 3G services operating between 1920-1980MHz and 2110-2200MHz. Licensing the band 2010-2025MHz to new high power services adjacent to the PMSE band is likely to paralyse channels near the bottom of the 2025-2110MHz band. Mitigation methods suggested in the Mason's report are impractical as suitable narrowband filters cannot be readily constructed. To reduce interference to PMSE services, it would be highly desirable to group the 2010-2025MHz allocation with the existing PMSE band 2025-2110MHz and license this through JFMG as described in the answer to question 1.

The results of the measurements from Mason's consultants show interoperability issues between PMSE and 3G users using 10MHz frequency offsets. The broadcasters have experienced problems even with 20MHz offsets, particularly with regard to airborne PMSE (e.g. helicopter-mounted radio camera links) interfering with 3G base stations and mobiles. Ofcom has proposed requirements to add additional filtering to mitigate these effects with filter attenuations of 30dB at the band edge in the PMSE receiver. This specification would be a very significant technical challenge as current PMSE filters have a 30MHz pass-band. The compatibility tables assume EN302-064 compliance by radio cameras. Since some PMSE equipment manufacturers have struggled to build equipment to this standard, compatibility issues are potentially even worse than the Mason's report suggests.

The statement in section 5.55 regarding protection to and from PMSE services between 2025-2110MHz is incorrect. Measurements made by JFMG (see http://www.jfmg.co.uk/jfmgecom/Docs/Wireless%20Cameras.pdf) suggest that filtering of PMSE equipment will not be sufficient. Higher power PMSE equipment often fails to meet the masks defined by EN302-064, as assumed in the Mason's report, and therefore could easily interfere with new services awarded in 2010-2025MHz. The problem is particularly acute as this PMSE band is used for high power airborne operation. Furthermore, the protection ratio for typical PMSE receivers is considerably less than that assumed by Mason's, so new services are likely to cause interference to the PMSE band.

With reference to section 5.69, we note that the allocation between 2290-2300MHz is likely to suffer from interference from PMSE services in the 2200-2290MHz band. We urge Ofcom to group this block with the existing PMSE channels between 2200-2290MHz as described in the answer to question 1.

Question 3: Do you agree that Ofcom should authorise use of the spectrum bands 2500-2690 MHz, 2010-2025 MHz and 2290-2300 MHz?

Yes we do believe that Ofcom should authorise use of these bands. As mentioned in the answer to question 1, we believe that the 2010 and 2290 MHz bands should be allocated to JFMG for PMSE (digital radio camera) usage.

We believe that it is vitally important that PMSE can continue in the 2.6 GHz band on a rolling basis while that spectrum is not required for other purposes. Spectrum in the 2.6 GHz band is still heavily used for PMSE, partly because the substitute alternative spectrum for which equipment is readily available on reasonable terms and conditions is insufficient in quantity and liable to interference.

So although current licences for PMSE usage are extended on a 3 month rolling basis in the 2.6 GHz band, we believe that the notice period should not start from the auction date or the award of licences. In practice, network build rollout for new technologies could take a considerable time and have significant geographical variations. Therefore, to avoid wasting spectrum through it lying unnecessarily fallow for any significant period of time, the notice to

quit for PMSE users should reflect actual network rollout plans of the new services and should allow for varied ongoing geographical availability depending on geographical rollout plans.

Question 4: *Do you agree that awarding licences by auction would be the appropriate mechanism for authorising use of the spectrum bands 2500-2690 MHz, 2010-2025 MHz and 2290-2300 MHz?*

For the reasons mentioned in the answer to question 1, we believe that the 2010 and 2290 MHz bands should be allocated to JFMG for PMSE (digital radio camera) usage.

Question 5: *Do you agree that it is likely to be in the interests of citizens and consumers to proceed with the award of the 2.6 GHz and 2010 MHz bands as soon as practicable, rather than to delay the award pending reduction in uncertainty relating to other bands?*

As mentioned in the answer to question 1, we believe that the 2010 MHz band should be allocated to JFMG for PMSE (digital radio camera) usage. We believe that this should happen as soon as is practicable.

Question 6: *Do you agree Ofcom should aim to award the bands 2500-2690 MHz, 2010-2025 MHz and 2290-2302 MHz by the end of 2007, while keeping the position on the 2.6 GHz and 2010 MHz bands under review in the light of possible developments in European regulatory fora?*

Clearly Ofcom must keep developments in Europe under close scrutiny. A potential RSC ruling in October 2007 would be mandatory and could not be ignored by the UK. It will be necessary to monitor RSC activity very closely to see whether any ruling might come out against technology neutral licensing and in favour of enforced harmonisation. Indeed if the RSC ruling is delayed (but not indefinitely), we believe that there may be a case for delaying the auction.

