Glasgow 2014 Commonwealth Games

Radio spectrum planning

Consultation

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Section 1

Executive Summary

1.1 Ofcom is the independent regulator and competition authority for the UK communications industries, with responsibilities across television, radio, telecommunications and wireless communications services. This document sets out proposals for making spectrum available for wireless communications at the Commonwealth Games to be held in Glasgow in 2014.

Spectrum Planning for Glasgow 2014

1.2 Glasgow 2014 will take place between 23 July and 3 August 2014. Glasgow 2014 will be staged at a number of locations around Scotland but concentrated in and around Glasgow. We are responsible for organising a full spectrum plan for Glasgow 2014, for arranging all the licences in good time in support of the plan and ensuring that key wireless services are free from harmful interference. These responsibilities flow from two guarantees given by the UK Government, underwritten financially by the Scottish Government to the Commonwealth Games Federation in support of Glasgow's bid for the Commonwealth Games. These guarantee the allocation of spectrum required for the organisation of Glasgow 2014 and the waving of fees otherwise payable for that spectrum by certain users.

1.3 We recognise the importance of services not covered by the spectrum Guarantees to the success of Glasgow 2014 and are working to ensure that any spectrum requirements they generate are met and coordinated with other uses.

1.4 This is the first stage in developing our spectrum plan; estimating demand. An independent study commissioned by Analysis Mason and published with this document has helped to inform our view which we now want to test by engaging with. stakeholders. Once we are confident we have view of estimated demand, we will seek to match that with available spectrum supply and produce the plan.

1.5 One critical body of evidence that we will draw on will be our own experience from managing spectrum for the London 2012 Games[1], which will happen during the course of this consultation. The London 2012 Games events are very different in scale to those of Glasgow 2014, but the tasks and processes are similar. Indeed, this document already reflects some of the learnings to date from our experience of planning for the Olympics, which will also bring other legacy benefits to the Glasgow 2014 Games by way of re-usable equipment such as Time Difference Of Arrival (TDOA) spectrum monitoring sensors.

1.6 Our provisional conclusions, which are supported by the Analysys Mason study, on which we are seeking views are that we may experience high demand for spectrum for key services like PBR, wireless microphones and wireless cameras. However, the demand for spectrum is likely to be significantly less for most services than expected for the London 2012 Games. We anticipate that we will be able to meet the estimated demand if the supply is bolstered with some additional spectrum sourced from public sector holdings. We will consult on a draft spectrum plan and how we propose to secure the spectrum needed for it in the next stage of this process.

[1] We have published the spectrum plan and our guide to spectrum for the London 2012 Games, which stakeholders may find provides useful background.
See: http://stakeholders.ofcom.org.uk/spectrum/olympics/

Next steps

1.7 We are consulting over a longer period than Ofcom's standard maximum of ten weeks. This is to ensure that anyone involved with the London 2012 Games who may have a view on our proposals will have ample opportunity to comment. Following the closure of the consultation we will analyse the responses we receive and seek to issue a statement in spring 2013.

Section 2

Introduction

The Glasgow 2014 Commonwealth Games

2.1 On 9 November 2007, Glasgow was chosen to host the XXth Commonwealth Games ("Glasgow 2014"), which will take place between 23 July and 3 August 2014, during which 17 sports will be played over the 11 days of competition.

2.2 Television, radio, telecommunications and wireless communications services will play an important role both in the build-up to and during Glasgow 2014 serving the Commonwealth Family, an association of independent states spread over every continent and ocean, by bringing Glasgow 2014 to the homes of the Commonwealth's two billion people - thirty percent of the world's population.

Ofcom's role and the purpose of this document

2.3 The Office of Communications (Ofcom) is the independent regulator and competition authority for the UK communications industries, with responsibilities across television, radio, telecommunications and wireless communications services. This document sets out the evidence we have of the demand for spectrum for Glasgow 2014 and outlines our proposals for making spectrum available for Glasgow 2014.

2.4 Ofcom has experience of major sporting events including the UEFA Cup Final 2007 (held in Glasgow) and we are currently implementing our plans for spectrum for the London 2012 Games.

2.5 We are responsible for organising a full spectrum plan for Glasgow 2014, for arranging all the licences in good time in support of the plan and for ensuring wireless services covered by the spectrum guarantees[2] are free from harmful interference. We also recognise the importance of services not covered by the spectrum guarantees to the success of Glasgow 2014 and we are working to ensure that the spectrum requirements of all these services are met and co-ordinated with other day-to-day uses and users of spectrum.

2.6 The spectrum is a resource of fundamental importance in the modern world. It is the essential input into every wireless application, from satellites and radars to broadcasting and mobile communications. At Glasgow 2014 spectrum will support a very wide range of services from internet Wi-Fi access for the athletes to the broadcasting of high definition TV pictures world-wide. But spectrum is a scarce resource in very short supply, so planning how it is managed is vital to the success of Glasgow 2014 and the UK economy as a whole.

2.7 Our statutory duties, set out in the Communications Act 2003 and the Wireless Telegraphy Act 2006,[3] include a requirement to secure the optimal use of spectrum in the interests of citizens and consumers. It is essential that the regulatory regime for spectrum responds to changes in demand for and use of spectrum in the UK.

2.8 Glasgow 2014 will generate an increase in the demand for spectrum, principally in the centre of Glasgow, where spectrum is already heavily used. These demands, and hence the spectrum guarantees, is a complex task. We would like to give

[2] See paragraphs 2.12 and 2.13 below.
[3] http://www.legislation.gov.uk/ukpga/2006/36/pdfs/ukpga_20060036_en.pdf

broadcasters and other stakeholders, some of whom will be in the UK for the London 2012 Games, as much information as we can as early as possible to enable them to plan for the best possible coverage of Glasgow 2014; and we are keen to gather relevant information that may help us to minimise any negative impact on other spectrum uses and, ultimately, on citizens and consumers who benefit from those uses.

2.9 It is for these reasons that we have started the task of spectrum planning for Glasgow 2014. We want to make an early start in assessing the demand for radio spectrum and the availability of spectrum to meet these demands, although this will be an iterative process.

Governance

2.10 The Scottish Government, in collaboration with its Games delivery partners: Glasgow City Council (GCC), Commonwealth Games Scotland (CGS) and Glasgow 2014 Ltd (the Organising Committee (OC) set up to deliver Glasgow 2014) have recognised the importance of radio spectrum for television, radio, telecommunications and communications services to Glasgow 2014. To this end spectrum guarantees have been given by the UK Government, underpinned financially by the Scottish Government, to the Commonwealth Games Federation (CGF). The Commonwealth Games Spectrum Planning Group (COGSPLAG)[4], which is subordinate to the UK Government's Spectrum Strategy Committee (UKSSC), has been established to deliver on these guarantees by involving all the relevant parts of the UK and Scottish Governments, Glasgow 2014 delivery partners and key technology partners in the development of the spectrum plan for Glasgow 2014.

2.11 COGSPLAG supports Ofcom in meeting its responsibility to organise the spectrum plan for wireless services that fall within the spectrum guarantees for Glasgow 2014 and for those wireless services not covered by the spectrum guarantees, but which are essential to the success of Glasgow 2014.

Spectrum Guarantees

2.12 In 2007, the Secretary of State for the Department of Trade and Industry gave two guarantees to the President of the Commonwealth Games Federation on behalf of the UK Government:

(i) a full frequency plan will be organised for the Games and that all the spectrum licences will in place in good time in support of the plan (Guarantee 14.8); and

(ii) the fees payable for the allocated frequencies required for the Games will be waived (Guarantee 14.9)

2.13 The first of these (Guarantee 14.8) provides for the organisation of a full spectrum plan and spectrum licences; the second (Guarantee 14.9) for the waiving of fees for frequencies allocated for Glasgow 2014. These guarantees were underwritten financially by the then Minister for Culture in the Scottish Government, Patricia Ferguson, in a letter to Alistair Darling, then Secretary of State for Trade and Industry dated 1 March 2007. The implications of the second Guarantee and the waiving of fees is discussed elsewhere in this document.

[4] See Annex 11 for the Terms of reference for COGSPLAG

2.14 Under the guarantees, spectrum will be made available free of charge to the following constituent groups during Glasgow 2014:

- Commonwealth Games Federation
- Commonwealth Games Associations (which would include Athletes and Team Officials)
- International Federations
- Host Broadcast (HB) Services
- Rights Holding Broadcasters (RHBs)
- Other Accredited Media (Press, Photographers, Digital Media)
- Ceremonies Production and Sports Presentation
- Glasgow 2014 PBR (Private Business Radio) solution contractor
- Commonwealth Games partners and sponsors for the delivery of services specific to Glasgow 2014.

Structure of this document

2.15 This document provides a high level summary of our spectrum planning including:

- An overview of Glasgow 2014, Ofcom's role and the purpose of this consultation
- Governance and the spectrum guarantees
- Economic and financial considerations
- Our approach to the spectrum plan for Glasgow 2014
- Next steps and acknowledgements

2.16 The rest of this document is structured as follows:

- Section 3 - Estimating the demand for and supply of spectrum for Glasgow 2014.
- Section 4 - Requirements for support and infrastructure services
- Section 5 - Other spectrum requirements
- Section 6 - Reducing spectrum demand
- Section 7 - The spectrum supply for Glasgow 2014
- Section 8 – Planning assumptions
- Annexes – These give more information on technical aspects of spectrum planning for specific radio services and provide guidance on how to respond to this consultation.

2.17 At this stage, we have not conducted a full impact assessment. This is because this consultation is about *developing* the spectrum plan and we are consulting on the assumptions that go into formulating plan to meet the guarantees the UK Government has given to the Commonwealth Games Federation on the allocation of the frequencies required for the organisation of Glasgow 2014. Nonetheless, we have attempted where relevant – and where we have sufficient information to do so – to make a qualitative assessment of the potential impact of our proposals and steps that can be taken to mitigate those effects. We also invite responses from stakeholders as to the impact of the proposals set out in this consultation.

Approach to the spectrum plan

2.18 The development of the spectrum plan for Glasgow 2014 will draw extensively on what we have learned from previous major events and in particular from our spectrum plan for the London 2012 Games[5]. For Glasgow 2014 our approach is to:

- identify and test the demand for spectrum and consider how it might be reduced;
- identify spectrum that is currently available or can be secured with the assistance of the UK Government from the public sector and establish how the efficiency of its use can be maximised taking into account the day-to-day requirements for spectrum in and around Glasgow; and
- match supply to demand to meet the spectrum guarantees at least cost to other spectrum users, citizens and consumers; but noting that there will be a number of key changes to spectrum supply by the summer of 2014, including in the public sector, from which much of the spectrum supply for the London 2012 Games has been sourced.

Demand by venue

2.19 Glasgow 2014 will make use of existing venues and new facilities being constructed, including the new Commonwealth Arena and the Sir Chris Hoy Velodrome that will be used by athletes and clubs from across Scotland in the build up to and following Glasgow 2014.

2.20 Glasgow 2014 will also make use of a wide range of existing indoor and outdoor facilities, including sports centres, pitches, woodlands, parks, cycle-paths, natural resources of water and the rural environment[6]. Glasgow 2014 will also use three competition venues at satellite locations outside of the City of Glasgow: the Barry Buddon Shooting Centre near Carnoustie; the Royal Commonwealth Pool in Edinburgh; and Strathclyde Country Park. We have considered the demand for spectrum for all these locations.

Minimising the cost of spectrum use

2.21 Glasgow 2014 is expected to have significant economic, regeneration and social benefits[7] – primarily in Scotland, but also in the rest of the UK and the Commonwealth as a whole. However, as with any other scarce resource, using spectrum to realise these benefits comes at a cost.

[5] See: http://stakeholders.ofcom.org.uk/spectrum/olympics/
[6] See: http://www.glasgow2014.com/the_games/athletes_village_and_venues/venue_locations.aspx
[7] See: http://www.glasgow2014.com/the_games/games_impact/legacy.aspx

2.22 It is important that we encourage approaches to the demand for spectrum for Glasgow 2014 that will minimise these costs. This could involve using spectrum more efficiently; for example using higher-frequency spectrum that is less scarce, using existing legacy spectrum or relying more heavily on wired communications.

Analysys Mason study

2.23 To help us estimate and verify the demand for spectrum for Glasgow 2014 a study has been undertaken by Analysys Mason[8]. This study, which we have published alongside our consultation, estimates what demand there might be for spectrum based on interviews with key stakeholders. The conclusions of this study are used extensively in this consultation document to inform our proposals.

Economic and financial considerations

2.24 In general, spectrum used by one party in a particular location cannot be used by another because of the interference that would be caused. In other words, there is an opportunity cost to spectrum use. Making users face this opportunity cost encourages efficient spectrum use because they will use spectrum when it generates benefits greater than the opportunity cost. This is the logic behind our spectrum pricing policy[9], which attempts to reflect the opportunity cost of spectrum use in licence fees in order to incentivise efficient use.

2.25 As noted above, fees for spectrum users for the different constituent user groups at Glasgow 2014 will be waived under the spectrum guarantees. However, those fees will be met by the Scottish Government (as financial underwriter of the guarantees) following the agreement of a suitable spectrum plan. In this way, the relevant decision-makers will still have incentives to ensure that spectrum is used efficiently where it needs to be used at all and explains why we are seeking to evaluate the demand for spectrum in this consultation.

Demand

2.26 We have identified that different television, radio, telecommunications and wireless communications services will require different amounts of spectrum and use different frequencies with different requirements to prevent harmful interference. In sections 2 to 5 we consider how to assess:

- user requirements and the services that will generate them;
- technology changes that might affect those requirements;
- how those requirements might be reduced with no loss of benefit; and
- the suitability and availability of spectrum to meet those requirements.

2.27 As part of this process, we also refer to relevant studies carried out for us previously on the impact on the opportunity cost of and demand for spectrum of relying more heavily on wired communications.

[8] See: www.Analysysmason.com
[9] See: http://stakeholders.ofcom.org.uk/spectrum/spectrum-pricing/

Supply

2.28 Because of the scale of the spectrum demand generated by Glasgow 2014 in conjunction with the day-to-day demands that are already high in the Glasgow area, we have considered three potential sources of supply to meet that demand:

- civil spectrum;
- public-sector spectrum; and
- licence exempt spectrum.

Licence exempt spectrum

2.29 Certain equipment may be exempted in the UK from the requirement to be licensed under the Wireless Telegraphy Act 2006 because its use is not likely to cause harmful interference. Experience has shown, however, that the unusual concentration of such equipment in particular locations can create the potential for localised harmful interference. We are exploring with the OC how such use can best be controlled or co-ordinated to avoid any disruption to the smooth running of Glasgow 2014, but practical steps such as preventing certain types of equipment from being brought into Glasgow 2014 venues or actively co-ordinating use between users have proved successful at other major public events.

2.30 We understand that the OC plan to put in place a policy for Wi-Fi use in Glasgow 2014 venues in place during 2013 and we will take this into account. We cannot rule out the possibility that changes to the Wireless Telegraphy Exemption Regulations[10] will be needed. If changes are needed we will consider what the impact is expected to be on citizens and consumers and on key stakeholders such as the cellular Mobile Network Operators (MNOs).

2.31 Our experience would also lead us to caution against extensive use of licence exempt spectrum band, particularly for critical aspects of the Glasgow 2014 Games, including private business radio (PBR) and timing and scoring. Licence exempt spectrum bands are heavily used and we cannot coordinate their use, so there is an increased risk of harmful interference

Assessments

PBR

2.32 We set out our assessment for private business radio (PBR) also referred to as private mobile radio (PMR) in Annex 1.

Audio links, wireless microphones, in-ear monitors and talkback

2.33 We set out our assessment for temporary audio links, wireless microphones and in-ear monitors (IEMs) and for outside broadcast talkback in Annex 2 .

[10]See:http://stakeholders.ofcom.org.uk/spectrum/spectrum-management/licence-exempt-radio-use/wireless-telegraphy-regulations/

Video links (including airborne), wireless cameras and telemetry (e.g. camera control)

2.34 We set out our assessment for video links (including airborne and temporary portable point-to-point links), wireless cameras and telemetry (e.g. camera control) links in Annex 3.Temporary (portable) point-to-point links might be used to provide connection from venues (in lieu of fibre).

Other guaranteed services

2.35 In Annex 4 we set out our assessment for fixed satellite services: permanent earth stations, transportable earth stations, including satellite news gathering (SNG); for mobile satellite services and for radionavigation satellite services, and for telemetry and telecommand.

Services and spectrum

2.36 Though we expect the demand for spectrum for Glasgow 2014 to be primarily for PMR and broadcasting (TV and radio) services, the Analysys Mason study [11] indicates that the demand for wireless services for Glasgow 2014 can broadly be grouped into six main classes:

- private business radio (PBR) – also referred to as private mobile radio (PMR)
- audio links (wireless microphones, talkback and in-ear monitors) and telemetry (e.g. camera control)
- wireless cameras
- temporary video links
- airborne video links
- satellite news gathering
- event timing, system synchronisation and results services

2.37 There will also be spectrum demands for the support and infrastructure services including:

- Emergency and Public Safety
- safety, security and crowd management
- public telecommunications and
- healthcare (e.g. the Red Cross, St John's Ambulance).

Ceremonial events

2.38 There are four generic types of ceremonial events expected to be organised before and during the Commonwealth Games that Ofcom's spectrum plan will support:

[11] Analysys Mason, Estimating the demand for spectrum use for Glasgow 2014, 12 March 2012 http://stakeholders.ofcom.org.uk/binaries/consultations/glasgow2014/annexes/report.pdf

- Opening and Closing Ceremonies
- Welcome ceremonies at the Commonwealth Games Village
- Medal ceremonies

2.39 The Opening and Closing Ceremonies, team-welcome, medal and victory ceremonies are very pivotal to Glasgow 2014. The spectrum plan must take into account these events as they are likely to be periods of peak demand for spectrum.

