Spectrum Review – Update on Key Messages and Next Steps

A review of the management of the spectrum currently used for point to point fixed links and other services that share this spectrum

Update

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Section 1

Summary

Background

1.1 In January 2012 Ofcom published a Call for Input[1] in relation to a range of spectrum bands between 1.4 GHz and 86 GHz which, in total, represent to some 37 GHz of spectrum bandwidth. The common feature of these bands is that they can be used by fixed wireless point to point links, although some of these bands are also used by other applications, notably by a range of fixed satellite services.

1.2 We initiated the review as evidence was starting to emerge that demand for some of these spectrum bands may change significantly over the next 5 to 10 years. We wanted to understand the nature and timing of these changes so that we could ensure that spectrum resources were available on terms which best reflect the needs of users. The main purpose of the review has been to help inform the development of our strategy at three levels;

i) Allocation decisions to do with which services should have access to which bands, and on what terms, particularly in the context of Ofcom's involvement with international decision making bodies;

ii) UK band management strategy, including the extent to which Ofcom should delegate spectrum management to third parties as opposed to Ofcom managing these bands;

iii) Development and innovation in licence products offered in the bands which Ofcom continues to manage (such as the application of pricing and design of licence products).

1.3 It is important to consider such policy issues against the backdrop of an informed view of how demand for access to these spectrum bands from different services and applications might change over time. Accordingly, the Call for Input invited stakeholders to identify and evidence possible drivers of demand that may impact the spectrum under review. As part of this exercise we published (alongside the Call for Input) a report[2] commissioned by us from Aegis Systems Ltd which considered a range of plausible hypothetical scenarios which might impact demand for these spectrum bands.

Key messages from stakeholders on demand

1.4 The dominant use of these spectrum bands today is for the provision of backhaul within mobile networks, accounting for more than 80% of the current fixed link licence base. There is a widespread recognition that this use is likely to undergo significant change over the next few years, particularly as 4G networks are established to meet a rapid growth in demand for mobile data capacity. While many expect rollout of fibre to continue, there is a clear view, widely held, that wireless backhaul will continue to play an important and significant role. We note that many stakeholders foresee an increasing use of wireless links in dense urban areas to serve high capacity small cell backhaul to mobile base stations where wireless connectivity enables rapid initial

[1] http://stakeholders.ofcom.org.uk/binaries/consultations/spectrum-review/summary/condoc.pdf
[2] http://stakeholders.ofcom.org.uk/binaries/consultations/spectrum-review/annexes/report.pdf

deployment and subsequent flexibility which fibre may not be able to match. The very large capacity demands of such cells, and small scale topology, is expected by many to increase demand for higher frequency bands in preference to the lower bands which have until recently been subject to greatest demand.

1.5 The millimetre wave bands above 60 GHz, in particular, which are currently available on a self co-ordinated, light licensed basis, were identified by some as particularly suitable for high capacity, short range applications within mobile networks. There is a high level of interest in the potential use of the 71-76 GHz and 81-86 GHz bands (known as "E-Band") for the provision of backhaul in new 4G networks.

1.6 The anticipated growth in mobile data volumes has another potential implication for this Review in relation to the pressure to identify new spectrum bands for mobile data access. This could create a competing demand for the lower frequency bands that are currently used by fixed links and satellite earth stations.

1.7 There is recognition that additional spectrum may be required to support new application developments in smart grids, security, and business communications, but these were not thought likely to have a significant impact on demand for any spectrum band considered under this review.

1.8 Satellite stakeholders reported that the future growth in satellite based broadband applications and subsequent demand for such services will place a significant demand on Ka band capacity. These stakeholders argued that spectrum in the shared 18 GHz band should be made available to fixed satellite service applications for uncoordinated satellite terminals on a more favourable basis than the current approach allows. In the 28 GHz band stakeholders indicated that the band segmentation regulatory approach applied in the UK has resulted in an unfavourable environment for satellite services.

Policy issues

1.9 Stakeholders gave a consistent message that spectrum users require a stable regulatory environment in which they have a high degree of certainty about future access to spectrum. This was a key consideration for a very large proportion of spectrum users and manufacturers. Consistency with international standards and regulations was also another important consideration for many stakeholders.

1.10 In terms of way that different service and applications can access the bands in question (the hierarchy of service allocations by band and the terms as spectrum access) the main policy areas relate to:

- The potential identification of bands for mobile use and wireless data traffic: and
- The regulatory conditions under which ubiquitous, un-coordinated satellite applications (e.g. for provision of consumer broadband services) might, in future, be able to access spectrum in the Ka band between 17.7-19.7 GHz.

1.11 In response to the questions we asked around band management, there appeared to be little appetite for a migration of spectrum from Ofcom band management to third party band management (whether for own use or for the provision of commercial band management services to others). There was a general sentiment that the current mix of spectrum management approaches is broadly right with around 12 GHz of the spectrum bands being managed by Ofcom (with detailed technical coordination between licensees), around 6 GHz of spectrum with third parties (managed largely for

their own use and acquired through auctions and subsequent trading) and with remainder of the bands being subject to a variety of light licensing and licence exempt spectrum management regimes.

1.12 Turning to the Ofcom licence product set, stakeholders expressed a broad level of satisfaction with the current arrangements. A number of proposals were put forward for specific developments that we can take forward as part of our ongoing programme of development work. However, the most important area of requested change relates to the licensing of the 71-76 GHz and 81-86 GHz bands (E-Band); the importance of this issue is connected with the observations above about the prospective importance of this band for 4G network backhaul. Mobile network operators and some of their equipment suppliers reported that the current self co-ordinated management regime for this band does not provide them with the level of protection that they believe is required for carrier grade applications. They felt that operator led co-ordination in shared bands could lead to extended dispute resolution discussions. On this basis some argued that Ofcom should more actively manage these bands.

Forward Work Programme

1.13 Sections 5 of this Update sets out our priorities for taking forward the range of policy issues identified in section 4 (and summarised above), taking into account the comments and feedback made by stakeholders in response to the Call for Input.

1.14 The highest priority project relate to the following two areas:

- **Review of the spectrum management arrangements in the 71-76 GHz and 81-86 GHz bands ("E band").** We have already initiated work on a review of the current self co-ordination approach for this band in light of the responses to the Call for Input that have indicated the potential importance of E band due to the imminent 4G infrastructure requirements. We plan to engage with interested parties in the new year to discuss options for changes to the current arrangements. In parallel, we plan to review the future use of the 52 GHz and 55 GHz bands which are currently subject to Ofcom management but which remain unused. We are interested to know whether these bands may be suitable for carrier grade applications and what, if any, changes are required to the terms on which these bands are currently made available.

- **Identification of additional spectrum for mobile use and wireless data traffic.** In light of the emerging international interest to consider potential candidate bands for next generation broadband mobile systems under WRC15 AI 1.1, as well work within the RSPP to identify spectrum for wireless data traffic, we note the possible implications of this international work on the spectrum considered under this review. As international work develops, it is likely that both 1.4 GHz and 4 GHz will be considered amongst the list of potential candidate bands to be studied. We are planning to continue to engage within the relevant groups and address the likely impact on existing use. This is with a view to developing a clear direction on the future use of this spectrum and whether there are alternative bands suitable for existing services if bands considered under this review were harmonised for mobile broadband use.

1.15 The other main areas of work to take forward are as follows:

- **Fee Review**: We confirm that we intend to conduct a review of fees payable for licences in the bands covered by the Call for Input. This will include licences for both point to point fixed links and links to / from satellite earth stations.

- **Enhanced use of the 18 GHz band spectrum for Fixed Satellite Services**. This could become an important issue both for satellite stakeholders that are looking for enhanced access for the operation of uncoordinated satellite earth station receivers within the 18 GHz band, and for the fixed link sector that could be impacted by any changes in the regulatory environment to support this. Work is currently under way in CEPT on this area which Ofcom will continue to monitor. Depending on the nature of any arrangements for enhanced access that are developed (notably, the extent to which enhanced satellite access would come at the expense of fixed link access) we may conduct our own analysis on the national situation from the perspective of longer term spectrum demands.

- **Improved access to spectrum planning information**. We are supportive, in principle, of stakeholder proposals that spectrum users should have access to parts of Ofcom's spectrum planning database to enable them to test network planning options and monitor likely future availability of spectrum in areas of interest to them. We intend to consider in due course how such facilities could be made available and whether it would be cost effective to do so, noting that there could be significant systems implementation costs in doing so.

1.16 A number of other issues can be taken forward as part of our normal programme of sector spectrum management (for example, the development of arrangements to enable digital use in the 31GHz band and various enhancements to the current licence product set, such as larger channel sizes).

1.17 Ofcom plans to move ahead with the programme of work emerging from this review as set out in this Update. Where we develop new policy proposals in the course of this work we will set these out as part of a separate consultation exercises. We are not seeking formal responses from stakeholders on this Update. However, we would like to hear from stakeholders if they have strong views on our prioritisation of the policy issues in the forward programme, or if they feel that there are any material omissions.

Section 2

Background

Why Ofcom initiated a spectrum review

2.1 As set out in Ofcom's Call for Input (31 January 2012) there are a number of reasons why Ofcom felt that it was appropriate to conduct a review of the Ofcom managed spectrum used by fixed links in the United Kingdom.

2.2 Firstly, we have started to see significant changes in the demand for spectrum used to provide fixed links. Demand from the predominant application, backhaul for mobile networks, is undergoing fundamental change as networks and businesses evolve. At the same time, a number of network operators now have access to a number of bands that were auctioned in 2008 (the "10-40 GHz auction") or through acquisitions via spectrum trading. Therefore they have alternatives to the Ofcom managed bands for provision of their wireless backhaul infrastructure. In addition, demand from providers of other services which share some of the relevant spectrum bands now, or could do so in future, may also change significantly (e.g. satellite applications and broadband wireless access). We therefore need to understand what impact the changes could have on demand for these spectrum bands over the next 5 to10 years.

2.3 Secondly, and linked to the above point on the changing nature of spectrum demand, Ofcom faces a range of pressures to enable access to some of these bands for competing applications (both terrestrial and satellite). We therefore need an appropriate evidence base on which to consider our policy approach to these issues. This is particularly relevant in the international regulatory fora (the EU, CEPT and the ITU), noting that the international regulatory environment has a significant impact on what we do in the UK. International and European changes to frequency allocations and technical conditions obviously play an important part with regard to the allocations indentified in the UK. These are reflected in the technical conditions across the range of licence products we make available and as reflected in the UK Frequency Allocation Table, although at a national level we have always have the flexibility to take decision based on our specific indentified requirements.

2.4 Thirdly, the Strategic Review of Spectrum Pricing (SRSP) concluded in December 2010 that we should undertake a review of frequency bands used in the UK for fixed links, with the review encompassing all services that share these bands to reflect our intention to price spectrum through consideration of feasible alternative uses, rather than just addressing specific licence sectors. The SRSP also highlighted that the review should not be restricted just to pricing but, rather, be a review of our overall approach to managing these frequency bands and licence sectors.

The scope of the review

2.5 Approximately 37 GHz of spectrum is available in the UK for fixed terrestrial point to point links. As illustrated in Annex2, this includes a wide variety of bands ranging from 1.4 GHz to 86 GHz. The manner in which use in each band is authorised is distinguished between:

- Ofcom coordinated: this spectrum is licensed and technically coordinated on a link by link basis, managed by Ofcom. We set the technical assignment criteria in consultation with stakeholders and we use this to coordinate the links to prevent

interference. In one band (at 31 GHz), the assignment function has been outsourced and Ofcom sets the assignment criteria but the link assignments are carried out by a third party assignment manager. All of these fixed link bands consist of a pair of sub-bands which are used, respectively, for the 'go' and 'return' transmission paths (i.e. a FDD duplex arrangement). There is around 12 GHz of spectrum in this category spread across fourteen separate bands between 1.4 GHz and 60 GHz.

- Light licensed: individual licences are issued by Ofcom, but the licensees themselves have responsibility for assigning and coordinating their links. Ofcom does not specify the channel arrangements in these bands and licensees have maximum flexibility and the freedom to choose the channel size. In the 65 GHz, 70 GHz and 80 GHz bands, a self-coordinated approach applies and links are registered on Ofcom's wireless telegraphy register and are given priority in the band on a 'time/date of registration' basis, which can be referred to should an interference case arise. The register of links is publically available and is used as the basis for licensees to access the information necessary for them to be able to self co-ordinate links. In the 5.8 GHz band each licensee is required to register their own links using an online system. However, at 5.8 GHz there is no time/ date of registration priority and licensees can only view the registered links attached to their own licence(s). Co-channel interference between links and primary services is avoided by automatic interference mitigation techniques built into the equipment as required by ETSI standards (dynamic frequency selection and transmitter power control). There is around 12 GHz of spectrum in this category located between 64 GHz and 86 GHz and at 5.8 GHz.

