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Strategic Review of UHF Band 1 and Band 2

410 to 470 MHz

Consultation

Publication date: 19 December 2016

Closing Date for Responses: 13 February 2017

About this document

This document consults on proposals to use the spectrum in the 410 to 450 MHz (UHF Band 1) and 450 to 470 MHz (UHF Band 2) bands more intensively and efficiently to best address the requirements of current and future users.

The spectrum in this range is attractive to users as it has good in-building penetration as well as coverage. These bands already deliver important benefits to UK citizens and consumers, including robust and immediate communications for businesses, Emergency Services, and Programme Making and Special Events.

Our proposals are to increase sharing, change some of the licence products to better meet the needs of the users, and to make access to this spectrum more uniform. The aim of the policy proposals is to set a framework for managing this spectrum for the next ten years.

We invite stakeholders' views on our analysis and policy proposals.

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Section 1

Executive Summary

- 1.1 This document sets out our proposals for ensuring that management of the spectrum bands 410 to 450 MHz (UHF Band 1) and 450 to 470 MHz (UHF Band 2) will meet the future needs of existing and new users and applications. Frequencies in these ranges are attractive to users due to their favourable propagation characteristics; they deliver good coverage along with better in-building penetration and lower infrastructure costs.
- 1.2 These bands are used by a wide range of parties, including Ministry of Defence (MOD), Emergency Services (ES) and civil users referred to as Business Radio (BR). BR provides services to many industry sectors, for example transport, security, manufacturing and utilities (water, gas and electricity industries). The bands also support Programme Making and Special Events (PMSE), maritime and aeronautical sectors, Amateur Radio and licence exempt (LE) use (including short range devices).
- 1.3 There are a number of challenges for managing this spectrum. Generally, there is small but continuing growth in spectrum demand from current users which, in some urban areas, has led to congestion and limited spectrum availability for Technically Assigned and Area Defined licences. We also see continuing growth in the number of Light Licences on issue and see these licence products as being an effective and cost efficient option for spectrum access.
- 1.4 We expect demand for spectrum for Internet of Things (IoT) and Machine-to-Machine (M2M) applications to increase. UHF Bands 1 and 2 could support these applications but, given the variety of technologies and potential spectrum options the scope for these devices being deployed in UHF 1 and 2 is unknown.
- 1.5 We have received expressions of interest from some stakeholders relating to spectrum for private wideband/broadband type applications, but we do not currently see any widespread demand for these applications in UHF Bands 1 and 2. However, it is important that our future spectrum management strategy provides the flexibility to accommodate new technologies if the need arises.
- 1.6 We have identified three policy proposals in order to address these spectrum management challenges. These are:
 - Add additional channels to Simple UK and Simple Site licences to recognise the appeal of these licence products;
 - Changes to the Technical Frequency Assignment Criteria, which includes increasing the sharing factor¹ from two to four (with an initial increase to a sharing factor of three) for Technically Assigned licences and increasing the planning thresholds with respect to the noise floor for the bands 55.75 to 68.0 MHz (VHF Band 1) and 68 to 87.5 MHz (VHF Low Band); and

¹ The sharing factor relates to the number of users sharing a channel within the same geographical area

- Channel plan reconfiguration to a rationalised set of more common duplex spacings in order to defragment the bands and release additional capacity.
- 1.7 For a number of years there have been discussions about aligning UHF Band 2 to match the channel configuration used in continental Europe. That would be a major intervention and would cause significant cost and disruption to all users of the band, most of whom would receive limited, if any, benefits from alignment. We have concluded that it is not necessary or proportionate to reconfigure the band as there is insufficient evidence to suggest that the benefit would outweigh the costs.

Section 2

Introduction

- 2.1 This document consults on Ofcom’s proposed strategy for the management of spectrum bands 410 to 450 MHz (UHF Band 1) and 450 to 470 MHz (UHF Band 2).
- 2.2 UHF 1 and 2 are busy, heavily populated bands that already deliver important benefits to UK citizens and consumers. The spectrum in this range is attractive to users as it has good in-building penetration as well as coverage. Business Radio (BR) is the most significant civil user of the bands, of which Private Mobile Radio (PMR) is the most common type of use.
- 2.3 We currently have approximately 40,000 BR licences issued for use in these bands, of which 22,000 are for Light Licences (Simple UK, Simple Site and Suppliers Light licences) and 18,000 for coordinated licences (Technically Assigned and Area Defined). Within the coordinated licences there are approximately 10,000 licensees with 32,000 assignments. In addition, these bands also support potentially thousands of licence exempt devices.
- 2.4 Current users of the bands include:
- | | |
|----------------------------------|--|
| UHF 1
(410 – 450 MHz) | Primarily used by the Ministry of Defence. Other users in the band include Arqiva and the Department of Health (both using 2 x 2 MHz), Business Radio (BR), Amateur Radio (secondary use between 430 to 440 MHz), Emergency Services (ES), Programme Making and Special Events (PMSE) and Licence Exempt (LE) devices ² . |
| | Military use places a number of constraints on other spectrum users of the band, including geographical limitations, which limit civil use to specific areas around conurbations ³ . |
| UHF 2
(450 – 470 MHz) | Contains many different types of users including mission and safety critical services. Users include BR, PMSE, scanning telemetry, ES and Licence Exempt devices ⁴ . There are also long standing international allocations for maritime (on board ships communications sharing the telemetry bands). |
- 2.5 This review does not consider any changes to spectrum management for scanning telemetry, PMSE, Amateur Radio, or UHF Maritime allocations.

² The Licence Exempt spectrum in UHF 1 is harmonised across Europe

³ UK Frequency Allocation Table, Annex C

https://www.ofcom.org.uk/data/assets/pdf_file/0021/36228/ukfat_2013.pdf

⁴ The Licence Exempt spectrum in UHF 2 (458.5 to 459.5 MHz) is a UK only allocation

Background

- 2.6 In 2014 we published our Spectrum Management Strategy (SMS)⁵ which established our strategic approach and priorities for spectrum management over the next ten years. Further to this, we are carrying out (or have carried out) a number of sector, or band specific reviews, for example the Space Spectrum Strategy⁶ and strategic review of PMSE spectrum use⁷.
- 2.7 The initial step in the UHF Strategic Review was to publish a Call for Inputs (CFI) in December 2014⁸. This asked stakeholders to provide views of current and future trends that might impact the demand for, or supply of, spectrum. We received 34 responses to that CFI from a wide range of stakeholders, including equipment manufacturers, industry bodies and licensees. The 30 non-confidential responses are published on our website⁹. In our 2015/16 Annual Plan¹⁰ we outlined our intention to publish a consultation to set out our policy proposals for UHF Bands 1 and 2.
- 2.8 In April 2016 we sent an online survey to approximately 7000 Technically Assigned and Area Defined licence holders. In June 2016 we surveyed 13000 Simple UK, Simple Site and Suppliers Light licence holders in order to collect views on trends in demand and seek more information about how the spectrum is currently used and what changes are envisaged. In total we received we received over 2200 responses.
- 2.9 This document does not provide a detailed summary of responses to the CFI and questionnaires or respond to the individual comments received. However, input from stakeholders via responses to the CFI and questionnaires have provided us with a more detailed understanding of the current and future needs of users of the spectrum which we have taken into account in developing our proposals
- 2.10 We have also continued to engage with stakeholders both individually and through Business Radio stakeholder forums such as Business Radio Interest Group (BRIG) and Technical Advisory Group (TAG) in order to gather information to inform our assessment of future spectrum management options.
- 2.11 In addition, we are working with users in the public sector to understand their demand and any potential to add to the supply of spectrum for commercial use.

Purpose of the review

- 2.12 The aim of the review is to build on our sectoral analysis and establish a long term spectrum management strategy for civil use of the UHF spectrum at 410 to 470 MHz. This strategy will also provide the flexibility to adapt to any growing, or changing requirements, for example increased demand for spectrum for Internet of Things (IoT), Machine-to-Machine (M2M) or wideband/broadband applications in the band.

⁵ Spectrum Management Strategy <http://stakeholders.ofcom.org.uk/binaries/consultations/spectrum-management-strategy/statement/statement.pdf>

⁶ <https://www.ofcom.org.uk/consultations-and-statements/category-1/space-spectrum-strategy>

⁷ https://www.ofcom.org.uk/_data/assets/pdf_file/0038/57899/annex5.pdf

⁸ <http://stakeholders.ofcom.org.uk/binaries/consultations/420-470-mhz/summary/420-470-mhz.pdf>

⁹ CFI response: <https://www.ofcom.org.uk/consultations-and-statements/category-1/420-470-mhz>

¹⁰ https://www.ofcom.org.uk/_data/assets/pdf_file/0040/49999/annual_plan_statement.pdf

Once confirmed, our Strategic Review will provide a framework for how we manage and licence this spectrum for the next ten years.

- 2.13 In the CFI we said that the scope of this Strategic Review addressed spectrum frequencies between 420 and 470 MHz. We have since revised the scope and extended the frequency range to 410 to 470 MHz in order to take a full assessment of the band.
- 2.14 To maximise the potential benefits of this spectrum and to ensure our spectrum management approach is consistent across all BR bands, some proposals in this consultation will apply to spectrum outside UHF 1 and 2. The proposed increase in sharing factor will apply to Technical Assignments in all spectrum bands used by BR. In VHF Band I (55.75 to 68.0 MHz) and VHF Low Band (68 to 87.5 MHz) only we are also proposing to adopt a higher noise floor in the planning criteria for both Technically Assigned and Area Defined licences (see Section 5).