Queen's Baton Relay

2.40 The Queen's Baton Relay is of significant importance in promoting Glasgow 2014 and the unity of the Commonwealth[12]. Its arrival in Scotland will play a significant part in the build-up to Glasgow 2014, culminating in its arrival at the Opening Ceremony. When further information is made available about the relay route across Scotland we may update the spectrum plan to include the spectrum demand for the Queen's Baton Relay so that the geographical spread of spectrum requirements can be considered.

Cultural programme

2.41 The Cultural Programme being organised in conjunction with Glasgow 2014 will be developed in stages and both the activities and the scale of it will increase towards 2014 when the main programme will take place. The spectrum plan will continue to develop to account for this and will, as far as possible, consider the spectrum demands of the other cultural and associated events (such as live sites) being conducted in association with Glasgow 2014.

Initial conclusions

2.42 Our initial conclusions, independently verified by the Analysys Mason study, on which we are seeking views are that we may experience high demand for spectrum for key services like PBR, wireless microphones and wireless cameras. However, the demand for spectrum is likely to be significantly less for most services than currently forecast for the London 2012 Games. We anticipate that we will be able to meet the estimated demand if the supply is bolstered with some additional spectrum sourced via public sector holdings.

Next steps.

2.43 We welcome all views from stakeholders on the questions raised in this consultation document and set out in later sections. This consultation will close on 23rd November 2012.

2.44 We recognise many stakeholders involved in Glasgow 2014 may not be familiar with our consultation processes, Ofcom itself or the regulatory environment for wireless services in the UK. We will be happy to discuss our proposals in detail during the consultation period with stakeholders who would find this helpful.

2.45 We plan to publish a statement of the draft spectrum plan for Glasgow 2014 in Spring 2013. We anticipate it will be subject to ongoing refinement in the run-up to Glasgow 2014 themselves. It is therefore important to note that broader spectrum policy in the UK will be subject to change between now and Glasgow 2014.

[12] http://www.glasgow2014.com/about_us/culture_and_ceremonies/the_queens_baton_relay.aspx

Acknowledgements

2.46 We are grateful for the advice and support we have received from members of the Commonwealth Games Spectrum Planning Group (COGSPLAG) in our work to construct the information contained in this document and on which we are now consulting.

We are also grateful to those stakeholders who gave us and Analysys Mason the benefit of their time and experience as we examined past Commonwealth Games and comparable events.

Section 3

Estimating the demand for spectrum

Introduction

3.1 Estimating the demand for spectrum is difficult this far in advance of Glasgow 2014 for an number of reasons:

- not all users have been selected or identified so we cannot seek their views on demand directly;
- many known users will have not considered their requirements for Glasgow 2014 yet and may be entirely focused on other events such as the London 2012 Games;
- technological choices and developments cannot reliably be foreseen or have not been made yet; and
- business as usual demand will also increase during the Glasgow Games and this will also need to be considered in the plan; and
- we will be drawing on our experience from the London 2012 Games, but the timing of this consultation means that our learnings from London 2012 will not be complete until later this year.

3.2 We commissioned Analysys Mason to undertake an assessment of likely demand for each of the six main classes of system identified in section 1 and anticipate that the main users of wireless equipment during Glasgow 2014 will be:

- Organising Committee (OC) – the organising committee for Glasgow 2014, which is also responsible for all ceremonies, including the Opening and Closing Ceremonies.
- Glasgow City Council – responsible for transport, roads, public information and events management within the Glasgow City area, it will also have certain responsibilities for the delivery of the cultural programme for Glasgow 2014 on behalf of the OC (which will be undertaken by Glasgow Life).
- The Host Broadcaster (HB) appointed by the OC who will be responsible for producing the coverage of the Games.
- International Rights Holding Broadcasters (RHBs), appointed or to be appointed by the OC.
- BBC Sport – the domestic rights holding broadcaster of the Games.
- BBC Scotland – which will be responsible for producing sports and other events coverage for the BBC Scotland schedule for local content matters and enhanced coverage of certain elements within Scotland as well as supporting the overall BBC team.
- Other international non-RHB broadcasters from non-UK countries.

- Other non-RHB domestic broadcasters that might also produce sports and other events coverage for their schedules largely performing a 'business as usual' role which will include enhanced media interest in the Games.

3.3 A summary of the main users that are likely to have spectrum requirements to operate systems within each of the classes is summarised in Table 3.1 below.

Table 3.1: Likely users of wireless systems at Glasgow 2014

Class	Likely users
PBR	Glasgow 2014, Glasgow City Council/ Glasgow Life, HB, RHBs, BBC Sport, BBC Scotland, other domestic broadcasters
Wireless microphones	Glasgow 2014, HB, RHBs, BBC Sport, BBC Scotland, other domestic broadcasters
Talkback	Glasgow 2014, HB, RHBs, BBC Sport, BBC Scotland, other domestic broadcasters
IEM	Glasgow 2014, HB, RHBs, BBC Sport, BBC Scotland, other domestic broadcasters
Wireless cameras	HB, RHBs, BBC Sport, BBC Scotland, other domestic broadcasters
Point to point video links	HB, RHBs, BBC Sport, BBC Scotland, other domestic broadcasters
SNG uplinks	HB, RHBs, BBC Sport, BBC Scotland, other domestic broadcasters
Airborne links	HB, RHBs

Source: Analysys Mason Ltd, 2012[13]

Planning assumptions

3.4 Our planning assumptions are set out in section 8. Analysys Mason have assumed that:

- the opening ceremony stadium capacity will be approximately 60,000. The closing ceremony stadium capacity will be approximately 45,000. Full capacity has been assumed.

- the OC has appointed a Host Broadcaster (HB) who will be responsible for producing the coverage of the Games. RHBs will broadcast those feeds as well as produce their own unilateral content. Contracts have so far been agreed with BBC (UK) and Network Ten (Australia);

- feeds produced by the HB will be in high definition (HD), although standard definition (SD) may be available for some RHBs;

- standard and HD cameras will use 10 MHz channels;

- not all RHBs will transport their own feeds back to the International Broadcasting Centre (IBC) although the majority will receive their feeds in the IBC;

[13] Analysys Mason Ltd, Estimating the demand for spectrum use for Glasgow 2014, 12 March 2012. http://stakeholders.ofcom.org.uk/binaries/consultations/glasgow2014/annexes/report.pdf

- all broadcasters may require spectrum for reporting both within and outside venues;
- 71 Commonwealth nations will be competing, with an estimated broadcast audience of over 1 billion viewers worldwide covered by the RHBs;
- there will be 4,500 athletes and 2,000 officials;
- over 1,550 press and photographers will cover the Games;
- 5 main RHBs and 5 or 6 other RHBs;
- optical fibre will be used at and link all competition venues although satellite transmissions may be used for resilience purposes;
- spectrum will be required for partners and venue setup from April 2014, for broadcasters from February 2014 and for the OC from May 2014 although some minor requirements will exist before April, such as for village preparation etc;
- all spectrum requirements will cease by the end of August 2014;
- wireless equipment will be re-tuneable to some extent;
- wireless equipment is likely to be imported from participating nations and RHBs;
- during the Games, PMR services will be used by the OC and teams,
- Emergency and Public Safety Services (E&PSS), security services and some defence and security users have confirmed their intention to use the Airwave TETRA trunked network within their business as usual capacity limitations;
- a satellite-dish farm will be deployed at a fixed location adjacent to the IBC;
- the HB and other RHBs might also use satellite links from competition venues back to their facilities in the IBC or at other locations;
- news-gathering organisations will also use satellites;
- cultural events may require spectrum before the Games.

Approaches to estimating the spectrum demand

3.5 For other major events like the London 2012 Games we have taken three different approaches to estimating the spectrum requirements and the classes of applications that will generate them. We have used these approaches for Glasgow 2014, but placed less emphasis on the first of these, the top-down approach to spectrum demand, and more on the second; the bottom-up approach; while using the third, the theoretical approach, to validate results and assumptions. Each of these approaches is described below.

Top-down approach to demand

3.6 This approach examines, at an aggregated level, spectrum requirements for the London 2012 Games and comparable events. The most useful comparators may be:

- Manchester 2002 Commonwealth Games;

- Melbourne 2006 Commonwealth Games (the Melbourne Games);
- The G8 Summit of 2005;
- 2005, 2006 and 2007 Tours de France; and
- The London 2012 Games.

3.7 Examining the spectrum demands for these events reveals a general increase over time as more extensive use is made of wireless applications. It might therefore be reasonable to assume that the spectrum demands for previous Commonwealth Games reflect a lower level of use than we might reasonably expect at Glasgow 2014. For example, the broad assumption developed for the London 2012 Games was an increase of 20 percent on the demand for spectrum at the Beijing Games. However, current evidence[14] suggests that a broad scaling up of this kind misses demands arising from some key new technologies (high definition broadcast TV for example).

3.8 Although we had made an allowance for growth in the use of high definition broadcast TV in our spectrum plan for the London 2012 Games and 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) confirmed that the demand for wireless camera channels below 4 GHz will be greater than we had predicted[15].

3.9 Similarly, the Information Age Partnership notes[16] that in "in gauging the spectrum required, it is important not simply to extrapolate from previous [Olympic] Games. The 2012 Games – characterised by digital content, IP connectivity and seamlessness - will create an unprecedented level of demand for spectrum".

3.10 With this evidence in mind, Analysys Mason's research[17] has placed less emphasis on an assessment of demand based on a top-down analysis of previous comparable events. However, comparing our estimated demand for Glasgow 2014 to the London 2012 Games – as the most recent event, albeit of a much larger scale - is valuable and the research has considered this.

3.11 We think that comparing the number of radio frequency channels required for Glasgow 2014 to similar requirements for the London 2012 Games is valuable (these are summarised in Table 3.2 below), but we also think that an accurate measure of demand cannot be established based solely on this approach. This is because the different categories of use have different channel bandwidths, which may vary over time.

Question 1. Do you agree that the most relevant comparator for a top-down approach is likely to be the London 2012 Games?

[14] See paragraph 3.10 of our Statement on our extension of Ofcom's spectrum plan for London 2012 : http://stakeholders.ofcom.org.uk/binaries/consultations/band-2500-2690-london-2012-games/statement/statement.pdf

[15] See: http://stakeholders.ofcom.org.uk/consultations/band-2500-2690-london-2012-games/statement

[16] This document is available from Department for Business, Innovation and Skills. See: http://www.bis.gov.uk/

[17] AnalysysMason, Estimating the demand for spectrum use for Glasgow 2014. http://stakeholders.ofcom.org.uk/binaries/consultations/glasgow2014/annexes/report.pdf

Question 2. Do you agree that comparing data for the number of radio channels used for specific services at different events is an appropriate approach to estimating spectrum demand? If you disagree, please explain your reasoning.

Table 3.2: Spectrum demand estimate for Glasgow 2014

Category	London demand	Glasgow demand	Percentage difference (%)
PBR	1770	598	-66
Wireless microphones	659	320	-51
In-ear monitoring (IEM)	563	267	-53
Talkback	238	113	-53
Camera control	88	44	-50
Wireless cameras including airborne cameras	52	44	-20
Point-to-point video links	14	30	114[18]
Airborne downlink	–	2	–
Satellite news-gathering (SNG) uplinks	–	18	–
Fixed satellite links (between venues)	–	9	–
Radio control for props	–	5	–

Source: Analysys Mason Ltd, 2012[19]

Bottom-up approach to demand

3.12 This approach attempts to assess the spectrum requirements of each application associated with each class of user. Our assessment can only be as good as the information available from stakeholders and obtaining relevant and reliable information is often challenging especially where the spectrum guarantees are such that users are not incentivised to minimise their spectrum use. However, the co-operation extended to Analysys Mason has been excellent and we have gained some very valuable insights into the specific demands likely from key stakeholders. This information is summarised below.

[18] One area of demand that Analysys Mason estimates suggest may be greater for Glasgow than for London is point-to-point video links. This is largely due to uncertainty regarding the availability of fibre connections at each of the venues for the Glasgow Games, and their assumption that, even with fibre being available, point-to-point links may be deployed in some cases as a back-up link. Once the availability of fibre to each venue is confirmed, it is expected that the requirement for point-to-point links can be more firmly defined, and is likely to reduce compared to our estimates.

[19] AnalysysMason, Estimating the demand for spectrum use for Glasgow 2014: http://stakeholders.ofcom.org.uk/binaries/consultations/glasgow2014/annexes/report.pdf

Comparison of bottom-up estimates with London 2012 benchmarks

3.13 For the purposes of comparing the estimated demand for Glasgow 2014 with London 2012, estimates of the numbers of frequency requests for the London 2012 Games have been used, noting that it is expected that the Glasgow 2014 requirement will be somewhat less for a number of reasons:

- there are fewer sporting events in Glasgow 2014 compared to the London 2012 Games, and some key events where wireless use will be significant are not included (e.g. sailing);
- there are fewer countries involved in Glasgow 2014 compared to the London 2012 Games and therefore media coverage is somewhat lower; and
- previous experience of Commonwealth Games reported to us by a number of stakeholders suggests that fewer broadcasters produce their own live footage of Commonwealth Games, with many using pictures taken from the HB. The estimates we have been given are that broadcasters from only four or five Commonwealth countries will produce their own footage, with the rest using the coverage provided by the HB.

Demand by user

Glasgow City Council (GCC)

3.14 GCC will be responsible for managing various aspects of Games requirements and supporting the OC:

- city wide operations supporting Glasgow 2014
- transport within the Strathclyde region for Games spectators (and visiting teams)
- provision of public information on Games events, travel and road closures in conjunction with the OC
- delivery of the cultural programme
- resilient communications

3.15 At this stage, the only requirement that we have been able to gather from GCC relates to resilient communications. For this, the following requirements were identified:

- GCC has a resilient extranet (part of a national network) that provides communications between Council buildings and externally.
- The Council have a MPT1327 trunked radio, 'TaitNet', system. The Council's estimate is that this system has around 40–50% spare capacity that can be utilised at larger events such as Glasgow 2014.
- GCC's resilience officers have Airwave radios, with their own Airwave talk group[20]. There is also scope to borrow Airwave radios from neighbouring Council areas, which use the same talk group. Initial estimates are that the Airwave network will have sufficient capacity within its current configuration within

[20] See: http://www.airwavesolutions.co.uk/

Glasgow to accommodate the additional usage that the Games will create without requiring further spectrum.

- The Council also commented that in other large sporting events hosted in Glasgow (e.g. Glasgow Half Marathon), Glasgow Life (who organise the running events) make use of the Radio Amateur's Emergency Network (Raynet)[21].

Glasgow 2014 Organising Committee (OC)

3.16 Requirements for the OC have been identified under the following sub-categories of demand:

Operational

3.17 Only PMR requirements were identified for the operational functioning of the OC. The OC has identified that by default PMR communications would typically be self-contained at venues or with adjacent venues, with the exception of the transport operations, road events and the Queen's Baton Relay, where wider area coverage may be required. The provisional estimate from our independent research provides for 15 frequency channels for large venues; 12 channels for medium-sized venues and 8 channels for small venues, including the IBC and Athletes' Village. It is assumed that outdoor events would require 20 channels, slightly more than for a large venue, reflecting increased complexity. Inter-venue communications will use wired solutions or mobile telephony.

Timekeeping, synchronisation and results

3.18 Timekeeping, synchronisation and results services will be provided by to Glasgow 2014 by their appointed service provider. At this stage, provision for one PMR channel for this use per venue, with a further channel for outdoor events are the only requirements identified. Other requirements are expected to use licence exempt spectrum unless changes in working practices arise before 2014.

Catering/vendors

3.19 Only PMR requirements have been identified for a single catering/vendor contractor. One PMR channel is assumed per Games venue as sufficient for this function.

Safety, Security and Crowd Management

3.20 The preliminary requirements for PMR for the Games safety, security and crowd management operations are estimated at between 50% and 100% of the operational requirements of Glasgow 2014. For the interim estimate we are assuming a scenario of 100% of the operational requirements.

Fleet

3.21 The OC expects to provide cars, but will make use of mobile telephony to communicate with these. Some use of PMR may be expected for other Games transport such as buses for athletes and for overall transport operations between venues. It has been estimated that a single PMR channel per Games site would be required.

[21] See: http://www.raynet-uk.net/

Queen's Baton Relay

3.22 The Queen's Baton Relay will also be managed using PMR radios and it has been estimated that 50 handsets/users might be expected for this, which could be served by 6 channels, equivalent to the number of PMR channels required for a large venue in the Games. As the relay route is expected to cover most of Scotland, frequencies for this will be required on a Scotland-wide basis. In addition, it is likely that there will be a small PMR requirement to support 'sports presentation', which refers to presentations and announcements made to spectators before and during events

3.23 Ofcom will work with stakeholders to ensure that we conserve spectrum in the UHF frequency range, which includes the spectrum for PMR required for the Queen's Baton Relay. We also believe that talkback, telemetry and wireless camera spectrum (including spectrum for airborne wireless cameras) may be needed for the Queen's Baton Relay.

Press conferences

3.24 A requirement for wireless microphones was identified by the OC for press conferences at each of the Games venues and key sites. It is assumed that two wireless microphones would be sufficient for these purposes at each site.

Opening and Closing Ceremonies

3.25 Requirements for wireless microphones and IEMs have been identified for the opening and closing ceremonies. These requirements will not be confirmed until after a ceremonies contractor has been appointed and has begun its planning. Although we expect the demand for Glasgow 2014 to be less than that for the London 2012 Games, the benchmark figures from the London 2012 frequency requests have been used to estimate the number of each type of equipment required for Glasgow 2014.