- Licence Exempt: users of licence exempt spectrum must comply with general conditions intended to prevent or minimise interference, but there is no requirement for users to co-ordinate between each other or to notify Ofcom of planned use. There is around 7 GHz of licence exempt spectrum available in the 57 - 64 GHz band which benefits from high atmospheric oxygen absorption that allows intensive short hop frequency reuse.

- Auctioned / Block licensed spectrum: around 6 GHz of spectrum which is suitable for fixed links use (amongst other uses) is licensed to and managed by 3rd parties. The largest part of this was acquired through the "10-40 GHz" auction that took place in 2008; other blocks in the 28 GHz band were acquired through an earlier auction in 2000. In addition, there is a UK wide licence for two large blocks of spectrum in part of the 4 GHz band. The licensees have wide discretion over the management of the spectrum in question.

2.6 The scope of this review covered the first three categories above, although as expected, the main focus of feedback has been on the Ofcom coordinated bands. Details on the bands included are shown in Annex 3. In summary, these include:

Frequency Bands Under Review

1.4 GHz	1350-1374.5 MHz paired with 1492.5 -1517MHz
4 GHz	3600-4200 MHz
5.8 GHz	5725-5850 MHz
Lower 6 GHz	5925-6425 MHz

Upper 6 GHz	6425-7125 MHz
7.5 GHz	7425-7900 MHz
13 GHz	12.75-13.25 GHz
15 GHz	14.5-14.613 MHz paired with 15.229-15.35 GHz
18 GHz	17.7-19.7 GHz
23 GHz	22-23.6 GHz
26 GHz	24.5-26.5 GHz
31 GHz	31.0-31.3 GHz paired with 31.5-31.8 GHz
38 GHz	37-39.5 GHz
52 GHz	51.4-52.6 GHz
55 GHz	55.78-57 GHz
60 GHz	57-64 GHz
65 GHz	64-66 GHz
70 GHz	71-76 GHz
80 GHz	81-86 GHz

Table 1

2.7 The auctioned / block licensed bands are included in Annex 2 for information only because they represent a substitute source of spectrum supply to the bands covered by the review.

2.8 Although the spectrum bands covered by this review were chosen with reference to their availability for use by fixed point to point links, the review has considered the current and likely future use in these bands by all services. To inform the review, Ofcom considered the demand that may arise for this spectrum over the next 5 to 10 years from:

i) Existing uses in the spectrum under review (which includes a range of fixed satellite applications in some bands as well as point to point fixed links);

ii) Potential alternative uses of the spectrum under review where the potential alternative uses may or may not be compatible with existing use.

2.9 In terms of current use, the majority of fixed links in the UK are used to provide backhaul for mobile networks and are licensed to mobile operators, and to BT (and other fixed network operators) which provides backhaul links to at least some MNOs (as well as providing links to a wide variety of other types of end user). As a result, approximately 90% of all links which are licensed by Ofcom are held by just eight companies.

2.10 The remaining 10% of individual fixed link licences are spread across more than 300 other licensees, the majority of whom hold only a few licences each. These licensees use fixed links for a variety of applications including broadcast distribution, utility networks, public safety communications networks, broadband and CCTV by local authorities

2.11 The other main uses in the spectrum bands under review (as from point-to-point fixed links) relate to:

- Broadband Wireless Access applications at 3.6 and 3.9 GHz: and
- A range of satellite based applications In the 3.6 – 4.2 GHz, 5.925 - 7.075 GHz, 12.75 -13.25 GHz and 17.7-19.7 GHz bands.

Ofcom's approach to the Spectrum Review

2.12 Our approach to this Spectrum Review, as set out in our Call for Input, has been sequenced as follows:

- First, we have sought to understand the key drivers of changes in demand for the spectrum under review and how demand might change in future in light of these.
- Second, and in the light of this, we have considered whether there would be benefits in changing aspects of our spectrum policy or spectrum management approach towards these bands. The range of policy and management issues has been framed as an open question to be influenced by the responses to the Call for Input.

2.13 In order to help us understand the drivers of demand for spectrum in the bands covered by this review, we commissioned Aegis to carry out a demand study. We then published this study alongside the Call for Input and invited stakeholders to comment on Aegis' findings and to provide their own views and insights into the factors will drive future demand from their sector.

2.14 The Call for Input also gave stakeholders the opportunity to signal the policy and spectrum management issues that they thought should be addressed in subsequent policy phase of this review. Although we had no preconceived ideas about the nature of any changes in spectrum management approach which should be considered, we suggested that stakeholders might consider issues relating to any of the following main themes:

- Allocation issues to do with which services should have access to particular spectrum bands on either an exclusive of shared basis;
- Band management strategy, including the extent to which Ofcom should package spectrum bands for management by third parties as opposed to continuing to manage the detailed assignment coordination process via well defined licence products; and
- Changes to licence products offered in the bands which Ofcom continues to manage, such as in pricing and design of licence products.

Responses to Call for Input

2.15 Ofcom received 32 responses to the Call for Input from various stakeholder communities including the Fixed and Satellite Services stakeholder groups. A list of the non confidential respondents is provided in Annex 1.Ofcom also had a bilateral meetings with a number of stakeholders that wished to engage in one to one discussions. We are very grateful for the time and effort invested by those who responded to the Call for Input, both through the written responses received and through attendance at face to face meetings.

This publication

2.16 This publication provides stakeholders with a summary of key messages that have been raised as part of this review. Section 3 summarises the issues raised in responses in relation to changes in demand for spectrum in the bands under review; the section concludes with a summary of the main messages on demand drivers. Section 4 considers the range of policy issues raised in responses, organised under each of the main themes above; this section concludes with a list of candidate policy projects that might be taken forward as part of our future programme of work. Section 5 then goes on to consider the priority that we attach to each of these policy projects and, where relevant, to provide further comments on the nature of the issues that we expect to consider. Ofcom intends to address the highest priority work items in our forward programme with immediate effect. Where possible, we comment on the possible timing of other work items.

Section 3

Demand for spectrum under review

Introduction

3.1 A number of different applications use the spectrum bands covered by this review. Their demands for spectrum will change over time and stakeholders may seek access to the spectrum bands for new applications. These prospective changes in demand provide the fundamental context within which the policy agenda needs to be viewed.

3.2 This section is set out in the following order:

- A short commentary on the relevance of understanding demand evolution for our policy making role.
- A summary of the main findings of the independent study conducted by Aegis Systems on behalf of Ofcom on spectrum demand (which was published alongside the Call for Input). This report focused on the key trends, and underlying drivers, that likely to impact demand, and on events that could result in a "step change" in demand. The study was intended to consider plausible hypothetical scenarios rather than to provide a precise band by band forecast for Ofcom.
- A summary of the key messages from stakeholders in response to the Call for Input on the underlying factors which will influence demand on a sector specific basis.
- Our summary of the main messages from stakeholders on demand trends and our conclusions on the key drivers that we should monitor going forward.

The need to understand market and technological developments which may impact demand for the spectrum bands under the review

3.3 Ofcom has a duty to secure optimal use of radio spectrum, and in doing so must have regard to the different needs and interests of people and organisations which may wish to use it.

3.4 Spectrum is a finite resource, in so far as one person's use of a set of frequencies in one location may prevent others from using the same frequencies, and adjacent frequencies, in the surrounding area. The spectrum bands which we have reviewed are all used, at least in part, by point to point fixed links. The other major application is to support communications links between earth stations and satellites. Provided that use of these bands is adequately planned (either centrally by Ofcom or locally by users) many of these services and users can co-exist without causing undue interference to each other. The way that these spectrum bands are planned often reflects international agreements intended to maximise efficient use of the resource on an international basis, although many allocation decisions are also taken by Ofcom on a national basis.

3.5 When issues to do with allocations are reviewed, Ofcom often has to balance the competing interests of different user groups. Underpinning these decisions are assumptions about future availability and demand for the various frequencies. There

is some evidence that demand for many of the bands under review is likely to undergo significant change in the next 5 to 10 years. Technological and commercial factors may well change the balance of demand between different bands. Some bands may face a large increase in demand and some a reduction. If care is not taken, there is a risk, in principle, that some bands may become congested such that new assignments cannot be provided in some areas. Conversely, in other bands, outdated management arrangements, including pricing, may cause the resource to be under-used where a different approach would enable the resource to be put to wider productive use.

3.6 Change to allocations decisions and to the technical and commercial terms on which licences are granted is often a protracted exercise as the needs of existing applications necessarily have to be taken into account. For this reason, it is important to identify changes in the demand/supply equation as far ahead as possible.

Independent work conducted for Ofcom on the Review of the Fixed Link Spectrum (The Aegis Study)

3.7 One of the core purposes of the Call for Input was to gather information about the likely influences on future demand for the spectrum bands under review. The report which we commissioned from Aegis, and which was published alongside the Call for Input, explored a set of demand scenarios as a backdrop against which to develop our strategy for managing these bands over the next decade. Rather than attempt to provide a precise forecast of demand for each band, Aegis was asked to consider how demand might change under a range of hypothetical scenarios. The study reviewed potential demand from a wide range of applications that might wish to access these spectrum bands in future, not limited to point to point fixed links and the services which currently share these bands.

Aegis' conclusions on overall levels of spectrum demand

3.8 As summarised in its report, the view of the Aegis study was that demand for fixed links spectrum above 20 GHz will be generally be "considerably less" than the available supply in all scenarios due to the very intensive frequency reuse feasible in these bands. The availability of additional spectrum above 60 GHz for very short links and the migration of links from Ofcom managed bands to auctioned spectrum would further reduce this pressure.

3.9 However the situation in bands between 3 GHz and 20 GHz was viewed to be more complex due to the more limited availability of spectrum and demand growth rising from mobile broadband rollout, fixed wireless access in rural areas and the potential launch of a broadband public safety wireless network. The study indicated that there is considerable uncertainty about whether all or part of the 18 GHz band be required to accommodate consumer satellite terminals in the future. Should the whole or the majority of this band be re-allocated to satellite, this would lead to congestion in the 13 GHz and 15 GHz bands, mainly in urban and suburban areas. It also however suggests the possible scope for geographical band segmentation at 18 GHz between urban and suburban fixed links and rural satellite terminals.

3.10 The study also indicated that congestion may also arise in the 6 GHz and 7.5 GHz bands on a more localised basis which could be relieved by greater use of the 4 GHz band however it notes that the large antennas required at 4 GHz could make the band less popular for fixed link deployment and that the propagation properties of the band make it potentially attractive for alternative uses such as mobile.

3.11 The study concluded that there would be sufficient capacity in the 1.4 GHz band to meet demand in all of the scenarios modelled.

Trends, Key Trigger Points and Events likely to cause Step Changes in Demand as indentified by the hypothetical scenarios

3.12 Aegis indentified the following key factors that are likely to influence demand:

- Cost and Availability of fibre would have a strong bearing on fixed link demand in urban and suburban areas. The effect would be concentrated in higher frequency bands (mainly above 20 GHz) and likely to be a gradual change over the 10 year period.
- Demand for fixed wireless broadband access in rural areas. This would require significantly higher backhaul capacity per user than mobile broadband and is likely to drive demand in bands below 30 GHz.
- Launch and extent of coverage of 4G (LTE) mobile services. This will result in a step increase in fixed link demand prior to service launch.
- The roll out of a national public safety broadband network (if delivered as a new private network) would be one of the main sources of new demand for fixed link capacity and would result in a large step increase in demand.
- Expansion of DAB coverage is likely to be the largest driver of demand growth in the 1.4 GHz band though demand will concentrate in rural areas.
- Demand for consumer satellite terminals is identified by Aegis as a significant uncertainty.

3.13 The study indentified two events that could result in a step change in demand, namely the rollout of 4G mobile services and the rollout of a national public safety broadband network. The latter was identified as having the greater impact as Aegis indicates that a radio would be required at every site, unlike 4G which Aegis expects to use mainly fibre in urban and suburban areas. Aegis also suggested that coverage would need to be rolled out quickly to all areas of the country to meet the demanding needs of the public safety community.

3.14 The study noted that the emergence of a real market for consumer satellite broadband terminals could, under some of the scenarios, lead to more exclusive spectrum for satellite applications in the 18 GHz band. Aegis suggested that Ofcom monitor developments in the sector closely and may wish to investigate the feasibility of geographic sharing in this band.

3.15 Other developments identified by the study are seen to be more gradual in nature and unlikely to result in a sudden demand for fixed link spectrum

Respondent views on Aegis Study and on sector specific developments that will impact demand

3.16 Stakeholders broadly agreed with the analysis set out by Aegis while questioning some points of detail. The areas where they disagreed exceptions generally related to frequency bands which are shared between different types of applications, in

particular the 18 GHz band which is currently shared between point to point fixed links and the Fixed Satellite Service.

3.17 In the Call for Input we sought views on how demand would impact the spectrum under review from specific industry / service sectors. We asked for demand evidence from existing uses as well as potential demand arising from new uses that do not currently have access to the spectrum under review. We were specifically interested in information that would help us to understand how demand may change over the next 5 to 10 years.