Our duties

- 2.15 Ofcom has a statutory duty to further the interests of citizens and consumers. In doing so, we are required to ensure the optimal use of spectrum and (amongst other things) encourage innovation.
- 2.16 In line with these duties, we undertake sector and/or band specific reviews to help us understand market developments and different needs. This enables us to develop action plans covering both the UK and international arena.

Our approach to the analysis

- 2.17 In formulating our proposals for how best to manage this spectrum we have sought to:
- Understand current use of this spectrum, including issues such as congestion and interference through engagement with stakeholders and our own analysis;
 - Consider future demand from current users as well as potential new services over the next ten years;
 - Assess what the implications are for future use of this spectrum;
 - Consider whether any of the issues can be addressed by market mechanisms alone, without taking any regulatory action; and
 - Develop proposals we consider will enable us to meet current and future demand.

Alignment of UHF Band 2

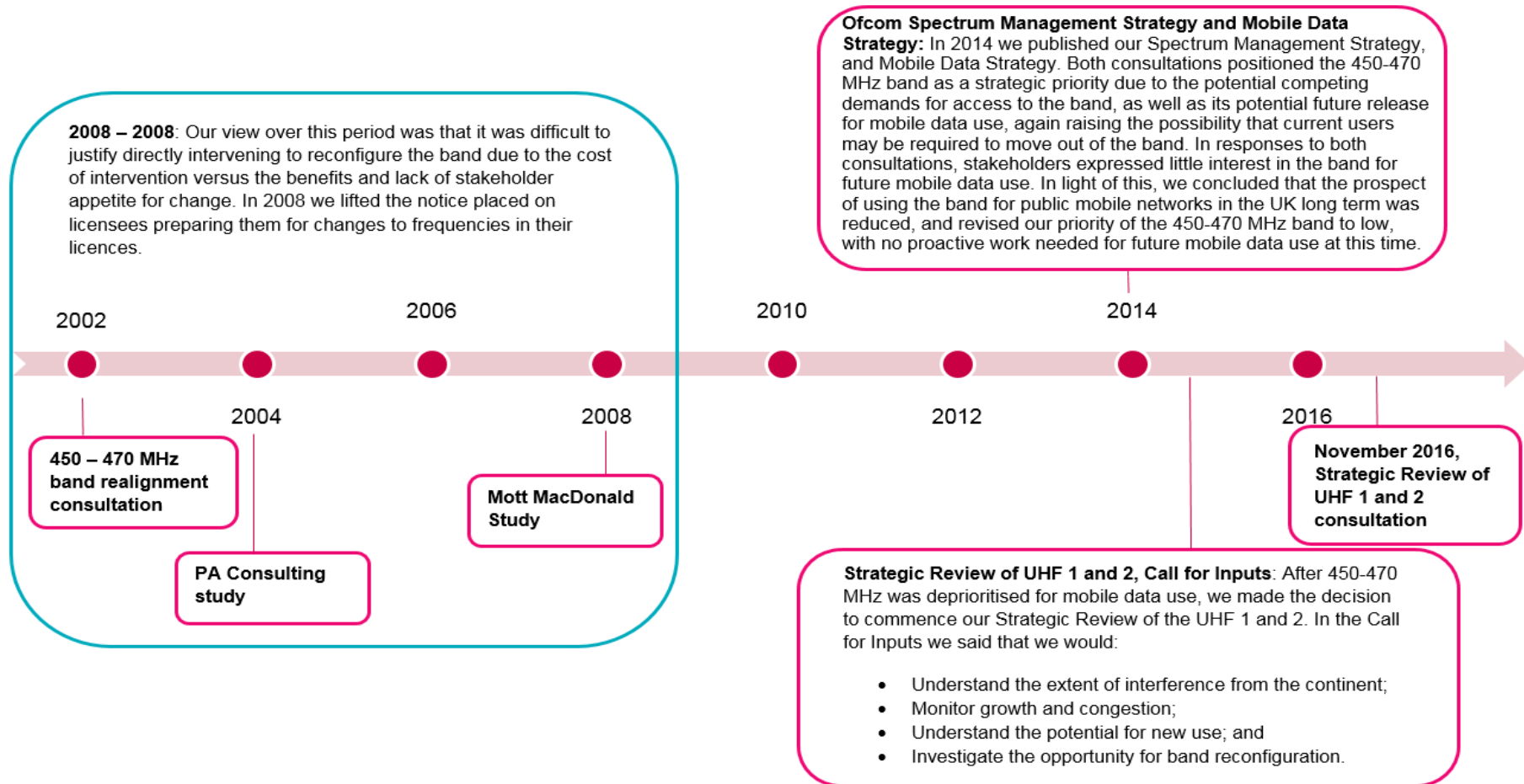
- 2.18 Dating back to 2002 there have been several reviews of UHF Band 2 looking at the potential to align the duplex arrangement to match that in continental Europe. We

detailed these previous initiatives in the CFI¹¹. The most recent reviews of this spectrum and wider spectrum management strategies that looked at UHF 2, are shown in Figure 1.

- 2.19 We are aware that this has caused uncertainty for stakeholders who have lived with the prospect of band alignment for a number of years. We are using this consultation to draw a line under the question of alignment of the band where we have seen no evidence to contradict previous studies which concluded that the potential scale of the costs and disruption for users outweighs the benefits.
- 2.20 We will not consider this issue again unless there is a significant and material change to the spectrum environment which would necessitate regulatory intervention. Our horizon scan of the band does not indicate any changes which would require such an intervention.

¹¹ Page 14 to 18 <http://stakeholders.ofcom.org.uk/binaries/consultations/420-470-mhz/summary/420-470-mhz.pdf>

Figure 1: Timeline of initiatives looking at alignment of UHF Band 2



Impact Assessment

- 2.21 This document represents an impact assessment as defined in Section 7 of the Communications Act. Impact assessments provide a valuable way of assessing different options for regulation. They form part of best practice policy-making.
- 2.22 In preparing this document we have considered the citizen and consumer interests in respect to our overall policy objectives of ensuring efficient use of spectrum in UHF Band 1 and Band 2. We have also considered the impact on existing users of the spectrum and potential future users.
- 2.23 Ofcom is an evidence based organisation and welcomes responses to this consultation. Any comments about our assessment of the impact of our proposals should be sent to us by the closing date for this consultation. We will consider all comments before deciding whether to implement our proposals. For further information about our approach to impact assessments, see the guidelines, Better policy-making: Ofcom's approach to impact assessment, which are on our website: http://www.ofcom.org.uk/consult/policy_making/guidelines.pdf .

Document structure

The remainder of this document is structured as follows:

- Section 3: Current and Future uses of the spectrum
- Section 4: Policy Proposals

Section 3

Current and future use of the spectrum

Trends in demand

- 3.1 To assess whether any changes are required to the way we manage this spectrum, we have sought to gather information from stakeholders and industry more widely. This included gathering information directly from stakeholders via meetings and from responses to our CFI and the two online surveys to BR licence holders. The surveys were sent to approximately 20,000 BR licensees, and we received 2285 responses. We also carried out an assessment of international developments in order to gain a better understanding of trends, developments and potential future uses of the 400 MHz range across Europe.
- 3.2 In November 2013 the Radio Spectrum Policy Group¹² published its report on Strategic Sectoral Spectrum Needs¹³. This report identified the emerging spectrum needs and demands over the coming years for eleven different sectors, including Professional Mobile Radio (which we refer to as Business Radio). The conclusions of this report and those from our own analysis are largely aligned, for example:
- there are no indications that the bandwidth requirements of the narrowband BR sector will increase within the medium or long term future;
 - possible future evolution towards BR broadband services would raise the need for availability of spectrum resources, but there is insufficient evidence at this stage to estimate any possible new spectrum needs or the future market demand for these applications; and
 - UHF Bands 1 and 2 are, in general, highly used by analogue or digital narrowband PMR networks reducing the possibility of deploying broadband PMR networks with larger bandwidths.
- 3.3 The RSPG report also noted that the UHF bands could provide a spectrum solution for smart meters and smart grids. However, it highlighted that demand may differ between networks and countries depending on network configuration, and that there are other options for communications including a range of applications such as fixed links, commercial cellular networks (M2M application) and Short Range Devices using existing harmonised spectrum. The RSPG considered that an exclusive designation of spectrum to smart energy grids/meters is not necessary.
- 3.4 Through our own analysis and engagement with stakeholders we have identified the following trends in civil use of the spectrum.

¹² The RSPG is a high-level advisory group that assists the European Commission in the development of radio spectrum policy.

