making communications work
for everyone

Statement on improving spectrum access for consumers in the 5 GHz band

and

Notice of proposal to make Wireless Telegraphy Exemption Regulations 2017

Consultation on Regulations and proposed technical parameters

Statement and Consultation

Publication date: 9 March 2017

Closing Date for Responses: 11 April 2017

About this document

We present in this document our decision to proceed with our proposals to extend Wi-Fi access in the 5 GHz band to an additional 125 MHz (5725 to 5850, the ‘5.8GHz band’).

In order to give effect to our decision, we invite stakeholders’ views on draft Regulations (‘the Proposed Regulations’) to allow licence exempt use of the frequencies in the 5.8 GHz band.

We are also consulting on the technical conditions which manufacturers of equipment such as smartphones, tablets and laptops would have to comply with, in order to benefit from licence exempt use of this spectrum. These technical conditions form part of the Proposed Regulations.

We also present guidance on how these technical conditions might be implemented in practice, in the form of a Voluntary National Specification.

Contents

Section 1

Executive Summary

1.1 Consumer demand for Wi-Fi to connect wireless devices such as smartphones, tablets and laptops is growing at a fast pace. High capacity applications such as video streaming are driving this demand and will increase the need for bandwidth required for Wi-Fi devices.

1.2 In our consultation on *Improving spectrum access for consumers in the 5 GHz band*[1] (the 'May 2016 consultation'), we identified a range of options for increasing the amount of radio spectrum available for Wi-Fi in the 5 GHz band. These options included:

- **Short term**: Opening up spectrum at 5725 -5850 MHz for Wi-Fi;
- **Medium term**: Re-examining the technical requirements for Wi-Fi – such as those designed to protect radars – to ensure they remain fit for purpose and are no more restrictive than necessary;
- **Medium term**: Promoting Wi-Fi use under the existing primary mobile allocation in 5850 -5925 MHz;
- **Longer term**: Removing outdoor restrictions on Wi-Fi access to the 5150 – 5350 MHz range; and
- **Longer term**: Opening up spectrum at 5350-5470.

1.3 In Part 1 of this document we set out how, having carefully considered the responses received to our May 2016 consultation, we have decided to proceed with the first, short-term option above, of opening up spectrum at 5725 - 5850 MHz for Wi-Fi. We have made this decision in order to meet increasing consumer demand for Wi-Fi.

1.4 This additional spectrum will allow for more and wider channels to become available for Wi-Fi, enabling better quality of experience and releasing congestion from neighbouring users. The number of 80 MHz channels will increase from four to six[2]. Three additional 40 MHz channels and six additional 20 MHz channels would also be available. Further detail as to our reasons for deciding to proceed with opening up the 5725 – 5850 MHz frequencies are set out in Section 3 and Annex 5 of this document.

1.5 In relation to the medium and longer-term options set out above, we have not reached a decision on those options at this stage, but will continue to explore these possibilities. In the meantime, this document focuses on our decision to extend Wi-Fi use in the 5725 – 5850 MHz frequencies ('the 5.8 GHz band').

1.6 In Part 2 of this document, we set out our Notice of proposals for implementing our decision to open up the 5.8 GHz band for Wi-Fi use. In particular, we propose to make regulations allowing radio equipment to be used on a licence exempt basis

[1] https://www.ofcom.org.uk/consultations-and-statements/category-1/5-GHz-Wi-Fi

[2] The gain in bandwidth in 80 MHz channels adds to 160 MHz, which is more than the 125 MHz within the 5.8 GHz band. This is because we will be able to authorise an additional channel that overlaps both the 5470-5725 and 5725-5850 MHz bands.

when operating in the 5.8 GHz band. Our proposed approach follows the existing arrangements for not requiring licences for smartphones, tablets and laptops to access wireless services via Wi-Fi in the 5150 – 5350 and 5470 – 5725 frequency bands. The Wireless Telegraphy (Exemption and Amendment) (Amendment) Regulations 2017 (the "Proposed Regulations", set out in Annex 7) will amend the existing regulations which apply to the use of short-range devices on a licence-exempt basis[3] (see Annex 8). We are now consulting on the Proposed Regulations and invite comments on this draft instrument.

1.7 We are also consulting on proposed technical conditions: a power limitation to 200 mW per channel, a ban on fixed outdoor use, and normal WAS/RLAN channel access and occupation rules. These proposed technical parameters were informed by our technical studies taking into account existing spectrum users and stakeholders responses to our May 2016 consultation, and form part of the Proposed Regulations. We also propose issuing guidance on possible techniques for avoiding interference into radar (Dynamic Frequency Selection, or 'DFS').