Mobile backhaul

3.18 Although fixed links are used by a variety of industry sectors, 80% of all fixed links in the bands managed by Ofcom are currently used to support mobile backhaul. Therefore, as the predominant application, any change in the demand for spectrum to support mobile backhaul can be expected to have a significant impact on the overall demand/supply equation for these spectrum bands. In our Call for Input we referred to the current decline in numbers of Ofcom fixed link licences to support mobile backhaul. Noting that this alone does not give a complete picture of the likely future call upon spectrum under review, Ofcom specifically asked stakeholders, whether the reducing trend in numbers fixed links would continue.

3.19 The overriding view of stakeholders in relation to the future supply / demand balance is that there is necessarily a high degree of uncertainty on the level of demand with the advent of 4G. Responses suggest that it would be premature for Ofcom to consider reducing spectrum for mobile backhaul given the importance of the mobile sector and uncertainly over demand. There is an expectation that this uncertainty will reduce as 4G deployment proceeds.

3.20 Respondents commented that the growing MNO use of auctioned bands (between 10 and 40 GHz: see below) is expected to offset the use of spectrum currently available from Ofcom in the 18-38 GHz range. However, most responses indicate that the current reducing trend in total numbers of fixed links in the spectrum under review is unlikely to continue and that judgements on trend should take account of the capacity of individual links to carry traffic for mobile backhaul as well as the total numbers of links. It is widely accepted that there will be a very significant increase in demand for data capacity in mobile backhaul networks. Views differ on how this will be met with reference to factors such as: how far fibre may be extended into the networks, how much Wi-fi offload may be used, and what the new network architecture may look like. These observations do not, however, translate into widespread requests for additional spectrum to be made available for mobile backhaul. This may be due to the individual situation of each operator such as the amount spectrum they may have acquired through auction or spectrum trading. MNO consolidation and network sharing is a further suggested as a factor likely to impact demand for spectrum bands in this range.

3.21 The mobile sector is undergoing a period of significant change, including network consolidation and redesign of networks to accommodate very large increases in demand for mobile data capacity. The Aegis report, and stakeholder responses to the Call for Input, have all tended to emphasise the high probability of significant change in the way the frequency bands within the scope of this review will be used for mobile backhaul. There is an expectation that fibre will continue to be rolled out further beyond urban areas, but that there will continue to be a reliance on wireless systems in many areas (urban as well as rural).

3.22 Many stakeholders (service providers as well as manufacturers) forecast a significant shift in demand from lower to higher frequencies. Respondents have commented that technology to address the fast growing demand for data backhaul capacity is expected to differ markedly from that used today. The change from TDM to pure Ethernet is also commented as likely to change demand as 4G networks roll out.

3.23 The expected deployment of large numbers of localised, high capacity, small cells in 4G networks is however, forecasted by stakeholders, to generate a significant increase in demand for millimetre wave spectrum above 60 GHz where many of these bands are currently used only lightly. The superior bandwidth available in these bands will drive greatly increased use of these bands to serve such demand. Many stakeholders believe rapid deployment of backhaul from small urban cells will require fixed link spectrum rather than fibre (again, focusing on bands which offer high capacity over relatively short hops).

3.24 Respondents have, however, raised concerns regarding the self coordinated approach applicable in the UK for the 71-76 GHz and 81-86 GHz bands which we discuss in sections 4 and 5.

3.25 It is unclear whether, and to what extent, a demand will emerge for non line of sight links or for point to multipoint applications; the interest expressed to us largely reflects the current vendor commercial aspirations.

3.26 In-band backhauling was referred to by Aegis in its report, but those few stakeholders who commented on this option did not consider that this would be a material factor in considering demand for backhaul in the bands covered by this Review.

3.27 It will be important to monitor the impact on demand for fixed links in the Ofcom managed bands as MNOs (and fixed network operators which provide backhaul services) turn to using auctioned spectrum. We note that EE and MBNL already has substantial holdings of auctioned spectrum in the 10 GHz, 32 GHz and 40 GHz bands which may be well suited to providing mobile backhaul. We also note that Cable and Wireless which has recently been acquired by Vodafone, has holdings of auctioned spectrum in the 28 GHz band, and Telefónica too has recently acquired auctioned spectrum in the 28 GHz band. Subsequent to the Call for Input, Vodafone has acquired Transfinite's spectrum holdings at 28 GHz. To the extent that auctioned spectrum is used to support backhaul services, this could impact demand for spectrum in the bands managed by Ofcom, which are the focus of this review.

Satellite Services

3.28 The Fixed Satellite Service is the predominant sharer of spectrum with the Fixed Service in the spectrum under review. The means by which bands are shared by the two services vary by application, nature of the interference environment and regulatory approach. We asked stakeholders to evidence the likely demand for the spectrum under review for satellite services and the bands in which most significant changes in demand were likely. We also asked about the continued and future spectrum requirements for permanent earth stations (PES) and the bands in which demand might be likely. We noted the slow demand for satellite consumer terminals in contrast to the forecasted demand and asked stakeholders for information to assist Ofcom to make a reasonable assessment of future demand in the spectrum currently shared with fixed links.

Ka Band and consumer broadband services

3.29 Many in the satellite sector would like improved access to Ka band (broadly 17.3-20.2 GHz paired with 27.5-30 GHz) to support a major expansion of satellite based consumer broadband (internet access) terminals in the UK. It is argued that the access to Ku band (10.7-14.5 GHz) is now seriously congested (at the space end of the links), largely because there is no room for further orbital slots which would enable frequency and geographic reuse. Technology advances such as adaptive coding, fade compensation techniques, smaller antennas and the use of spot beams, mean that widespread deployment of Ka band services is now much more feasible. Bands above Ka band are currently not considered feasible for satellite applications due to high atmospheric propagation issues affecting the satellite link path.

3.30 Reflecting the Ku band congestion, the satellite sector would like parts of the Ka sub band 17.7-19.7 GHz (currently shared with fixed terrestrial services) allocated for use with ubiquitous uncoordinated consumer satellite terminals on a protected basis (see section 4).

C Band and Permanent Earth Stations

3.31 Satellite Stakeholders suggest that the future use the 4 GHz band will remain stable and the continued access to this band on a general international basis is required as it provides resilient communications and coverage. Stakeholders indicate that the current satellite earth station and fixed service coordinated environment at C band works well and this should be maintained.

3.32 Respondents commented on the continued need for feeder links to deliver broadcasting services and specifically referred to the need to maintain access to spectrum at C Band (3.6-4.2 GHz). The need for Ku and Ka band for permanent earth stations was also mentioned, though without detail about expected numbers of earth stations and demand for additional sites.

3.33 Ofcom notes that the 4 GHz band may be considered for future mobile or wireless broadband applications under current international work items (see sections 4 and 5). Some satellite stakeholders feel there is no justification to add further allocations to mobile application in the 3.6-4.2 GHz range.

Other applications

3.34 The response on the use of microwave spectrum for utility applications indicated the importance of continued access to the 1.4 GHz due to the properties of this band for providing resilient communications during weather related incidents over long paths and low latency when compared with satellite links. For such applications the respondent's view is that microwave bands are not necessarily substitutable and therefore any proposals to consider changes in management of the spectrum should respect this principle.

3.35 Responses from the PMSE sector highlighted the fact that demand for spectrum by PMSE applications is increasing at the same time as spectrum access for PMSE applications is being reduced. They noted that these factors could lead to increasing congestion over time in the 5-7 GHz range, which contains allocations for PMSE, notably as existing PMSE services have to migrate out of their current bands around 2 GHz. In light of this, a number of bands considered under this review in the 4-7 GHz range would be of potential interest from the point of view of future PMSE use. PMSE stakeholders made a more general point that uncertainty regarding the ongoing availability of currently available bands makes it difficult for the PMSE industry to make future planning decisions. They asked that long term, stable access to bands

suitable for PMSE use must be established to provide certainty to manufacturers and users.

3.36 There appears to be a broad recognition that spectrum demand from the emergency services may undergo some change, particularly as the current term of the contract with the Emergency Services mainland operator comes to an end.

3.37 In responding to the Call for Input, stakeholders identified no other single application (new or modified) which was considered likely to have a major impact on overall demand for spectrum in these bands. There is an expectation that environmental concerns will drive an increase in the use of smart metering and smart grids, but the capacity requirements of these are expected to be low with increased points of presence and unlikely to place additional demand in the spectrum under review. Similarly, there is a broad expectation that we will see an increase in the deployment of CCTV which may also place some additional demand on spectrum bands within the scope of this review but whether backhaul is provided by radio (likely to be the most flexible option in urban areas) or by fibre, is likely to depend on cost and availability of spectrum.

3.38 Subsequent to our publication of the Call for Input, we have also noted increased demand for fixed links, particularly in the lower bands, by the financial services industry which requires exceptionally fast communications links between financial centres. The preference for microwave wireless links, over fibre, for this application relates to the speed of transmission over microwave spectrum being faster than over optical fibre and the more direct routing between nodes that can often be achieved. Most of these low latency links are currently in the 6 GHz band which appears to provide an optimal balance of bandwidth and hop length to enable transmission of large amounts of data at very high speed across long distances and national boundaries.

Use of fibre as a substitute to spectrum

3.39 There is a clear view that there are significant cost advantages to deploying wireless solutions where fibre is not available as the cost of fibre is still considered relatively high (even with public sector intervention). Where fibre is already economically available, it is the preferred option of choice for backhaul provision though responses indicate that spectrum should continue to be made available in areas where fibre provision is unlikely e.g. rural areas as microwave does provide cost advantages over new fibre provision. Most agree that fibre provision should be viewed as a complement rather than a substitute for wireless solutions with fibre mainly used in the core of the network and radio for access and aggregation links.

3.40 Respondents do, however, view microwave links and fibre as substitutes in some situations and caution that the level of fixed link licence fees are a factor in the decision on whether to consider microwave or fibre; they comment that the level of fixed link fees should not distort this choice. We also understand that some MNOs have chosen to reduce their reliance on leased fibre due to high costs above certain data rates and that, in some cases, they may have used microwave links in place of leased fibre.

Ofcom Conclusions on Demand

Ofcom observations and actions on the key findings of the Aegis Study and Stakeholder views received on demand

Mobile backhaul

3.41 We conclude that the mobile backhaul sector is most likely to have a material impact on demand for the spectrum bands under review. It appears unlikely that any other development will have an impact of this order of magnitude. We will therefore closely monitor developments in mobile backhaul to assess the likely impact on demand for the relevant spectrum bands.

3.42 There is an expectation that the need for rapid deployment, and upgrading of links in urban areas may result in greater use of radio where fibre deployment would be slow to implement. In particular, a new network topology of more densely packed small urban cells, equipped to offer very high data capacity, is likely to favour relatively high frequency bands where bandwidth demands are more likely to be met. Stakeholders specifically refer to bands above 60 GHz for the provision of small cell backhaul.

3.43 The self coordinated bands 71-76 GHz and 81-86 GHz (also referred to as “E band”) have generated considerable interest during this review. Respondents see this spectrum as a key component in providing high capacity backhaul to small cells and in delivering the requirements for 4G services complementing both existing conventional microwave fixed links as well as fibre. The bands offer a large amount of spectrum to deliver high capacity data and have good frequency re-use capabilities. We note however the concerns raised by stakeholders that the current licensing policy for E band is considered to hinder the use of this spectrum from small cell backhaul. We refer to this band in detail in the next section on policy considerations as well as our review of E band in the forward work programme.

3.44 As noted above, there is no clear view on the extent to which MNOs will rely on Wi-Fi offload. Many stakeholders have noted that Wi-Fi already carries far more data from/to mobile devices than is carried by MNOs’ backhaul. (We note that a recent report by SCF Associates for the European Commission forecasts and recommends that far more spectrum should be made available on a licence exempt basis). We are separately preparing to review our licence exempt framework, which is the set of guidelines we currently use to determine whether particular uses of spectrum should be exempted from licensing. Part of this activity will involve assessing the likely future demand for wireless and mobile data services, including Wi-Fi, and the supply of spectrum to meet this demand on a licence exempt basis. We currently plan to consult on our review of the licence exempt framework during 2013.

3.45 In-band backhauling was referred to by Aegis in its report, but those few stakeholders who commented on this option considered it would likely be constrained by cost as “mobile” spectrum (currently sub 3 GHz) tends to command much higher prices at auction than does spectrum at higher frequencies which is more commonly used for mobile backhaul. Nevertheless, we will continue to monitor developments in this area, along with other related changes to mobile network topology such as direct backhaul between neighbouring base stations.