¹³ RSPG Report on Strategic Sectoral Spectrum Needs
https://circabc.europa.eu/d/d/workspace/SpacesStore/f15d622c-183f-44d4-8412-19f2335a714d/RSPG13-540rev2_RSPG%20Report%20on%20Sectoral%20needs.pdf

Moderate overall growth for services currently in the band

- 3.5 Stakeholder feedback, and responses to the CFI and our recent surveys to licensees, demonstrate that users value voice applications and expect to continue using them for the foreseeable future. Voice is currently the dominant application for BR and we expect demand to remain broadly stable. Our survey indicated 95% of users currently use BR for voice communications and this dropped to 91% when asked to indicate their future use in the next 5 to 10 years.
- 3.6 In relation to data, 22% of users responded that they currently use data applications and this is expected to grow over the next 5 to 10 years to 36%. Growth was also predicted for other specific data applications, for example M2M/IoT rising from 7% to 18%.
- 3.7 This increasing demand for data does not appear to be across the BR sector as a whole. In response to the online survey 15% of stakeholders stated that they expected data use to increase over the next ten years, whereas 40% indicated they did not expect any change.
- 3.8 Data services in the band tend to support low data rate applications, and are ideal for applications that require reporting, such as remote control or asset management, where each communication only requires a small amount of data. The introduction of digital PMR has enabled users to make use of data services.
- 3.9 This increasing demand for low bit rate data does not necessarily equate to a significant or separate increase in spectrum demand than that for voice, but does need to be considered when assessing the potential to increase sharing between users. As the Federation of Communication Services (FCS) noted in its response to the CFI, data services may have characteristics that are not compatible with sharing due to duty cycles, periodicity and other factors relating to all sharers on that same channel.
- 3.10 In its response to the CFI the Joint Radio Company Ltd (JRC) commented that utility requirements for additional spectrum in the 380 to 470 MHz band will increase over the next ten years and suggests this could lead to higher demand for UHF 1 and UHF 2 spectrum. Critical Messaging Association and Pagers Direct suggested such demand should be met outside UHF 1 and UHF 2.
- 3.11 The Telecommunication Association of the UK Water Industry (TAUWI) stated that increasing environmental regulations, a trend towards greater granularity of data and uncertainty on the long term support from mobile operators has resulted in a move away from circuit switched data communications technologies to “always on” types, such as UHF scanning telemetry. TAUWI also noted that with BT’s decision to discontinue the support of sub 2 Mbit/s private circuit services members are actively looking at alternative means of providing connectivity. Their view is that this will result in an increasing demand for licensed scanning telemetry systems and therefore additional spectrum to support these systems.

Light Licence products

- 3.12 In its report UHF 1 & 2 Future Demand Final Report¹⁴ Aegis highlighted that there is significant growth in demand for light licences (Simple UK and Simple Site). Aegis suggested that this may in part be due to industry's perception that obtaining technically assigned licences in major metropolitan areas is difficult or even impossible and that light licences are used as a substitute for technically assigned licences.
- 3.13 Our licensing records show that there is continuing growth of light licences on issue. We understand from stakeholders that they see these licence products as being an effective and cost efficient option for spectrum access for BR.

Potential increased use for IoT / M2M type applications from both new and current users

- 3.14 In its report on Strategic Sectoral Spectrum Needs the RSPG noted that a large development is foreseen within the sector of IoT and M2M, with potential of a large growth and contribution in socio economic benefits. In relation to spectrum requirements the RSPG identified that some applications would require spectrum below 1 GHz due to propagation characteristics (e.g. in-building penetration) and that commercial networks could also support IoT/M2M.
- 3.15 In response to the CFI, the FCS noted that M2M communications has been a part of BR operations for many years in the form of telemetry solutions. Modest growth is to be expected but the FCS did not see a need to identify M2M as some fundamentally different type of operation. Pagers Direct commented that IoT and M2M will increase demand but much of this could be satisfied on WiFi or on cellular networks.
- 3.16 The scale of IoT and M2M devices currently operating in UHF 1 and 2 is unknown. As noted by the FCS M2M devices in the form of telemetry equipment are already deployed throughout UHF 2¹⁵. In relation to scanning telemetry we do not know how many devices are deployed as we license the spectrum and not the use. There are also licence exempt devices deployed in this spectrum.

We see some interest in wideband services / private broadband communications network for businesses

- 3.17 For the purposes of this review we consider wideband and broadband to be:
- Wideband – channel allocations generally considered to be between 25 kHz and 1 MHz, (although for CDMA this may be 1.25 MHz) supporting data rates of several hundred kilobits per second (e.g. in the range of 384 to 500 kbit/s); and
 - Broadband – channel allocations greater than 1 MHz, enabling new functionality with additional capacity to support higher speed data and higher resolution images.

¹⁴ https://www.ofcom.org.uk/__data/assets/pdf_file/0022/51637/aegis-report.pdf

¹⁵ Scanning telemetry devices are limited to 457 MHz paired with 463 MHz

- 3.18 As outlined in our Mobile Data Strategy¹⁶ (MDS) there was limited interest expressed by stakeholders in the prospect of using UHF Band 2 for public mobile networks in the long term. Consequently, we re-assessed the band as low priority for mobile data. In our MDS update¹⁷ we deprioritised UHF Band 2 as a candidate for public mobile use.
- 3.19 We have received some expressions of interest in the potential for deploying private wideband and broadband communications network for businesses. Stakeholders have told us that they prefer to have access to private networks that offer a greater degree of certainty (generally within the user's control) with regard to quality of service and coverage, compared with public mobile services.
- 3.20 Although some users have expressed interest in private wideband/broadband type systems, we have not yet seen a push towards practical implementation. The RSPG report did note that, "LTE seems to be a technology that can evolve to meet all or part of PMR needs with channel bandwidths of, for example, 1.4 MHz, 3 MHz, 5 MHz or 10 MHz but that it is difficult to estimate any possible new spectrum needs or the future market demand for these applications."
- 3.21 In response to the CFI Motorola commented that it had not seen any significant demand in the market for wideband services. Southern Water noted the likely future demand for an increased wideband services for CCTV at remote sites. TAUWI thought that the demand for wideband data services in the 450 to 470 MHz band was limited at this time.
- 3.22 The FCS suggested there was little demand foreseen for large volumes of wideband over-the-air traffic supported by spectrum in the 450 to 470 MHz range. It did not consider the deployment of a consumer technology such as CDMA or LTE at 450 MHz to be attractive due to the complexity of the current arrangements in the UHF bands in the UK and the lack of user demand.
- 3.23 Other responses were similarly split between indicating a potential requirement for wideband/broadband applications or suggesting that there is no requirement. Generally, there was agreement that it would be difficult to accommodate the bandwidth requirements within UHF Bands 1 and 2.
- 3.24 Although some stakeholders have suggested that there is interest in wideband/broadband services our assessment is consistent with that of RSPG i.e. the actual level of demand for these networks is uncertain within the UK. However, it is noted that a number of countries have deployed broadband/wideband networks in UHF bands.
- Germany is currently undertaking trials of LTE 450 for utilities.
 - France has indicated that it may deploy LTE for PPDR in 450 to 470 MHz, which will require substantial spectrum refarming.
 - In Nordic countries LTE 450 is used on commercial basis, particularly in rural areas for applications such as forestry and fishing, as well as consumer broadband.

¹⁶ https://www.ofcom.org.uk/__data/assets/pdf_file/0027/58347/Mobile-Data-Strategy-statement.pdf

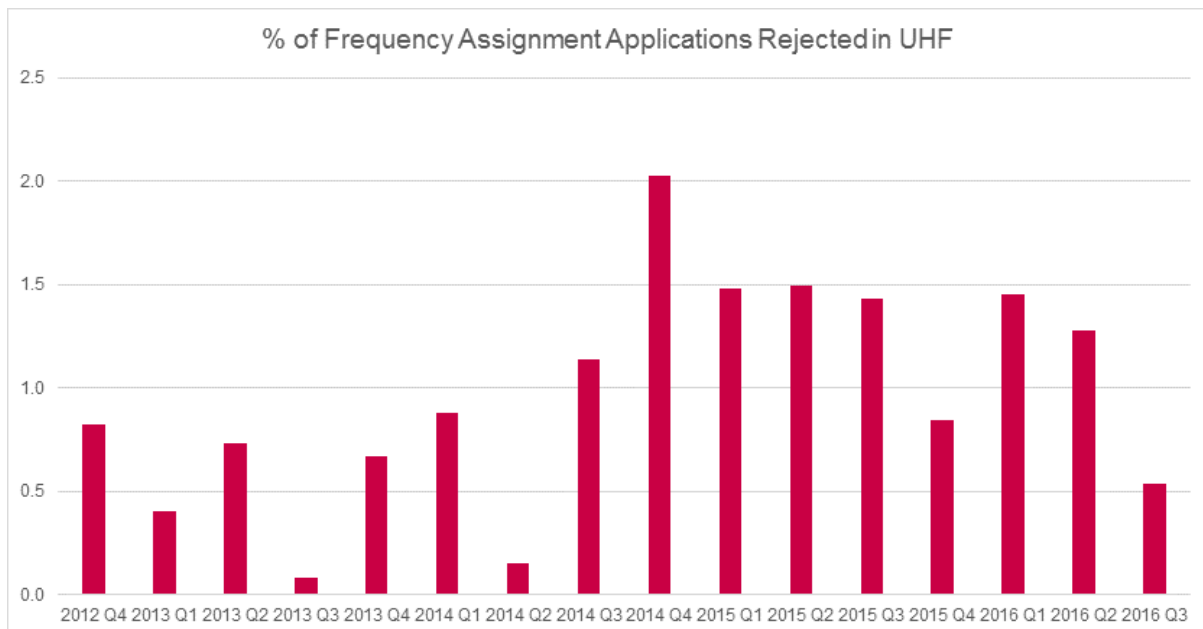
¹⁷ https://www.ofcom.org.uk/__data/assets/pdf_file/0033/79584/update-strategy-mobile-spectrum.pdf

- We are aware that Brazil has deployed broadband fixed wireless access systems in 452.5 to 457.5 MHz paired with 462.5 to 467.5 MHz (2 x 5 MHz) on a regional basis.