1.8 The Proposed Regulations will extend the use of Wi-Fi to the 5725 – 5850 MHz band by making reference to a separate document setting out the relevant technical requirements, namely "IR 2030 – UK Interface Requirements 2030 Licence Exempt Short Range Devices"('IR 2030'). IR 2030 will, therefore, form part of the legal requirements for operating in the 5.8 GHz band on a licence-exempt basis. A draft of the Proposed Regulations is set out in Annex 7 and a draft of proposed updates to IR 2030 is set out at Annex 9.

1.9 In addition, we also propose issuing some general guidance which we refer to in this document as a 'Voluntary National Specification' ('VNS') in order to assist individuals who may wish to make best use of the 5725 – 5850 MHz band. The proposed VNS is set out in Annex 10.

1.10 Ofcom is now inviting stakeholders who may be affected by the making of the Proposed Regulations to make representations to us on the drafting and content of that instrument and the proposed technical parameters. The deadline specified for making representations on the Proposed Regulations and IR as set out in this document is **5pm on 11 April 2017**. Details of how to respond to this Notice are set out at Annex 1.

1.11 While the analysis set out in this entire document represents a Regulatory Impact Assessment ('**RIA**'), specific aspects of the RIA are set out at Annex 4.

1.12 We will notify the Proposed Regulations, the draft update to IR 2030 and the proposed VNS to the European Commission. The decision as to whether or not to make the Proposed Regulations will be subject to taking into account any comments or Opinion we receive from the Commission or Member States, as well as the responses to this consultation.

[3] The Wireless Telegraphy (Exemption and Amendment) Regulations 2010 (S.I. 2010/2512).

Section 2

Introduction

2.1 In May 2016, we consulted on *Improving spectrum access for consumers in the 5 GHz band*, ('May 2016 consultation'[4]). In that document we set out our views on consumer demand for Wi-Fi[5] and the role played by technology developments, densification of access points and spectrum in meeting that demand. We identified spectrum as a critical component to deliver the expected capacity and quality of service, and we provided an overview of the options to make additional spectrum available. In particular, we identified the following options:

- **Short term**: Opening up spectrum at 5725-5850 for Wi-Fi to enable use of two 80 MHz channels (and/or one 160 MHz channel);
- **Medium term**: Re-examining the technical requirements for Dynamic Frequency Selection (DFS) to make sure they are still fit for purpose and/or are only as restrictive as is necessary to protect incumbent radar systems;
- **Medium term**: Promoting Wi-Fi use under the existing primary mobile allocation in 5850-5925 MHz (to be considered at WRC-19, but could be determined earlier through CEPT – see below);
- **Longer term**: Removing the outdoor restriction on Wi-Fi access to the 5150-5350 MHz range and/or changing existing 5 GHz radiated power limits to enable outdoor use where only indoor use is currently possible;
- **Longer term**: Opening up spectrum at 5350-5470 MHz.

2.2 In Part 1 of this document we set out our decision to proceed with the first, short-term option set out above, namely to make the spectrum between 5725 – 5850 MHz ('the 5.8 GHz band') available for Wi-Fi use. In making this decision, we have taken account of stakeholders' responses to our May 2016 consultation and our technical analysis.

2.3 In relation to the remaining medium to longer-term options, we have not yet reached a decision as to how best to proceed. We will continue to explore these possibilities, taking into account the responses we have received to the May 2016 consultation, together with any further technical analysis which may be appropriate for us to undertake.

2.4 In Part 2 of this document, we set out our consultation on proposals for implementing our decision to open up the 5.8 GHz band. In particular, we set out our Notice of proposals to make regulations ('the Proposed Regulations') which will exempt equipment from requiring a licence when operating in the 5.8 GHz band. The Proposed Regulations will amend the existing Regulations (ie. The Wireless Telegraphy (Exemption and Amendment) Regulations 2010 or "the 2010 Regulations") and will include the applicable technical conditions by making

[4] https://www.ofcom.org.uk/consultations-and-statements/category-1/5-GHz-Wi-Fi

[5] When we say "Wi-Fi" in this document, we mean also a number of related technologies that could use the spectrum under similar conditions. The umbrella term for these types of technologies is Wireless Access Systems including Radio Local Area Networks (WAS/RLANs). We use the term "Wi-Fi" simply because it is a widely understood term.

reference to the interface requirements set down in a separate document, "IR 2030 – UK Interface Requirements 2030 Licence Exempt Short Range Devices" ('IR 2030'). We are now consulting on the Proposed Regulations (as set out in Annex 7) and proposed technical parameters (as set out in Section 4 and in the draft amendments to IR 2030 at Annex 9), and invite stakeholders' comments accordingly.

2.5 We also set out a guidance document (referred to herein as a Voluntary National Specification, or VNS) to assist notified bodies[6] and manufacturers with the conformity assessment process when placing products on the market under the Radio Equipment Directive (RED). It should be noted that even though we provide this guidance document it is ultimately the responsibility of the notified bodies and manufacturers to determine compliance or not under the RED. In the longer term, we anticipate that this may be superseded by an ETSI standard for RLANs in this band. This is a similar process that we followed previously for the use of broadband fixed wireless access (BFWA) in this band. A copy of the proposed VNS is set out in Annex 10.