Technology developments

3.46 We note that many responses to the Call for Input indicate a degree of optimism that technology can deliver solutions to spectrum shortages, albeit at some cost. Many

stakeholders report that higher order modulation techniques can be used more effectively to increase data capacity on existing links, and that network topologies can be implemented which more efficiently route or aggregate traffic. Stakeholders also commented on the use of MIMO but without specific proposals with respect to the Ofcom licence product set. Similarly for satellite communications systems, adaptive coding, fade compensation, antenna design and small spot beams were all cited as capable of enabling a wider range of frequency bands be used than is feasible today.

Ka Band

3.47 Most respondents from the satellite sector referred to the progressing trend of next generation satellites to utilise spectrum at Ka band with some services already in operation. The spectrum at Ka band offers much higher capacity for a range of satellite based applications including but not limited to satellite based broadband.

3.48 From the responses received it has been difficult to evidence, in the immediate term, the need to access the additional spectrum in the 17.7-19.7 GHz band in the space to earth direction in addition to the availability of non shared spectrum for Fixed Satellite Services mentioned above as well as the long term dependence on this band for fixed links.

Other services

3.49 The Emergency Services are currently considering their replacement communications system for the UK mainland. This is currently at an early stage, as are discussions and considerations for spectrum at CEPT and the European Commission (captured under Public Protection and Disaster Relief (PPDR)). Whilst we do not have any specific inputs on fixed link demand with regard to this, we anticipate that there will be demand to provide the new network with backhaul capacity which could likely have implications on fixed link spectrum which we will monitor.

3.50 There is also an expectation that power companies and, to a lesser extent, water companies will require spectrum to manage smart grids and pollution monitoring systems, but this is not thought likely to have a significant impact on overall demand as the bandwidth required is likely to be modest.

3.51 Responses from the PMSE community request from the PMSE community indicate interest in the 5-7 GHz bands but with stable access to spectrum. We refer to the future of PMSE spectrum in section 4

3.52 We plan to monitor developments as indicated above however there are a set of policy issues that stakeholders have highlighted that we discuss in detail in subsequent sections and how we will take these forward. However the review raises a set of focussed issues with some more immediate than others that have been identified as a result of the Call for Input as well as international developments on which Ofcom needs to take action. These are identified and detailed in Section 5.

Key trends and drivers identified that we will monitor

3.53 Further to our conclusions and monitoring initiatives above, we set out below a set of key drivers that we aim to monitor to further inform our views on demand for the spectrum under review:

- **Mobile Backhaul requirements with 4G:** We recognise the predominance of the use of fixed links for mobile backhaul and the associated demand prior to the

deployment of 4G services which as indicated by Aegis is likely to drive a step change in demand. We will monitor closely how the demand may change in the spectrum under review. We however note the need for regulatory review of spectrum at E band is more pressing which we will consider in our immediate forward programme.

- **Future demand at 18 GHz from the fixed and fixed satellite service:** There is a need to understand likely level of demand for additional shared Ka band spectrum for uncoordinated satellite consumer terminals and whether there is a case to make available additional shared spectrum specifically in the 18 GHz band on a more favourable basis for such use.

- **Financial Sector requirement for low latency links:** It is not clear whether spectrum demand from emerging applications for low latency links for financial services will continue to grow significantly or whether this will remain a niche application and how this may impact the future use of spectrum around 6 GHz. We will continue to monitor these developments.

- **National Public Safety broadband network:** We note that the view of Aegis regarding the potential impact of a public safety broadband network. We also note that changes in the management of the emergency services spectrum could impact the demand in the spectrum under review. We aim to closely monitor such developments.

- **Wi-fi Offload**: Another factor which contributes to the general uncertainty about future demand for spectrum to support mobile backhaul is the possibility of Wi-Fi offload. Depending on the commercial strategies of mobile operators and providers of Wi-Fi services, Wi-Fi could accommodate a significant proportion of the additional demand for mobile connectivity (and, hence, mobile backhaul). We propose to continue monitoring carefully the extent to which mobile originated traffic is offloaded to Wi-Fi.

- **Cost and Availability of fibre**: As indicated by Aegis, this would have a significant bearing on spectrum demand in suburban and urban areas. Most respondents have referred to fibre and fixed links as complementing applications. We aim to monitor developments in this area and the associated impact on demand for fixed links.

- **Rural fixed broadband:** Aegis referred to a potential increased demand for the spectrum under review in bands below 30 GHz for rural broadband of a greater magnitude than that for mobile broadband. Respondents have provided little information on such demand and the associated spectrum requirement. We intend to monitor such developments with respect to any associated demand for the spectrum under review.

- **Technological Developments:** Technological developments were referred to in many instances that could influence the demand for spectrum as well as potential regulatory solutions. Therefore, as well as monitoring changes in demand, it will be important that Ofcom continues to maintain a close watch on technological developments which may impact availability of spectrum capable of meeting demand.

Section 4

Spectrum Management Policy Issues

Introduction

4.1 In this section we discuss the issues raised by stakeholders in relation to our spectrum management policy and approach.

4.2 Although we had no preconceived ideas about how changes should be made to the way these spectrum bands are managed, we invited comments from stakeholder of issues in three general areas,

i) Service allocation issues

ii) Spectrum band management

iii) The design of licence products in the bands managed by Ofcom

4.3 We summarise a range of issues under the each of these categories below and add our own observations on the issues raised in a number of cases. Before doing so we highlight the main message and general flavour of the feedback was along the lines of stability.

Stability and Certainty

4.4 The key message from most stakeholders, satellite and terrestrial, is that Ofcom should take great care not to create an environment of regulatory uncertainty to the detriment of incumbent spectrum users. Regulatory certainty and conformance to international harmonisation are given far more weight than any, as yet unformed, proposals to improve access to spectrum and that fees charged shouldn't prevent access to the spectrum.

4.5 The timing of this review, ahead of 4G deployment and with the associated uncertainty, was questioned by some stakeholders.

Service Access to different spectrum bands

4.6 Different services[3] can sometimes share the same spectrum. In the context of this review the main service that shares with the Fixed Service spectrum (which includes point to point fixed link applications) is the Fixed Satellite Service (which includes permanent earth stations or PES) but the technical and regulatory terms under which they can coexist can make a significant difference to the nature of access that each

[3] By "service" we mean the transmission, emission or reception of radio waves for specific telecommunications purposes as defined by the Radio Regulations. There are various services that we refer to in this publication though mainly we refer to the Fixed Service which is a radiocommunication service between specified fixed points or from a point to specified area. We refer to use of fixed links for various as applications within the Fixed Service such as mobile backhaul, fixed or broadband wireless access. We also refer to the Fixed Satellite Service which is a radiocommunications Service between earth stations at given positions (either at a fixed point or within specified areas), when one or more satellites are used. In some cases this service includes feeder links or other spaces radio communications services. We refer to permanent earth stations (PES) and ubiquitous deployment of uncoordinated earth stations within the Fixed Satellite service.

service can have to the spectrum. In other cases it can be very difficult to for services to share spectrum (for example, it is difficult for mobile applications, or ubiquitous, uncoordinated satellite receivers to share spectrum with fixed links). In these cases, the regulatory regime may need to set a hierarchy of access through decisions on national, European and International allocations (with primary services taking precedence over secondary services such that, in general, secondary services cannot cause harmful interference to or claim protection from primary services).

4.7 Decisions that are made about the nature of spectrum access, either in terms of service allocations by band or through conditions of access and sharing, clearly have the most significant impact of on the use of spectrum by a particular service. These types of issues are therefore at the top of the hierarchy of policy issues we consider, particularly where Ofcom manages the spectrum in the frequency band concerned. Where spectrum blocks are licensed to, or managed by, a third party then we can set the licence conditions for the spectrum block that are more service and technology neutral; however there is still a strong international influence on the types of use in many bands relating to the availability of equipment and the international nature of some services and applications. The international regulatory environment can therefore have a strong influence on the type of services that a third party band manager can support and Ofcom takes a lead in representing the UK interest in the bodies that drive changes in the international regulatory environment.

4.8 The respondent views to the Call for Input as well as current International issues draw our attention to the service access issues in the following spectrum bands and/or applications:

- Potential identification of spectrum under this review for the Mobile Service and wireless data traffic
- Enhanced access to the 17.7- 19.7 GHz by the uncoordinated fixed satellite service terminals
- The use of digital CCTV systems and the future use of 31.5-31.8 GHz
- Future spectrum requirements for PMSE

Access to spectrum for the Mobile Service and wireless data traffic

4.9 Changes to service allocation policy in the UK, and internationally, could have a marked impact on the availability of spectrum in some of the bands under review. The EC's Radio Spectrum Policy Programme's (RSPP) includes a work stream to review bands between 400 MHz and 6 GHz for their suitability as bands which might be harmonised for new service such as mobile broadband. The 1.4 GHz and 4 GHz bands, which are within the scope of this Spectrum Review, fall well within the scope of the RSPP inventory work. If these bands were to cease being available for point to point fixed links, or fees necessarily became reflective of their harmonisation as "mobile" bands, this could place additional pressure on other fixed link bands such as the 6 GHz and 7.5 GHz bands if current users of the lower frequencies were displaced. The 4 GHz band is currently used only lightly (less than 40 links across the UK) and changes to its availability might have limited impact on demand for other bands. The 1.4 GHz band, however, contains more than 800 licensed links which, if displaced, could have a material impact on demand for other bands. In considering displacement of existing use we would need to consider how substitutable other bands might be to facilitate the current applications. Any changes to allocations in these bands would be subject to considerable public debate. It will therefore be important to ensure that the implications for demand in adjacent bands are considered as part of the decision making process.

4.10 We also note that WRC-15 Agenda Item 1.1 is considering additional spectrum allocations to the mobile service and identification of additional frequency bands for International Mobile Telecommunications (IMT). We note further that the spectrum under this review may fall within the scope of this agenda item as it develops. Ofcom will monitor activities and contribute as necessary to the ongoing CEPT and ITU-R preparation processes for the WRC. These contributions, will, as appropriate, consider both stakeholder views and Ofcom's wider spectrum management objectives and will assist in the development of the UK view on this agenda item. While responses have not explicitly referred to reviewing specific bands under this review for mobile applications, respondents have specifically referred to the need to retain access to spectrum to certain bands under this review for the existing services they provide such as fixed links at 1.4 GHz and satellite earth stations at C Band (4 GHz).

Enhanced access to the 17.7- 19.7 GHz by the uncoordinated fixed satellite service terminals

4.11 Some Satellite stakeholders would like parts of the Ka sub band 17.7-19.7 GHz (the "18GHz band") made available under regulatory arrangements that make the deployment of ubiquitous uncoordinated consumer satellite terminals more feasible (as compared to the current arrangements under which these applications share spectrum access with fixed terrestrial services).They argue that the ability to exploit the Ka band for these types of satellite application depend on having regulatory certainty, noting that the provision of satellite services requires long lead times.

4.12 CEPT is already working on the issue of enhanced access to the shared 17.7 to 19.7 GHz band and plans to conduct technical studies to determine whether more of this band could be shared between point to point fixed links and satellite downlinks.

4.13 The potential policy issues to consider depend on the nature that of enhanced access, as discussed below. However, we note Aegis' view, as set out in its report, that if the majority of the 18 GHz band was to be used to accommodate satellite based broadband service (in a way that restricted its use for fixed links) this could cause significant congestion in the nearby 13 GHz and 15 GHz fixed link bands.

4.14 The current regulatory arrangements are as follows. The Ka band downlink spectrum that is available to the Fixed Satellite Service on a non shared basis with fixed terrestrial point to point links is generally 17.3-17.7 GHz and 19.7-20.2 GHz. The shared 17.7-19.7 GHz part of Ka band spectrum is available to both the Fixed Service (generally for terrestrial point to point fixed links) and to the Fixed Satellite Service (for satellite receivers both gateway and user terminals).

4.15 From a practical perspective it is perceived that the continued use of the 17.7-19.7 GHz band, by fixed point to point links, creates an environment that carries a risk of likely interference to ubiquitous satellite receivers operating in the same geographic area. For this reason, it may not be possible for these applications to utilise the 17.7-19.7 GHz band without one of the following developments: some form of geographical separation between fixed link and satellite receiver deployment: frequency segmentation to increase the spectrum available for exclusive basis by satellite receivers; or by equipment innovation that could exploit applications such as dynamic channel allocation techniques. For the latter approach it could be feasible that no significant regulatory change would be required in UK with both Fixed Service and the Fixed Satellite Service continuing to have primary allocations in this band. We note that geographical separation has not been a favoured spectrum management approach by many satellite respondents as indicated in this review.

4.16 A fallback, or interim, position proposed by some satellite respondents is that Ofcom should refrain from making terrestrial assignments in the 17.7-19.7 GHz part of the band in locations where other frequencies for terrestrial applications are available, typically in rural areas where demand for terrestrial fixed links may be low and potential demand for satellite broadband high. Other users, predominantly terrestrial operators are more sceptical about such a level of demand.