3.26 Our current data from the London 2012 informs our view of demand.. The figures we have are not final demand numbers for the London 2012 Games and cannot be released for publication, but they do provide a benchmark value in the absence of more detailed information from stakeholders.

Sports presentation

3.27 The following requirements have been independently estimated for sports presentation and the medal ceremonies:

- one PMR channel per venue and a further channel for outdoor events
- two wireless microphones per venue and a further two microphones for outdoor events
- one IEM channel per venue and a further channel for outdoor events
- one talkback channel per venue and a further channel for outdoor events.

Broadcasters

3.28 For the Commonwealth Games it is typically the case that a Host broadcaster (HB) is appointed to produce the main live TV coverage that RHBs will transmit in their own countries. A domestic rights holder is also appointed.

3.29 For the Manchester Commonwealth Games in 2002 the BBC was appointed as both HB and domestic rights holder. For Glasgow 2014, the BBC is the domestic rights holder, but is not the HB, which was announced in July as Global Television. Therefore, one reason why the spectrum demand for Glasgow 2014 may be higher than it was for the Manchester Games, may be that at least two broadcasters (i.e. the HB and the BBC) are present and providing extensive coverage of Games events. We also anticipate that the spectrum requirement for other RHBs and non-RHBs will be different because non-RHBs don't have access to footage except for news reporting purposes.

3.30 At previous Commonwealth Games we understand that a national broadcasting presence is typical from a broadcaster based in each of Canada, South Africa, Australia, New Zealand and the UK. Thus, it was assumed that estimates should provide for up to five broadcasters present at Glasgow 2014. Estimates for the HB's requirements are described below. In addition, BBC Sport's estimated requirements as domestic rights holder were included in the data gathered by Analysys Mason.

3.31 Estimates for a further three RHBs were based on the following factors, assuming a smaller presence than BBC Sport:

- rights holding broadcaster #1: 75% of BBC Sport's requirements
- rights holding broadcaster #2: 75% of BBC Sport's requirements
- rights holding broadcaster #3: 75% of BBC Sport's requirements.

3.32 It was assumed that aerial uplinks/downlinks and airborne (e.g. helicopter) camera links would be required only by the HB. The BBC stated that if the HB's provision of footage is sufficient it would not look to supplement footage by deploying an additional helicopter.

Host Broadcaster's requirements

3.33 The HB's requirements for each category of use were estimated as follows:

- **PBR/PMR** – It is estimated that four PMR channels would be required by the HB per venue for its own logistical and operational requirements, with four further channels for outdoor events.

- **Wireless microphones**– It has been assumed that only wireless cameras have associated wireless microphones, and wired cameras used wired options. It was also assumed that two wireless microphones would be required per wireless camera. Hence, the number of wireless microphones required is twice the number of wireless cameras estimated below.

- **In-ear monitoring**– It was assumed that four IEMs would be required for the HB at each venue or Games site, sufficient for two presenters and two further guests on-screen simultaneously in a studio or venue environment. This is a generous estimate and we would therefore expect actual requirements to be less at many venues.

- **Talkback**– One outside broadcast supplier estimated that three talkback channels are typically required per venue or Games site. We have used this estimate multiplied by the number of Games sites with a further three channels for outdoor events.

- **Camera control and telemetry**– On the assumption that a wireless camera will require wireless camera control wherever it is deployed alongside other cameras to ensure continuity of picture quality, it has been assumed that each wireless camera deployed would require camera control. It is also assumed that wired cameras could be controlled through a wired option. Where wireless cameras are deployed for ENG/SNG it is assumed that camera control is not required. No separate requirement for telemetry was identified.

- **Wireless cameras**– On the basis of interviews it has been estimated that 29 wireless cameras would be required across all venues, with a further five vehicle-mounted (e.g. motorcycle) wireless cameras for outdoor events. In our independent study no distinction was made between venue-based cameras that would use terrestrial links and vehicle-mounted wireless cameras, which would use an aerial uplink to an airborne relay.

- **Temporary video links**– It has been assumed that 50% of Games sites would require a fixed point-to-point microwave links for resilience against the failure of fibre links, and hence calculated that the host broadcaster would require ten temporary fixed video links. A single helicopter downlink was added to account for relaying wireless camera footage from outdoor events and for aerial footage.

- **SNG uplink**– Provision for five SNG-type uplinks from OB trucks was included for the HB, other RHBs, BBC Sport and other domestic broadcasters, in line with an estimate for the number expected by BBC Sport (which said up to ten trucks might be used).

- **Fixed satellite uplink/downlink**– it is assumed that a fixed satellite uplink would be required for redundancy at 25% of venues for the host broadcaster. We also assumed that a further uplink/downlink site would be required to receive these links and for distribution purposes.

- **Props**– No requirement for RF-controlled props was identified for the host broadcaster.

Domestic rights holder's requirements

3.34 BBC Sport's requirements were estimated, based on discussions about its provisional requirements. BBC Sport has said that it will look more closely at requirements for Glasgow 2014 after the London 2012 Games.

- **PBR/PMR**– BBC Sport estimated requirements of ten handsets at the two main stadiums for athletics and the opening and closing ceremonies (Hampden Park and Celtic Park), and a further ten handsets in the Pacific Quay area. As a worst-case scenario, we assumed three users per channel, giving a total requirement of ten channels.

- **Wireless microphones**– BBC Sport estimated the following requirements:

    - two wireless microphones per wireless camera
    - two wireless microphones for each of ten roving non-wireless cameras
    - six wireless microphones for the studio used for presentations
    - six wireless microphones each for Hampden Park and Celtic Park.

- **IEMs**– BBC Sport estimated the following requirements:
    - six channels of in-ear monitoring each for Hampden Park and Celtic Park
    - four channels for the studio used for presentations.
- **Talkback** – BBC Sport estimated the following requirements:
    - one talkback channel per wireless camera
    - four talkback channels for the studio
    - two talkback channels each for Hampden Park and Celtic Park.
- **Camera control and telemetry**– BBC Sport estimated the requirement of one camera control channel per wireless camera.
- **Wireless cameras**– BBC Sport expected to prepare fixed receivers at all venues and to use only three wireless cameras in total in and around venues.
- **Temporary video links**– Requirements are small, mainly for resilience/redundancy between key locations such as the studio, IBC and other presentation space to Pacific Quay. In addition, up to ten temporary links between roving cameras and OB trucks are expected at venues. We have assumed that five will be used as a typical scenario.
- **SNG uplink**– A worst-case scenario of ten satellite uplinks would be required if fibre was unavailable and for resilience. These would be re-used between venues.
- **Fixed satellite uplink/downlink**– Two further fixed uplinks would be required for resilience from the two stadiums for athletics and the opening/closing ceremonies.
- **Props**– No requirements identified.

Day-to-day requirements

3.35 In addition, day-to-day requirements for national broadcasters have been estimated. These includethe annual wireless licences that the UK broadcasters currently hold covering Glasgow/Scotland.

3.36 In this case, BBC Scotland's current studio and external requirements have been collected and a scaling factor applied to account for similar operations by other national broadcasters such as STV, Sky and Channel 4, in Glasgow. The following factors have been applied for our interim estimates to derive requirements from BBC Scotland's requirements:

- STV: 50% of BBC Scotland's requirements
- Sky: 50% of BBC Scotland's requirements
- SITN/Channel 4: 50% of BBC Scotland's requirements.

BBC Scotland's requirements

3.37 BBC Scotland's potential day-to-day requirements were identified as follows for each category of use:

- **PBR/PMR**– The BBC identified minimal day-to-day usage for PMR. Analysys Mason,estimate that two channels would be required.

- **Audio links and wireless cameras** – Our estimate is based on the number of licences held by the BBC for use at its Pacific Quay studios for wireless microphones, in-ear monitoring, talkback, camera control and telemetry. In addition, Analysys Mason have provided for two wireless microphones, two channels for IEMs and two talkback channels each for an ENG/SNG crew and documentary crew in line with the number of crews that BBC Scotland indicated would be typical. We further accounted for a wireless camera for the ENG/SNG crew.

- **Temporary video links**– The BBC does not currently expect to make use of fixed microwave links in the Glasgow area.

- **SNG uplink**– In 2014 BBC Scotland will own seven SNG trucks, with more available from other divisions of the BBC. Analysys Mason Ltd has included a requirement for seven SNG uplinks, although we would not expect the BBC to simultaneously deploy all seven in Glasgow during the Games.

- **Fixed satellite uplink/downlink**– The BBC uses satellite uplinks and downlinks at its Pacific Quay studio to receive SNG data and for distribution and resilience purposes. Analysys Mason Ltd have therefore accounted for this single fixed site for satellite links.

- **Props**– No requirement for RF-controlled props was identified by BBC Scotland.

Question 3. To what extent do you think we should place more emphasis on estimating demand from information provided by stakeholders rather than on the limited data available from past events of a similar scale?

Theoretical approach to validate results and assumptions

3.38 This approach takes into account existing technical guidance for programme making at large events. This guidance includes recommendations and reports from the European Radiocommunications Committee (ERC) and the Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT). These are listed below:

- ERC Recommendation 70-03 relating to the use of short-range devices;[22]
- ERC Recommendation 25-10 relating to frequency ranges for the use of temporary terrestrial audio and video SAP/SAB links (incl. ENG/OB);[23]
- ERC Report 33 - the use of radio frequencies above 20 GHz for fixed services and ENG/OB;[24]
- ERC Report 38 - handbook on radio equipment and systems video links for ENG/OB use;[25]
- ERC Report 42 - handbook on radio equipment and systems radio microphones and simple wide band audio links;[26] and

[22] http://www.erodocdb.dk/docs/doc98/official/pdf/rec7003e.pdf
[23] http://www.ecodocdb.dk/doks/relation.aspx?docid=1865
[24] http://www.erodocdb.dk/docs/doc98/official/pdf/REP033.pdf
[25] http://www.erodocdb.dk/docs/doc98/official/pdf/REP038.pdf

- ECC Report 44 - Guidance for radio usage at special events[27]; and
- ECC Report 2 - SAP/SAB (incl. ENG/OB) spectrum use and future requirements.[28]

Question 4. Is there any other relevant technical guidance that we should be taking into account in order to validate our assumptions and our estimate of spectrum demand?

[26]http://apwpt.org/downloads/ercreport042radioequipmentandsystemsradiomicro.pdf
[27] http://www.erodocdb.dk/docs/doc98/official/pdf/ECCRep044.pdf
[28]http://www.ecodocdb.dk/doks/relation.aspx?docid=1615

Section 4

Requirements for support and infrastructure services

Introduction

4.1 As the description suggests, support and infrastructure services support the organisation of Glasgow 2014 and/or have a presence at venues. They include:

- Emergency and Public Safety Services (E&PSS);
- safety, security and crowd management;
- public transport;
- construction;
- catering and vendors;
- public telecommunications;
- healthcare; and
- other third-party contractors.

Glasgow 2014 Organising Committee (OC)

4.2 Requirements for the OC have been identified under the following sub-categories for the categories of demand:

Operational

4.3 Only PMR requirements were identified for the operational functioning of the Organising Committee. Glasgow 2014 OC identified that by default PMR communications would typically be self-contained at venues or with adjacent venues, with the exception of the transport operations, road events and the Queen's Baton Relay, where wider area coverage may be required. The provisional estimate from our independent research provides for 15 frequency channels for large venues; 12 channels for medium-sized venues and 8 channels for small venues, including the IBC and Athletes' Village. It is assumed that outdoor events would require 20 channels, slightly more than for a large venue, reflecting increased complexity. Inter-venue communications will use wired solutions or mobile telephony.

Catering/vendors

4.4 Only PMR requirements have been identified for a single catering/vendor contractor. The OC confirm that there may be more than one catering/vending contractor. One PMR channel is assumed per Games venue as sufficient for this function.

Safety, Security and Crowd Management

4.5 The preliminary requirements for PMR for the Games safety, security and crowd management operations are estimated at between 50% and 100% of the operational requirements by Glasgow 2014. For the interim estimate we are assuming a worst-

case scenario of 100% of the operational requirements. No other category of use has been identified as relevant to security.

Fleet

4.6 The OC expects to provide cars, but will make use of mobile telephony to communicate with these. Some use of PMR may be expected for other Games transport such as buses for athletes and for overall transport operations between venues. It has been estimated that a single PMR channel per Games site would be required.

Glasgow City Council (GCC)

4.7 Glasgow City Council will be responsible for managing various aspects of Games requirements and supporting the OC:

- transport within the Strathclyde region for Games spectators (and visiting teams)
- provision of public information on Games events, travel and road closures
- cultural programme
- resilient communications, which is being led by Glasgow 2014.

4.8 At this stage, the only requirement that we have been able to gather from GCC relates to resilient communications. For this, the following requirements were identified:

- GCC has a resilient extranet (part of a national network) that provides communications between Council buildings and externally.
- The Council have a MPT1327 trunked radio, 'TaitNet', system. The Council's estimate is that this system has around 40–50% spare capacity that can be utilised at larger events such as Glasgow 2014.
- GCC's resilience officers have Airwave radios, with their own Airwave talk group[29]. There is also scope to borrow Airwave radios from neighbouring Council areas, which use the same talk group. Initial estimates from the E&PSS sectors are that the Airwave network will have sufficient capacity within its current configuration within Glasgow to accommodate the additional usage that the Games will create, without requiring further spectrum.
- The Council also commented that in other large sporting events hosted in Glasgow (e.g. Glasgow half marathon), Glasgow Life (who organise the running events) make use of the Radio Amateur's Emergency Network (Raynet)[30].

4.9 In common with the spectrum demands for the London 2012 Games we expect the spectrum demands for support and infrastructure services to develop in stages and increase towards 2014. Although no estimates are available at this early stage there is a potential need for additional aeronautical services, noting that these would be expected to be met in existing aeronautical bands.

[29] See: http://www.airwavesolutions.co.uk/
[30] See: http://www.raynet-uk.net/

4.10 The spectrum plan will continue to develop to account for these demands as far as possible. However, the establishment of COGSPLAG will be of considerable assistance in exposing these requirements at the earliest possible stage so that they can be taken into account in the spectrum plan.

Section 5

Other spectrum requirements

Introduction

5.1 There are a number of other services that will be important if not essential to the success of Glasgow 2014. These include:

- broadband mobile wireless applications that use licence exempt technologies such as WLANs, Wi-Fi and Bluetooth;
- timing, location and scoring services that also use licence exempt spectrum and can be linked to the radio-navigation satellite services (e.g. Global Positioning Service); and
- TV and radio satellite communications links.

Wireless Local Area Networks (WLANs)

5.2 We expect WLANs to be deployed for specific accredited client groups. Hot-spot services could also be offered to spectators and athletes. Spectrum for WLANs is available on a licence-exempt basis. We require an estimate of the likely demand for spectrum for WLAN-based applications.

5.3 We understand that the OC are expected to develop a policy for WLAN use in Glasgow 2014 venues during 2013 and we will take this into account. Where services are critical to the success of the Glasgow 2014 Games we recommend that users look to alternative bands where spectrum management (e.g. frequency coordination) can be applied.

Timing and Scoring

5.4 Nowadays, professional timekeepers and data handlers, supported by specially trained local volunteers, use equipment including public and sport-specific scoreboards; miles and miles of cables and optical fibre, dozens of TV generators and state-of-the-art timekeeping and data-handling technology and adapted to the requirements of each sport. For example in international swimming events only a hundredth of a second could separate a gold and silver medallist. High-speed video cameras confirmed that the results recorded by electronic systems. At other large events around the world there has been a trend towards using licence exempt spectrum for timing and scoring technologies, but we recommend that essential timing and scoring services do not use licence exempt spectrum for Glasgow 2014 because licence exempt spectrum is extensively used in the UK

Fixed and broadcast satellite services

5.5 Fixed satellite services are used for data, point-to-point links, broadcasting distribution and a number of other applications. We do not believe that there will be additional spectrum requirements for fixed satellite services.

Other Services

5.6 There are services that will not be directly linked with Glasgow 2014, but which will help to convey Glasgow's image around the world. These services include:

PMSE

5.7 Wireless applications are extensively used in the UK to support PMSE. In some cases, the five broad categories of use briefly described below may be linked directly or indirectly to Glasgow 2014. In other cases, they will be completely unrelated but because they are happening at the same time and nearby they may still have spectrum requirements.

Special events

5.8 This category includes sporting, musical and theatrical events. Such events will continue to take place during Glasgow 2014. Users will have similar requirements (e.g. wireless microphones, talkback and in-ear monitors) to those at the Games.

Newsgathering

5.9 News reporting is often unplanned. A radio or television news team is despatched at short notice to a previously unanticipated location to cover an unfolding story. Spectrum requirements cannot therefore be predicted in advance. A news team will typically comprise:

- an interviewer using a wireless microphone, an in-ear monitor and talkback to an Satellite News Gathering (SNG) truck;
- a camera operator using a wireless camera and talkback; and
- an SNG truck capturing the live coverage, communicating with all the parties involved and relaying this back to a studio.

5.10 We anticipate that current users of newsgathering applications will be more active during Glasgow 2014. We also expect the total number of users to increase with the presence of many non-RHB broadcasters.

5.11 Learning from past events we think that it will be essential to properly co-ordinate these day-to-day demands for PMSE with those for Glasgow 2014.

Outside broadcasts

5.12 Outside broadcasts often cover sporting events live. They are likely to use the full range of PMSE applications.

Community use

5.13 Community organisations (e.g. places of worship and schools) will continue to use wireless microphones during Glasgow 2014.