Increasing risk of congestion

- 3.25 We are currently seeing congestion in London and expect to see more of this in other urban hot-spots.
- 3.26 From our licensing data, we have identified high demand for UHF spectrum assignments in urban areas, resulting in a risk of congestion. In 2015, out of 6514 assignments attempted, 6430 were successful and 84 failed. So far in 2016 around 1.5% of requests for licences have been rejected, the majority of these rejections were in London. In addition to outright rejections there are often occasions where applications have to be amended to reduce power and/or antenna height in order to enable us to assign a frequency.

Figure 2 - Graph to show percentage of frequency Assignment Applications rejected in UHF Bands



- 3.27 In response to the CFI, Maxxwave thought that there was clear congestion in the band due to applications for licences are being refused in many areas and sometimes having reduced technical parameters to those initially requested. Anttele and Critical Messaging Association also agreed there is an industry view of severe congestion in the 450 to 470 MHz band with a marked increase in incidents across London, but there was little evidence of congestion in other parts of the country.
- 3.28 The FCS also agreed that there is congestion in the band and further suggested that most, large metro areas of the UK will suffer serious levels of congestion as reported by the licensing system under the current policies within the next five years. JRC suggested that actual levels of congestion as indicated by applications being rejected or amended may be an artefact of the assignment criteria rather than real world circumstances.

Question 1: Do you agree with our assessment of the trends in current and future demand in the band?

Continental interference

- 3.29 The effect of continental interference in UHF Band 2 has previously been highlighted as an issue for some stakeholders, especially those located in the east and south east of the UK.
- 3.30 In the UK, our duplex configuration of UHF Band 2 is opposite to that used in continental Europe i.e. our base stations receive in the high part of the band which corresponds to the base station transmit in continental Europe. As base stations are often sited on high ground or buildings this can increase the risk of interference.
- 3.31 In response to the CFI some stakeholders acknowledged the risk of interference from the Continent, but noted that it tended to occur to the east of the UK, for example JRC suggested that high-sited stations located east of a line drawn between Newcastle and the Isle of Wight are at risk. TAUWI noted that it had received reports of continental interference to scanning telemetry systems operating in East Anglia during periods of high pressure. Other stakeholders, such as Motorola Solutions Ltd and Pagers Direct, commented that they, or their customers, had not experienced degraded service due to continental interference.
- 3.32 In response to the CFI, the FCS asked its member companies with systems located along the east coast of England if they experienced interference from the Continent in the UHF Band 2. The result of the survey was that the number of interruptions to service reported was zero. However, FCS members did report that they can detect power in the band coming from the Continent, but this could be mitigated through site engineering.
- 3.33 Our online surveys did not specifically ask about continental interference but did ask stakeholder if they experienced interference on their channels. For coordinated licences (Technically Assigned and Area Defined) only 6% answered that they experienced interference during certain months of the year. Less than 1% of stakeholders holding light licences noted that interference occurred during certain months. Such interference events could be the result of anomalous propagation and would be consistent with responses to the CFI which indicated that a small proportion of stakeholders are at risk of continental interference.
- 3.34 In order to better understand the risk of continental interference we have carried out spectrum monitoring (including recording daily tropospheric ducting forecasts). Our assessment shows that cases of increased signal levels are infrequent and occur when atmospheric conditions give rise to anomalous propagation effects such as 'ducting'.
- 3.35 Annex 4 provides a summary of our analysis of a large scale interference event that occurred between 4th and 8th of June 2016. Many users reported disruption to their services and as can be seen this corresponded to a significant atmospheric lift during the period.
- 3.36 However, assignments in the band are coordinated in accordance with the Harmonised Calculation Method (HCM) which specifies the interference thresholds which must not be exceeded. These thresholds are calculated for 10% time which is used to account for anomalous propagation effects. This means that a coordinated

continental transmission may cause interference into a UK system for 36 days per year and still meet the HCM agreement.

- 3.37 Our view, based on comments received from stakeholders, interference and spectrum monitoring reports from affected stakeholders and our own monitoring and analysis is that the risk of continental interference is mainly confined to the east and south east of the UK during periods of atmospheric lifts causing anomalous propagation events. We do not have any evidence to show that the amount of interference received during such periods exceeds that which can be expected under the HCM agreement.

Question 2: Do you agree with our assessment that the risk of continental interference is limited to the east and south east of the UK during periods of atmospheric lifts?

Public Sector Spectrum

Public Sector Spectrum Release

- 3.38 The Public Sector Spectrum Release (PSSR) programme has identified parts of the UHF spectrum between 380 to 430 MHz to investigate for the possibility of granting civil access. If some spectrum in this frequency range can be released or made available for further sharing, while also protecting ongoing public sector uses, this would provide additional spectrum to help us implement our proposals and meet increases in demand. The bands are:
- 406.2¹⁸ to 430 MHz. This band is currently used by a range of civil and public sector stakeholders, including the Ministry of Defence, Emergency Services, PMSE, Business Radio and the Radio Astronomy Service¹⁹. There is potential for increased sharing between civil and military uses in this range.
 - 380 to 385 MHz paired with 390 to 395 MHz (380/390 MHz bands). These bands are currently licensed to Airwave to provide communications for Emergency Services using Terrestrial Trunked Radio (TETRA) in England, Scotland and Wales.²⁰ Airwave's licence comes to an end in December 2020.
- 3.39 The 380/390 MHz bands are part of the 225 to 400 MHz frequency range that is harmonised for NATO use and are used for defence purposes in the UK. A permanent essential military requirement exists in these bands for NATO operations and training in Europe, and so any use must ensure the protection of ongoing use by NATO. There is currently military use of the whole frequency range throughout NATO Europe which will continue post 2020. Across NATO Europe these bands have been made available for sharing with emergency services using TETRA or similar

¹⁸ 406 to 406.1 MHz is limited to low power satellite emergency position-indicating beacons. Resolution 205 (Rev.WRC-15) protects these systems and requests administrations not to make new frequency assignments within the frequency bands 405.9 to 406.0 MHz and 406.1 to 406.2 MHz to mobile and fixed services.

¹⁹ 406.1-410 MHz allocated to Radio Astronomy and subject to footnote 5.149 of the ITU Radio Regulations which "urge administrations to take all practicable steps to protect the radio astronomy service from harmful interference"

²⁰ Terrestrial Trunked Radio is a standard used by Government agencies and emergency services which supports 'mission critical' networks

technology, so as to be technically compatible with ongoing military uses in this range.

- 3.40 At this stage we are not assuming immediate access to these bands for civil use. Access will be dependent on further technical feasibility work undertaken by the public sector users. However, if spectrum within these bands were made available for civil use, it would provide us with greater flexibility in implementing our policy proposals for UHF 1 and 2.
- 3.41 The PSSR project is exploring options for the continued use of the 380/390 MHz bands for emergency services and public safety systems post 2020²¹. We note that any potential future access will need to consider the NATO requirement. We believe that making 380/390 MHz available for continued emergency services and public safety uses would ensure compatibility with the ongoing military requirement in the band and have a positive impact on our ability to implement our UHF 1 and 2 policy proposals.

Emergency Services in UHF Band 2

- 3.42 As a result of the rationalisation of ES spectrum we expect to see use of UHF Band 2 by the ES to decrease. In the near term it is anticipated that 4 MHz of non-contiguous spectrum in the 450 to 470 MHz band will become available for civil use.

Benefit of access to Public Sector Spectrum

- 3.43 We consider that access to the 380/390 MHz and 406.2 to 430 MHz bands, and to the 4 MHz of spectrum in UHF Band 2 will allow us to better address the strategic issues and trends we have identified, for example to address congestion and demand pinch points for narrowband users in urban areas. It would also facilitate the reorganisation of UHF 1 and 2 for more efficient use over time, and grant greater flexibility to respond to new applications and services. It may also help us to achieve the policy proposals we identify in the next section sooner and more effectively.

Question 3: Do you agree with our assessment that these bands could enable the implementation of our UHF policy proposals? Are there any additional uses you think we should consider if this spectrum becomes available for use?

²¹ As defined by the Public Safety Spectrum Policy Group (PSSPG) joint policy statement https://www.ofcom.org.uk/_data/assets/pdf_file/0025/53827/ips.pdf

Section 4

Policy proposals

- 4.1 In line with Ofcom's spectrum management strategy we have looked at whether any trends or challenges identified in the band can be addressed by market mechanisms alone, without taking any regulatory action. We have also considered whether taking regulatory action would be proportionate to the scale of the issue.
- 4.2 After analysis of current and potential future trends in demand, we consider that it is appropriate and proportionate to take some action in order to ensure efficient use of UHF spectrum. We believe that our policy proposals are necessary to:
- meet future demand for spectrum, particularly in congested areas, such as London, where demand continues to grow and where we already reject a small, but growing, percentage of licence applications; and
 - meet demand for, and provide flexibility to enable new technologies.