4.17 We note that this is an issue of sharing such that the means by which the current shared access to the 18 GHz band may not deliver an environment that is free from undue interference to uncoordinated satellite receivers and therefore conditions of access to the spectrum should be considered. We however note that future demand for access to the 18 GHz band should be considered for both the Fixed and Fixed Satellite Service in the longer term taking into account meaningful evidence that will demonstrate the value of the band to either or both services. We further consider this issue in our forward programme in Section 5.

Sharing between EESS and digital CCTV applications at 31 GHz

4.18 The 31 GHz band (31.0-31.3 GHz paired with 31.5-31.8 GHz) is used for analogue CCTV applications. The use of the 31.5-31.8 GHz sub band by fixed links is a cause for concern by the science services for the use of passive sensors operating within the Earth Exploration Satellite Service (EESS) due to interference concerns. In practice there is a requirement to change the current assignment approach at 31 GHz to facilitate the demand for digital CCTV applications. It is possible that this could lead to reduced use of 31.5-31.8 GHz in due course thereby easing any sharing issues with the EESS. Hence there is likely to be a strong connection between work to develop the licence product in this band (to facilitate digital applications) and improvements in sharing between CCTV fixed link use and passive use of the 31.5-31.8 GHz sub band by the EESS The response from the Met Office indicated that the 31.5-31.8 GHz band should be reviewed and fixed links should gradually be migrated out of this band due to potential interference concerns to passive services.

4.19 In order to protect the passive service allocations to the earth exploration satellite service at 31.5-31.8 GHz, Ofcom has been asked to consider and review the need for continued use of active services in this sub band.

Future Spectrum requirements for PMSE

4.20 Responses from the PMSE community to the Call for Input noted that they have access to spectrum in adjacent or nearby bands to the spectrum considered in this review (notably in the 5-7 GHz range). PMSE stakeholders referred to the need for stable access to this spectrum. Respondents indicated that the spectrum under review could also be considered for additional access for some PMSE applications should existing PMSE spectrum become congested. Although limited detail on specific demand was provided, Ofcom intends monitor such requirements. We are also planning to initiate a review of future PMSE spectrum requirements (separately from this Review of fixed link bands).

Approach to spectrum band management

4.21 As noted in section 2, the spectrum available for fixed links is made available in a number of ways: namely on a licensed basis whereby Ofcom is responsible for coordination of link by link assignments, block allocated (auctioned), light licensed

(including self-coordination) and licence exempt. The proportional split of these approaches is shown in figure 1 below.

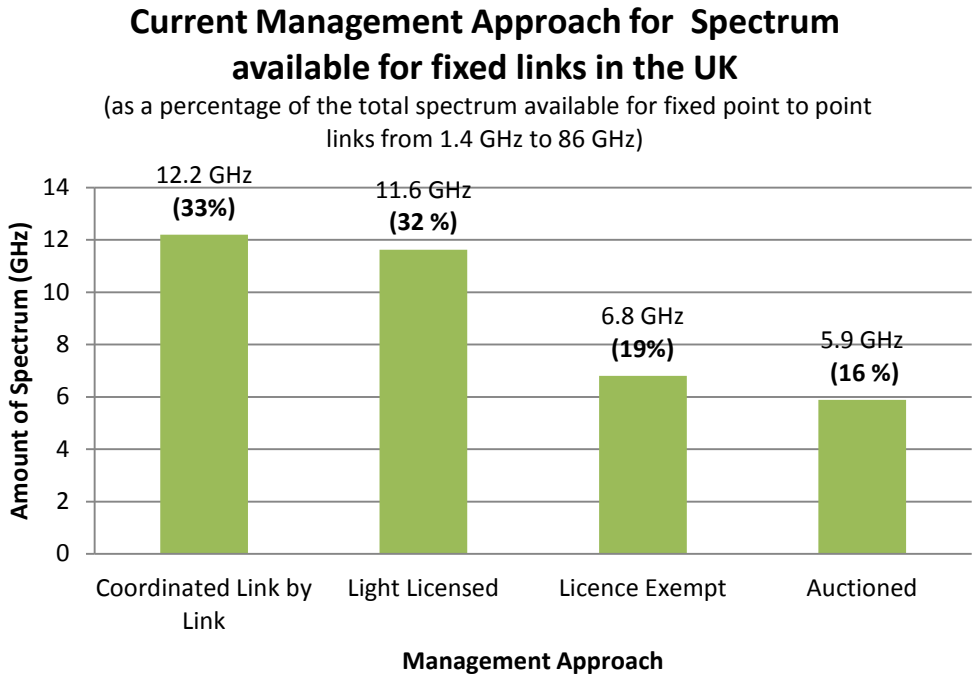


Figure 1

4.22 The focus of interest in respect of the approach to spectrum band management relates to the bands below 60 GHz where one of two broad approaches is used:

- **Ofcom band managed:** Ofcom itself manages the spectrum band and makes available a range of licence products which authorise transmissions of a certain type at particular locations and which are coordinated (or "technically assigned") under well defined technical frequency assignment criteria (TFAC); these licences are usually available on a first come first served basis and have a licence fee specified in regulations[4].

- **Commercial band management:** Ofcom packages the spectrum into blocks (typically, on a regional or UK-wide basis) that are licensed to a single commercial entity (typically via an auction process) to maximise the benefits that the licensee can derive from the resource. The licensee is then responsible for micro-management of any assignments within its licensed block and can use the spectrum either for its own use (e.g. backhaul for its own mobile network) or for provision of spectrum access services to others (third party band management).

4.23 Looking at the current balance between these two approaches, the above figure shows that there is some 12 GHz of spectrum which is under Ofcom band management as compared with 6 GHz that is managed by commercial players following auctions or block assignment (there have been two auctions of this type of

[4] Ofcom itself carries out the assignment management and licensing in the majority of bands. In the 31GHz band the assignment analysis is outsourced to a third party but Ofcom is still responsible for setting the TFACs and licence terms.

spectrum: the 28GHz auction in 2000 by the Radio Authority and the 10-40 GHz auction by Ofcom in 2008)

4.24 One question we asked for this review was whether we should consider transferring more spectrum from Ofcom band management to commercial band management, noting the variety of ways in which this approach could be applied.

Stakeholder comments

4.25 In summary, most respondents felt that Ofcom has the right balance among spectrum management approaches offered for these bands (i.e. Ofcom band managed with coordinated assignments, self managed spectrum in auctioned bands, light licensed and licence exempt spectrum, although there is an interest in making some specific changes to the light licence product above 70 GHz – see later in this section). No one requested that Ofcom transfer spectrum bands from Ofcom management to commercial band management (e.g. via new auctions), although there was one response that felt that Ofcom should not be a competitor in the market that it regulates. Some respondents explicitly stated that they do not favour further auctions on the grounds that the spectrum could get into the hands of a few and that this could lead to inefficient use of spectrum.

4.26 There was little appetite for a policy to extend the reach of commercial band management with most stakeholders unconvinced of the benefits and some raising concerns that it would be unlikely that a third party band manager would be able to manage spectrum at a lower cost or achieve substantially greater use.

4.27 Stakeholders expressed a number of concerns about the prospect of more spectrum being migrated to third party band management arrangements. They felt that this could make it harder to accommodate user requirements and dilute the current benefit of being able to apply for licences across a range of different bands. Some were concerned that auctions can allow large blocks of spectrum to fall into few hands with the effect of, excluding others from gaining spectrum access. There was also a concern that auctioning bands could create difficulties in implementing future international agreements on harmonised use of these bands.

4.28 Those companies with large volumes of fixed links (e.g. to provide mobile backhaul) observed that they found it useful to have (auctioned) spectrum blocks that they can manage for their own use. But they did not press for access to further blocks over and above those which they have already (as a result of past auctions and subsequent trading).

4.29 One view cautioned that should Ofcom look to commercial incentives to allocate spectrum then the spectrum used for critical national infrastructure, public safety and local authority should be reserved for non commercial gain to be managed by Ofcom or an independent 3rd party.

4.30 Generally most respondents felt that they were unclear of what problems such a policy (of extending the reach of commercial band management) would be trying to fix and that, unless there was an ambitious drive from industry, Ofcom would need to justify this in terms of the practical (rather than the theoretical) benefits that this might bring.

4.31 Responses instead suggested that Ofcom should continue to work with stakeholders to modify existing licensing and frequency assignment procedures to make them more attractive to businesses as technology and requirements evolved. Respondents

referred to Ofcom's criteria as being robust and supported by industry and merely need to be made more flexible to meet the requirements of industry.

4.32 Part of the auctioned 28 GHz band was licensed in the UK to a company (Transfinite Systems Ltd, who acquired this spectrum in the 10-40 GHz auction in 2008) which operated a commercial band management approach, using the leasing provisions (that were introduced by Ofcom in 2011). However there appears to have been limited market interest in leasing this spectrum. Transfinite's holding of spectrum in the 28 GHz band was recently sold to Vodafone. The Transfinite response to the Call for Input noted the challenge they faced in competing with licensed products in the Ofcom managed bands because of the relatively low cost of these fixed link licences. In essence, they felt it was difficult to have a mixed system in which third commercial band manages sought to compete with Ofcom for the provision of fixed link assignments to third parties.

4.33 Transfinite has, however, proposed third party managed services for the 71-76 GHz and 81-86 GHz band if the current light licensed, self coordinated approach is modified in (at least part of) this band (see below and section 5 discussion of E Band).

4.34 Other stakeholders have indicated that they have been more focussed on utilising access to the spectrum acquired through auction for their own use, notably for mobile backhaul and that this use is expected to increase substantially, in part shifting demand out of some Ofcom managed bands in the short term.

4.35 We also received a number of comments from the satellite community on use of auctions (to transfer rights for a band) and trading (as a means for other uses to gain access to the bands from the new owners of the auctioned spectrum). The main points raised were:

- **Little appetite for spectrum trading**. Most satellite stakeholders have indicated that they do not consider spectrum management to be a core part of their functions. The satellite community, in particular, would be concerned by the logistical implications of having to conduct commercial negotiations in numerous jurisdictions around the world

- **Exclusive access to shared spectrum**: Within the UK, earth station operators observe that it would be spectrally inefficient to acquire exclusive spectrum rights (through block auctions or first come first served reservations) to protect spectrum for future use in a specified area. They argue that this would prevent not only compatible terrestrial fixed link use but also use by other earth station operators which might otherwise be able to co-exist.

- **Application of market based approaches in shared spectrum:** Satellite stakeholders feel that it is not appropriate to apply market mechanisms in bands where the fixed service shares with the fixed satellite service as this could unfairly discriminate against satellite services

4.36 The satellite sector continued to express concern about the implications of the auctions of spectrum at 28 GHz held in 2000 and 2008. They note that the band is subject to European harmonisation measures that supports use by fixed satellite services. They believe that these auctions have not resulted in efficient use of this spectrum, claiming that it has been little used (although we note that the MNOs have, in fact, begun to use these bands for mobile backhaul provision). The sector is also

remains concerned by the precedent setting implications of this auction for other bands in other jurisdictions.

Ofcom's current Fixed Link Licence Products and Services

4.37 We invited comments in respect of the licence products, and associated licensing services, in the bands that Ofcom manages. We referred to the current products for point to point fixed links and were interested in views as to whether the products remain fit for purpose or whether they might need to be adapted in light of changing technology and usage patterns connected with, for example, asynchronous data-flow, adaptive power control, bandwidth etc. We also noted that, whilst there is a wide range of point to point licence products, we currently offer no point to multipoint licences.

4.38 There is broad agreement with the present management of the fixed links product set, with a few areas where changes might be helpful and, as noted above, a view that the mix of auctioned blocks, light licensing, licence exemption and first-come-first served band management provides a balanced portfolio of options for stakeholders. The responses on licence product design and terms are summarised below under the following headings::

- The Ofcom approach to licensing in the spectrum at 71-76 GHz and 81-86 GHz ("E band")
- Specific issues on the current licence product set
- Technical conditions (TFACs) relating to products
- Access to licensing information
- Fees

The Ofcom approach to licensing in the spectrum at 71-76 GHz and 81-86 GHz

4.39 As indicated in the previous section, the self coordinated bands 71-76 GHz and 81-86 GHz have generated considerable interest during this review. Respondents see this spectrum as a key component in providing high capacity backhaul to small cells and in delivering the requirements for 4G services complementing both existing conventional microwave fixed links as well as optical fibre. The bands offer a large amount of spectrum to deliver high capacity data and have good frequency re-use capabilities. However, respondents that are interested in use of this band for mobile backhaul have raised concerns regarding the light licensed, self-coordinated approach for this band that was implemented in the UK in 2007[5].