Short-term restricted-service (SRSs and RST Event)

5.14 S-RSs and RST-E licences are granted for covering special events, special projects (e.g. training) and trial services (e.g. in preparing to apply for a community radio licence). However, FM spectrum for such services is invariably in short supply. Subject to competing demands for SRS spectrum, it may be possible to license one or more such short-term, small area, analogue radio services dedicated to a specific (e.g. sporting or cultural) aspect of Glasgow 2014.

5.15 There are also RTSL-E licences, which may be available to provide a limited duration Digital Terrestrial Television service to cover a specific event. Ofcom issues RTSL-Es

licences under the Broadcasting Act 1990 as amended by the Broadcasting Act 1996 and the Communications Act 2003 ("the Broadcasting Act").

5.16 Further guidance on RTSL-E Broadcasting Act licences and the standard form RTSL-E Wireless Telegraphy Act (transmission) licence and further information about the range of television services that Ofcom licenses can be found on the Ofcom website, http://licensing.ofcom.org.uk/tv-broadcast-licences/rtsl-e/

Section 6

Reducing spectrum demand

Introduction

6.1 Glasgow 2014 is expected to bring significant economic and social benefits to the city of Glasgow. But, as with any other scarce resource, using spectrum to realise these benefits comes at a cost. In particular, there will be an opportunity cost because other services of value to society may be denied use of the same spectrum. Glasgow is one of the most congested cities of the UK for spectrum use, which therefore potentially carries a high opportunity cost even in normal circumstances. The requirements of Glasgow 2014 will increase that cost. We want to minimise this cost while meeting the UK spectrum guarantees[31].

6.2 One way to reduce that opportunity cost is to reduce demand, particularly by relying more heavily on wired communications. This is considered below.

Relying more heavily on wired communications

6.3 Independent advice for the London 2012 games[32] suggests that manufacturers have developed fixed and mobile optical-fibre cameras in response to the introduction of high definition (HD) TV. High-bandwidth optical fibre can carry many video streams over a single link, and the costs associated with installation have fallen. It is therefore possible to rely more heavily on wired communications, substituting for spectrum use, than has previously been the case. The Analysys-Mason study for the London 2012 Games of the potential to use wired technology[33] provides some qualitative assment of costs. However, it is important to keep in mind that the demand for wireless by some key groups will continue to increase – i.e. many more devices are being used these days that cannot connect to a LAN.

6.4 The independent advice for the London 2012 games[34] also suggests that fibre-wireless networks are currently used to good effect by broadcasters and so are already likely to be the solution of choice in venues that require wireless-camera reception. If so, there is little scope to improve spectrum efficiency. However, using higher frequencies (especially up to 7 GHz) for stadium applications would benefit spectrum planning.

Question 5. Do you have any comments on how relying on wired communicatiosn could be used to reduce spectrum demand at Glasgow 2014?

[31] SPECTRUM GUARANTEES

[32] See: http://stakeholders.ofcom.org.uk/binaries/consultations/london2012/annexes/wire_wireless2.pdf

[33] See: http://stakeholders.ofcom.org.uk/binaries/consultations/london2012/annexes/wire_wireless2.pdf

[34] See: http://stakeholders.ofcom.org.uk/binaries/consultations/london2012/annexes/wire_wireless2.pdf

Authorising spectrum use

6.5 Effective authorisation arrangements will be essential to ensure spectrum use for Glasgow 2014 is efficient and properly coordinated and the risk of harmful interference is minimised.

6.6 We authorise civil use of spectrum in the UK in two ways:

- by exempting use of particular equipment from the requirement to hold a licence under the Wireless Telegraphy Act 2006[35] and
- by granting such licences.

6.7 Under section 8(1) of the Wireless Telegraphy Act 2006, it is unlawful to establish, install or use wireless telegraphy equipment except under and in accordance with a licence granted by Ofcom unless the use of the equipment is exempt from the requirement to hold a licence. Each authorisation generally provides the right to transmit at particular powers, on a particular frequency and in a particular geographic area. Unauthorised use of spectrum is a criminal offence, the maximum penalty on conviction for which is a two-year prison term and/or an unlimited fine by the Courts.

Monitoring

6.8 We are currently monitoring spectrum use at two central Glasgow locations to verify and/or better understand levels of interference to spectrum that we believe can be made available for Glasgow 2014. We will continue to do so in the run-up to the Games to assess how changes to the built environment, especially in the centre of Glasgow, change propagation and the implications for ability to re-use spectrum.

Digital Technologies

6.9 For PMR and PMR like services the latest digital technologies provide twice as many traffic channels within the traditional 12.5 kHz bandwidth and any new or upgraded systems are strongly advised to implement one of these new technologies. They are now available in tier 3 format which is broadly equivalent to MPT1327, but with reduced bandwidth requirements. DMR uses conventional 12.5 kHz channel assignments but supports two concurrent traffic channels whereas DPMR uses 6.25 kHz channel assignments.

[35] www.opsi.gov.uk/acts/acts2006/pdf/ukpga_20060036_en.pdf.

Section 7

Spectrum supply for Glasgow 2014

Introduction

7.1 In the previous sections we have considered the demand for spectrum by:

- identifying users who might require spectrum for the Games;
- identifying more accurately users covered by the spectrum guarantees;
- estimating user demands and the services that will generate them;
- considering technology changes that might affect those demands;
- considering how those demands might be reduced with no loss of benefit; and
- our experience gained from planning for the London 2012 Games.

7.2 In this section we consider the supply of spectrum:

- assessing the suitability and availability of spectrum to meet the estimated demand; and

Supply

7.2 No spectrum is set aside in the UK specifically for events comparable to Glasgow 2014. Instead, spectrum could be supplied from three sources:

- civil spectrum;
- public-sector spectrum; and
- licence exempt spectrum.

7.3 Because of the scale of the spectrum demand likely to be generated by Glasgow 2014, alongside the day-to-day demands that are already high, we have considered supplying spectrum from all three of these sources.

Sources

Civil spectrum

7.4 All of the wireless services required by Glasgow 2014 operate to some extent day-to-day in the UK. We have therefore looked at the ability of the spectrum that they already use to meet the requirements of Glasgow 2014.

7.5 We have in the past (e.g. for the London 2012 Games) negotiated an extension to the arrangements for the temporary use of civil spectrum that has already been licensed. This, too, is a possibility for Glasgow 2014.

7.6 Under paragraph 8(5) of Schedule 1 to the Wireless Telegraphy Act, we may at any time by giving notice in writing revoke or vary a licence if it appears to us to be necessary or expedient to do so for the purpose of securing compliance with an

international obligation of the UK. The UK Government is able to direct us for the same purpose.

Land mobile radio

7.7 Spectrum used for land mobile radio (e.g. 450-470 MHz) is already congested in Glasgow. It is also used extensively for talkback. Any significant use of these bands for Glasgow 2014 is likely to affect other users.

PMSE

7.8 Some 2.5 GHz of spectrum in 75 distinct bands between 47.55 MHz and 48.4 GHz is currently allocated for services ancillary to programme making and broadcasting (SAP/SAB),also known as PMSE in the UK. But the amount that is readily usable is constrained by the preponderance of equipment in the UHF bands – primarily 470-862 MHz for wireless microphones and 2 to 3 GHz for wireless cameras.

7.9 We plan to award spectrum in the 2.6 GHz range, which is currently used by PMSE for wireless cameras, during 2012[36] and there will be no requirement for applicants for the licences associated with the 2.6 GHz award to take our plans for Glasgow 2014 into account.

7.10 Spectrum access for PMSE for wireless microphones is changing as the Digital Switchover of TV services nears completion. Our statement of 16 May 2011 refers[37], see also JFMG post-DSO look up tool for further information.[38]

Public-sector spectrum holdings

7.11 The UK Government has indicated that it will be making 500 MHz of spectrum below 5 GHz available by 2020[39]. Significant amounts of spectrum are managed by UK public-sector bodies. In particular, the Ministry of Defence (MOD) manages spectrum essential for defence and security purposes that is currently made available for PMSE use.

7.12 The UK Government's objective is to ensure that the UK meets its commitment to make spectrum available for Glasgow 2014 at minimum cost to UK citizens and consumers. It is therefore intended that the requirements of Glasgow 2014 will wherever possible be met from spectrum already available for PMSE. If spectrum demand exceeds current supply from spectrum already available for PMSE the UK Government will ensure that the UK meets its commitment to Glasgow 2014 by making spectrum from within bands managed by the public sector, notably the MOD, available.

7.13 The MOD has confirmed[40] that it plans to release spectrum in the 2.3 GHz range in 2013. Should the timing of the MOD's plans change, applicants for the licences associated with the 2.3 GHz spectrum release will need to take account of our plans

[36] See:http://stakeholders.ofcom.org.uk/spectrum/spectrum-awards/awards-in-preparation/800MHz_2_6_combined/

[37] http://stakeholders.ofcom.org.uk/consultations/bandmanager09/statement/

[38] http://www.jfmg.co.uk/jfmgecom/wireless/public/microphonedso.aspx

[39] Enabling UK Growth – Releasing public spectrum, Department for Culture, Media and Sport, March 2011. See: http://www.culture.gov.uk/publications/7994.aspx

[40] See: http://www.mod.uk/DefenceInternet/AboutDefence/WhatWeDo/ScienceandTechnology/Spectrum/

for Glasgow 2014 along with any requirements to ensure efficient coordination between shared Games and non-Games use of the same spectrum.

Licence-exempt spectrum

7.14 Certain equipment may be exempted in the UK from the requirement to be licensed under the Wireless Telegraphy Act 2006 because its use is not likely to cause harmful interference. Experience from past Games has shown, however, that the unusual concentration of such equipment in particular venues can create the potential for localised harmful interference. We are exploring with GCC, CGS and the OC how such use can best be controlled and/or coordinated to avoid any disruption to the smooth running of Glasgow 2014. Practical measures (e.g. preventing certain types of equipment from being brought into Glasgow 2014 venues or actively coordinating use between users) have proved successful at past Games.

7.15 We understand that the OC are developing a policy for Wi-Fi use in Glasgow 2014 venues and we will take this into account when further developing our plans for managing licence exempt spectrum. Though Wi-Fi policy is not likely to be defined until 2013 and owned by the OC, it may take into account whether broader regulatory changes to the Wireless Telegraphy Exemption Regulations are needed and what the impact is expected to be on citizens and consumers and key stakeholders including cellular Mobile Network Operators (MNOs).Any changes of to the Wireless Telegraphy Exemption Regualtions may require specific consideration and for Ofcom to consult upon them.

7.16 The following requirements have been noted as typically using licence-exempt frequencies:

- Timing and medal ceremonies at events tend to use some form of wireless link. Glasgow 2014 has informed us that this would use licence-exempt frequencies; It is our view that essential services and events such as the medal ceremonies should be resilient to interference. This cannot be guaranteed if licence exempt spectrum is used.

- Depending on the format of the opening and closing ceremonies, props might be envisaged (e.g. flares) that use some form of wireless control, which would typically be provided using a short-range device (SRD) or other licence-exempt radio.

Re-using spectrum efficiently

7.17 It will be necessary to protect wireless services used at Glasgow 2014 from harmful interference their required area of operation. However, most services (e.g. wireless microphones and cameras) will only need to operate over short distances, between the transmitter and its associated receiver. In many cases, these will be restricted to a venue, possibly extending to back-of-house facilities as well.

7.18 The principles for establishing the required protection distances could be:

- estimate the wanted signal at the edges of desired reception using free-space path loss;
- build in a fade margin; and
- add the relevant carrier-to-interference protection.

Wireless microphones

7.19 We commissioned CSMG to analyse how wireless microphones, IEMs and talkback systems could make more efficient use of spectrum. We published its report on 19 February 2009[41]. In summary, it found that:

- 470-862 MHz (UHF Bands IV and V) will remain critical in the period to the London 2012 Games; but for some uses (e.g. short-range camera audio), higher-frequency spectrum could start to be used by the London Games; and
- overall, there are opportunities for improvements in wireless-microphone technology (notably digital transmission systems) to improve spectrum efficiency.

Wireless cameras

7.20 Simultaneous use of the same spectrum without harmful interference is impossible when equipment is co-located unless the technology employed (e.g. dynamic frequency selection) or user behaviour facilitates this. Co-channel use is possible when a minimum distance between transmitters is achieved. This separation distance is a function of the radiated power and receiver characteristics.

7.21 The distance can also be reduced by offsetting the centre frequency of one of the channels being used. As the centre-frequency offset increases, the distance between the interferer and the victim reduces (all things being equal)[42]. It is therefore possible that offsetting the channels used by wireless cameras from one venue to another would allow more efficient use of the spectrum.

7.22 Practicality is an important consideration here. We understand most wireless cameras can be tuned in 1 MHz increments, but this may not be the case for all. Offsetting could also complicate licensing processes as each venue could end up with a different offset, making it more complicated to move equipment between venues or to protect against harmful interference from airborne use. It may therefore not be appropriate to all deployment scenarios, but this is an aspect that we will investigate further using legacy information from the London 2012 Games.

7.23 We have re-tested this approach in Analysys Mason's[43]. For PBR, a theoretical assessment using a radio planning tool to determine a practical re-use distance has been undertaken for propagation paths between 13 of the Glasgow 2014 venues that are located within central Glasgow, as set out in Table 7.1.

[41] http://stakeholders.ofcom.org.uk/binaries/spectrum/spectrum-policy-area/projects/ddr/wirelessmics.pdf

[42] One stakeholder has indicated that re-use distances of approximately 2km are typical.

[43] AnalysysMason, Estimating the demand for spectrum use for Glasgow 2014, 12 March 2012. http://stakeholders.ofcom.org.uk/binaries/consultations/glasgow2014/annexes/report.pdf

Table 7.1 Latitude and longitude for Glasgow city-based Games venues

Venue	Latitude	Longitude
Strathclyde Country Park	55.7975	-4.023056
Cathkin Braes Country Park	55.798605	-4.232141
Hampden Park	55.825864	-4.252003
Glasgow Green (Hockey Centre)	55.844301	-4.235015
National Indoor Sports Arena/Sir Chris Hoy Velodrome	55.847222	-4.208042
Barry Buddon Shooting Centre	55.847879	-4.205264
Tollcross Aquatics Centre	55.848307	-4.17724
Celtic Park	55.849722	-4.205556
Ibrox Stadium	55.853206	-4.309256
Scottish National Arena	55.860297	-4.284926
Scottish Exhibition and Conference Centre	55.860849	-4.28812
Kelvingrove Lawn Bowls Centre	55.867666	-4.289163
Scotstoun Leisure Centre Precinct	55.881137	-4.34181

Source: Analysys Mason Ltd, 2012[44]

7.24 For the London 2012 Games we predicted path losses between the Olympic Park and other venues using two different software tools. Both produced the same result to within ±3 dB. Although we have not reproduced this study for Glasgow 2014 we think the general modelling should be similar. The model parameters used for the London 2012 Games study were:

- ITU-R P1546-3 – 50% of time and 50% of locations, with both receive and transmit antenna at the same height; and
- ITU-R P452 – 10% availability, with both receive and transmit antenna at the same height.

7.25 The detailed results for London 2012 are set out in Table 7.2 over the page

Table 7.2 . London 2012 Games: Predicted path losses between the Olympic Park and other venues (dB)

Frequency	Propagation model	Antenna height	Broxbourne	Earl's Court	Eton Dorney	ExCeL Exhibition Centre	Horse Guards Parade	Hyde Park	Lord's Cricket Ground
170 MHz	ITU-R P1546-3	10 m	155.09	132.15	157.95	108.33	125.49	129.16	120.07
350 MHz			163.21	140.05	165.36	115.04	133.33	136.96	127.48
450 MHz			166.04	142.80	167.93	117.38	136.07	139.67	130.05
600 MHz		1.5 m	187.79	170.05	191.47	142.58	166.59	166.68	152.07
800 MHz			193.33	174.41	196.66	146.22	170.87	170.91	155.93
1 GHz		10 m	176.49	151.13	177.68	124.06	144.05	147.78	137.57
2 GHz	ITU-R P452		179.04	145.13	172.74	109.46	138.90	147.32	140.87
3 GHz			185.61	149.59	178.72	112.99	142.85	152.33	144.68
5 GHz			193.57	155.44	186.22	117.43	147.93	158.94	150.29
7.5 GHz			199.28	160.30	192.93	120.96	152.09	164.42	154.80
9 GHz			201.57	162.56	195.97	122.55	154.00	166.96	156.84

[44]AnalysysMason Ltd, Estimating the demand for spectrum use for Glasgow 2014. http://stakeholders.ofcom.org.uk/binaries/consultations/glasgow2014/annexes/report.pdf

Frequency	Propagation model	Antenna height	Maritime Greenwich	North Greenwich Arena 1	Regent's Park	Royal Artillery Barracks	Wembley Stadium	Wimbledon
170 MHz	ITU-R P1546-3	10 m	109.05	106.03	121.38	109.53	138.37	132.72
350 MHz			115.95	112.56	128.85	116.46	146.22	140.45
450 MHz			118.35	114.83	131.45	118.88	148.95	143.13
600 MHz		1.5 m	139.61	140.07	154.72	140.01	174.85	166.67
800 MHz			143.13	143.67	158.64	143.54	179.37	170.96
1 GHz		10 m	125.12	121.38	139.05	125.67	157.62	151.48
2 GHz	ITU-R P452		113.76	108.13	144.24	114.46	162.97	140.59
3 GHz			117.28	111.66	148.55	117.99	168.35	143.93
5 GHz			121.73	116.10	153.96	122.43	175.09	148.08
7.5 GHz			125.26	119.63	158.81	125.97	180.44	151.33
9 GHz			126.86	121.22	161.18	127.56	182.84	152.97

7.26 For Glasgow 2014 the analysis is provided below in Table 7.3, confirming that for the 13 sites analysed, five unique frequencies are required to avoid co-channel interference. It is noted however that additional frequencies may be required for capacity reasons – particularly if analogue PMR rather than digital mobile radio (DMR) is used.