Band alignment

- 4.3 As discussed previously, since 2002 there have been several initiatives exploring whether we should reconfigure UHF Band 2 to align with the arrangement in Europe. The duplex arrangement for the band in the UK is opposite to that in continental Europe i.e. in the UK base stations transmit on the low spectrum side of the channel and mobiles transmit on the high spectrum side, whereas on the continent the opposite is the case with base stations transmitting high and mobiles transmitting low.
- 4.4 However, our evidence does not justify proposing band alignment in UHF 2. In two reports commissioned to look at the costs and benefits (PA Consulting in 2004 and Mott McDonald in 2008) costs of alignment were estimated to be up to £310m. In addition, in its report on future spectrum demand in UHF Band 1 and 2, Aegis highlighted the likely high costs and disruption for users, a lack of stakeholder support, the band's fragmented use and multitude of deployed technologies which complicates any reconfiguration solution. These are summarised in the CFI. We therefore consider that such a large scale intervention would not be proportionate to the scale of the problem and consequently we are not proposing alignment of UHF 2.
- 4.5 The main purpose of alignment would be to mitigate the risk of continental interference; however, as outlined previously, such interference is generally only a concern to users on the eastern side of the UK during times of enhanced propagation due to atmospheric lifts.
- 4.6 It is also noted that users can take steps to mitigate the risk of continental interference, including using directional antennas to minimise incoming interference or operating with horizontal rather than vertical polarisation. Users could also consider using different technologies and frequency bands for their communication needs.
- 4.7 In response to our CFI and questionnaires some stakeholders agreed with the idea of aligning our duplex arrangement with the continent, but most respondents indicated

that they felt this was not required and that the cost and disruption to all UHF Band 2 users would outweigh the benefits to a small proportion of the sector. While it may be possible to reduce the cost and disruption by aligning the band over a period of a number of years the administrative burden would still be significant.

- 4.8 Additionally, equipment manufacturers have told us that the UK PMR market is large enough that aligning the band with continental Europe would bring little benefit in terms of economies of scale. We do not think that band alignment is necessary to facilitate new technologies.

Question 4: Do you agree with our conclusion that aligning UHF Band 2 with continental Europe is not required?

Policy proposals

- 4.9 The proposals we are putting forward for consultation in this document represent an evolution of the way we manage and license this spectrum rather than a revolutionary overhaul.
- 4.10 We consider that the policy proposals outlined provide the greatest benefit to addressing the spectrum use trends we have identified in UHF Band 1 and Band 2. We will consult on these to gather views of stakeholders. We believe these proposals can be implemented in a relatively resource and cost efficient manner and would address congestion, increase spectrum efficiency and provide the flexibility to adapt to new requirements should they emerge. These include:
- Add additional channels to Simple UK and Simple Site licences;
 - Changes to the Technical Frequency Assignment Criteria, which includes increasing the sharing factor for Technically Assigned licences from two to four; and increase planning thresholds with respect to the noise floor for VHF Band 1 and VHF Low Band; and
 - Channel plan reconfiguration to more common duplex spacings
- 4.11 In order to maximise the potential benefits of this spectrum and to ensure our spectrum management approach is consistent across all BR bands, some proposals in this consultation will apply to spectrum outside UHF 1 and 2. The proposed increase in sharing factor will apply to Technical Assignments in all spectrum bands used by BR. In VHF Band I (55.75 to 68.0 MHz) and VHF Low Band (68 to 87.5 MHz) only we are also proposing to adopt a higher noise floor in the planning criteria. Table 1 summarise the policy proposals and which bands they apply to.

Table 1 – Policy options and impacted frequency bands and licence products

Policy Proposal	Licence Products Impacted	VHF Band I	VHF Low Band	VHF Mid Band	VHF High Band	Band III	UHF 1	UHF 2
		(55.75 to 68.0 MHz)	(68.0 to 87.5 MHz)	(138.0 to 165.04 MHz)	(165.04 to 173.09 MHz)	(177.21 to 207.49 MHz)	(410 to 450 MHz)	(450 to 470 MHz)

Addition of spectrum to BR Light Licence	Simple Site (BR)								✓
	Simple UK (BR)								
Increase in sharing factor from 2 to 4 (initially 3)	Technically Assigned (BR)	✓	✓	✓	✓	✓	✓	✓	✓
Increase noise floor for planning thresholds	Technically Assigned (BR)	✓	✓						
	Area Defined (BR)								
Changes to spectrum allocations to reduce number of duplex spacings	Technically Assigned (BR)							✓	✓
	Area Defined (BR)								

4.12 As part of this Strategic Review, we have also looked at how we manage spectrum assignments in UHF 1 and 2. We have identified three areas in which we plan to undertake further work in order to understand how our management of the spectrum can generate greater efficiencies. These include

- Improvements to modelling of on-site/campus type systems;
- Benefit from spectrum efficiencies of digital systems; and
- Investigate the feasibility of incorporating the use of monitoring data into the assignment process.

Add additional channels to Simple UK and Simple Site licences

4.13 The Simple UK and Simple Site light licences are a popular BR product, with around 22,000 licences currently issued, and provide an effective alternative to Technically Assigned licences. The light licence authorises access to a range of channels from a set of 12.5 kHz and 25 kHz base and mobile transmit frequencies listed in the licence document. These channels are shared between users (of the same licence type), i.e. they are not coordinated like Technically Assigned licences. Users have the option of retuning to an alternative frequency if they suffer from interference from another authorised user. In the case of Simple Site licences, they are generally for a base station and mobiles operating over a very limited geographic area (e.g. 1 km radius).

4.14 The Simple UK and Simple Site licences are an important and valuable licence product for stakeholders. We think that adding UHF Band 2 channels will enhance the appeal of these products and make them more flexible to address users' requirements as an alternative to Technically Assigned licences. It is noted that there are no UHF Band 2 channels available on the Simple UK licence.

4.15 We are therefore proposing to add channels to the Simple UK licence and Simple Site licence from the 458.5 to 459.5 MHz band. This band is assigned to a range of

licence exempt short range device (SRD) applications including industrial/commercial telemetry and tele-command, model control, fixed alarms and medical and biological applications. Sub-bands within the 458.5 to 459.5 MHz range have been identified for use by different applications, e.g. 458.5 to 458.95 MHz is identified for use by telemetry and tele-command and 458.9625 to 459.1 MHz for use by medical and biological applications (see UK Interface Requirements 2030²²).

- 4.16 The 458.5 to 459.5 MHz band is a UK only allocation for SRD use. Under the Commission Implementing Decision 2006/771/EC (as amended) on harmonisation of the radio spectrum for use by short-range devices, the band 863 to 870 MHz provides a harmonised spectrum option to the 458.5 to 459.5 MHz band, and our understanding is that the majority of new apparatus operates in this harmonised band. Also model control has largely migrated to using the 2.4 GHz band.
- 4.17 The Simple Site light licence already includes 17 × 25 kHz channels within the upper half of the licence band (459.0 to 459.5 MHz) with a maximum ERP of 2 Watts and base station antenna height of 15 metres. Our proposal is to add up to 10 × 12.5 kHz channels to both the Simple UK and Simple Site licences with a maximum ERP of 2 Watts and with the same restriction on base station antenna height for the Simple Site licence. The use of base stations is not authorised under the Simple UK licence.
- 4.18 Our intention would be to include channels within the range 458.5 to 458.95 MHz for both types of licence and/or interleave 12.5 kHz channels between the 25 kHz channels in the upper part of the band, i.e. 459.1 to 459.5 MHz for the Simple Site licence only. We understand that interleaving a 12.5 kHz channel has the potential to cause interference to two adjacent, however, our view is that the Simple Site licence will generally be used by a single stakeholder at a location and they can make their own assessment of which channel arrangement they want to use. If interference exists between different users, there remains the option of tuning to another frequency.
- 4.19 The 458.5 to 459.5 MHz band is a UK only allocation for SRD use. Under the Commission Implementing Decision 2006/771/EC (as amended) on harmonisation of the radio spectrum for use by short-range devices, the band 863 to 870 MHz provides a harmonised spectrum option to the 458.5 to 459.5 MHz band, and our understanding is that the majority of new apparatus operates in this harmonised band. Also model control has largely migrated to using the 2.4 GHz band.
- 4.20 With respect to sharing channels between Simple UK and Simple Site licences and SRD use within the band 458.5 to 459.5 there is a risk of interference. However, given the view that new SRD applications will operate in harmonised spectrum, and that the relative profile and density of Business Radio and SRD use are both small and unlikely to coincide, we believe that this risk is acceptably low. It is highlighted that we are only proposing sharing a proportion of channels (up to a maximum of 20 × 12.5 kHz) which would leave a significant portion of the band solely for SRD use, and, as above, there is the option to tune to another channel should interference occur.
- 4.21 In addition to adding channels to the Simple Site licence from the 458.5 to 459.5 MHz band we are also considering providing a UHF 2 duplex pairing utilising spectrum released by the Emergency Services paired with a subset of the new channels we are proposing above. This could provide up to six duplex pairs with the base station

²² https://www.ofcom.org.uk/__data/assets/pdf_file/0028/84970/ir_2030-june2014.pdf

transmit in the ES spectrum and the new channels in the SRD band being limited to mobile transmit only.

Question 5: Do you agree with our proposal to add additional channels to the Simple UK and Simple Site licence products from spectrum within the 458.5 to 459.5 MHz band?

Question 6: Do you agree with our assessment that the risk of interference between Simple UK and Simple Site use and licence exempt short range devices in the 458.5 to 459.5 MHz band is low, and that any interference can be mitigated by users changing channels?

Changes to the Technical Frequency Assignment Criteria (TFAC)

- 4.22 The TFAC document details the technical and propagation modelling criteria and the process we take when assigning a frequency for the Business Radio Technically Assigned and Business Radio Area Defined licence products.
- 4.23 We have identified a number of improvements that can be made to the BR assignment process. These changes will both improve the way assignments are made and help to address the increases in demand that has resulted in congestion and rejected licence applications. We propose to:
- Increase the sharing criteria from two to four, with an interim step of three; and
 - Increase planning thresholds with respect to the noise floor for VHF Band 1 and VHF low band.