4.40 The current self-coordinated approach offers first in time priority on the basis of assignments registered with Ofcom on the 70/80 GHz section of the wireless telegraphy register[6]. An interference protection date is used to establish priority in the

[5](http://stakeholders.ofcom.org.uk/binaries/consultations/71-86ghz/statement/71_86ghz.pdf

[6] We currently use an arrangement in which assignments are registered on an excel spreadsheet (which is refreshed when new registrations are made). This was implemented as an interim approach with the intention of transferring the self service arrangements onto our main spectrum licensing system if and when the demand for the product warranted this, and is subject to practical IS implementation considerations.

band. The approach requires licensees to self manage the interference environment by engaging and coordinating their links with existing links on the register. It is the licensee's responsibility to ensure that all information that is published on the wireless telegraphy register relating to its links is correct.

4.41 Some operators are concerned that the approach adopted by the UK creates a perceived risk of interference from third parties and that such a risk would be too high where customer experience is a key priority. These operators feel that the self coordinated approach is not sufficient to offer the certainty that is required for them to deploy carrier grade backhaul in what are considered likely to become key backhaul spectrum bands to deliver 4G services. There is concern that a continued use of a light approach to the management of this spectrum is unlikely to encourage early adoption of E band technology to facilitate the rollout of 4G backhaul. Ofcom has therefore been asked to review the approach implemented for E band in the UK to provide a regulatory approach which provides stakeholders with the confidence to use this spectrum for mobile backhaul.

4.42 Some operators have also asked Ofcom to consider making this spectrum available on an exclusive basis for applications such as small cell backhaul where the licensee manages the interference environment in the most practical and efficient way given the nature of small cell deployment at street level.

4.43 Whilst the use of this band for 4G mobile backhaul represents a very important prospective use of this band, we note that other types of users may not have the same requirements. For these users, the current, self-coordinated approach may still offer a desired combination of flexibility and low cost, without creating material risks of interference. We note that there are around 130 links currently listed on the register.

Range of Ofcom product set

4.44 Currently all of Ofcom's coordinated licensed fixed link products are all for point to point applications. We sought views on whether there was a need for other fixed link product types in the Ofcom managed bands such as point to multipoint applications.

4.45 Responses indicated that there is less clarity on the scale of future demand for spectrum suitable for non line of sight applications. There are varied views on the future use of point to multipoint in urban backhaul, although no respondents argued that spectrum should be made available for point to multipoint applications under an Ofcom licence product. We aim to continue to keep under review the requirements in relation to the Ofcom fixed link product set.

Technical conditions (TFACs) relating to products

4.46 Many respondents referred to the trend towards the use of larger channel sizes for fixed microwave point to point links as the drive for 4G services increases. Operators see a general move towards greater use of 28 MHz and 56 MHz channels and above for their backhaul networks and request that channel arrangements should be revised in particular to accommodate 56 MHz and 112 MHz channel sizes.

4.47 The response from the 31 GHz assignment manager has suggested that current arrangements in the band should be reviewed to accommodate digital systems in the lower sub-band as this will allow spectrum to be used efficiently and allow the use of the 31.5-31.8 GHz band to be reduced over time, thereby easing sharing concerns with earth exploration satellites.

Information and on-line assignment testing

4.48 Stakeholders asked for two types of improved access to information in respect of fixed links and satellite earth stations:

i) Access to the database of fixed links and satellite earth stations to perform statistical analysis of the bands managed by Ofcom; and

ii) Passive access to the Ofcom fixed link assignment system to perform real time, online testing of whether a particular link assignment is likely to be possible.

4.49 Stakeholders were attracted by the possibility of more visibility of and closer involvement with Ofcom's spectrum planning, such that they are able to test hypotheses and planning options against Ofcom's planning data before making a formal application.

4.50 Many responses requested Ofcom to make the licensing database visible to them. Some fixed microwave point to point link licensees requested access to the database so that they can understand the deployment densities and technical characteristics of fixed microwave point to point links to be able to make a level of judgement on their requirements with respect to network planning and gauging the possible availability of an assignment. Stakeholders feel that they don't currently have a view of the density and geometry of links, something that is important for them in making decisions regarding the use of a particular frequency band. Licensees that have requested such information also felt that licensee information could be kept anonymous with only technical link information being made available.

4.51 Earth station operators also use most bands on a shared basis with fixed microwave point to point links. Such operators have to undergo a coordination process with fixed microwave links to be able to operate in the shared spectrum. For this case the request has been to enable access to licensee details of a particular link that may preclude an earth station assignment. Satellite operators would find it useful if Ofcom could provide access to such information to facilitate discussion between parties to come to mutually acceptable solution s over coordination.

Licence Fees

4.52 Most responses to the Call for Input would like to see fees reduced and believe that this would be the result of a fees review (at least for the higher frequency bands). Respondents also noted that the current fees algorithm, originally designed to encourage use of higher bands, has made access to lower bands like 4 GHz very expensive to use for point to point links. Some stakeholders thought that we should also consider the geographic dimension to pricing. For example, BT is keen to see fees reduced in rural areas. However, this desire to see fees reduced is tempered by a sense that a fee review (even a limited review of whether AIP remains appropriate in rural areas) could present a risk of disruption to the status quo.

4.53 Some satellite operators expressed a similar concern to one they have voiced in previous consultations about the application AIP to spectrum used by satellite applications. The concern expressed is that some satellite services may not become commercially viable if other countries followed the UK lead in this respect.

Ofcom Conclusions on Policy

4.54 This Spectrum Review has raised a number of policy issues for us to consider in our forward programme of work. Some of the issues are of a nature that will need focussed, issue specific projects; others could be addressed as part of Ofcom's ongoing programme of sector or policy specific activities. The specific projects that are candidates for Ofcom action relate to:

- **Spectrum under this review as potential candidate bands for use by the Mobile Service and/or wireless data traffic –** current European (RSPP) and international (WRC-15) work items that are looking to identify spectrum for wireless data services and which consider additional spectrum allocations to the mobile service and identification of additional frequency bands for IMT may have a material impact on the access to the current spectrum bands considered under the Spectrum Review. It is likely that the 1.4 GHz and 4 GHz bands will be considered amongst the list of potential candidate bands to be studied; however the work on WRC-15 agenda item 1.1 does not have an upper limit of spectrum that could potentially be studied, and ultimately identified for mobile use.

- **The long term use of the 17.7-19.7 GHz band** - Ofcom will need to consider the value of the 17.7-19.7 GHz band to the Fixed Service and the Fixed Satellite Service by considering how the demand for the continued use of this band by both services will change in the longer term.

- **Review of the 31 GHz band** – Ofcom agrees that the 31 GHz should be further reviewed to consider access to digital systems. In doing so Ofcom intends to review the long term spectrum requirements for existing applications within the band with a view to utilising the lower sub band (31.0-31.3 GHz) for future applications. Ofcom also feels that the assignment approach should be reviewed such that the most efficient process is implemented to facilitate future access to this spectrum by applications expected to demand access to this band.

- **Review of the Ofcom approach to making spectrum available in the 71-76 GHz and 81-86 GHz bands** - Given the responses to the Spectrum Review Call for Input on this subject, Ofcom has decided to review the light licensing self coordinated approach. In conducting this review Ofcom plans to consider a number of possible options that are likely to deliver the best outcome for all stakeholders that plan to and currently use this spectrum. In doing so Ofcom will also consider the urgent requirement to establish the way forward with respect to facilitating 4G infrastructure rollout.

- **Access to fixed link licence data for information and for testing –** Ofcom is supportive in principle of greater visibility of the licensing data for stakeholders to perform their analysis of information about the spectrum managed by Ofcom as well as availability of information for stakeholders to conduct relevant tests.

- **Review of Fees for the Fixed Links and Satellite Earth Stations** – Although the responses to this Call for Input have been mixed, we gave a firm commitment in the Strategic Review of Spectrum Pricing to respond to earlier requests for a fees review. We believe that it is still appropriate to take forward a review of fees for licences in the fixed link bands covered by the Call for Input. This will include licences for both point to point fixed links and for satellite earth stations.

4.55 Section 5 summarises our consideration of the priorities attached to each of these policy issues in the context of developing our forward programme of work.

4.56 Note that the above list does not include the issue around PMSE spectrum access. This is because we have already planned a significant project to review PMSE spectrum use, separately from the considerations in this Spectrum Review of fixed link bands.

4.57 On the subject of band management, we have taken note of stakeholder views on the benefits of the current mix of band management across the current selection of bands. We do not plan to change to the current approach to Ofcom management of bands that are technically coordinated on a link by link basis (broadly speaking, the bands below 60 GHz that are band managed by Ofcom). We note that stakeholders have commented on the robustness of the UK frequency assignment criteria and we will continue to work with stakeholders on the development and evolution of these criteria to meet their needs in Ofcom managed bands in a practical manner.

Section 5

Key Priorities in the forward programme

Introduction

5.1 The purpose of this section is to set out our view of priorities for tackling the policy issues identified in section 4 as part of our forward work programme. In doing so, we also provide some elaboration of the kinds of issues that we might consider in each policy area, although this is not the primary purpose of this Update. Where we do take policy areas forward we will set our consideration of the issues and any related policy proposals in public consultation documents as a part of the individual policy project concerned. Note that we intend to take these issues forward as separate projects.

5.2 Our assessment of priority of each policy issue is a function of both the potential impact on stakeholders and of the urgency in addressing the policy issue. The assessment of impact is a function of the size of the potential problem, or scale of the potential benefit, that may arise across all stakeholder groups affected. The urgency can be dependent on external drivers such as the lead time over which stakeholders wish to gain spectrum access or the timetable for international regulatory action.

Summary of our Prioritisation

5.3 The diagram below provides an indicative view of the prioritisation we attach to each of the issues identified in section 4. We clearly attach the highest priority to those issues that we've judged to have higher impact and higher urgency (towards the top right of the diagram). We discuss each policy area below in broad order of priority.

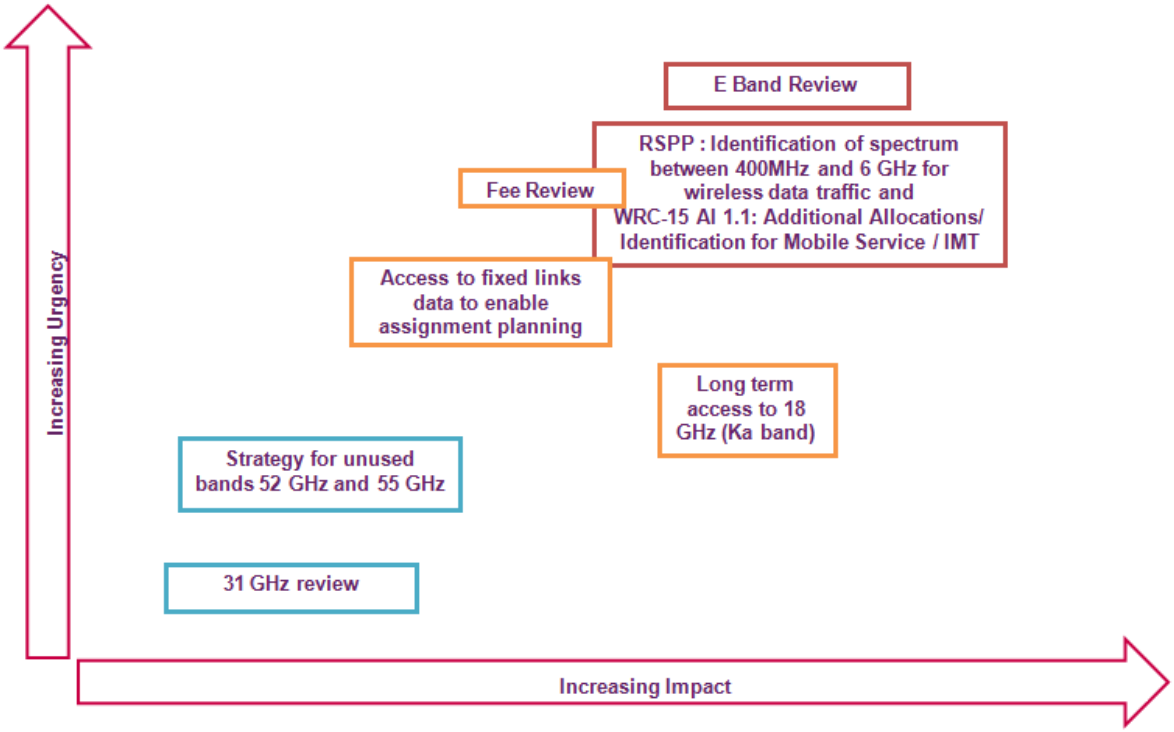


Figure 2

5.4 This section also comments briefly on other international regulatory issues that could impact the future use of this spectrum as well as on those issues which are best considered as part of our ongoing sector specific activities (rather than as a new, standalone project) relating to:

- Harmonisation at a CEPT and ITU level, and legislative changes resulting from any EC activities.
- The use of wider channels in the spectrum used by fixed links.
- Emerging issues in relation to the next World Radiocommunications Conference in 2015.