2.6 This document is structured as follows:

- In Section 3 we set out the rationale supporting **our decision** to open up the 5.8 GHz band, informed by our technical studies, international development and stakeholders responses to the May 2016 consultation.

- In Section 4 we present a summary of the proposed changes to existing regulations to allow use of Wi-Fi and related technologies in the 5.8 GHz band licence exempt and set out the **general effects** of the Proposed Regulations.

The document includes the following Annexes:

i) Annex 1 provides details of how to respond to this consultation;

ii) Annex 2 explains Ofcom's consultation principles;

iii) Annex 3 presents our consultation questions;

iv) Annex 4 provides an Impact Assessment on our Proposed Regulations;

v) Annex 5 provides a summary of responses to the May 2016 consultation;

vi) Annex 6 provides our technical analysis of the ability of Wi-Fi equipment to coexist with Fixed Satellite Systems (FSS) in the 5.8 GHz band;

vii) Annex 7 sets out our Proposed Regulations;

viii) Annex 8 sets out the 2010 Regulations which the Proposed Regulations will amend.

ix) Annex 9 sets out proposed updates to IR 2030 – UK Interface Requirements 2030 Licence Exempt Short Range Devices";

[6] A notified body is an organisation designated by an EU country to assess the conformity of certain products before being placed on the market. These bodies carry out tasks related to conformity assessment procedures set out in the applicable legislation, when a third party is required. The European Commission publishes a list of such notified bodies.

x) Annex 10 sets out a draft of a Voluntary National Specification (VNS); and

xi) Annex 11 sets out a glossary for use with this document.

Next steps

2.7 Following the publication of this consultation document, stakeholders are invited to provide their feedback on the drafting of the Proposed Regulations. The deadline to submit responses to us is 11 April 2017.

2.8 We will notify the Proposed Regulations, the draft update to IR 2030 and the proposed VNS to the European Commission in accordance with the Radio Equipment Directive ("RED")[7]. The decision as to whether to make the Proposed Regulations will be subject to taking into account any comments or Opinion we receive from the Commission or Member States, as well as the responses to this consultation.

[7] Directive (EU) 2015/1535 of the European Parliament and of the Council, laying down a procedure for the provision of information in the field of technical regulations and of rules on Information Society services, 9 September 2015. See in particular, Articles 5 and 6.

PART 1 - Statement on improving spectrum access for consumers in the 5 GHz band

Section 3

Our decision to open up 5.8 GHz

3.1 Our May 2016 consultation, *Improving spectrum access for consumers in the 5 GHz band*[8] set out proposals for increasing the amount of 5 GHz radio spectrum available for Wi-Fi and other related wireless technologies. It considered the extent to which growing demand can be met by increasing the supply of spectrum and/or by other means, such as through the adoption of new technology or densification of access points. It also invited stakeholders to submit their views on how to meet growing consumer demand. We received 100 responses to our consultation from a wide range of stakeholders. Non-confidential stakeholders' responses are published on our website[9], and a summary of responses is included here, and in more detail in Annex 5.

3.2 In particular, we consulted on the short-term option of opening up the 5.8 GHz band, subject to appropriate technical parameters[10]. We have now decided to proceed to do so, based on:

i) Evidence of increasing demand for Wi-Fi and the role of spectrum in addressing demand;

ii) Confirmation of interest from Wi-Fi industry and lack of compelling reasons not to make 5.8 GHz available;

iii) Our analysis of potential coexistence issues with other users of the band, in view of our proposed technical parameters;

iv) Our judgement that this band is best placed to make a significant difference to consumers Wi-Fi experience in the short term and in particular demand for spectrum in the 5 GHz band;

3.3 Our May 2016 consultation also considered medium and long-term options. This document focuses on our decision to extend Wi-Fi use at 5.8 GHz. We will continue to monitor development in other bands and to contribute to international studies aiming at extending spectrum access for Wi-Fi.

[8] https://www.ofcom.org.uk/consultations-and-statements/category-1/5-GHz-Wi-Fi

[9] See https://www.ofcom.org.uk/consultations-and-statements/category-1/5-GHz-Wi-Fi

[10] As set out in paragraph 2.1 of the introduction, we also consulted on other options, As explained in the Introduction, we have not yet made a decision on the medium to longer-term options set out in the May 2016 consultation. Those options are still subject to further deliberation.

Evidence of increasing demand for Wi-Fi

3.4 Wi-Fi is one of the UK's most important vehicles for communication, commerce and entertainment. 86% of the UK's 27 million households have a broadband connection[11]. Virtually all of these households[12] use Wi-Fi to provide the final link between their home broadband router and the various wireless devices in their homes. Wi-Fi also provides outdoor and indoor coverage to 'hotspots' such as transport hubs, sports stadia, shopping centres, hotels etc; and within commercial/business premises through enterprise networks.