Increase Sharing

- 4.24 It has been about eight years (2008) since we implemented the current frequency assignment model for the BR technically assigned licence product. This assignment model works by offering an exclusive or shared channel to the user, subject to the requirement and spectrum availability in the chosen geographical area. The sharing criteria is currently defined on the basis of allowing two equivalent PMR co-channel co-located systems (assuming they have equal technical parameters and radio coverage). We think the time is right to revisit this sharing criterion.
- 4.25 In 2014 we commissioned Transfinite Systems to review the sharing criteria²³. The report concluded that the number of sharers can and should be increased from the current level of two. The report also highlighted that with higher levels of sharing it becomes increasingly important to understand whether users are using voice or data, and more specifically, if they are using types of data that are not compatible with voice users (e.g. GPS polling).
- 4.26 The stakeholder technical sub-committee of the Business Radio Interest Group (BRIG) – the Technical Advisory Group (TAG), also concluded that sharing could be

²³ Business Radio assignment sharing criteria review, March, 2014:
http://webarchive.nationalarchives.gov.uk/20160702162827/http://stakeholders.ofcom.org.uk/binaries/spectrum/spectrum-industry-groups/business-radio-interest-meetings/28th-January-2016/Business_Radio_Assignment_Sharing_Criteria_Review.pdf

increased and noted that an increase from two to three would enable continued sharing but with more spectrum efficiency between users²⁴.

- 4.27 In May 2016 we undertook a monitoring exercise at a site in central London (for a period of 8 hours from 9 am) and recorded the spectrum occupancy across the UHF 2 frequency band. We compared the spectrum occupancy data with data from our licensing system. We found that across a number of channels our licensing system reported as congested, monitoring data showed that actual spectrum occupancy was much lower. This suggests that the spectrum could accommodate more users.
- 4.28 Out of the 137 channels analysed:
- 81 had average occupancy less than 10%;
 - 32 had average occupancy between 10% and 30%;
 - 12 had average occupancy between 30% and 50%; and
 - 12 had average occupancy greater than 50%.
- 4.29 We would expect actual use monitoring to show spare capacity on a channel as there is no obligation on licensees to use the channel all of the time, but considering the monitoring exercise showed that 81 of the 137 channels analysed had an average occupancy of less than 10%, there is clearly spare capacity that our application process is not taking in to account. This leads us to think that each channel could accommodate more users.
- 4.30 Additionally, as part of this review we have been monitoring the number of licence applications that are rejected each month. This is now around 1.5% of the applications assigned. Whilst this figure is relatively low demand continues to rise and hence we expect the numbers of rejections will also increase. One of the ways we can address this increase in demand, particularly in and around urban areas, is to increase the sharing factor.
- 4.31 We therefore propose to increase the number of equivalent PMR sharers from two to four. We have considered the impact of this proposal on existing users. The increase in sharing will result in slightly higher levels of channel use and may result in more call transmit re-tries being required for some users. Therefore, before moving to four sharers, we are carrying out further work to establish categories of use in order to minimise this impact on users, for example assessing the extent of data use.
- 4.32 We recognise that for some users increased sharing leading to higher levels of channel use will not be acceptable. In these circumstances there will still be the option of requesting an exclusive assignment subject to availability.

Moving to three sharers

- 4.33 Our intention is to move to a sharing factor of four subject to further analysis with an initial step of moving to a sharing factor of three, i.e. allowing up to the equivalent of

²⁴ TAG sub-group report into spectrum sharing, March, 2015:
http://webarchive.nationalarchives.gov.uk/20160702162827/http://licensing.ofcom.org.uk/binaries/spectrum/business-radio/technical-advisory-group/16th-April-2015/TAG_sub_group_report_into_spectrum_sharing.pdf

three co-channel/located users. Subject to the outcome of the consultation we expect to make this change in the short term which would realise additional capacity in existing channel assignments, reducing the number of licence application rejections or amendments.

- 4.34 The expected benefits of increasing the sharing level to three would yield (in a best case scenario) a 50% increase in spectrum capacity. We believe this maximum is unlikely to be achieved due to practical considerations such as the dependency on the type of PMR systems deployed in a given area and the number of existing users that are there already.

Moving to four sharers longer term

- 4.35 To move to our target of four sharers, we plan to undertake some further analysis in order to gain a better understanding of how existing users are utilising the channels and the typical transmit patterns in the time domain. We plan to do this with a view to establishing categories of use, this is likely to be achieved by defining whether the channel is being used for voice, ‘voice-like’ data or data.
- 4.36 We need to carry this work out as there are certain types of transmission, for example GPS polling, that do not co-exist well with voice or voice like transmissions. This is because voice or voice like transmissions tend to be more random, do not follow a particular pattern, and the gaps between messages are generally longer, whereas the duty cycles and periodicity of data transmissions may have greater spectrum occupancy in the time domain. Therefore, to move to a sharing level of four there are a number of activities that need to be undertaken in order to better understand current use. These are detailed in Table 2.

Table 2: Proposed activities for moving from three to four sharers

Activity	Next steps
Establish typical profiles (or usage type categories) for voice, voice-like data and data	Analysis of monitoring data Feedback from stakeholders and radio suppliers
Categorisation of assignments to determine which voice/data usage type is the most appropriate	New assignments: update application forms, guidance and TFAC for applicants to choose appropriate category; and Existing assignments: combination of feedback from licensees (possibly at technical validation) and targeted spectrum occupancy monitoring. Update our licence records to hold the appropriate usage type.

- 4.37 We are carrying out the above work to assess the potential impact on users and to see how this could be mitigated. The impact of defining usage type categories in conjunction with increasing the sharing criterion to four will result in improved spectrum efficiency.

Question 7: Do you agree with the proposal to initially increase the sharing criterion from two to three, and, subject to further analysis, move to four in the longer term?

Increase in planning thresholds with respect to the noise floor for VHF Band 1 and VHF Low Band

- 4.38 Radio noise from different sources introduce a certain unwanted background RF level at the input stage of any receiver which the wanted signal has to overcome for successful reception i.e. the wanted signal needs to be higher than the noise level in order to ensure reception. This is known as the signal to noise ratio. The noise floor varies across different frequency bands and is greater at lower frequencies.
- 4.39 The noise floor limits the wanted coverage area (for a given transmitted power) serving a specific business requirement being limits the range over which mobile terminals are able to communicate with the base station. Consequently, the noise floor is an important variable in radio planning.
- 4.40 In our current planning criteria, we assume a wanted radio service can be received using a typical Receiver Sensitivity Level (RSL) of -104 dBm / 12.5 kHz, and then apply a signal to interference plus noise ratio (SINR) of 12 dB. This means that unwanted signals are modelled at -116 dBm / 12.5 kHz. It has come to our attention following stakeholder feedback and a measurement exercise that in the lower frequency bands used by PMR, VHF Band 1 (55 to 68 MHz) and VHF Low band (68 to 87.5 MHz), that the noise floor is around -104.2 dBm/12.5 kHz, i.e. the wanted signal level and noise floor are the same.
- 4.41 Assuming a required SINR of 12 dB the proposal is to change the planning levels we use in our modelling by increasing both the RSL and unwanted levels by 12 dB. This results in using an RSL of -92 dBm / 12.5 kHz and an unwanted level of -104 dBm / 12.5 kHz. This change would apply to both Technically Assigned and Area Defined licences. As the noise floor is less significant at higher frequencies this proposal only refers to VHF Band 1 and VHF Low Band as shown in Table 3.

Table 3: Table showing current and proposed planning levels

Frequency Band	Current levels (dBm/12.5 kHz)		New levels (dBm/12.5 kHz)	
	Wanted/Service planning level	Unwanted/interference planning level	Wanted/Service planning level	Unwanted/interference planning level
Band I	-104	-116	-92	-104
VHF Low	-104	-116	-92	-104
VHF Mid	-104	-116	No change	No change
VHF High	-104	-116	No change	No change
Band III	-104	-116	No change	No change
UHF-1	-104	-116	No change	No change

UHF-2	-104	-116	No change	No change
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- 4.42 As the planning levels for both wanted and unwanted signal levels both increase by 12 dB there should be no impact on licensees, but will ensure that our modelling better represents the spectrum environment.
- 4.43 It is noted that in Area Defined licences the power spectral density at the geographical boundary is defined²⁵. Subject to the outcome of the consultation, if we decide to implement this change to the planning levels we will need to formally vary all Area Defined licences within VHF Band 1 and VHF Low Band.

Question 8: Do you agree with our proposal to change the planning levels we use in our modelling by reducing both the RSL and unwanted levels by 12 dB for VHF Band 1 and VHF Low band?

Channel plan reconfiguration to more common duplex spacings

- 4.44 The Business Radio channel plans in UHF 2 have evolved over many years resulting in a large number of different duplex spacings. As mentioned previously, we do not have evidence to justify the cost of complete reconfiguration of the band to align fully with CEPT TR-25/08²⁶ (10 MHz duplex spacing). However, we think a number of benefits could be gained from more uniform duplex spacings.
- 4.45 There are currently 17 different duplex splits in UHF 1 and 2, we think this can be reduced to around five. Internally this will reduce the administrative burden of managing these splits, and externally will allow equipment manufacturers and users to standardise on more common duplex splits, reducing the need to customise equipment.
- 4.46 The expected release of 4 MHz of Emergency Services spectrum coupled with more generic duplex splits will provide the opportunity to defragment and rationalise the UHF 2 band. This will lead to more efficient spectrum use and release additional capacity to address current and future requirements.
- 4.47 We have considered the potential impact of this policy proposal on affected parties and think any disruption will be minimal. We may need to vary some licences, but this would be carried out over a prolonged period in order to minimise any disruption. The timescale for implementation would be in the region of five to seven years to allow for the release of spectrum by the Emergency Services and any necessary variation in users' licences.