Review of the assignment approach at 71-76 GHz and 81-86 GHz

5.5 We regard the review of our authorisation approach to the 71-76 GHz and 81-86 GHz ("E band") as the highest priority project in the forward work programme. This is due to the importance of this spectrum for the prospective delivery of high capacity mobile backhaul for 4G networks, combined with stakeholder responses which suggest that some changes to our existing approach may be needed to support the exploitation of the spectrum in this way.

5.6 The urgency to address this issue comes from the expectation that new 4G networks will be deployed over the coming year following the 800 MHz and 2.6 GHz award.

5.7 This band was made available for use in the UK in 2007 for the first time. We chose to make it available on a light licensed, self coordinated basis so as to maximise flexibility and to give much greater control to the market on the management of the coordination and interference environment in this band. The natural properties of this spectrum, coupled with highly directional radio beams offered the feasibility to enable a lighter management approach to be implemented. During the development of this policy Ofcom also considered that the market should be given a much greater role in establishing and managing the criteria for interference which best suited operator systems and requirements. Licensees were therefore given maximum flexibility and the responsibility for ensuring that unacceptable interference did not occur to links that had an earlier date/time priority.

5.8 However, at the time when the policy for these bands was developed Ofcom also recognised that the maximum flexibility inherent in the self co-ordinated 'light' approach was a step away from the more fixed traditional planning methods and also indicated in its statement that it intended to review the interference approach when sufficient experience had been gained to assess if any refinements to the approach would be necessary.

5.9 Given the responses to the Spectrum Review Call for Input calling for Ofcom to review the way in which spectrum is made available at E band in the UK, Ofcom has decided to review the light licensing self coordinated approach. In conducting this review Ofcom plans to consider a number of possible options for delivering the best outcome for all stakeholders that plan to, and that currently, use this spectrum. In doing so Ofcom will also consider the urgent requirement to establish the way forward with respect to facilitating 4G infrastructure rollout. The options could include (but are not necessarily limited to):

- Leaving the management of E band as a self coordinated product, but with some refinements of the current approach and replacing the existing interim

spreadsheet register with a robust permanent IS solution. It is important that UK stakeholders clearly understand the benefits and flexibility that the current E band approach provides in the UK, and that they also take due account of the availability of millimetre wave spectrum in nearby bands 52 GHz and 55 GHz which is licensed under a fully coordinated approach.

- Turning the existing self coordinated approach at E band into a technical coordinated product (as in other Ofcom managed bands) which could be managed by Ofcom or by a third party. However we note that this could raise a number of challenges, notably in relation to modelling the propagation environment at street level.

- Packaging up blocks of spectrum within E Band for award; these blocks could then be self-managed by the mobile networks themselves or used for the provision of services on a third party basis using the leasing provisions.

5.10 The following considerations are likely to be relevant in developing and assessing options:

- New licensing approaches will take time to develop and implement (significantly longer than Q2 2013/14). Therefore early 4G deployments intending to use E band would probably need to use the existing self coordinated approach. We would therefore need to consider how to transition links that are registered under the current arrangements into a longer term, more controlled environment.

- There is a range of uses at E band (not just 4G mobile backhaul) and we need to consider existing uses and their long term requirements for which the current regime may meet their needs. This could lead to a mixed approach of segmenting the band to allow controlled coordination in part of the band to meet the needs of mobile backhaul with the retention of the self coordinated approach in remainder.

- There could be other approaches which could be plausible depending on many factors including the amount of spectrum needed, implementation of a channel plan (and noting the importance of an internationally harmonised plan in this context).

5.11 We have already begun some preliminary work on the review of E band due to the associated urgency and plan to take this forward by engagement with stakeholders in the most practical and productive manner. We intend to work towards publication of a consultation on the review of 71-76 GHz and 81-86 GHz in Q1 2013/14.

Impact of additional spectrum for mobile data access

5.12 As observed in section 4, there are two very major areas of international work that are looking at new bands for mobile and wireless data access between 400 MHz and 6 GHz (the RSPP work in Europe) and at the identification of new bands for IMT (WRC15's Agenda Item 1.1). A number of the bands that are covered by this Review are of direct relevance in this context, notably the 1.4 GHz band and the 4 GHz band in the range below 6 GHz that falls within the scope of RSPP.

5.13 It is this interest for mobile that moves the bands considered under the Spectrum Review towards to "high impact" end of the scale in our consideration of relative priorities ("high impact" both in terms of potential value of alternative use and in terms

of potential impact on existing users), albeit that the impact would be a long term one (takes many years for changes of this nature to take effect).

5.14 Similarly, the timetable for our consideration of these bands is driven by the WRC15 timetable on AI 1.1 and by the timetable of related EU work on RSPP .The timetables for WRC15 and RSPP are such that we will need to consider the policy issues relating to these bands over next 2 years

5.15 Clearly, the main driver for us to address these issues is that this is needed to inform the UK position in relation to the relevant international regulatory discussions. The following paragraphs give an idea of the range of issues we might decide to consider in this context. However, these paragraphs set out a number of generic considerations only; we stress that we have made no decisions on scope of work beyond the need to monitor progress in AI 1.1, a process in which we are already engaged. Moreover, what we decide to look at in more detail will depend, in large part, on how the international regulatory debate evolves.

5.16 The development of our policy position towards these bands could require us to consider, amongst other things:

- The extent to which existing uses might be able to share spectrum access with mobile data applications (noting that, in general, mobile data applications do not easily share spectrum with point to point fixed links or satellite earth stations
- The opportunity cost to existing users of ceasing to have access to spectrum in these bands if existing uses had to move out in the event of a decision to make the spectrum available for mobile data uses in future (under circumstances in which sharing with mobile data services was not possible)

5.17 Considerations of this type depend on:

- The type of mobile data service that might consider use of the bands (e.g. high power base stations v. low power Wi-fi-like services, national coverage network layers v. geographically restricted use to provide capacity in hot-spot locations etc)
- The nature of current PES and fixed link use in the bands in UK[7]

5.18 It is worth making a general point that if an IMT identification (or Mobile allocation) was made across some of these bands, and if this future mobile use was incompatible with existing uses of these bands (either on a nationwide basis, or location by location basis) then there would be different ways of enabling a transition from existing uses to new mobile uses:

- By regulatory action; e.g. closing the band to new licence applications and / or giving notice to existing users to vacate the band at some date in the future (this is the way that band clearance has happened in the past e.g. with L band and 2.6 GHz bands)
- By market driven mechanisms: e.g. relying on spectrum trading in which companies interested in deploying new mobile services buy out existing licensees to make room for new mobile services (which they would need to acquire rights to deploy through, for e.g. an overlay auction or via the creation of a new licence product to enable mobile deployment on a “mixed bathing” basis with PESs).

[7] Note that UK stakeholders also have an interest in the international regulatory regime for these bands, irrespective of the way the bands are used in UK.

5.19 We intend to continue to progress the work of these work items in accordance with the international preparation timetables and engage with stakeholders through the relevant international preparation process.

Feasibility / Requirements Analysis on enhanced satellite use at 18 GHz (Ka band)

5.20 This issue relates to the prospect of uncoordinated satellite terminals gaining increased, or more favourable, access to the 18 GHz band (17.7-19.7 GHz) so as to increase the spectrum available for ubiquitous uncoordinated consumer satellite terminals (over and above the 500 MHz of exclusive access that is already available for such uses). As noted in section 4, this issue could, in principle, have material implications for both the satellite and fixed link sectors. However, there is considerable uncertainty about the level of future demand for these types of satellite applications in the UK and limited evidence has been presented to support the case for increased spectrum access. We therefore consider that any practical impact would be longer term in nature. Accordingly, we rank this as a low / medium impact issue in the near term, but with the understanding that it could possibly increase in importance in the years to come.

5.21 Because of the long timescales, and no clear evidence of immediate demand, we also see this as having relatively low urgency in terms of UK national spectrum policy. The one qualification is that work is already underway in CEPT on the feasibility for enhanced access by uncoordinated ubiquitous terminals and, in consequence, we are giving this issue some attention as discussed below.

5.22 The potential benefits to satellite, and the consequent scale of impact on fixed link use, depends on the mechanism under which satellite might gain enhanced access in future:

- **Shared access** - Equipment innovation that would enable technically feasible and robust cognitive access to the 18 GHz band by the Fixed Satellite Service which would require limited, if any, changes to the current regulatory approach.

- **Geographic separation** - If shared access is not feasible, an alternative option for providing protection for satellite receivers from fixed link transmissions in this band would be to have geographic segmentation between satellite receivers and fixed links. However, this sort of geographic segmentation could be fairly complicated to implement in our licensing systems.

- **Frequency separation** - Frequency segmentation would imply closing a part of the 18 GHz band to fixed links in order to guard against interference into satellite terminals using these frequencies. This would clearly have an impact on existing fixed links.

5.23 If we were to pursue either of these segmentation options in the UK in the longer term, we would need to consider the relative value that could be associated with the additional satellite services enabled as against the opportunity cost of any consequential denial of access to the Fixed Service. As one input to this, we would want to receive further information to substantiate the potential value of providing enhanced access to this band for satellite services.

5.24 Should the conditions relating to existing use, and to prospective satellite use, vary significantly between countries, it is important to note that UK can decide on policy for

the UK quite independently of the international regulatory position developed in CEPT. The UK can therefore support work on enhanced access in CEPT in a way that would enable administrations throughout Europe to take their own policy decisions about whether to implement any resulting recommendations in their own country. Accordingly, we plan to continue to monitor the relevant CEPT work on technical sharing work and we will await the outcome of CEPT work to further assess the regulatory situation at 18 GHz in the longer term. We do not plan to initiate our own work outside of the CEPT studies in the near future. However, we will continue to monitor demand for the continued use of this band by fixed microwave point to point links and potential future demand for satellite applications.

Fee Review

5.25 We confirm that we intend to conduct a review of fees payable for licences in the bands covered by the Call for Input. This will include licences for both point to point fixed links and links to/from satellite earth stations. We now expect to commence this review in 2013 when Ofcom resources become available. We are grateful for the information and views shared with us in response to the Call for Input which will be extremely helpful in the assessment of likely future demand for the various spectrum bands under review, an important input to the fees review.

5.26 The prioritisation of this item in the forward work programme reflects the fact that we have indicated for some time an intention to carry out a fees review in this area in response to stakeholder requests.

5.27 There is a connection between the review of fees for the fixed link bands and a separate exercise that is looking at the level of spectrum fees for those licences which are charged for on the basis of a contribution to costs of licensing (as opposed to charges based on Administered Incentive Prices, or AIP). The connection arises as the level of this cost based charge sets a floor on the level of fees that are charged for licence products. This floor might become relevant when setting new licence fees for products in the fixed link bands if the level of assessed AIP was to be below this floor (perhaps in some of the higher frequency bands). Accordingly, the exercise on cost based spectrum charges might (in mid 2013) feed into the review of fees for products in the fixed link bands.

Access to fixed links database and assignment system

5.28 Ofcom supports stakeholders' proposals for greater visibility of the licensing database in order to help them carry out planning and analysis of future deployment plans. Ofcom has already conducted considerable work in preparation for this as part of the Spectrum Information Project[8] to make as much information available the public domain as possible. Through this work we plan to publish on the Wireless Telegraphy Register (WTR)[9] more information relating to the licences that we issue. This includes location data for Fixed Links and Satellite Earth stations along with other technical information. Through this work a number of stakeholders have stated that the release of information relating to their network would pose a risk to national security and/or public safety and therefore should not be disclosed. We are currently working with Government to assess these claims and, where appropriate, withhold this information from publication.

[8] http://stakeholders.ofcom.org.uk/consultations/providing_spectrum_information/?a=0
[9] http://spectruminfo.ofcom.org.uk/spectrumInfo/licences

5.29 Once the information is published on the WTR we will remain open to suggestions on whether additional analysis and methods of making the data available would be helpful to stakeholders. We are also supportive, in principle, of the request for passive access to the Ofcom fixed link assignment system to perform real time, online testing of whether a particular link assignment is likely to be possible. This would reduce the time and effort required to identify viable assignments in congested bands and also help with detailed planning.

5.30 A key factor in making these additional services available to stakeholders will relate to the cost and complexity of designing and implementing the functionality in our spectrum licensing systems. All development work of this nature also needs to be prioritised against the other demands on our resources for implementing IT change and would be subject to a cost benefit analysis of any systems implementation.

5.31 We view this area as having a medium priority and hope to be able to provide a better feel for possible timescales in 2013, depending on the availability of resources and the progress of the other work items in the forward work programme.

31 GHz band review

5.32 There are several drivers for reviewing the 31 GHz band including the channel plan requirements for digital deployments of CCTV backhaul, the desire to enhance the protection of neighbouring earth exploration satellite services (EESS) and the longer term arrangements for management of the band. We will give attention to the requirements for facilitating digital systems over the coming year (which, as noted in section 4, may help address the EESS adjacency concerns). We will also turn our attention to the future management approach for this band when resources can be made available to do so; however, this is not an early priority. .