3.5 Our Digital Communications Review[13] identified a strategic shift towards encouraging large-scale deployment of new ultrafast broadband networks, including fibre direct to homes and business.

3.6 Faster fixed line broadband speeds mean consumers expectations with regards to their use of high data rate applications, such as video streaming, using Wi-Fi are also increasing. These applications require wide spectrum channels to deliver the required speed and to avoid quality issues such as 'buffering' or the break-up of video streams. Very high data rate applications are likely to require 80 or 160MHz wide channels.

3.7 We expect demand for Wi-Fi (and other similar technologies) to continue to grow as the number of connected wireless devices increases, and as those devices make use of ever higher data applications.

3.8 Our May 2016 consultation set out our high level view of Wi-Fi demand growth, informed by industry trends and pre-consultation discussions with Wi-Fi stakeholders. Our consultation aimed at reaching stakeholders more widely asking for their views on demand and potential supply of Wi-Fi spectrum.

3.9 Most respondents agreed with our assessment that demand for Wi-Fi will grow significantly in the future. For example, Cisco forecasts a 4.6-fold increase in "busy hour" internet traffic between 2015 and 2020. Ericsson predicts a tenfold increase in internet traffic across Western Europe, in a slightly longer time reference (2015 to 2022). Annex 5 provides more details of responses.

3.10 The general exceptions to this were the responses from the amateur radio and drone racing communities, which suggested demand may be better met with technological improvements or spectrum outside of the 5 GHz band.

3.11 Overall, the balance of evidence continues to suggest that we are likely to see strong growth in consumer use of Wi-Fi.

---

[11] *Communications Market Review 2016,* August 2016, p7 https://www.ofcom.org.uk/__data/assets/pdf_file/0024/26826/cmr_uk_2016.pdf

[12] Ofcom's Communications Market Report for 2015 indicates that Wi-Fi routers are being used by 95% of households with a broadband connection – an increase from 75% in Q1 2011. See http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr15/CMR_UK_2015.pdf, p. 340. And http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr11/UK_CMR_2011_FINAL.pdf, p. 8.

[13] *Making communications work for everyone - Strategic Review of Digital Communications,* February 2016 http://stakeholders.ofcom.org.uk/binaries/telecoms/policy/digital-comms-review/DCR-statement.pdf

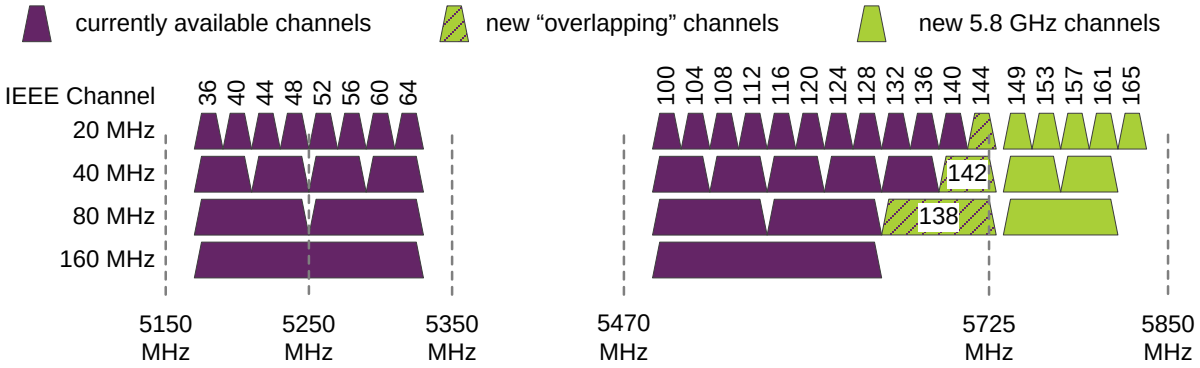
The role of spectrum in addressing demand for Wi-Fi

3.12 Wi-Fi currently operates in both the 2.4 GHz and 5 GHz bands. There are 83 MHz available for Wi-Fi at 2.4 GHz against 455 MHz at 5GHz. The 5 GHz band is much more suitable than the 2.4 GHz band for delivering very high data rates because there is much more spectrum available allowing for more and wider channels. Although the spectrum has a shorter transmission range, it is able to address many of the quality of service issues that may be experienced by equipment only able to access the 2.4 GHz band.

3.13 The way in which Wi-Fi spectrum is used to deliver services to consumer devices depends on the type of application being used. High data rate applications - such as streaming of high definition TV, video and games - benefit from access to wider spectrum channels. On the other hand, other applications such as internet browsing or e-mail communications requiring low bandwidth can be delivered using smaller channels.