Ofcom has said that the CEPT band plan for 2.6 GHz is a 'useful reference point', but is not binding on the UK – indeed Ofcom's proposals for this auction do allow for a variation on the CEPT band plan. The EU RSPG does have powers to make binding decisions on spectrum allocation, using qualified majority voting, but we do recognise that this needs a strong consensus and that there is no strong consensus yet in favour of, or against, technology neutral licensing and auctions.

As Ofcom's position on the regulatory uncertainty running into the auction appears to be 'caveat emptor', it would be prudent to consider delaying the auction if not to do so would cause great uncertainty and risk to bidders entering into the auction (which would not therefore deliver the optimal outcome). This decision would need to be taken in the light of the latest best information from Europe.

As mentioned in the answer to question 1, we believe that the 2010 and 2290 MHz bands should be allocated to JFMG for PMSE (digital radio camera) usage. We believe that this should happen as soon as is practicable.

Question 7: *Do you agree with Ofcom's proposals for licence conditions (technology neutrality, tradability, conditions of tenure and absence of roll-out obligations)?*

Whilst encouraging as many users as possible to enter an auction in this band is likely to result (at least theoretically) in the maximum financial return from an auction, there are serious technical difficulties with technology neutral licences, some of which were described in the answer to question 2 above. These difficulties primarily arise when different

applications require different transmitter powers, as this can cause receiver linearity problems and interference issues. Guard channels become necessary and this fragments and wastes the spectrum.

It seems that Ofcom measures the efficiency and success of spectrum allocations solely by the net income returned by an auction. The bidder with the biggest budget is assumed to have the best application for the spectrum. We remain concerned by an approach that relies solely on spectrum auctions to assign radio spectrum in circumstances where there may be strong reasons of interference minimisation that suggest that a more interventionist approach may deliver a more optimal outcome under these special circumstances.

A technology neutral approach could easily lead to wastage of spectrum in real terms, with potentially many 5 MHz "buffers" being required between users, and further difficulties if 5 MHz proves not to be sufficient to avoid interference, as we fear.

We would be interested in Ofcom's views on how change could happen in usage between paired and unpaired use because that clearly has implications for secondary trading.

We strongly believe that Ofcom should consider some form of "use it or lose it" provisions to prevent the risk of spectrum hoarding.

Question 8: *Do you have views on whether or not there should be a "safeguard" cap on the amount of spectrum that any one bidder could win in an award for the 2.6 GHz bands and, if so, do you have a view on whether 90 MHz would be an appropriate size for a safeguard cap?*

Yes we do believe that there should be a "safeguard" cap on the amount of spectrum that any one bidder could win in an award for the 2.6 GHz band to prevent the risk of spectrum hoarding. We do believe that 90 MHz would be an appropriate size for a safeguard cap and that this should be sufficiently high not to restrict any likely genuine uses.

Question 9: *Do you agree with Ofcom's proposal to package spectrum as lots of 2 x 5 MHz for paired use and 5 MHz lots for unpaired spectrum and to allow the aggregation of lots by bidders?*

This approach will have risks for PMSE usage: for PMSE applications, a minimum allocation of 10 MHz of unpaired spectrum is required. Given the expected difficulties with technology neutral licensing and the consequent likely requirements for guard bands, an allocation of 15 MHz would be the minimum necessary for a single radio camera. The lower 5MHz of this 15 MHz allocation would have restrictions "to avoid harmful interference between users".

Ofcom has recognised interoperability issues between different applications and the need for guard bands. Guard bands seem to be quite a wasteful way of using spectrum and how these restricted channels would be enforced is unclear. High-power unpaired or paired users in the upper adjacent channels could easily cause interference to PMSE channels if the restrictions were not observed.

In addition to the interference issues mentioned above for PMSE, there would also be significant aggregation risks for any bidder wishing to secure spectrum for PMSE usage in the 2.6 GHz band. Unless the bidder could ensure that it could secure contiguous 5 MHz blocks totalling one 15 MHz channel per radio camera usage, it would not be in a position to meet its needs.