Table 7.3 Frequencies required for 13-site PBR for Glasgow 2014

Site	Frequency
Tollcross Aquatics Centre	1
Scottish Exhibition and Conference Centre	1
Celtic Park	2
Cathkin Braes Country Park	2
Glasgow Green Hockey Centre	2
National Indoor Sports Arena/Sir Chris Hoy Velodrome	3
Scottish National Arena	3
Ibrox Stadium	3
Kelvingrove Lawn Bowls Centre	4
Barry Buddon Shooting Centre	4
Hampden Park	5
Scotstoun Leisure Centre	5
Strathclyde Country Park	5

Source: Analysys Mason Ltd, 2012[45]

7.27 All venues will have different propagation characteristics because of construction materials, seating arrangements and overall layout. We understand some venues will be temporary in whole or in part, and the materials used in their construction may include metallic tubes that interconnect to form a mesh. In some cases, these would increase the building penetration loss and maybe even block electromagnetic fields (including radio frequencies). Materials providing shielding are also available on the market and could be used specifically to stop radiation coming into or out of a building. As a result, propagation into and out of the venue could be very poor, allowing possibly more efficient spectrum reuse.

[45] AnalysysMason Ltd, Estimating the demand for spectrum use for Glasgow 2014. http://stakeholders.ofcom.org.uk/binaries/consultations/glasgow2014/annexes/report.pdf

Question 6. Do you have any comments on the scope for maximising supply by reusing spectrum efficiently?

Technologies to be deployed

Wireless cameras

7.28 For the London 2012 Games a mix of standard definition (SD) and high definition (HD) wireless cameras will be used by different broadcasters. By 2014, it is expected that all broadcasters will be using HD. At present, HD cameras typically use an 8MHz carrier (DVB-T, MPEG-2/MPEG-4 type camera), or 10MHz (e.g. Vislink's LMS-T type camera).

7.29 By 2014, it is expected that other forms of modulation and coding may be employed (e.g. DVB-T2 with MPEG-4, DVB-S2 or the newer form of LMS-T). These will typically use the same channel widths as are currently employed (i.e. 8MHz or 10MHz), although the new LMS-T cameras will support variable bandwidths, from 3MHz to 12MHz. There is also the possibility of 20MHz versions and the, so-called, 'super HD' or 1080-P (progressive scan) HD would require 20MHz carriers. However, it is not clear whether demand will exist for super HD (and some stakeholders have indicated that broadcasters are reluctant to use technologies requiring 20MHz carriers due to the additional cost of having to acquire double the number of RF channels than would be required for 10MHz bandwidth systems).

7.30 Broadcasters such as Sky have started using 3D for sports events, and BBC Sport has informed us that the BBC is entering into trials of 3D (although 3D will not be used during the London 2012 Games). A 3D camera would typically require two 10MHz channels (involving two pictures captured from two cameras). As noted above, it is apparent that there is some reluctance to use 20MHz carriers; therefore, we understand equipment suppliers are focussed on optimising 3D use using better encoding to fit within a 10MHz channel.

7.31 Wireless cameras predominantly use spectrum in the 2.0 to 2.7GHz range. Various equipment manufacturers and hire companies have indicated that there is more widespread use of 7.5GHz wireless cameras now that frequencies in the 2GHz range are becoming increasingly scarce. Whilst wireless cameras can be developed to work in various bands between 2 and 7GHz, equipment is typically only produced to cover bands that are commonly available. Suppliers have noted that a particular problem with wireless camera frequencies being offered for use in the London 2012 Games is that some of the frequencies (e.g. 2.7 to 3.1GHz) are only available for the duration of the London 2012 Games.

7.32 Analysys Mason has found that this is not sufficient to encourage broadcasters and hire companies to invest in equipment to use these bands, unless there was a greater degree of certainty that the band(s) will be available for use after the London 2012 Games. Broadcasters and hire companies stressed the need for greater regulatory certainty regarding frequencies that will be available for wireless camera use in future (particularly after the 2.6GHz band is no longer available for PMSE). One equipment supplier mentioned that the 3.4–3.6GHz band is becoming more popular since it is less congested than the 2GHz bands, but provides better range than higher frequencies at 7.5GHz.

Using higher-frequency spectrum

7.33 We have noted that much wireless camera technology operates between 2 and 3 GHz. The propagation characteristics of this spectrum allow reasonably long-range

communication links, including ground-to-air and air-to-ground relays, to be established.

7.34 At higher frequencies, the range that can be achieved for a given transmitter power and antenna gain is reduced. However, with a modest increase in power and the use of multiple receive antennas in a diversity arrangement, it might be possible to exploit higher-frequency spectrum in addition or instead. The scope for this appeared to be greatest within venues, where communication distances are shorter and operational parameters can be more tightly controlled.

7.35 As well as reducing the cost of spectrum use, such developments could also allow access to significantly more bandwidth, and hence better video quality, than would otherwise be possible.

7.36 We commissioned Sagentia to consider the feasibility of wireless cameras using higher frequencies in the SHF (3 to 30 GHz) and EHF (30 to 300 GHz) bands. We published its report on 30 January 2008[46]. In summary:

- it would be feasible to implement system architectures which would accommodate the shorter range of 7.5 GHz versus 2.3 GHz in outside broadcast (OB) applications;
- the greatest opportunity for using 7.5 GHz was in stadium OB applications. Some increase in power would be needed, and the number of receive antennas may also need to be increased. But the use of 7.5 GHz would allow greater frequency reuse than would be possible at 2.3 GHz; and
- increased transmitter power and the use of multiple receive antennas may make the use of 60 GHz possible within stadia on the back of technology developments at this frequency. It may also be possible to deploy 60 GHz line-of-sight links in mobile-OB-to-helicopter and OB/ENG-helicopter-to-static-vehicle applications. However, existing applications at the time of the report were not sufficiently close to those of wireless cameras to make the technologies relevant in time for the London 2012 Games, but may be by 2014.

7.37 Wireless camera technology that operates at up to 10 GHz is now increasingly available from manufacturers and used for sports and ENG broadcasts. 60 GHz products are also beginning to become available, although our demands for spectrum for wireless cameras for London 2012 suggest very strongly that users are continuing to deploy technologies that use the 2 to 4 GHz bands in preference to higher bands.

PMR/PBR

7.38 There is no clear indication of what form of PMR technology will be required for the Games until such time as a PMR supplier is appointed. The OC has issued an ITT for suitable suppliers; however, this will be technology-neutral and so suppliers will be expected to propose whichever technology best suits the requirements.

Wireless microphones

7.39 We understand that there is some research being developed within Europe on 'cognitive wireless microphones', which would use similar adaptive technology to that being considered in the context of cognitive radio. However, this will take some

[46] www.ofcom.org.uk/consult/condocs/spectrum2012/shf_ehf/report.pdf.

years to develop. The wireless microphone industry has traditionally been slow to adopt new technology and the majority of wireless equipment in use today is still analogue. However, it is expected that there will be a wider adoption of digital UHF wireless microphones by 2014.

7.40 According to a wireless microphone equipment supplier that Analysys Mason Ltd have interviewed, digital equipment in theory allows more microphones to be used per channel (eight per channel being a typical benchmark at present). However, there is an impact on latency, robustness to interference and audio quality.

Question 7. Do you have any comments on the scope for maximising supply by using higher-frequency spectrum?

7.41 We understand that short terrestrial point-to-point links can also be achieved with free-space optics technologies that use infrared light. These do not suffer from radio interference, do not require a licence to operate and can meet communications needs where certain microwave links are not allowed (e.g. near airports). We understand such technologies are also very quick to set up.

Question 8. Would you consider using free-space optics technologies?

Section 8

Planning assumptions

Introduction

8.1 This section sets out the assumptions we have made for the purposes of this consultation document and our reasoning for them. It then summarises the conclusions we have drawn so far for Glasgow 2014 in the light of these assumptions and the demand and supply assessments set out in section 4.

Assumptions

A. It is estimated that over 4000[47] accredited media staff will cover Glasgow 2014

B. Wired rather than wireless technology will be used where practicable

8.2 Discussions with broadcasters and our independent study indicate that wired technology is preferred where practicable because it is more reliable than wireless alternatives, but that there are circumstance when only wireless will do. This corroborates responses to our independent study. This means that wireless cameras, for example, will not be used at all venues or for all events.

C. Spectrum will be required for partners and the venue setup from May 2014, for broadcasters from June 2014 and for teams from July 2014

8.3 We understand these were typical timescales at past Games. The IBC and the MPC will open in June 2014. The Commonwealth Games Village will open in July 2014,

8.4 The technology fit-out should occur in time for the start of any test events. .

D. All spectrum requirements covered by the UK Government's spectrum guarantees will cease by the end of August 2014.The Commonwealth Games Village will close in early August 2014.

E. Wireless equipment is likely to be imported from participating nations

8.5 We understand this from discussions with broadcasters and spectrum regulators' experiences of past Games.

F. Wireless equipment will be re-tuneable to some extent

8.6 We understand this from discussions with broadcasters, spectrum regulators' experiences of past Games, our experience of the London 2012 Games and day-to-day practice in the UK.

8.7 Most broadcasters to whom we have spoken indicated they could retune their own equipment or hire other equipment if given sufficient notice.

[47] Figure supplied by OC

G. Radiated power for all wireless equipment will be limited to the minimum necessary to obtain required coverage

8.8 This is based on best practice in spectrum management, our understanding of past Games updated in the light of our learnings from the London 2012 Games and comparable events and CEPT reports (especially ERC Reports 38 and 42 and ECC Report 2). In particular, we believe that:

- PMR will need a maximum of 3 W EIRP[48] for handheld-to-handheld communications and 5 W for in-vehicle mobile equipment;
- wireless microphones will need 100 mW EIRP at most, with 50 mW EIRP sufficing in most cases; and
- wireless cameras will need 100 mW EIRP in enclosed venues and 1-10 W EIRP for mobile ground-to-air (e.g. motorcycle-to-helicopter) links.

H. The bandwidth for wireless equipment will not increase

- Wireless microphones will generally use 200 kHz channels (although, in some countries, this can be 125-140 kHz).
- The bandwidth for IEMs can reach up to 300 kHz.
- Talkback typically uses 12.5 kHz channels.

8.9 10MHz is the channel width typically allocated to wireless cameras by spectrum regulators. HD wireless cameras used 10 MHz channels for the London 2012 Games, the London stages of the 2007 Tour de France and the Beijing Games, among other events. Current work on the MPEG-4 encoding technology envisages the same bandwidth for HD. Within this, DVB-T nominally uses only 8 MHz, while the proprietary LMS-T modulation uses 9.4 MHz, giving additional throughput.

I. All wireless equipment will comply with the relevant ETSI standards defined in UK Interface Requirements (IRs) even when using spectrum not normally available in the UK

8.10 All wireless equipment used at Glasgow 2014 will need to comply with the Radio Equipment and Telecommunications Terminal Equipment Regulations 2000,[49] as amended.[50] These implement the European Union Radio and Telecommunications Terminal Equipment (R&TTE) Directive (Directive 99/5/EC)[51]

8.11 IRs provide a link between the requirements of the R&TTE Directive and the use of spectrum. UK IRs describe the minimum technical specifications (e.g. power limits, frequency bands and channel spacing) necessary to avoid harmful interference between wireless services. In particular, IR 2000 sets out the requirements for point-to-point links[52]

[48] EIRP means Equivalent Isotropically Radiated Power. It is often used to estimate the service area of transmitters operating at frequencies about 1 GHz, and to coordinate transmitters on the same frequency so that their coverage areas do not overlap. This differs to ERP or Effective Radiated Power which is the actual power out of an antenna once loss in the system and the gain of the system have all been taken into account.

[49] www.opsi.gov.uk/si/si2000/uksi_20000730_en.pdf.

[50] www.opsi.gov.uk/si/si2003/uksi_20031903_en.pdf and www.opsi.gov.uk/si/si2003/uksi_20033144_en.pdf.

[51] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1999:091:0010:0028:EN:PDF.

[52] www.ofcom.org.uk/radiocomms/ifi/tech/interface_req/ir2000.pdf.

and IR2038 contains the requirements for licensing and using wireless equipment for PMSE.[53]

8.12 Further information about the R&TTE Directive is available on our website.[54]

J. The HB will provide live and recorded video feeds of all sporting events and make them available at the IBC to RHBs

8.13 The HB is appointed by the OC and is responsible for producing the television and radio signals of the Glasgow Games as a service to the OC and appointed RHBs.

8.14 The HBs specific functions are to:

- produce the international television and radio signals of the Games;
- design, build, install, operate and then dismantle the IBC;
- design, build, install, operate and then remove facilities and equipment at competition and select non-competition venues other than the IBC;
- coordinate and provide various facilities and services to RHBs; and
- represent the needs of RHBs to the OC for a variety of facilities and services.

K. Those feeds will be mainly in HD

8.15 The HB has indicated that most feeds will be in HD, although some RHBs will still want to receive this in standard definition. This corroborates responses to our discussion document.

L. Wireless cameras used by the HB will not move between venues (with the exception of those used for wide-area sports)

8.16 We understand this from initial discussions with the HB, but will seek greater clarity nearer the time of Glasgow 2014.

M. Lower-frequency spectrum is preferable for wireless cameras

8.17 The laws of physics determine that propagation is better at lower frequencies, all other things being equal. Nonetheless, with strict power limits, spectrum at 7 GHz could be used within venues, which might permit reuse in other locations.

N. Adjacent-channel use by wireless cameras is possible

8.18 Adjacent-channel use is possible especially when all systems use similar radiated power. In most venues, 100 mW is sufficient to achieve the desired link. Within venues, the distance from the wanted receiver to the wanted transmitter is similar to the distance to an unwanted transmitter. Keeping the required ratio between wanted and unwanted signal strength and reducing overall noise will therefore ensure successful operation. Some broadcasters have successfully used adjacent channels in these circumstances at past Games or comparable events.

[53] www.ofcom.org.uk/radiocomms/ifi/tech/interface_req/ir2038.pdf.
[54] www.ofcom.org.uk/radiocomms/ifi/tech/RTEE/.

8.19 At higher power levels, both the level of interference received in adjacent channels and the noise floor will increase. At and above 1 W, adjacent-channel use will only be possible if all wireless cameras in the vicinity use similar power and there is broadly the same distance between receivers and wanted transmitters. If this is not the case, a guard band of a size related to the power used by both systems will be required to ensure a channel can be used without harmful interference.

O. The HB will coordinate all spectrum requirements for broadcasting within venues

8.20 Although the HB may contract for the provision of live video feeds in some venues, we foresee it remaining the licensee for spectrum use and so having a full view of requirements across all venues. This will mean we have only one contact point with which to communicate, assist our understanding of spectrum use and, in some cases, allow better spectrum reuse.

P. Wireless-camera links can be engineered so that more than one receive point is deployed

8.21 We understand this from discussions with broadcasters and manufacturers and from Analysys Mason's work.

Q. RHBs will transport their own feeds back to the IBC in some cases

8.22 Some RHBs will want to capture their own content (e.g. following certain athletes rather than relying on a neutral feed). Generally, the HB will offer physical space in competition venues to enable them to do this. We therefore anticipate they will need to transport those feeds back to the IBC, to temporary studies in OB trucks or to other studios.

R. Optical fibre may be used at and link some competition venues

S. All PMR will use CTCSS tones/DCS codes to set the squelch automatically

8.23 Use of CTCSS tones/DCS codes will ensure PMR users do not hear unwanted communications and/or noise from other users. Moreover, a single channel may be used for multiple talk groups, with each being given a different tone. This will increase the opportunities to reuse spectrum.

T. RHBs will deploy a satellite-dish farm at a fixed location adjacent to the BC

8.24 Satellite uplinks have been deployed at past Games to allow broadcasters to send feeds back to their country of origin.

8.25 We understand a satellite-dish farm will be deployed close to the IBC. As live video feeds will be available there from the HB, the need to deploy dish farms at other venues will be reduced. However, some RHBs may wish to deploy temporary trucks.

U. RHBs might also use satellites to link competition venues back to their facilities in the BC or at other locations

8.26 We understand this is business-as-usual practice.

V. ENG organisations will also use satellites

8.27 We understand this is business-as-usual practice.

W. Test events will have a much smaller spectrum requirement than Glasgow 2014

8.28 Some test events will take place in a single venue with international broadcasters attending. These will afford opportunities for those broadcasters to become familiar with the radio environment and test equipment with Glasgow 2014 in mind. Other events, organised by Glasgow 2014, will take place in clusters of venues that will be closer to the reality of Glasgow 2014 with regard to density of use.

X. Spectrum use can be licensed for periods as short as – or even shorter than – one day, maximising the opportunities for frequency reuse

8.29 Discussions with broadcasters suggest that, while not typical practice, they could use specific frequencies in a venue only at specific times if given sufficient and sufficiently clear notice.

Y. The spectrum plan will be subject to change in the run-up to Glasgow 2014

8.30 Key factors that might trigger changes to the spectrum plan include:

- the results of our monitoring activities;
- ongoing discussions with likely spectrum users both at Glasgow 2014 and for day-to-day use;
- lessons learned from other comparable events, such as the London 2012 Games, the Vancouver Games and the Melbourne Commonwealth Games;
- lessons learned from test events;
- the development of the cultural-events programme;
- the broadcasting plans to be developed by the HB and RHBs;
- actual applications for spectrum;
- discussions with those applying for spectrum;
- technology developments; and
- changes to broader spectrum policy in the UK.