3.14 The channel plan for Wi-Fi allows devices to use spectrum in wider channels or narrower channels in the 5 GHz band, as shown in Figure 1.

Figure 1: Existing 5 GHz Wi-Fi channels and the new channels we are making available



3.15 The actual number of spectrum channels open to Wi-Fi is also an important factor. Access to a large number of channels allows for neighbouring users to use different channels, avoiding slowdowns. Neighbouring users in this context could be different devices within the same household; or neighbouring households tuned to the same channel; or several individual users trying to access the same channel through access points physically close to each other.

3.16 Opening up the 5.8 GHz band will enable more and wider channels as shown in Figure 1. The number of 80 MHz channels would increase from four to six and the number of 40 MHz channels will increase from nine to twelve. Six additional 20 MHz channels would also be available.

3.17 In our May 2016 consultation, we looked at three ways to meet future demand:

- Through advances in technology;
- By increasing the number of Wi-Fi access points in a coordinated way (densification);
- Through the provision of more spectrum.

3.18 We said in our consultation that additional spectrum may be the only means of meeting demand in certain circumstances e.g. in order to support the wider channels necessary for superfast broadband speeds.

3.19 We asked stakeholders whether they thought technology improvements and densification would be sufficient to meet demand, or whether additional spectrum will be required. They generally agreed that improvements in technology and densification of access would be beneficial, although most also believed that additional spectrum would be necessary to meet future demand, given the fast pace of growth in demand observed in recent years and forecasted (see Annex 5 for more detail on responses).

3.20 On balance, we consider that there is sufficient evidence that more spectrum will be required, in particular, that more spectrum at 5 GHz will likely be required. We agree with some respondents' views there will be opportunities in the future to make better use of higher frequencies, and also that there are already frequencies in 60 GHz that are authorised for licence exempt use by technologies similar to Wi-Fi. However, we consider that higher frequencies have different characteristics, such as inability to penetrate walls, and will play a complementary role to 5 GHz spectrum for Wi-Fi, not a substitute for it.

3.21 We also note that several responses highlighted the demand for wider (80 MHz) channels. We agree that it is likely that these will grow in importance. This is one source of benefits of making 5.8 GHz available (as it increases the total number of 80 MHz channels available in the UK from four to six).

Confirmation of interest from the Wi-Fi industry, lack of compelling arguments against 5.8 GHz

3.22 In our May 2016 consultation we identified the 5725-5850 MHz sub-band as a priority for release for Wi-Fi. We noted that Wi-Fi's 'polite' sharing mechanisms such as listen-before-talk and DFS meant that it was likely to share well with other users of the sub-band.

3.23 All Wi-Fi stakeholders strongly supported our proposal to prioritise making 5725-5850 MHz available for Wi-Fi. Many noted that the band was already available for Wi-Fi in other parts of the world, including the US. Most respondents recommended making the sub-band available with a radiated power limit of 1 W EIRP, indoor and outdoor, subject to coexistence with other users. Some respondents recommended that a radiated power limit of up to 4 W should be considered to match the current technical parameters for this sub-band in the US. Similarly, some respondents noted that this sub-band had no DFS requirement in the US and recommended that Wi-Fi in the UK should not be required to implement DFS in this sub-band either, unless it was necessary for coexistence with radars.

3.24 Some existing users of the 5.8 GHz band presented objections to the proposal, based on concerns about coexistence. These include radio amateurs, drone racing users, and some respondents who use the band for broadband fixed wireless access (BFWA). We examined these coexistence arguments as detailed in the section below, and have not found a compelling reason not to authorise 5.8 GHz for Wi-Fi services given the benefits this extension will deliver for citizen and consumers.

Our analysis of potential coexistence issues with other users of the band

3.25 In this section we consider the impact on existing users of sharing the 5725-5850 MHz sub-band with WAS/RLAN. We previously set out our view of coexistence in our May 2016 consultation and we have updated our views based on feedback from stakeholders currently using the 5725-5850 MHz sub-band. These stakeholders include: the fixed satellite service (FSS); radiolocation; programme making and special events (PMSE); broadband fixed wireless access (BFWA); amateur radio and satellite; short range devices (SRDs); and road tolling (TTT).

3.26 We have taken these issues into account when setting our proposed technical parameters - power limitation at 200 mW EIRP per channel, no fixed outdoor use, and a requirement to implement specific techniques to avoid interference into radar – as explained below and in Annex 6.

Fixed Satellite Service (FSS)

3.27 In our May 2016 consultation we noted that satellites in the fixed satellite service use spectrum at 5850-5925 MHz for data uplink in the Earth-to-space direction from ground stations across the globe, and 5725-5850 MHz for data uplink in Region 1[14] only. These satellite receivers might have a footprint which is continental in size or even covering half the globe, so the coexistence studies have had to consider the impact of aggregate emissions from Wi-Fi devices across a large number of countries. In our consultation we stated our view that these studies indicate that sharing spectrum with these FSS uplink receivers is feasible.