Question 10: *Do you agree with Ofcom's proposed approach to allowing the respective amounts of paired to unpaired spectrum for the band 2500-2690 MHz to be varied (maintaining the 120 MHz duplex spacing and allowing additional unpaired spectrum, if needed, at the top end of the band)?*

Yes.

Question 11: *Do you agree with Ofcom's proposals for a 5 MHz restricted block between FDD and TDD neighbours and between TDD and TDD neighbours and with a modified out-of-band base station mask for second adjacent 5 MHz blocks?*

We believe that this does appear to be necessary in this case but it does illustrate how spectrum can be lost/ wasted due to interference issues when a variety of different incompatible applications are encouraged to use a single band through technology neutral auctions.

Question 12: *Do you agree with Ofcom's proposals to award the 2010 MHz band as a single 15 MHz lot?*

Yes we do believe the 2010 MHz band should be made available as a single 15 MHz allocation but we believe that it should be allocated to JFMG for PMSE usage for the reasons given in our answer to question 1.

Question 13: *Do you agree with Ofcom's proposals to award the 2290 MHz band as a single 10 MHz lot?*

Yes we do believe the 2290 MHz band should be made available as a single 10 MHz allocation but we believe that it should be allocated to JFMG for PMSE usage for the reasons given in our answer to question 1.

Question 14: *Do you agree with Ofcom's proposals to combine the award of the 2.6 GHz and 2010 MHz bands and to hold the award of the 2290 MHz band separately and in advance?*

No. We believe that the 2010 and 2290 MHz bands should not be auctioned but instead should be allocated to JFMG for PMSE usage for the reasons given in our answer to question 1.

Question 15: *Do you agree with Ofcom's proposals for a two-stage auction design for the 2.6 GHz and 2010 MHz bands?*

We do not agree with the auction approach for the 2010 MHz band as we believe that should be allocated to JFMG for PMSE usage for the reasons given in our answer to question 1.

Question 16: *Do you agree with Ofcom proposals to award the 2290 MHz band through a second price sealed bid auction?*

No. We believe that this band should be allocated to JFMG for PMSE (digital radio camera) usage for the reasons given in our answer to question 1.

Question 17: *Do you have a preference for either of the two approaches to specifying technical licence conditions?*

It will be very difficult to verify if Spectrum Usage Rights (SUR) limits are being violated by an adjacent user of the spectrum. Extensive site surveys would be needed to check Power Flux density (PFD) levels over the licensed area. Statistical analysis would then be needed to determine if interference levels generated by adjacent users were within the terms of their licence. It is much easier to calculate interference levels using transmitter spectrum masks. Simple measurements on transmitters can then determine if equipment is operating within its specifications.

Question 18: *Do you have any comments on the transmitter spectrum masks defined below?*

The spectrum masks are appropriate to UMTS (3G) equipment but not to WiMAX or PMSE equipment. For PMSE equipment, EN302-064 is specified. WiMAX specifications are not yet clear and equipment is not yet widely available.

Question 19: *Do you have any comments on the SUR parameters defined below?*

In the event of an operator breaking the terms of their licence, it would be very difficult for a victim to verify the Spectrum Usage Rights parameters of the interfering service. We understand that Ofcom is unlikely to offer assistance in resolving such interference problems and we would welcome Ofcom's views on how such problems should be resolved.

Question 20: *Do you have any comments on the SUR methodology and assumptions detailed in this annex?*

It is unclear how the SUR methodology could be applied in practice, to assist a licensee suffering interference from another licensee. The Z parameter implies protection to 50% of locations, yet digital reception of broadcasting currently uses 90% for reliable operation.

The choice of the parameter Z set to 50% in section 9.50 seems to be completely arbitrary. This would allow a licensee to generate considerable interference in 50% of its licensed locations which could result in widespread interference problems.

To support this statement, we can confirm that PMSE (digital radio camera) users are currently experiencing interference problems when sharing spectrum adjacent to existing 3G allocations. It is likely that the interfering 3G transmissions are well within the Spectrum Usage Rights (SUR) parameters that have been proposed by Ofcom in this consultation. The SUR approach seems to encourage a liberal regime where users may be seeking to increase transmitter powers until a service can be operated reliably. This is similar to the US model in their 2GHz bands and is not felt to be appropriate for battery-powered, portable equipment.

Question 21: *Do you have any comments on the use of the Visualyse tool as described, on the assumptions or the propagation model proposed in this annex?*

No.

Question 22: *Do you have any comments on the assumptions detailed in this annex?*

No.