Question 9. Do you have any comments on our planning assumptions?

Section 9

Assessment and proposals

9.1 Annexes 1 to 6 of this document set out our initial assessment and proposals for key services (e.g. PMR, audio and video links), for other guaranteed services, on operational issues and for test events.

9.2 In this section we provide a number of more detailed questions relating to our initial assessment and proposals, which you may wish to consider, but on which we welcome your views.

Further questions relating to our initial assessment and proposals for key services, for other guatanteed services, on operational issues and for test events.

Services

Question 10. how would you prefer to receive PMR/PBR services?

Question 11. Would you be willing to use CTCSS tones/DCS codes to allow the same channel to be used for PMR/PBR?

Question 12. Do you have any comments on our assessment and proposals for wireless microphones and IEMs?

Question 13. Do you have any comments on our assessment and proposals for talkback?

Question 14. Do you have any comments on ADS?

Question 15 Which bands would you prefer to use for wireless cameras?

Question 16. Which bands would you be willing to use for wireless cameras if you cannot use your preferred bands?

Question 17. Do you have any other comments on our assessment and proposals for wireless cameras?

Question 18. Which bands would you prefer to use for point-to-point links?

Question 19. Which bands would you be willing to use for point-to-point links if you cannot use your preferred bands?

Question 20. Do you have any other comments on our assessment and proposals for point-to-point links?

Question 21. Do you have any comments on our assessment and proposals for FSS?

Question 22. Do you have any comments on our assessment for Mobile Satellite Services (MSS)?

Question 23. Do you have any comments on our assessment for Radio navigation Satellite Services (RNSS)?

Question 24. Do you have any comments on our assessment and proposals for telemetry and telecommand?

Question 25. Do you have any comments on our assessment and proposals for WLANs?

Operational issues

Question 26. Do you agree that licensing arrangements for users covered by the spectrum guarantees should not be subject to a special regime as we have for the London 2012 Games?

Question 27. How can efficient sharing and co-ordination between Games and non-Games spectrum use best be achieved?

Question 28. Do you have any other comments on how best to license spectrum use for Glasgow 2014?

Question 29. How can interference management be most effective in ensuring the successful running of Glasgow 2014? Are there other measures we should consider implementing? To what extent is your response based on previous experience of similar events?

Test events

Question 30. Do you have any comments on our approach to test events?

Annex 1

Proposals: Private mobile radio

Introduction

A1.1 This section sets out our assessment and proposals for spectrum for PMR.

Assessment and proposals

A1.2 Because the OC has not yet secured the provision of its PMR services, we have only assessed those requirements that we have already cited in sections 2-5 of this consultation document.

Proposals

Licensed channels

A1.3 There are several disadvantages to our licensing channels individually to guaranteed users with their own equipment:

- it would not use spectrum efficiently. In particular, it would fail to realise the efficiencies achievable from using a trunked network. As a consequence, the amount of spectrum we would need to make available would be relatively high;
- it is unlikely we could make the same channels available to the same user at all venues. Users may therefore have to change channels as they change locations;
- it would be complicated. In many countries, equipment operates on a fixed 10 MHz duplex split. In the UK, most bands used for land radio are configured for a smaller duplex split such as 6.5, 7 or 8 MHz. Moreover, the configuration for the base- and mobile-transmit frequencies in the UK may also be reversed compared to other countries;
- there would be a greater impact on the availability of spectrum for day-to-day PMR use; and
- for all of these reasons, there would be a greater risk of harmful interference.

A1.4 It will also be essential that the spectrum used for PMR for Glasgow 2014 is coordinated where this overlaps with PMSE use. However, if there are good reasons to license channels to guaranteed users with their own equipment, we could make the bands set out in Table A1.1 below available.

Table A1.1. Bands for PMR and handheld communications (MHz)

68.08125-87.49375	137-173	193.2-207.5[55]	430-440[56]	450-470
470-478	494-502	870-872[40]		

A1.5 We would prefer to accommodate PMR and handheld communications at 137-173 MHz as this spectrum is much less congested than higher frequency bands,

[58] On a licence-exempt basis.
[58] On a licence-exempt basis.

although some equipment will need to use 430-478 MHz. At past Games, Amateur Radio bands (especially 430-440 MHz) have been used.

A1.6 The narrow band digital technologies enable 2 traffic channels (voice or data) to be provided within the same bandwidth of traditional 12.5kHz analogue PMR and this clearly offers significant spectrum efficiency benefits. There are two variants to the narrow band digital technologies one uses 6.25kHz channels and is referred to as the FDMA implementation and the other provides 2 traffic channels within 12.5 kHz and is referred to as the TDMA version. Both versions can offer simplex, duplex or trunked configurations.

A1.7 Many guaranteed users with their own systems will want channels. Use of CTCSS tones/DCS codes would allow the same channel to be used without harmful interference, reducing demand by a half. Currently, for each frequency assignment made, a minimum of one CTCSS tone and one DCS code is assigned if it is available in the area requested. We do this using a technical tool to check which tones and codes are not being used by other licensed systems in the surrounding area.

A1.8 Table A1.2 below lists the available CTCSS tones.

Table A1.2. Available CTCSS tones

Primary set reference	Secondary set reference	Tone	Frequency (MHz)	Primary set reference	Secondary set reference	Tone	Frequency (MHz)
A	A1	1	67	A	A4	22	141.3
C	C1	2	69.3	B	B1	23	146.2
B	B1	3	71.9	A	A1	24	151.4
C	C2	4	74.4	B	B2	25	156.7
A	A2	5	77	A	A2	26	162.2
C	C3	6	79.7	B	B3	27	167.9
B	B2	7	82.5	A	A3	28	173.8
C	C3	8	85.4	B	B4	29	179.9
A	A3	9	88.5	A	A4	30	186.2
C	C1	10	91.5	B	B1	31	192.8
B	B3	11	94.8	C	C1	32	198
C	C2	12	97.4	A	A1	33	203.5
B	B4	13	103.5	C	C2	34	206.5
A	A4	14	107.2	B	B2	35	210.7
B	B1	15	110.9	A	A2	36	218.1
A	A1	16	114.8	B	B3	37	225.7
B	B2	17	118.8	C	C1	38	229.1
A	A2	18	123	A	A3	39	233.6
B	B3	19	127.3	B	B4	40	241.8
A	A3	20	131.8	A	A4	41	250.3
B	B4	21	136.5	C	C2	42	254.1

A1.9 Table A1.3 below lists the available DCS codes.

Table A1.3. Available DCS codes

DCS group	Code	DCS group	Code	DCS group	Code
A	23	D	143	H	261
A	43	D	252	H	325
A	114	E	71	H	331
A	115	E	72	H	332
A	212	E	145	I	32
B	25	E	155	I	343
B	53	E	255	I	346
B	122	F	73	I	371
B	125	F	74	I	432
B	243	F	156	I	466
C	26	F	162	J	36
C	54	F	266	J	431
C	131	G	116	J	565
C	132	G	165	J	606
C	246	G	205	J	624
D	31	G	311	J	654
D	65	G	315		
D	134	H	226		

Licence exempt equipment

A1.10 PMR 446 equipment – also called family radio service – can use eight 12.5 kHz simplex channels anywhere in the UK on a licence-exempt basis.

A1.11 The equipment must:

- be hand portable;
- have an integral antenna;
- have a maximum effective radiated power of 500 mW; and
- comply with European Telecommunications Standard ETS 300 296 if placed on the market before 8 April 2001 or IR 2009[57]if placed on the market after this date.

A1.12 Other equipment that can use different frequencies, including short range business radio equipment capable of operating at 461 MHz band, may not be used for PMR 446.

A1.13 As with all licence exempt equipment, PMR 446 use is not protected from harmful interference, which may occur if there are many other users locally, as may be the case during Glasgow 2014. Problems may be reduced by changing channel or by using use CTCSS tones/DCS codes.

A1.14 DMR (Digital Mobile Radio) equipment is also now available and delivers two channels in 12.5 kHz bandwidth.

Other means of communication

A1.15 It may be possible for some PMR requirements to be met through other means of communication, particularly mobile telephones.

[58] On a licence-exempt basis.

Annex 2

Proposals: Audio links

Introduction

A2.1 This section sets out our assessment and proposals for spectrum for audio links – wireless microphones, IEMs, talkback and ADS.

Wireless microphones and IEMs

A2.2 Wireless microphones are mainly used by broadcasters or events organisers to capture interviews, music or sounds. They can be handheld or body worn, with integrated or body-worn transmitters. They are still predominantly analogue, although digital wireless microphones have improved to the extent that they are now being used in professional theatrical productions.

A2.3 IEMs are mainly used by broadcasters or event participants to listen to their own voice or mixed feedback.

A2.4 We expect to need to accommodate most, if not all, wireless microphones and IEMs in UHF Bands IV and V. For this reason, we have considered them alongside each other.

Assessment

A2.5 The biggest requirement for wireless microphones and IEMs at past Games has come from the Opening and Closing Ceremonies. We understand there will be limited demand from RHBs during these events.

A2.6 Based on the London 2012 Games, we believe we will need to accommodate a peak in the Celtic Park during the Opening Ceremony of Glasgow 2014.

Proposals

A2.7 The Digital Switch Over to Digital Terrestrial Television (DTT) is complete in Scotland and will shortly be complete across the whole of the UK. During 2013, there are some further changes envisaged to the frequencies used by digital television to enable the launch of mobile broadband services in the 790 MHz – 862 MHz band. This work is expected to be complete before the end of 2013. From that point, the availability of channels in UHF Bands IV and V for wireless microphones and IEMs is expected to be as set out in Table A2.1 below.

Table A2.1. Availability of UHF Bands IV and V for wireless microphones and IEMs

21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	69	69	

Available
Available if held back from new use
Available, but constrained to indoor use in some locations
Not available – awarded for new use
Not available – used for DTT

A2.8 Table A2.1 assumes that there is no use of Black Hill frequencies (Channels 40, 41, 43, 44, 46, 47). It also assumes that there is indoor use only in some areas that are served by signals from Darvel (Channels 22, 23, 25, 26, 28, 29) or Glasgow West Central (Channels 50, 55, 59)

A2.9 The following channels are unavailable for outdoor use:

- Scotstoun: Channels 22, 25, 28, 40, 41, 43, 44, 46, 47, 50, 53, 54, 55, 57, 58, 59, 60
- Ibrox: As above with the exception of Channels 22, 25, 28, 55
- Hampden: As for Ibrox with the exception of Channel 59

A2.10 Accommodating a peak demand for wireless microphones and IEMs would require a higher than average number to be supported in each available channel, perhaps as may as 10. This already compares well with reference in ERC Report 42 to “12 microphones using a channel without separation between users, where distances as low as 3-6 metres could significantly improve efficiency of spectrum use”. We understand that 16 microphones per channel are routinely realised by some, while a maximum of 23 microphones per channel was achieved during the London stages of the 2007 Tour de France.

A2.11 Moreover, we believe it may be possible to interleave wireless microphones and IEMs in the same channel without harmful interference between the two systems if they are deployed by different users.

A2.12 We will use practical measurements from the London 2012 Games legacy to inform the limits to efficient use of UHF Bands IV and V by wireless microphones and IEMs, particularly given the proximity of broadcasters to each other in venues.

A2.13 We propose to make the bands set out in Table A2.2 below available for wireless microphones and IEMs.

Table A2.2. Bands likely to be available for wireless microphones and IEMs (MHz)

191.6-210.1	470-790	863-865[58]	1785-1800[59]

Talkback

A2.14 Talkback is mainly used by broadcasters, allowing producers to give directions to production-team members such as camera operators, reporters and presenters. We understand equipment will not move between venues.

Assessment

A2.15 Based on the Analysys Mason Report, we have forecast demand at 120 channels.

Proposals

A2.16 Talkback uses PMR-like technology and tends to operate in similar spectrum. We therefore propose to make the bands set out in Table A2.3 below available for talkback.

Table A2.3. Bands for talkback (MHz)

430-440[60]	450-470	470-478	494-502

A2.17 In particular, we propose to provide duplex channels in 460-468 MHz paired with 470-478 MHz.

A2.18 Talkback users in the UK already use duplex channels paired with a non-generic 4 MHz gap within 470-478 MHz. To minimise the impact on existing users, we could also make duplex channels available within 470-478 MHz and within 494-502 MHz.

ADS

A2.19 Audio Distribution Systems (ADS) retransmit material already prepared for public use. They cover events and other temporary purposes. ADS are for the transmission of audio content for direct reception within a small defined area. ADS are not licensed for operation on the FM or AM wavebands, but within other parts of the spectrum. Further information can be found in the RSL Notes of Guidance[61].

A2.20 The band available for ADS is 60.75 to 62.75 MHz.

[58] On a licence-exempt basis.
[59] Digital wireless microphones only.
[60] Subject to coordination with MOD.
[61] http://licensing.ofcom.org.uk/radio-broadcast-licensing/restricted-service-licences/current-rsls/ads-rsl

Annex 3

Proposals: Video links

Introduction

A3.1 Video links include both wireless cameras and point-to-point links. They are used by broadcasters for capturing and reporting live events and by closed-circuit television for security purposes.

Wireless cameras

A3.2 Wireless camera use is directly linked to broadcasting requirements. We expect this to be by far the largest spectrum demand. Moreover, wireless cameras are more susceptible to harmful interference than many other applications.

A3.3 According to Analysys Mason, various equipment manufacturers and hire companies have indicated that there is more widespread use of higher frequency wireless cameras (e.g. 7.5GHz) now that frequencies in the 2GHz range are becoming increasingly scarce. However, a RHB's view is that frequencies beyond 3GHz do not lend themselves as well to non-line-of-sight propagation and additional costs are incurred in order to transition to use new frequencies (e.g. all antennas, low noise filters and transmitter RF stages need changing). The RHB has also noted that higher frequencies (5 to 6GHz) may be used successfully for portable wireless cameras, but for high speed operation (e.g. from aircraft) doppler shift becomes an increasing issue as frequency increases, meaning that lower frequencies are needed.

A3.4 Suppliers have noted a particular issue in relation to the wireless camera frequencies being offered for use in the London 2012 Games is that some of the frequencies (e.g. 2.7 to 3.1GHz) are only available for the duration of the London 2012 Games, and will then revert to their original use.

A3.5 Broadcasters and hire companies have said to Analysys Mason that they are unwilling to invest in new equipment that can only be used during the London 2012 Games and require a sufficient degree of certainty that the band(s) will be available for use after the Olympics in order to justify investment in the new camera, antenna, filter and converter equipment that is needed. We have agreed with the Government that its spectrum guarantees for the London 2012 Games do not extend beyond its end and so do not cover legacy. Spectrum temporarily made available by UK public sector bodies will be returned to them once the London 2012 Games requirement has ended.

A3.6 Broadcasters and hire companies that Analysys Mason have spoken to as part of their study have stressed the need for greater regulatory certainty regarding frequencies that will be available for wireless camera use in the UK post 2012.

Assessment

A3.7 We believe we will need to accommodate a peak of 50 to 60 camera channels in simultaneous use. This is based on:

- a peak for channels experienced at the London 2012 Games;
- a generous allowance for growth given how production values (e.g. point-of-view cameras) have taken advantage of developments in technology.

A3.8 For the purposes of this consultation document, we have not allowed for any reductions in demand. We think it may also be prudent to plan on the basis that using adjacent channels is not possible without causing harmful interference, though we anticipate that it will be possible to reduce the frequency offset between two co-located adjacent channels to 5MHz (and perhaps even less as the cameras move away from each other geographically) in practice. This approach would be particularly valuable for bands where demand at Glasgow 2014 exceeds supply.

Airborne use

A3.9 We anticipate airborne use of some channels to allow wireless camera coverage of wide-area events. This may involve use of fixed or rotary-wing aircraft. Their altitude means opportunities for spectrum re-use are greatly diminished, while the range of usable spectrum is itself limited because of the mobility of these links and difficulties in obtaining line of sight transmission paths. The radiated power required for the uplink (from ground-based vehicle to an aircraft) is also much higher as the required link can be obstructed by terrain or clutter and the transmitter and receiver may not always be in the same alignment (i.e. vertically aligned to the ground-based vehicle).

A3.10 Because of these factors, we think it appropriate to limit the number of channels available for airborne use to:

- meet international coordination requirements; and
- comply with the conditions under which some spectrum can be made available. Those bands used for radars may be usable because some wireless cameras are low-power and used only within the events venues.

Proposals

A3.11 Several considerations underpin our proposals for wireless cameras:

- we expect the HB and RHBs to use wired rather than wireless cameras wherever practicable because of the greater quality and reliability that they afford;
- we believe we should identify more spectrum than forecast by Analysys Mason and give users the opportunity to indicate those bands they would prefer to use and which they would be willing to use if they cannot use their preferred bands (particularly if there excess demand). In particular, we have identified spectrum above 7 GHz that is not currently widely used by broadcasters but may become of value in the run-up to Glasgow 2014;
- not all channels within available bands will offer comparable utility, but their use in certain circumstances should not be discounted at this early stage of spectrum planning for Glasgow 2014;
- even within preferred bands, we understand new clip-on transmitters can allow wireless cameras to tune over as much as 500 MHz from a user-selected frequency that can be factory-set to anything between 1.3GHz and 7.5GHz; and
- only spectrum at 1 to 4 GHz can be made available for airborne. Below this band, it is difficult to secure sufficient bandwidth and equipment is not readily available. Above this band, signal alignment and propagation characteristics are not favourable.

A3.12 In the light of these considerations, we propose to make the bands set out in Table A3.1 below available for wireless cameras. Also indicated is the number of 10 MHz channels in each band we currently think might be available during Glasgow 2014.