3.28 Ofcom has been close to the international studies (mainly within the European Conference of Postal and Telecommunications Administrations - CEPT), making frequent contributions, including a series of airborne measurements of aggregate Wi-Fi emissions from London and Northampton in the UK. On the basis of these studies and reasonable assumptions, we said that we believed that coexistence between Wi-Fi and FSS would likely be feasible.

Responses

3.29 Responses from the satellite operators were mixed. The EMEA Satellite Operators Association (ESOA) and Global VSAT Forum's (GVF) joint response agreed that, of the 5 GHz sub-bands under consideration, the 5725-5850 MHz sub-band is the relatively less critical band for satellite services, and one where sharing under cautious technical parameters may be feasible. Thuraya's view is that the 5.8 GHz band if used for Wi-Fi, should be limited to indoor use. The UK Space Agency (UKSA) disagreed with our proposal for 5.8 GHz, saying that existing space services should be the priority, and that a unilateral approach to revise existing power limits within this band could cause interference to FSS users.

[14] Article 5 of the ITU Radio Regulations divides the world into three regions for the allocation of frequencies. Region 1 includes Europe, Africa, parts of the Middle East, the former Soviet Union and Mongolia.

3.30 Most satellite stakeholders highlighted the main international sharing studies between mobile and Wi-Fi networks and C-band satellite uplinks, namely ECC[15] Report 244, CEPT Report 64 and ITU-R S.2367[16]. These studies consider the risk of aggregate interference from, potentially, several millions of mobile and Wi-Fi terminals to C-band satellite receivers. On the basis of these studies, many respondents suggested limiting 5.8 GHz Wi-Fi to indoor-only use and to a low radiated power level in order to facilitate sharing with C-band satellites.

3.31 We noted from the consultation responses that there appeared to be little detailed evidence to suggest that FSS systems were being operated in the 5725-5850 MHz band. We also investigated ITU filings as additional evidence for current use of the band by FSS. We identified some filings which might indicate that FSS is being used in the 5725-5850 MHz band and we have taken these into account in our assessment, as detailed in Annex 6.

Our conclusions

3.32 We conducted additional analysis which is detailed in Annex 6. This analysis shows that we can authorise Wi-Fi use in 5725 – 5850 MHz by constraining power to 200 mW EIRP and forbidding fixed outdoor deployments. The risk to satellite systems is minimal even in a scenario where the rest of Europe and Africa would start authorising Wi-Fi in this band under the same technical conditions. Wi-Fi use in the UK alone presents no risk to satellite systems, and would create interference far below the safe thresholds used by the ITU.

3.33 It is possible that coexistence would be feasible at higher powers or with outdoor use, even if Europe and Africa were to extent Wi-Fi use in this band, but further studies would be required to demonstrate this.

Radiolocation

3.34 In our May 2016 consultation, we noted that radars are used across the 5250-5850 MHz sub-band and applications include defence systems such as tactical and weapon radars as well as weather radars (ground based and airborne). Wi-Fi devices are required to implement mitigation techniques such as DFS in order to coexist with radars in this frequency range. This technology requires Wi-Fi devices to switch to a different channel if they detect co-channel radar pulses.

3.35 Mitigation techniques to protect incumbent services such as DFS are also required in BFWA equipment using the 5725 – 5850 MHz band under a light licence regime in the UK. Elsewhere within CEPT countries have also allowed BFWA use in accordance with similar technical conditions and mitigation techniques as described in ECC Recommendation (06)04 and standard ETSI EN 302 502. Some countries outside of CEPT (e.g. USA and Canada) allow Wi-Fi usage in this band without the requirements for mitigation techniques such as DFS.

[15] The Electronic Communications Committee (ECC) considers and develops policies on electronic communications activities in European context, taking account of European and international legislations and regulations.

[16]The International Telecommunication Union is the United Nations specialized agency for information and communication technologies. ITU-R is the ITU Radiocommunication Sector, which focuses on radio spectrum and satellite orbits. S.2367 is an ITU-R report on spectrum sharing between mobile and satellite systems.

3.36 We have taken a cautious approach to sharing with radars and, for the moment, we will be requiring Wi Fi to implement techniques to mitigate interference to radar, such as DFS, in 5725-5850 MHz. However, we believe that the use of radars in 5.8 GHz might be fairly light in the UK and we will keep this requirement, as it applies to this band, under review.

Programme Making and Special Events (PMSE)

3.37 In the UK, parts of the 5 GHz band are used by PMSE for fixed video links with geographical restrictions[17] and some airborne use is permitted above 5770 MHz[18]. Use of the band by PMSE is very light, with only 27 assignments across the whole of the UK in 2015 (compared to thousands in other PMSE bands). We believe that this is because this spectrum is already shared with other incumbent users (such as existing Wi-Fi and BFWA users).