Question 9: Do you agree with our assessment that moving towards more common duplex spacings will increase spectrum efficiency?

²⁵ The Licensee must operate the Radio Equipment with a power spectral density of not more than -116 dBm/12.5kHz from a single transmitter at and beyond the geographical boundary(ies) specified in Schedule 2 of the licence.

²⁶ Planning criteria and coordination of frequencies for land mobile systems in the range 29.7 to 470 MHz

Longer Term changes to the way we manage spectrum

- 4.48 As part of this Strategic Review, we have also looked at how we manage spectrum assignments in UHF 1 and 2. We have identified two areas in which we plan to undertake further work in order to understand how our management of the spectrum can generate greater efficiencies.

Improvements to the modelling of on-site/campus type systems

- 4.49 On-site/campus type systems (which include systems with mobiles operating up to 5 km from the base station) make up around 59% of the current technically assigned licences. Demand for these systems has been increasing in recent years. However, our current assignment process is not optimised for these short range applications which leads to a reduction in spectrum efficiency.
- 4.50 In order to model these systems more accurately, we are looking at the benefit of different modelling approaches, including a simplified coordination/modelling method applied to short ranges, or a change in propagation model to one which includes algorithms specifically adapted to short range propagation. This will improve the efficiency of our assignment process for these systems.

Efficiency of digital PMR

- 4.51 In its report on Strategic Sectoral Spectrum Needs the RSPG noted that current spectrum efficiency for analogue PMR is one channel in 25 kHz or 12.5 kHz, while new digital technologies provide a two-fold to four-fold increase to 6.25 kHz equivalent spectrum efficiency such as the technologies standardised in ETSI, e.g. TETRA25, Digital Mobile Radio (DMR) and dPMR.
- 4.52 Through engagement with stakeholders and the results of our questionnaires we can see that analogue technology is still important to many users, but digital use is growing. As the market increasingly transitions to digital technologies we will look at how this could promote efficient spectrum use but have no proposals at this time. We will continue to monitor the sector and gather information from manufacturers and users to see if, in future, the requirement for analogue systems naturally declines leading to an opportunity to benefit from the efficiency of digital PMR.

Incorporating use of monitoring data into assignment process

- 4.53 Making frequency assignments using modelling of a shared environment has limitations, for example, the model cannot know if a particular assignment is underutilised. In these cases, it would be beneficial to incorporate real world feedback into the assignment process.
- 4.54 We consider that there is merit in investigating whether spectrum occupancy data received from the monitoring stations we have located throughout the UK could be used to improve our assignment process. Identifying unused capacity could help us to increase spectrum efficiency.
- 4.55 We plan to undertake some further work to investigate how we could capture and analyse the data and incorporate this into the assignment process.

Improving stakeholder guidance around sharing

- 4.56 We acknowledge that some of the changes we are proposing around increasing the sharing factor are complex, and that existing information on sharing is not as clear as it could be.
- 4.57 In order to facilitate the transition to increased sharing, we are currently exploring ways we could improve guidance available to stakeholders and licensees to help them better understand the shared environment. Table 4 summarises the activities we are considering to improve stakeholder guidance.

Table 4: Table showing proposed activities for improving stakeholder guidance

Proposed activity	Next steps
Improving definition of sharing in context of the assignment model.	<p>Develop clearer and simpler guidance in both the application forms and the TFAC to help manage the expectations of licensees.</p> <p>This may involve changing the current terminology used in the application forms to better reflect phrases more commonly used by licensees.</p>
Improve processes to address complaints of interference in relation to sharing.	<p>Provide licensees and our Spectrum Assurance teams with clearer guidance on how to manage complaints of interference in relation to sharing, including a checklist for licensees who believe they are experiencing intolerable levels of interference.</p> <p>Identify the most appropriate regulatory tool to ensure that all licensees who are using systems on shared channels are operating fairly in conjunction with other users, and that mitigations are available when users are not operating fairly.</p>
Providing more information on congestion through use of measuring application rejections by geographical area.	<p>Investigate whether it is feasible to expand the way application rejections are recorded to produce a heat map showing where the areas of the UK that are most likely to result in Technically Assigned application rejections and provide more detailed guidance to applicants to optimise the opportunity for gaining access to spectrum in that area.</p> <p>This will also be supported and facilitated by the implementation of the other policy options identified in this review.</p>

Question 10: Do you agree with our proposed activities for improving stakeholder guidance? Are there further steps you think Ofcom could take to ensure stakeholders and licensees can make an informed decision when considering their licensing needs?

Question 11: Are there any other policy options you think we should consider to make use of UHF 1 and 2 more efficient?

Annex 1

Responding to this consultation

How to respond

- A1.1 Ofcom would like to receive views and comments on the issues raised in this document, **by 5pm on 13 February 2017**.
- A1.2 We strongly prefer to receive responses via the online form at <https://www.ofcom.org.uk/consultations-and-statements/category-1/strategic-review-of-uhf-band-1-and-band-2> We also provide a cover sheet (<https://www.ofcom.org.uk/consultations-and-statements/consultation-response-coversheet>) for responses sent by email or post; please fill this in, as it helps us to maintain your confidentiality, and speeds up our work You do not need to do this if you respond using the online form.
- A1.3 If your response is a large file, or has supporting charts, tables or other data, please email it to kevin.delaney@ofcom.org.uk, as an attachment in Microsoft Word format, together with the cover sheet (<https://www.ofcom.org.uk/consultations-and-statements/consultation-response-coversheet>).
- A1.4 Responses may alternatively be posted to the address below, marked with the title of the consultation.
- Kevin Delaney
Ofcom
Riverside House
2A Southwark Bridge Road
London SE1 9HA
- A1.5 If you would like to submit your response in an alternative format (e.g. a video or audio file), please contact Kevin Delaney on 020 7981 3143, or email kevin.delaney@ofcom.org.uk
- A1.6 We do not need a paper copy of your response as well as an electronic version. We will acknowledge receipt if your response is submitted via the online web form, but not otherwise.
- A1.7 You do not have to answer all the questions in the consultation if you do not have a view; a short response on just one point is fine. We also welcome joint responses.
- A1.8 It would be helpful if your response could include direct answers to the questions asked in the consultation document. The questions are listed at Annex 3. It would also help if you could explain why you hold your views, and what you think the effect of Ofcom's proposals would be.
- A1.9 If you want to discuss the issues and questions raised in this consultation, please contact Vaughan John on 020 7981 3093, or by email to vaughan.john@ofcom.org.uk

Confidentiality

- A1.10 Consultations are more effective if we publish the responses before the consultation period closes. In particular, this can help people and organisations with limited resources or familiarity with the issues to respond in a more informed way. So, in the interests of transparency and good regulatory practice, and because we believe it is important that everyone who is interested in an issue can see other respondents' views, we usually publish all responses on our website, www.ofcom.org.uk, as soon as we receive them.
- A1.11 If you think your response should be kept confidential, please specify which part(s) this applies to, and explain why. Please send any confidential sections as a separate annex. If you want your name, address, other contact details or job title to remain confidential, please provide them only in the cover sheet, so that we don't have to edit your response.
- A1.12 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and try to respect it. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.
- A1.13 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's intellectual property rights are explained further at <http://www.ofcom.org.uk/terms-of-use/>

Next steps

- A1.14 Following this consultation period, Ofcom plans to publish a statement in the Spring of 2017.
- A1.15 If you wish, you can register to receive mail updates alerting you to new Ofcom publications; for more details please see <http://www.ofcom.org.uk/email-updates/>

Ofcom's consultation processes

- A1.16 Ofcom aims to make responding to a consultation as easy as possible. For more information, please see our consultation principles in Annex 2.
- A1.17 If you have any comments or suggestions on how we manage our consultations, please call our consultation helpdesk on 020 7981 3003 or email us at consult@ofcom.org.uk. We particularly welcome ideas on how Ofcom could more effectively seek the views of groups or individuals, such as small businesses and residential consumers, who are less likely to give their opinions through a formal consultation.

If you would like to discuss these issues, or Ofcom's consultation processes more generally, please contact Steve Gettings, Ofcom's consultation champion:

Steve Gettings
Ofcom
Riverside House

2a Southwark Bridge Road
London SE1 9HA

Tel: 020 7981 3601

Email steve.gettings@ofcom.org.uk

Annex 2

Ofcom's consultation principles

Ofcom has seven principles that it follows for every public written consultation:

Before the consultation

- A2.1 Wherever possible, we will hold informal talks with people and organisations before announcing a big consultation, to find out whether we are thinking along the right lines. If we do not have enough time to do this, we will hold an open meeting to explain our proposals, shortly after announcing the consultation.

During the consultation

- A2.2 We will be clear about whom we are consulting, why, on what questions and for how long.
- A2.3 We will make the consultation document as short and simple as possible, with a summary of no more than two pages. We will try to make it as easy as possible for people to give us a written response. If the consultation is complicated, we may provide a short Plain English / Cymraeg Clir guide, to help smaller organisations or individuals who would not otherwise be able to spare the time to share their views.
- A2.4 We will consult for up to ten weeks, depending on the potential impact of our proposals.
- A2.5 A person within Ofcom will be in charge of making sure we follow our own guidelines and aim to reach the largest possible number of people and organisations who may be interested in the outcome of our decisions. Ofcom's Consultation Champion is the main person to contact if you have views on the way we run our consultations.
- A2.6 If we are not able to follow any of these seven principles, we will explain why.