Other emerging international issues that could impact the spectrum under review in the future

5.33 There are a number of additional international issues that are emerging and these are as part of the preparation process for the next World Radiocommunications Conference, to be held in 2015 (WRC-15). Of the responses received: there was little detail related to that preparation, however Ofcom highlights the following WRC-15 agenda items that could impact the future use of some of the spectrum subject to this review and plans to engage and monitor developments under these related agenda items.

5.33.1 **WRC-15 Agenda Item 1.5**: to consider the use of frequency bands allocated to the fixed-satellite service not subject to Appendices 30, 30A and 30B for the control and non-payload communications of unmanned aircraft systems (UAS) in non-segregated airspaces, in accordance with Resolution 153 **(WRC-12);**

5.33.2 **WRC-15 Agenda Item 1.6.1**: to considering additional Ku Band spectrum for the fixed-satellite service (Earth-to-space and space-to-Earth) of 250 MHz in the range between 10 GHz and 17 GHz in Region 1(Resolutions 151 refers).

5.33.3 **WRC-15 Agenda item 1.8**: to review the provisions relating to earth stations located on board vessels (ESVs), based on studies conducted in accordance with Resolution **909 (WRC-12);**

5.33.4 **WRC-15 Agenda Item 1.9.2**: the possibility of allocating the bands 7 375-7 750 MHz and 8 025-8 400 MHz to the maritime-mobile satellite service and additional regulatory measures, depending on the results of appropriate studies (Resolution 758 refers);

5.33.5 **WRC-15 Agenda Item 1.10**: to consider spectrum requirements and possible additional spectrum allocations for the mobile-satellite service in the Earth-to-space and space-to-Earth directions, including the satellite component for broadband applications, including International Mobile Telecommunications (IMT), within the frequency range from 22 GHz to 26 GHz, in accordance with Resolution **234 (WRC-12)**;

5.33.6 **WRC-15 Agenda Item 1.11**: to consider a primary allocation for the Earth exploration-satellite service (Earth-to-space) in the 7-8 GHz range, in accordance with Resolution **650 (WRC-12)**;

Other issues to take forward as part of Ofcom's work going forward

5.34 There are a number of issues that were raised, as part of the Call for Input, which Ofcom feels should be considered as part of our on-going programmatic activities rather than forming specific projects to look at these issues. These are detailed below:

5.34.1 There has been a very clear message from the responses on the need for harmonisation and alignment with CEPT and ITU outputs and the importance of this activity to UK stakeholders.

5.34.2 Stakeholder also raised the need to consider a number of issues to enhance the current licence product set (such as larger channel sizes). Ofcom plans to engage with stakeholders through our industry liaison forum for fixed links (FWILF) on consideration of wider channel bandwidths.

5.34.3 Ofcom agrees that the future use of the 31 GHz band should be reviewed with an eye to implementation of digital systems in the lower 31.0-31.3 GHz sub-band, as suggested as part of this review. There is also a case to consider the future sustainability of the current 31 GHz band management/ assignment approach but the timing of any work on this will depend on the availability of resources.

Next Steps

5.35 Ofcom will take forward the highest priority issues with immediate effect, most notably the project on the review of E Band licensing (71-76 GHz and 81-86 GHz). We plan to tackle the above portfolio of issues under separate policy projects and will engage with stakeholders through our normal consultation processes.

5.36 Ofcom's plans to keep stakeholders updated on these projects via the Spectrum Review sections of the Ofcom website via the Spectrum Review page http://stakeholders.ofcom.org.uk/consultations/spectrum-review/ Relevant links will be made available via this page to consultations in relation the policy projects that are initiated following this Spectrum Review.

Responding to this Update

5.37 We are not seeking formal responses from stakeholders on this Update. However, we would like to hear from stakeholders if they have strong views on our prioritisation of the policy issues in the forward programme set out above, or if they feel that there are any material omissions. If stakeholders generally agree with the forward programme, then there is no need to respond to this Update. As noted above, stakeholders will be consulted separately as part of the activities of the specific areas of work identified.

Annex 1

Stakeholders that contributed to the Call for Input

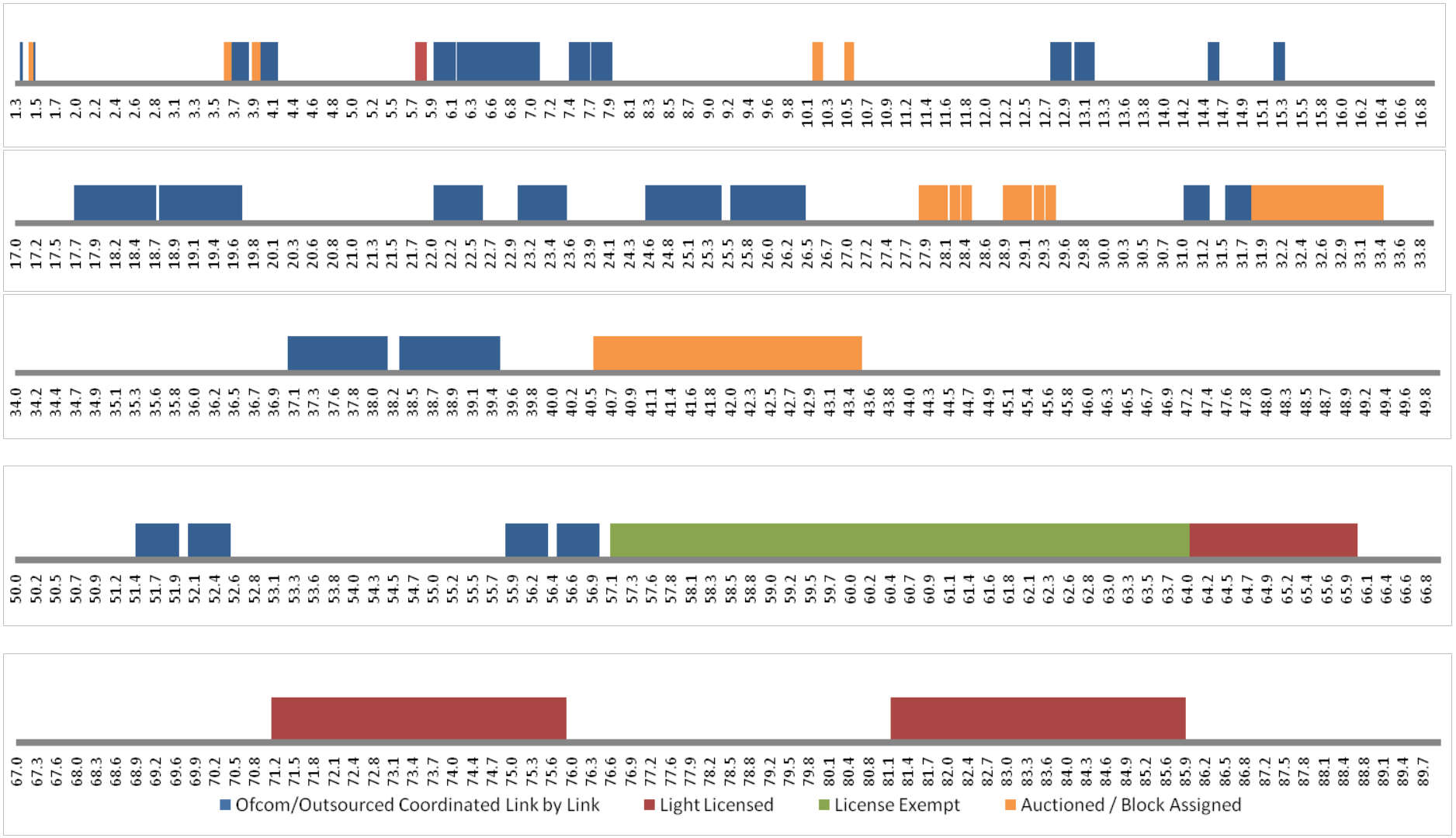
Written responses to the Call for Input were received from the following stakeholders;

1. Aviat Networks
2. Avanti Communications Group plc
3. BBC
4. British Entertainment Industry Radio Group
5. British Sky Broadcasting Group plc
6. BT Plc
7. Cable&Wireless Worldwide
8. ESOA
9. Inmarsat
10. Intellect
11. Intelsat S.A
12. JRC
13. Joint Response from STFC, Mullard Radio Astronomy Observatory, Jodrell Bank Observatory, Astrophysics Dept - University of Oxford)
14. ManSat Limited
15. Met Office
16. Ministry of Defence
17. O3b Limited
18. Ogier Electronics Ltd
19. SES
20. Transfinite Systems Ltd
21. UK Space Agency
22. ViaSat Inc
23. Wi-Fi Alliance

A further 9 responses were submitted to Ofcom which were either confidential or the respondent's name was withheld. Ofcom held bilateral meetings with 24 stakeholders and a workshop on the review was also hosted by Intellect to inform stakeholders of the work of this review and seek their views

Annex 2

Frequency Bands used by point to point fixed links in the UK (GHz)



Annex 3

List of Bands covered by this review

Frequency Band[10]		Amount of spectrum available to the Fixed Service[11]	Method of assignment for the Fixed Service
1.4 GHz	1350-1374.5 MHz paired with 1492.5 - 1517MHz	2 x 24.5 MHz	Technically coordinated and assigned on a first come first served basis
4 GHz	3600-3875 MHz paired with 3925-4200 MHz	2 x 275 MHz	Technically coordinated and assigned on a first come first served basis 3605-3689 MHz and 3925-4009 MHz is block assigned on a technology neutral basis
5.8 GHz	5725-5850 MHz	125 MHz	Light licensed
Lower 6 GHz	5925-6167.8 MHz paired with 6182.42-6425 MHz	2 x 242 MHz	Technically coordinated and assigned on a first come first served basis
Upper 6 GHz	6425-6760 MHz paired with 6780-7125 MHz	2 x 335 MHz	Technically coordinated and assigned on a first come first served basis
7.5 GHz	7425-7652 MHz paired with 7673-7900 MHz	2 x 227 MHz	Technically coordinated and assigned on a first come first served

[10] UK service allocations for the frequency bands listed are in the UK Frequency Allocation Table http://stakeholders.ofcom.org.uk/binaries/spectrum/spectrum-policy-area/spectrum-management/ukfat2010.pdf

[11] The amount of spectrum given here is indicative as in some bands the size of the paired sub-bands are not equal and also includes guard bands at the band edges.

Frequency Band[10]		Amount of spectrum available to the Fixed Service[11]	Method of assignment for the Fixed Service
			basis
13 GHz	12.75-12.975 GHz paired with 13.017-13.25 GHz	2 x 224 GHz	Technically coordinated and assigned on a first come first served basis
15 GHz	14.5-14.613 GHz paired with 15.229-15.35 GHz	2 x 112 MHz	Technically coordinated and assigned on a first come first served basis
18 GHz	17.7-19.7 GHz (variable centre gap)[12]	2000 MHz	Technically coordinated and assigned on a first come first served basis
23 GHz	22-22.6 GHz paired with 23-23.6 GHz	2 x 600 MHz	Technically coordinated and assigned on a first come first served basis
26 GHz	24.5-25.445 paired with 25.557-26.5 GHz	2 x 943 MHz	Technically coordinated and assigned on a first come first served basis
31 GHz	31.0-31.3 GHz paired with 31.5-31.8 GHz	2x300 MHz	Technically coordinated and assigned on a first come first served basis
38 GHz	37-38.178 GHz paired with 38.438-39.5 GHz	2 x 1178 MHz	Technically coordinated and assigned on a first come first served basis
52 GHz	51.4-51.944 GHz paired with 52.056-	2 x 540 MHz	Technically coordinated and

[12] See OfW 48 http://licensing.ofcom.org.uk/binaries/spectrum/fixed-terrestrial-links/guidance-for-licensees/OfW48.pdf

Frequency Band[10]		Amount of spectrum available to the Fixed Service[11]	Method of assignment for the Fixed Service
	52.6 GHz		assigned on a first come first served basis
55 GHz	55.78- 56.346 GHz paired with 56.458 – 57 GHz	2 x 542 MHz	Technically coordinated and assigned on a first come first served basis
60 GHz	57-64 GHz	7000 MHz	Licence-exempt
65 GHz	64-66 GHz	2000 MHz	Light-licensed on a self coordinated basis
70 GHz	71-76 GHz	5000 MHz	Light-licensed on a self coordinated basis
80 GHz	81-86 GHz	5000 MHz	Light-licensed on a self coordinated basis

Annex 4

Responding to this Update

How to respond

A4.1 Ofcom is inviting stakeholders to respond to this Update, but only if they have strong views on the prioritisation of the policy issues in the forward programme set out in section 5, or if they feel that there are any material omissions from this forward programme.

A4.2 Responses may be sent to mrinal.patel@ofcom.org.uk. Responses may alternatively be posted or faxed to the address below, marked with the title of the Update.

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