3.38 In our May 2016 consultation, we noted the very light use, and that PMSE already shares with other users such as BFWA. For these reasons, we said that improving Wi-Fi access to the 5.8 GHz band will have minimal additional impact on PMSE.

3.39 We have not received any responses that provided evidence to the contrary. Our conclusion was that additional coexistence analysis between PMSE and Wi-Fi was not necessary.

Broadband Fixed Wireless Access (BFWA)

3.40 BFWA is light-licensed on a non-interference non-protection basis[19]. It is mainly used in the UK for wireless cameras and fixed broadband, including in rural areas.

Responses

3.41 The responses received to our consultation were mixed. For example, some respondents believed that careful installation can mitigate the risk of interference from Wi-Fi whilst others were concerned about the additional risk to their services. Some respondents believed that light licensing in 5.8 GHz gave some greater security of access compared to 5470-5725 MHz, though the BFWA light licences give no guarantees of exclusivity.

Our view

3.42 The polite protocols used in Wi-Fi, combined with difference in power (up to 4W for BFWA against 200 mW, with no fixed outdoor use, for Wi-Fi), should make interference to BFWA unlikely. We note that in some countries (including US, New

[17] Fixed video links. Geographic restrictions apply: 5472-5588 MHz, 5682.5-5702.5 MHz, 5705-5725 MHz, 5732.5-5752.5 MHz

[18] Fixed video links. Geographic restrictions apply. Some airborne use permitted, restrictions apply: 5770-5790 MHz, 5795-5815 MHz, 5850-5925 MHz

[19] Light-licensing is a mechanism whereby the users of a band are awarded non-exclusive licences which are typically available to all, and are either free or only have a nominal fee attached to them. There may be further obligations associated with the provision of a licence such as the need to register the location of any transmitters and possibly to co-ordinate their deployment with other registered users. For more information on the specific terms of light licensing for BFWA at 5725-5850 see https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences/fixed-wireless-access

Zealand and Canada) Wi-Fi and BFWA already share spectrum at 5.8 GHz, even with Wi-Fi operating at higher power than that we are proposing.

3.43 We note that some respondents have asked for additional spectrum for BFWA. While we acknowledge the arguments that such additional spectrum could bring benefits, this issue is outside of the scope of this document and will not be discussed further here.

Amateur radio and satellite

3.44 Amateurs can access 5650-5850 MHz with amateur satellite Earth-to-space links in the 5650-5670 MHz sub-band and space-to-Earth links in the 5830-5850 MHz sub-band on a licence exempt, non-interference, non-protection basis. In our May 2016 consultation, we noted that amateur users already coexist with other incumbent users in this sub-band, and that the introduction of Wi-Fi into these frequencies was unlikely to significantly further degrade coexistence.

Responses

3.45 We received 25 responses from the amateur sector. They disagreed with our proposals to make this sub-band available, and some respondents called for additional studies.

3.46 Some respondents[20] suggested that allowing use of the 5.8 GHz band would raise the noise floor in the band and would impair their receiver's ability to listen for weak signal propagation beacons, "moonbounce" signals and amateur data and TV transmissions. Weak signal propagation beacons are narrowband signals used for communicating over very long distances, typically hundreds of kilometres. "Moonbounce" is communication between two radio amateur radios, typically at long distances from each other, by transmitting a signal from Earth towards the Moon, which then reflects it back to Earth. Others told us that they use 5830-5850 MHz for amateur-satellite space-to-Earth downlinks and that use of this band for Wi-Fi could raise the noise floor of their receiving earth stations.

Our view

3.47 We note that amateur radio users already share the sub-band with other users, and will continue to do so.

3.48 While some modes of operation may require a very quiet radio environment, this will be possible in locations where there are not many other 5.8 GHz users in close proximity. This is currently the case and will continue to be the case if we go ahead with our proposals. Amateur radio users operate on the basis that they should not cause harmful interference to others and can expect no protection from interference themselves from other authorised users (non-interference/non-protection)[21].

[20] See for example responses from the Radio Society of Great Britain (RSGB) and from the UK Microwave Group.

[21] The convention around "non-interference and non-protection" was made explicit in former Amateur Radio Licence terms and conditions booklet provided that amateurs "cannot claim protection from undue interference from any other authorised services, such protection being afforded only to users whose frequencies have been registered nationally or internationally. In the United Kingdom, individual frequency assignments are not registered in the Amateur Service, except for beacons and repeaters. This applies equally to all bands allocated on a secondary basis where stations of the

3.49 For these reasons we do not consider it appropriate to conduct a coexistence analysis to assess the impact on amateur satellite services. This is consistent with past policy, such as our consideration of the 2.3 GHz and 3.4 GHz bands, where we considered the impact of amateur use to LTE but not the impact of LTE to amateurs due to its "non-interference / non-protection" status.