After the consultation

- A2.7 We think it is important that everyone who is interested in an issue can see other people's views, so we usually publish all the responses on our website as soon as we receive them. After the consultation we will make our decisions and publish a statement explaining what we are going to do, and why, showing how respondents' views helped to shape these decisions.

Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

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

Nothing Name/contact details/job title

Whole response Organisation

Part of the response If there is no separate annex, which parts?

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

DECLARATION

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

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

Name

Signed (if hard copy)

Annex 3

Consultation questions

Question 1: Do you agree with our assessment of the trends in current and future demand in the band?

Question 2: Do you agree with our assessment that the risk of continental interference is limited to the east and south east of the UK during periods of atmospheric lifts?

Question 3: Do you agree with our assessment that these bands could enable the implementation of our UHF policy proposals? Are there any additional uses you think we should consider if this spectrum becomes available for use?

Question 4: Do you agree with our conclusion that aligning UHF Band 2 with continental Europe is not required?

Question 5: Do you agree with our proposal to add additional channels to the Simple UK and Simple Site licence products from spectrum within the 458.5 to 459.5 MHz band?

Question 6: Do you agree with our assessment that the risk of interference between Simple UK and Simple Site use and licence exempt short range devices in the 458.5 to 459.5 MHz band is low, and that any interference can be mitigated by users changing channels?

Question 7: Do you agree with the proposal to initially increase the sharing criterion from two to three, and, subject to further analysis, move to four in the longer term?

Question 8: Do you agree with our proposal to change the planning levels we use in our modelling by reducing both the RSL and unwanted levels by 12 dB for VHF Band 1 and VHF Low band?

Question 9: Do you agree with our assessment that moving towards more common duplex spacings will increase spectrum efficiency?

Question 10: Do you agree with our proposed activities for improving stakeholder guidance? Are there further steps you think Ofcom could take to ensure stakeholders and licensees can make an informed decision when considering their licencing needs?

Question 11: Are there any other policy options you think we should consider to make use of UHF 1 and 2 more efficient?

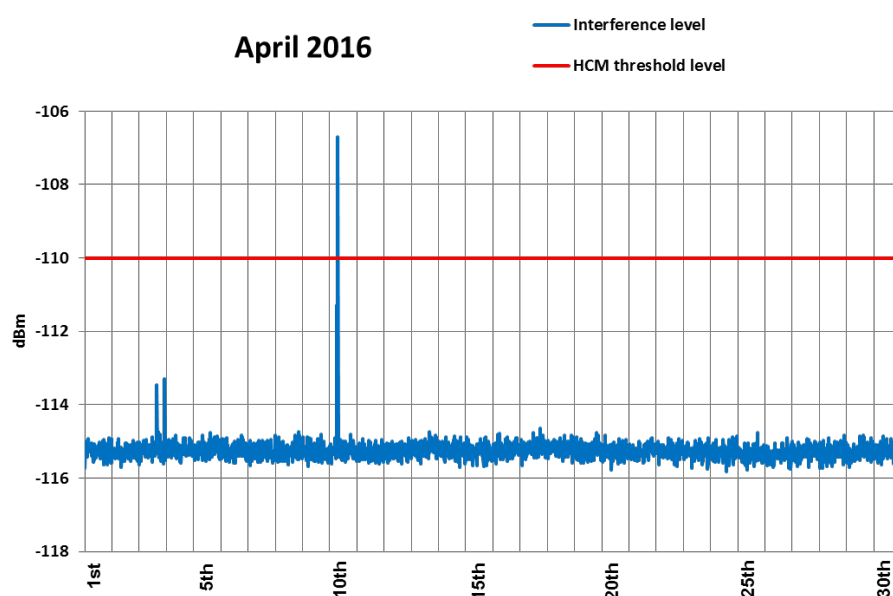
Annex 4

Continental Interference Monitoring

A4.1 In order to gather evidence on Continental interference a series of monitoring stations have been deployed along the East Coast from Fife to Colchester, monitoring both UHF Band 1 and Band 2. In addition to the monitoring data we have also recorded the tropospheric ducting forecast in order to compare any high levels of interference with atmospheric conditions.

A4.2 Figure 3 shows a plot of signal levels taken during April 2016 at our monitoring site in Mundesley, Norfolk. This figure shows the typical scenario where signal levels are below the Harmonised Calculation Method (HCM) threshold. In this example it can be seen that there was a short duration event early on the 10th April which caused a significant increase in monitored signal level.

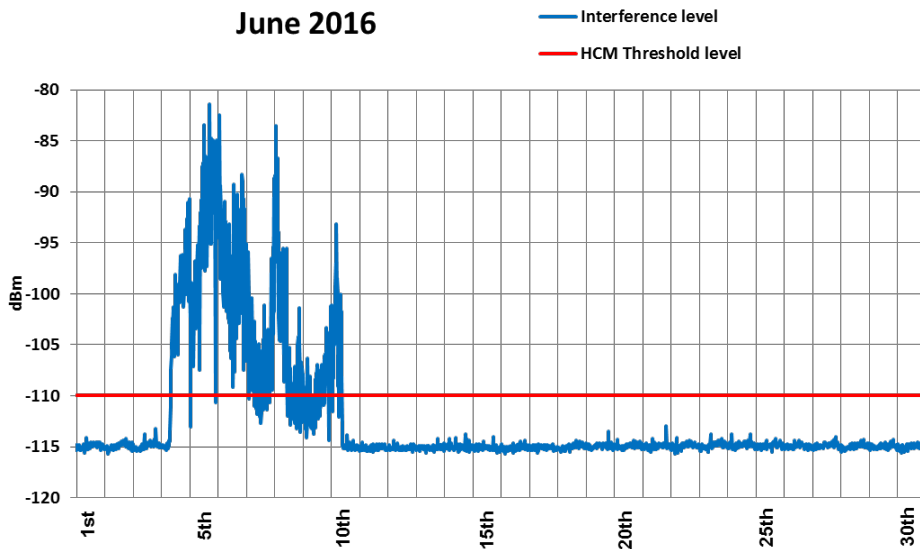
Figure 3 Interfering signal level monitored during April 2016



A4.3 Although these interference events are infrequent and tend to be of short duration, there are occasions where increased interference persists for a period of time leading to disruption to some spectrum users. One such event occurred in June 2016. On Monday 6 June 2016, we received reports of continental interference from utility companies (National Grid, Anglia Water and Scotia Gas) impacting a large number of UHF radio based telemetry and telecontrol systems on the South and East Coast of the UK. Parts of the Midlands and Scotland were also affected. Stakeholders stated that the scale and duration of this particular interference event was exceptional and exceeded those experienced for a number of years.

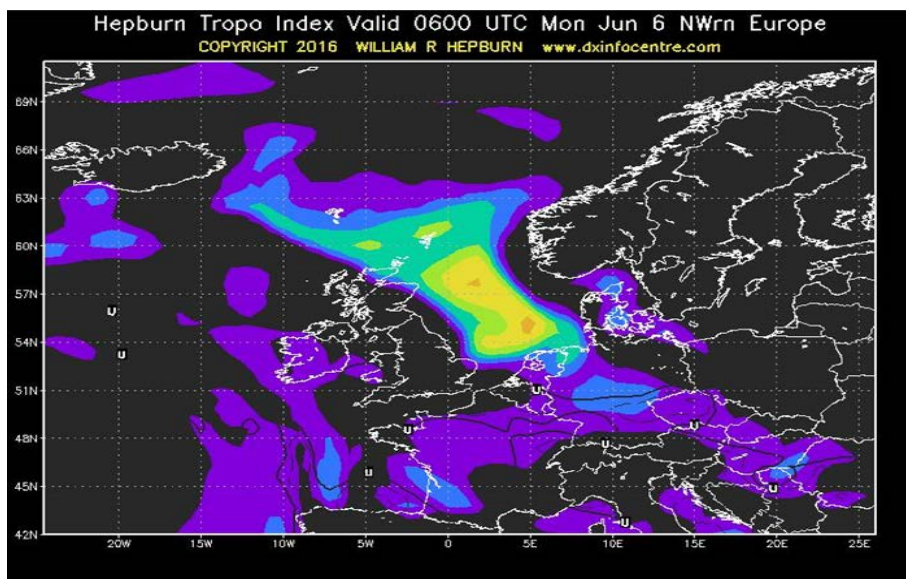
A4.4 This interference event lasted for several days through early June. Our monitoring data captured this increased level of incoming interference as shown in Figure 4. In some cases, interference levels exceeded the HCM threshold by more than 25 dB. Outside this period the background interference level remained at -115 dBm

Figure 4: Interfering signal level monitored during June 2016



A4.5 During the same period we also recorded the tropospheric ducting forecast. Figure 5 shows the tropospheric index value for the 6 June which shows that there was significant tropospheric ducting, up to “Very Strong”, between the UK and the Continent. This level of lift will cause significant anomalous propagation and it is reasonable to conclude that this was the cause of the interference events.

Figure 5 - Tropospheric ducting forecast on 6 June 2016 (courtesy of William Hepburn - www.dxinfocentre.com)



Key -

0	1	2	3	4	5	6	7	8	9	10+
NIL SIG	MARGINAL	FAIR	MODERATE	GOOD	STRONG	VRY STRONG	INTENSE	VRY INTENSE	EXTREME	EXTREME