These estimates are likely to change at the margin as we receive new information, not least in response to this consultation document.

Table A3.1. Bands and channels for wireless cameras

Band(MHz)	Notes
1300-1320	Subject to compatibility with aeronautic/maritime radar
1660-1670	
2025-2110	Airborne use allowed
2200-2300	Some airborne use at 2200 – 2290 MHz
2390-2500 MHz	Some airborne use at 2410-2450 MHz, 2450-2470 MHz and 2470-2490 MHz
2483-2500	
2700-2720	Subject to compatibility with aeronautic/maritime/meteorological radar
2742-2772	
2820-2850	
2870-2890	
2900-3100	
3100-3400	Subject to compatibility with military radar
3440-3480	Refer to MOD release plan[62]
3690-3920	Subject to coordination with fixed links and satellite services
3925-4009	
4010-4200	Subject to coordination with fixed links and satellite services;indoor use only
4400-4800	
5472-5588	
5682.5-5702.5	Airborne use allowed
5705-5725	
5732.5-5752.5	
5770-5790	Some airborne use allowed
5795-5815	
5900-7110	Subject to coordination with fixed links and satellite services
5850-592	Fixed video links
7110-7250	Airborne use allowed
7300-7350	
7360-7425	
8460-8500	
10.30-10.36 GHz	Fixed video links. Geographical restrictions apply. Some airborne use permitted
12.2-12.5 GHz	Fixed video links
24.25-24.5 GHz	Fixed video links
48.0-48.4 GHz	Video links
61000-61500	On a licence-exempt basis

A3.13 At this stage, we believe we can fulfil the forecast demand from spectrum already available between 1300MHz and 4800 MHz. These are all frequencies that broadcasters are accustomed to using or for which we understand equipment is already readily available. A full assessment of channel availability is outside the scope of this consultation document. We will return to this in the light of consultation responses, more detailed information about the operating environment for wireless cameras in these bands and legacy information from the London 2012 Games.

A3.14 Based on the current competition schedule, these channels would also suffice for airborne use. It would be significantly more difficult to accommodate multiple simultaneous wide-area events without taking further steps, for example:

[62] http://www.mod.uk/DefenceInternet/AboutDefence/WhatWeDo/ScienceandTechnology/Spectrum/

- clearing more channels for airborne use, particularly in the 2 to 3 GHz range; or
- using alternative solutions.[63]

A3.15 Nonetheless, if our proposals are broadly sufficient:

- it will be necessary to make available spectrum at 3400-3600 MHz that MOD plans to release available for airborne use;
- we do not believe it necessary to rely on spectrum at 2.4 GHz and 5 GHz available for licence exempt use, though it could be used if necessary;
- we do not believe it necessary to rely on EHF spectrum at 5 to10 GHz, though it could be used if desired; and
- we do not believe it necessary to rely on SHF spectrum, though this, too, could be used if desired.

A3.16 If it proves necessary to make 20MHz channels available, we will create these from 10MHz channels. Since doing so could significantly reduce the number of wireless cameras that could use high-demand bands, our preference is to look first at the 5 to 10 GHz bands where we believe congestion is much less likely.

Point-to-point links

A3.17 It is assumed by Analysys Mason that each of the venues used for the Games will be linked by fibre to the international broadcast centre (IBC) located at the Scottish Exhibition and Conference Centre (SECC) and that this will reduce the number of point-to-point wireless links needed to transport video and data information between venues. Notwithstanding this, there will be a possible requirement for point-to-point wireless links to be used as back-up links between venues and the SECC (i.e. for resilience). In addition, BBC Sport has indicated that temporary point-to-point video links are often used at satellite-news gathering sites.

A3.18 Broadcasters and equipment suppliers have pointed out that point-to-point video requirements will be dependent upon confirmation of the availability of suitable fibre connection at each venue. Broadcasters would only envisage using point-to-point video links where a suitable fibre connection is not available. However, they may use portable (i.e. temporary) links at open race events (e.g. marathon, road and mountain biking).

A3.19 It is noted that the one area of demand that may be greater for Glasgow 2014 than for the London 2012 Games is for point-to-point video links. This is largely due to uncertainty regarding the availability of fibre connections at each of the venues for Glasgow 2014. Analysys Mason have assumed that, even with fibre being available, point-to-point links may be deployed in some cases as a back-up link. Once the availability of fibre to each venue is confirmed, it is expected that the requirement for point-to-point links can be more firmly defined and is likely to reduce compared to estimates.

A3.20 It is also noted that point-to-point links may be used to connect certain venues for the London 2012 Games, but may not have been included in the London demand estimates that Ofcom has provided to Analysys Mason for the study. This is

[63] See, for example,www.skylink.aero.

because the London demand estimates provided to Analysys Mason only provide the additional, Olympic-specific licensing requirements, whereas it is possible that additional annual point-to-point link licences have been assigned within standard microwave bands by our fixed link licensing teams for use at Olympic venues.

Assessment

A3.21 We nonetheless foresee a demand for point-to-point links for Glasgow 2014 that may be greater than that for London 2012. Some could carry video signals from airborne downlinks to the IBC, a production truck or a satellite uplink, and they have a role to play where it is impractical or prohibitively expensive to deploy fibre.

A3.22 A specific forecast would not be helpful for spectrum-planning purposes this far ahead of Glasgow 2014, not least because of the variation in required bandwidth and the scope for frequency re-use as a result of using highly directional antennas.

Proposals

A3.23 Where terrestrial point-to-point links can be planned in advance, we expect the spectrum requirements they generate to be met using bands available for fixed links using Ofcom's usual business arrangements for these.

A3.24 It may be more suitable for point-to-point links deployed at short notice to use spectrum specifically proposed for wireless camera use to reduce the need for co-ordination with other spectrum users, though in bands already available for fixed links our normal co-ordination procedures will apply. Our preference is to look first at the 5 to 10 GHz bands where we believe congestion is much less likely.

A3.25 We therefore propose to make the bands set out in Table A3.2 below available for terrestrial point-to-point links.

Table A3.2. Bands for point-to-point links (MHz)

5725-5850	7425-7900	10300-10360	10600-10680	12750-13250
14500-15350	17700-18456.25	18462.5-18700	18700-19466.25	19470.5-19700
22000-23600	24250-26500	31000-31300	31500-31800	37000-39500
51400-52600	55780-59000	64000-66000	71125-75825	81125-85875

A3.26 Where bands are managed by the MOD their availability is subject to frequency coordination.

A3.27 It may also be possible to reduce the requirement for point-to-point links by using alternative solutions (e.g. free-space optics).

Annex 4

Proposals: Other guaranteed services

Introduction

A4.1 This section sets out our assessment and proposals for other guaranteed services – satellite services, telemetry and telecommand; and WLANs.

Satellite services

A4.2 Satellite services may be fixed or mobile. Satellites may also provide radionavigation (i.e. position-fixing) services.

Fixed satellite services

A4.3 Fixed satellite services (FSS) use earth stations operating at known locations that transmit to and/or receive from satellites. At Glasgow 2014, FSS will be used by broadcasters to carry video and audio feeds from OB venues to studios or directly to national and international broadcasting networks. We understand two different applications will be used:

- permanent earth stations (PES); and
- transportable earth stations (TES), also known as satellite newsgathering terminals.

PES

A4.4 PES communicate to and from a known location with a satellite located in a geostationary orbit.

Assessment

A4.5 We expect there may be demand for a limited number of short-term licences for PES at some venues.

Proposals

A4.6 As PES are planned well in advance and at a known fixed location, we expect the spectrum requirements they generate to be met using Ofcom's existing operational and licensing processes. Authorisations are available in the bands shown in Table 4.1 below and on our website[64].

[64] See: http://licensing.ofcom.org.uk/radiocommunication-licences/satellite-earth/products/pes/?a=0

Table A4.1. Bands for PES

Band	Transmit frequencies (MHz)	Receive frequencies (MHz)	Notes
C	5850-7075	3600-4200	Shared with fixed services (all frequencies) and broadband wireless access (parts of 3600-4200 MHz in some locations)
Ku	12750-13250	10700-11700	Shared with fixed services (12750-13250 MHz); limited sharing 10700-11700 MHz
	13750-14500	11700-12750	Shared with fixed services (14250-14500 MHz)
Ka	27500-27818.15	17700-19700	Shared with fixed services (17700-19700 MHz)
	28454.5-28826.5	17700-19700	
	29462.5-29500	17700-19700	
	29500-30000	19700-20200	

A4.7 As PES share spectrum with other services, coordination and, in some cases, electromagnetic compatibility may be necessary before we can authorise use.

TES

A4.8 TES are transportable in nature but transmit from a fixed known location at any one point in time.

Assessment

A4.9 We expect demand for TES to be high at Games venues. There will be some geographic restrictions on their use in close proximity to airports and other sensitive sites.

Proposals

A4.10 We expect the spectrum requirements generated by TES to be met on a business-as-usual basis. Spectrum access is mainly via commercial agreements with satellite operators, and availability is primarily dictated by the capacity on each satellite.

A4.11 Authorisations are available in the bands shown in Table A4.1 below and on our website[65]. In 2010 we made additional bands available for TES. Further information on these bands can be found on our website[66].

Table A4.2. Bands for TES

Band	Transmit frequencies (MHz)	Receive frequencies (MHz)	Notes
Ku	13780-14500	10700-12750	Shared with radio location services (13780-14000 MHz) and fixed services (14250-14500 MHz)

A4.12 As TES share spectrum with other services, clearance and authorisation are required from us for each and every use prior to making any transmissions. As terminals are deployed at very short notice to any location they require equally rapid clearance procedures. We therefore provide online clearance and authorisation for licensed TES terminals on our website using a tool called SPECTRAsc. This assesses the interference risk of clearance requests with regard to terrestrial fixed

[65] See: http://licensing.ofcom.org.uk/radiocommunication-licences/satellite-earth/products/TES/
[66] See:http://stakeholders.ofcom.org.uk/binaries/consultations/tes-additional-spectrum/statement/statement.pdf

links, aircraft navigation systems and sensitive sites and then indicates the outcome both online and by email.

A4.13 No coordination of the receive component of TES services takes place however. As a consequence, no protection is afforded currently to any signals received by TES terminals. Given the static nature of fixed services operating in spectrum shared with TES, the risk of harmful interference is small.

A4.14 Some TES use of C-Band may be possible at "planned" locations, with known fixed transmission requirements. Such applications will be managed throughour day-to-day business processes for PESs.

Mobile satellite services

A4.15 Mobile satellite services (MSS) operate globally through a number of geostationary and non-geostationary satellite constellations, normally using the 1 to 3 GHz for service links. They support general consumer voice communications and broadband video and data transmissions. In addition, they provide communication links for defence and security services that are independent of terrestrial networks[67].

Assessment

A4.16 MSS terminals are unlikely to be used during Glasgow 2014 though some maybe used specifically for operational tasks associated with the Games.

Proposals

A4.17 More information on the licensing arrangements for MSS terminals can be found on our website[68]. The bands for MSS set out in Table A4.3 below.

[67] www.cabinetoffice.gov.uk/ukresilience/preparedness/resilient_telecommunications/enhancing/ catalogue.aspx.

[68] See:http://stakeholders.ofcom.org.uk/binaries/spectrum/spectrum-policy-area/spectrum-management/research-guidelines-tech-info/interface-requirements/IR2016final.pdf

Table A4.3. Bands available for MSS

Earthto space (MHz)	Space toEarth (MHz)	UKalternate use	Current operators	Notes
1518-1525	1670-1675	PMSE (limited)		Primary MSS;likely to be geostationary
1626.5-1660.5	1525-1559		Inmarsat, Thuraya, SkyTerra, Volna	Primary MSS; geostationary
1610-1626.5	2483.5-2500	PMSE (2483.5-2500 MHz)	Globalstar	Primary MSS; non-geostationary
1621.35-1626.5	1621.35-1626.5		Iridium	Secondary MSS; non-geostationary
1980-2010	2170-2200		Two operators as probable candidates	Primary MSS

Radionavigation satellite services

A4.18 Radionavigation satellite services (RNSS) – commonly known as “sat nav” – provide signals for security, business and consumer devices. GPS, Glonass and Galileo all transmit location-based positioning and timing signals. These systems, especially GPS, are used everywhere to allow accurate location of people, goods and terminals and for timing and synchronisation.

Assessment

A4.19 RNSS will be widely used at Glasgow 2014.

Proposals

A4.20 RNSS receivers are licence exempt. The available bands are set out in Table A4.3 below.

Table A4.3. Bands available for RNSS

Space to Earth (MHz)	Notes
1215-1300	Non-geostationary
1559-1610	Non-geostationary

A4.21 The Ministry of Defence conduct occasional tests on military systems which may result in some loss of service to civilian users of the Global Positioning System (GPS) including in-car navigation devices and networks which rely on GPS signals. Ofcom seeks to provide citizens and consumers with information about possible interruptions to these services. It must be emphasised that this notification process only warns of future jamming exercises that are brought to the notice of Ofcom and may not cover all jamming exercises. It cannot be assumed that any loss of service is due to jamming exercises.

A4.22 We propose to ask the UK Government to cease jamming trials during the period of the Glasgow 2014 Games where these could disrupt services as we have done for the London 2012 Games.

Telemetry and telecommand

A4.23 Telemetry is the use of radiocommunications to automatically indicate or record measurements at a distance. Telecommand is the use of radiocommunications to initiate, modify or terminate equipment functions at a distance.

A4.24 Telemetry and telecommand will be used at Glasgow 2014 to remotely control cameras, camera shutters and other equipment and for localised data communications.

Assessment

A4.25 The use of telemetry and telecommand is increasing over time. Based on our understanding of past Games, we have forecast demand for these services for around 40-50 channels.

Proposals

A4.26 Spectrum is available on a licence exempt basis, so no arrangements will be required for most applications. Some of the available bands are set out in Table 4.4 below.

Table A4.4. Bands available for telemetry and telecommand on a licence exempt basis

Band (MHz)	Reference standard
0.009-0.325	EN 302 195
169.4-169.475	EN 300 220
173.2-173.35	
433.05-434.79	
458.5-459.1	
869.4-869.65	
2445-2455	EN 300 440

More applications are addressed in IR 2030[69].

A4.27 Although Bluetooth devices operating at 2.4 GHz are now ubiquitous, the possibility of harmful interference from WLANs (see below) and even microwave ovens means they may not be suitable for critical services. Spectrum at 430-470 MHz proposed for land radio and/or talkback (see sections 5 and 6) may be better suited instead, although no requirements have yet been identified to us.

WLANs

A4.28 We expect WLANs to be deployed for specific accredited client groups. Hot-spot services could also be offered to spectators and athletes. Spectrum for WLANs is available on a licence-exempt basis. We require an estimate of the likely demand for spectrum for WLAN-based applications.

[69] www.ofcom.org.uk/radiocomms/ifi/tech/interface_reg/ir2030final.pdf.

A4.29 We understand that the OC are developing a policy for WLAN use in the Glasgow 2014 venues and we will take this into account when further developing our plans for managing licence exempt spectrum. Though WLAN policy is not likely to be defined until 2013 it may take into account whether changes to the Licence Exemption Regulations are needed and what the impact is expected to be on cellular Mobile Network Operators (MNOs), citizens and consumers. Any changes of to the Wireless Telegraphy Exemption Regualtions may require specific consideration and for Ofcom to consult upon them.

Proposals

A4.30 Spectrum is available on a licence-exempt basis. Table A4.5 sets out the available bands, maximum power levels and applicable IRs.

Table A4.5. Bands for WLANs on a licence exempt basis

Band (MHz)	Maximum power	Applicable IR
2400-2483.5	100 mW EIRP	IR 2005[70]
5150-5350	200 mW mean EIRP 10 mW/MHz mean EIRP density in any1 MHz band – TPC and DFS implemented	IR 2006[71]
5470-5725	1 W mean EIRP 50 mW/MHz mean EIRP density in any 1 MHz band – TPC and DFS implemented	

[70] www.ofcom.org.uk/radiocomms/ifi/tech/interface_req/uk2005.pdf.
[71] www.ofcom.org.uk/radiocomms/ifi/tech/interface_req/uk2006.pdf.

Annex 5

Operational issues

Licensing/authorisation

A5.1 As previously noted, Glasgow 2014 presents a challenge to our authorisation arrangements, but not to the extent that a bespoke set of licensing products are required like that for the London 2012 Games. Consequently, we do not propose establishing a licensing regime specifically for users covered by the spectrum guarantees. We will need however to provide for licences tailored to their needs and designed to make the most efficient use of the available spectrum.

A5.2 We also propose that a monitoring scheme is required to ensure that frequencies and equipment used during Glasgow 2014 complies with licence conditions The OC has informed us that a 'testing and tagging' scheme was employed during the Melbourne 2006 Commonwealth Games, which worked well. So we propose to bring in a testing and tagging scheme for Glasgow 2014.

Coordination with non-Games use

A5.3 Some of the spectrum identified in the draft spectrum plan will be shared with non-Games users. In the run-up to and during Glasgow 2014, it may be necessary to coordinate some of this non-Games use with the requirements of the Games. In performing this task, we will seek to strike an appropriate balance between ensuring the success of the Games and minimising their impact on other spectrum users. We are currently examining a number of ways in which this can best be achieved. There are a number of options, and our current view is that we will use a combination of the following:

- identifying particular channels that are set aside for Games use and not otherwise available for their duration;
- establishing geographic coordination zones where we will perform the necessary technical checks to ensure proper coordination between Games and non-Games use; and
- establishing geographic exclusion zones around Games venues where any spectrum use will require specific additional authorisation from us.

Conclusion

A5.4 Our initial conclusions, independently verified by the Analysys Mason study, on which we are seeking views are that we may experience high demand for spectrum for key services like PBR, wireless microphones and wireless cameras. However, the demand for spectrum is likely to be significantly less for most services than currently forecast for the London 2012 Games. We anticipate that we will be able to meet the estimated demand if the supply is bolstered with some additional spectrum sourced via public sector holdings.

A5.5 In certain circumstances, it might be necessary to revoke or temporarily vary licences to allow spectrum use for Glasgow 2014. We believe such circumstances are likely to be very rare, and we would endeavour to explore all options to accommodate both Games and non-Games use prior to taking such action.

A5.6 We are currently examining how best to ensure efficient coordination between shared Games and non-Games use of the same spectrum. It is likely that arrangements will vary by band and by service. We will make more details known in due course.

Interference management

A5.7 We expect Glasgow 2014 to place unprecedented pressure on the use of spectrum within Glasgow. Our Field Operations teams will help to ensure the Games' success by seeking to ensure that key wireless services remain as free from harmful interference and by taking enforcement action if necessary. We will use a risk-based approach to determine the appropriate operational response and ensure resources are deployed effectively.

A5.8 As part of our response, we will consider providing a validation service for wireless transmitter equipment that will be used within key Games venues. The purpose of this service would be to establish whether equipment settings were consistent with the authorisation to use the equipment. Validation could include measuring operating frequency, transmitter power, modulation bandwidth and spurious emissions. Where appropriate, we will consider working with the OC's security staff to ensure only wireless transmitter equipment that has successfully passed these validation checks is taken into Games venues.

A5.9 Before Glasgow 2014, we will ensure the spectrum the OC require is as free from unauthorised use and unwanted emissions as is reasonably practicable. During the Games, we will endeavour to resolve any cases of harmful interference to wireless services that arise according to the following operational priorities:

- safety of life
- defence and national security
- business-critical systems
- OC PMR
- The HB
- RHBs
- other members of the Commonwealth Games Family
- day-to-day spectrum users

A5.10 We will consider deploying dedicated interference resolution teams within key Games venues to reduce our response times as far as reasonably practicable.

A5.11 All spectrum users will be required to operate within the terms of their authorisation, including transmitting at the specified frequency. Any found not to be doing so – a criminal offence in the UK – will be required to stop transmitting and to tune to their authorised frequency or apply for one immediately. We may also take enforcement action – including removing equipment and prosecution.

Annex 6

Test events

A6.1 A number of test events will be held to test different competition venues and infrastructure. They will vary from full international competitions, including to technical rehearsals.

Relevance for spectrum management

Spectrum plan

A6.2 We do not believe that the test events will be relevant to the spectrum plan for Glasgow 2014 for four main reasons:

- the spectrum we are proposing to make available is overwhelmingly already used for the services in question, whether in the UK or overseas;
- spectrum not already available for use in the UK is unlikely to be released until shortly before the Games to minimise the impact on existing users;
- even spectrum that is already available for use may be subject to change; and
- spectrum requirements for test events will be far less than at Games time due to the difference in the number of concurrent events. This was highlighted in responses to our discussion document for London 2012[72].

A6.3 Stakeholders expecting to use new equipment during the Games, particularly where this enables them to use spectrum more efficiently and/or use higher-frequency spectrum, may wish to test that equipment in advance. We grant non-operational licences for this purpose.[73]

Licensing

A6.4 We may use test events to license spectrum users in a manner similar during Glasgow 2014. This will enable us to determine how best to undertake detailed assignment planning when licensing for the Games themselves. We will certainly wish to test any new systems that are required well in advance of the Games and may do so not only at test events but also on other occasions.

A6.5 We will endeavour to cause minimum disruption to those using spectrum on a business-as-usual basis. At present, we do not anticipate revoking or varying licences during test events, but should our assessments of demand and supply change, we may need to do so.

Enforcement

A6.6 We will work closely with the OC to ensure we are involved at an appropriate level in test events to assess and optimise our enforcement activities leading up to Glasgow 2014.

[72] http://stakeholders.ofcom.org.uk/consultations/london2012/?showResponses=true
[73] www.ofcom.org.uk/radiocomms/ifi/licensing/classes/noperational/.

Annex 7

Consultation Questions

Approach to demand and supply

Question 1. Do you agree that the most relevant comparator for a top-down approach is likely to be the London 2012 Games?

Question 2. Do you agree that comparing data for the number of radio channels used for specific services at different events is an appropriate approach to estimating spectrum demand? If you disagree, please explain your reasoning.

Question 3. To what extent do you think we should place more emphasis on estimating demand from information provided by stakeholders rather than on the limited data available from past events of a similar scale?

Question 4. Is there any other relevant technical guidance that we should be taking into account in order to validate our assumptions and our estimate of spectrum demand?

Question 5. Do you have any comments on how relying on wired communications could be used to reduce spectrum demand at Glasgow 2014?

Question 6. Do you have any comments on the scope for maximising supply by reusing spectrum efficiently?

Question 7. Do you have any comments on the scope for maximising supply by using higher-frequency spectrum?

Question 8. Would you consider using free-space optics technologies?

Assumptions

Question 9. Do you have any comments on our planning assumptions?

Services and technologies

Question 10. how would you prefer to receive PMR/PBR services?

Question 11. Would you be willing to use CTCSS tones/DCS codes to allow the same channel to be used for PMR/PBR?

Question 12. Do you have any comments on our assessment and proposals for wireless microphones and IEMs?

Question 13. Do you have any comments on our assessment and proposals for talkback?

Question 14. Do you have any comments on ADS?

Question 15 Which bands would you prefer to use for wireless cameras?

Question 16. Which bands would you be willing to use for wireless cameras if you cannot use your preferred bands?

Question 17. Do you have any other comments on our assessment and proposals for wireless cameras?

Question 18. Which bands would you prefer to use for point-to-point links?

Question 19. Which bands would you be willing to use for point-to-point links if you cannot use your preferred bands?

Question 20. Do you have any other comments on our assessment and proposals for point-to-point links?

Question 21. Do you have any comments on our assessment and proposals for FSS?

Question 22. Do you have any comments on our assessment for MSS?

Question 23. Do you have any comments on our assessment for Radio Navigation Satellite Services (RNSS)?

Question 24. Do you have any comments on our assessment and proposals for telemetry and telecommand?

Question 25. Do you have any comments on our assessment and proposals for WLANs?

Operational matters

Question 26. Do you agree that licensing arrangements for users covered by the spectrum guarantees should not be subject to a special regime as we have for the London 2012 Games?

Question 27. How can efficient sharing and co-ordination between Games and non-Games spectrum use best be achieved?

Question 28. Do you have any other comments on how best to license spectrum use for the Glasgow 2014 Games?

Question 29. How can interference management be most effective in ensuring the successful running of Glasgow 2014? Are there other measures we should consider implementing? To what extent is your response based on previous experience of similar events?

Question 30. Do you have any comments on our approach to test events?

Annex 8

COGSPLAG terms of reference and membership

COMMONWEALTH GAMES 2014 SPECTRUM PLANNING GROUP (COGSPLAG)

TERMS OF REFERENCE

A8.1 The Commonwealth Games 2014 Spectrum Planning Group s a subcommittee of the UK Cabinet Official Committee on UK Spectrum Strategy (UKSSC) and is established in response to a decision reached by UKSSC in January 2007.

A8.2 In a letter dated 14 March 2007 to the President of the Commonwealth Games Federation, the Secretary of State for Trade and Industry guaranteed on behalf of the UK Government the allocation of the spectrum required for the organisation of the Games and the waiving of fees payable for the spectrum so allocated. COGSPLAG is required to support the Office of Communications (Ofcom) in meeting its responsibility to organise a full spectrum plan for the Games—addressing uses that fall both within and without the Government guarantees—and to arrange all the spectrum licences in good time in support of the plan.

A8.3 Membership of COGSPLAG is open to representatives from:

- Ofcom
- Commonwealth Games 2014
- Scottish Government
- Glasgow City Council
- Clyde Gateway
- Glasgow Strategic Events Forum
- Strathclyde Police
- Strathclyde Fire and Rescue
- Scottish Ambulance Service
- Scotland Office
- Department for Culture, Media and Sport
- HM Treasury
- the Ministry of Defence
- the Civil Aviation Authority
- the Maritime and Coastguard Agency

- the London Organising Committee of the Olympic Games and Paralympic Games

as well as other members as appropriate

A8.4 COGSPLAG is chaired by Ofcom, which also provides the secretariat. Meetings will be held quarterly, if required, between June 2010- June 2011 and likely to be more frequently as required thereafter. Where appropriate, work will be progressed in the intervening periods by email correspondence. Where necessary, COGSPLAG will seek advice from and work with others who it determines will assist in meeting its remit.

A8.5 Members of COGSPLAG are free to escalate issues within its remit to other appropriate governance processes, notably the Glasgow 2014 Organising Committee Board.

A8.6 COGSPLAG will support the Spectrum Plan for the Commonwealth Games 2014 by:

- Managing changes to the Spectrum Plan:
  - Co-ordinating the loan of spectrum by COGSPLAG members for use at the Games
  - Determining changes and modifications to the plan meet the spectrum requirements of COGSPLAG members
- Overseeing the arrangements for access to spectrum and its use
- Discussing issues surrounding the implementation and management of the plan, especially with public sector users:
  - Synergies in implementing and testing the plan (including disaster recovery and scenario planning)
  - Providing venue specific spectrum plans
  - Co-ordination of command and control, problem management processes, and service level requirements between public sector spectrum users
- Sharing knowledge about spectrum use and identifying opportunities and risks in the spectrum plan

Annex 9

Responding to this consultation

How to respond

A9.1 Ofcom invites written views and comments on the issues raised in this document, to be made **by 5pm on 23 November 2012**.

A9.2 Ofcom strongly prefers to receive responses using the online web form at http://stakeholders.ofcom.org.uk/consultations/glasgow2014/howtorespond/, as this helps us to process the responses quickly and efficiently. We would also be grateful if you could assist us by completing a response cover sheet (see Annex 11), to indicate whether or not there are confidentiality issues. This response coversheet is incorporated into the online web form questionnaire.

A9.3 For larger consultation responses - particularly those with supporting charts, tables or other data - please email claire.mack@ofcom.org.uk attaching your response in Microsoft Word format, together with a consultation response coversheet.

A9.4 Responses may alternatively be posted or faxed to the address below, marked with the title of the consultation.

Claire Mack
Ofcom
39 St Vincent Place
Glasgow
G1 2ER

Fax: 0141 229 7433

A9.5 Note that we do not need a hard copy in addition to an electronic version. Ofcom will acknowledge receipt of responses if they are submitted using the online web form but not otherwise.

A9.6 It would be helpful if your response could include direct answers to the questions asked in this document, which are listed together at Annex 7. It would also help if you can explain why you hold your views and how Ofcom's proposals would impact on you.

Further information

A9.7 If you want to discuss the issues and questions raised in this consultation, or need advice on the appropriate form of response, please contact Claire Mack on 0141 229 7403.

Confidentiality

A9.8 We believe it is important for everyone interested in an issue to see the views expressed by consultation respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, ideally on receipt. If you think your response should be kept confidential, can you please specify what part or whether all of your response should be kept confidential, and specify why. Please also place such parts in a separate annex.

A9.9 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and will try to respect this. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.

A9.10 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's approach on intellectual property rights is explained further on its website at http://www.ofcom.org.uk/about/accoun/disclaimer/

Next steps

A9.11 Following the end of the consultation period, Ofcom intends to publish a statement around Q1 2013.

A9.12 Please note that you can register to receive free mail Updates alerting you to the publications of relevant Ofcom documents. For more details please see: http://www.ofcom.org.uk/static/subscribe/select_list.htm

Ofcom's consultation processes

A9.13 Ofcom seeks to ensure that responding to a consultation is easy as possible. For more information please see our consultation principles in Annex 10.

A9.14 If you have any comments or suggestions on how Ofcom conducts its consultations, please call our consultation helpdesk on 020 7981 3003 or e-mail us at consult@ofcom.org.uk . We would particularly welcome thoughts on how Ofcom could more effectively seek the views of those groups or individuals, such as small businesses or particular types of residential consumers, who are less likely to give their opinions through a formal consultation.

A9.15 If you would like to discuss these issues or Ofcom's consultation processes more generally you can alternatively contact Graham Howell, Secretary to the Corporation, who is Ofcom's consultation champion:

Graham Howell
Ofcom
Riverside House
2a Southwark Bridge Road
London SE1 9HA

Tel: 020 7981 3601

Email Graham.Howell@ofcom.org.uk

Annex 10

Ofcom's consultation principles

A10.1 Ofcom has published the following seven principles that it will follow for each public written consultation:

Before the consultation

A10.2 Where possible, we will hold informal talks with people and organisations before announcing a big consultation to find out whether we are thinking in the right direction. If we do not have enough time to do this, we will hold an open meeting to explain our proposals shortly after announcing the consultation.

During the consultation

A10.3 We will be clear about who we are consulting, why, on what questions and for how long.

A10.4 We will make the consultation document as short and simple as possible with a summary of no more than two pages. We will try to make it as easy as possible to give us a written response. If the consultation is complicated, we may provide a shortened Plain English Guide for smaller organisations or individuals who would otherwise not be able to spare the time to share their views.

A10.5 We will consult for up to 10 weeks depending on the potential impact of our proposals.

A10.6 A person within Ofcom will be in charge of making sure we follow our own guidelines and reach out to the largest number of people and organisations interested in the outcome of our decisions. Ofcom's 'Consultation Champion' will also be the main person to contact with views on the way we run our consultations.

A10.7 If we are not able to follow one of these principles, we will explain why.

After the consultation

A10.8 We think it is important for everyone interested in an issue to see the views of others during a consultation. We would usually publish all the responses we have received on our website. In our statement, we will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex 11

Consultation response cover sheet

A11.1 In the interests of transparency and good regulatory practice, we will publish all consultation responses in full on our website, www.ofcom.org.uk.

A11.2 We have produced a coversheet for responses (see below) and would be very grateful if you could send one with your response (this is incorporated into the online web form if you respond in this way). This will speed up our processing of responses, and help to maintain confidentiality where appropriate.

A11.3 The quality of consultation can be enhanced by publishing responses before the consultation period closes. In particular, this can help those individuals and organisations with limited resources or familiarity with the issues to respond in a more informed way. Therefore Ofcom would encourage respondents to complete their coversheet in a way that allows Ofcom to publish their responses upon receipt, rather than waiting until the consultation period has ended.

A11.4 We strongly prefer to receive responses via the online web form which incorporates the coversheet. If you are responding via email, post or fax you can download an electronic copy of this coversheet in Word or RTF format from the 'Consultations' section of our website at www.ofcom.org.uk/consult/.

A11.5 Please put any parts of your response you consider should be kept confidential in a separate annex to your response and include your reasons why this part of your response should not be published. This can include information such as your personal background and experience. If you want your name, address, other contact details, or job title to remain confidential, please provide them in your cover sheet only, so that we don't have to edit your response.

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

Please tick below what part of your response you consider is confidential, giving your reasons why

Nothing ☐

Whole response ☐

Part of the response ☐

Name/contact details/job title ☐

Organisation ☐

If there is no separate annex, which parts?

If you want part of your response, your name or your organisation not to be published, can Ofcom still publish a reference to the contents of your response (including, for any confidential parts, a general summary that does not disclose the specific information or enable you to be identified)?

DECLARATION

I confirm that the correspondence supplied with this cover sheet is a formal consultation response that Ofcom can publish. However, in supplying this response, I understand that Ofcom may need to publish all responses, including those which are marked as confidential, in order to meet legal obligations. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.

Ofcom seeks to publish responses on receipt. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here. ☐

Name

Signed (if hard copy)

Glossary of abbreviations

ACMA	Australian Communications and Media Authority
ADS	Audio-distribution systems
AM	Amplitude modulation
BBC	British Broadcasting Corporation
CATV	Wireless access from handheld terminals to video feeds being carried by the Host Broadcaster.
CEPT	European Conference of Postal and Telecommunications Administrations
CGF	Commonwealth Games Federation
CGS	Commonwealth Games Scotland
COGSPLAG	Commonwealth Games Spectrum Planning Group
DMR	Digital mobile radio (TDMA variant)
DPMR	Digital Private Mobile Radio (FDMA variant)
E&PSS	Emergency and public-safety services
EBU	European Broadcasting Union
ECC	Electronic Communications Committee
EIRP	Equivalent Isotropically radiated Power
ENG	Electronic newsgathering
ERC	European Radiocommunications Committee
ERP	Effective Radiated Power
ETSI	European Telecommunications Standards Institute
FDMA	Frequency Division Multiple Access
FM	Frequency modulation
GCC	Glasgow City Council
GHz	Gigahertz
HB	Host Broadcaster
HD	High Definition

IBC	International Broadcasting Centre
IRB	International Rugby Board
IP	Internet Protocol
kHz	Kilohertz
MHz	Megahertz
mW	Milliwatt
OB	Outside broadcasts
OC	Organising Committee for the Glasgow 2012 Games
Ofcom	Office of Communications
PBR	Private Business Radio (Considered to be identical to PMR)
PMR	Private mobile radio
PMSE	Programme making and Special Events
RHB	Rights-holding broadcaster
SAB	Services ancillary to broadcasting
SD	Standard Definition
SAP	Services ancillary to programme-making
SNG	Satellite newsgathering
SRS	Short-term restricted-service licence
TDMA	Time Division Multiple Access
TETRA	Terrestrial trunked radio
UEFA	Union of European Football Associations
UKSSC	Cabinet Official Committee on UK Spectrum Strategy
W	Watt
WLAN	Wireless local-area network
3D	3 Dimensional