SRDs including drones

3.50 5725-5875 MHz is used for non-specific short range devices (SRDs), including airborne use and short-range indoor data links on a non-interference non-protection basis. Generic coexistence with Wi-Fi has not yet been studied, but a subset of these devices for wireless industrial applications (WIA) has been studied at a high level for coexistence with Wi-Fi at SE24. Similar to the BFWA case, there might be a risk of interference if Wi-Fi and WIA are operating co-channel within a few hundreds of metres of each other, but careful installation of Wi-Fi and WIA systems in a controlled industrial environment, such as a factory, can mitigate the risk of interference in a factory environment.

Responses

3.51 We received 28 responses, all relating to first-point-view (FPV) drone racing. This is a nascent sport where participants wear Virtual-Reality style goggles with a live wireless link to a camera on board a drone, acquiring a bird's eye view of the drone they are also controlling. We understand that the 5.8 GHz sub-band is often used for the first-person view video link, under licence exempt SRD regulations.

3.52 All respondents in this sector have urged Ofcom to not allow Wi-Fi and related technologies in the 5.8 GHz band. Many of them stated that such use would clash with IR 2030, which is the document that sets interface requirements for licence exempt short range devices[22]. Some respondents have claimed that our proposals would wipe out their ability to operate.

Our view

3.53 Short range devices operate on a non-protected, non-interference basis[23], sharing with other services in this band and many other bands. In particular, Wi-Fi and related technologies already coexist with SRDs in other bands, and the SRDs in this band also already coexist with other current users. We believe that our proposal to authorise Wi-Fi in this band is consistent with the concurrent use by SRDs.

3.54 Furthermore, we do not see any evidence that Wi-Fi authorisation would deprive FPV drone racing enthusiasts of their ability to also use this spectrum. This band is already in use for Wi-Fi in the US and is also used for drone racing there, according

---

Amateur Service are also required not to cause undue interference to stations of a primary or permitted service to which frequencies are already assigned or to which frequencies may be assigned at a later date"
http://webarchive.nationalarchives.gov.uk/frame/20040104233440/http://www.ofcom.org.uk/static/archive/ra/publication/ra_info/br68f/br68f.htm

[22] IR 2030 - UK Interface Requirements Licence Exempt Short Range Devices, June 2014, https://www.ofcom.org.uk/__data/assets/pdf_file/0028/84970/ir_2030-june2014.pdf

[23] See for example, our Short Range Devices Information Sheet https://www.ofcom.org.uk/spectrum/radio-spectrum-and-the-law/licence-exempt-radio-use/licence-exempt-devices/short-range-devices-information

to the US drone racing association[24]. The technical parameters we are including in our Proposed Regulations (which will be set out in an update to IR 2030) are also more cautious than those in the US, and includes lower power constraints and restrictions to outdoor use (no fixed outdoor use).

3.55 We also note that additional mitigations may be possible, such as drone racing organisers ensuring that any Wi-Fi routers using on-site at events are using other channels.

Road tolling (TTT)

3.56 5795-5815 MHz is widely used for road tolling in some EU countries on a licence exempt, non-interference, non-protection basis. Toll road booths tend to be located in rural areas where the density of Wi-Fi use is low. We said in our consultation that we believe road tolling equipment is used relatively lightly in the UK; this continues to be our view. Furthermore, even if the density of road tolling devices increased in future, the equipment would have to comply with EU Directives ensuring it is adequately robust against interference. Finally, we note that our proposals for authorising 5.8 GHz use only at relatively low power (200mW) and with no fixed outdoor use further mitigates any residual risk of interference with road tolling.

3.57 We did not receive any responses from toll road operators. Our view remains that authorising 5.8 GHz for consumer use will not cause a material negative impact on road toll operators.

This band is best placed to make a significant difference to consumers' Wi-Fi experience in the short term

3.58 The UK is able to act unilaterally to change the national licensing rules for the 5.8 GHz band because there is no legally binding EC Decision that restricts the UK from doing so. Equipment for the 5.8 GHz band already exists and is largely in the hands of consumers. We understand from discussions with manufacturers that the ability to use this band can in many cases be activated via a software or firmware upgrade, with no need to change equipment.

3.59 We stated in the May 2016 consultation that no other additional band would be available to the UK in the same time frame, because all of them are dependent on more complex international discussions, and in most cases would need a change to a legally binding EC Decision. The alternatives we examined includes:

i) Re-examining the technical requirements for Wi-Fi – such as those designed to protect radars - to ensure they remain fit for purpose and are no more restrictive than necessary. Radar protection is required by a EC decision[25] for current 5 GHz bands in use for Wi-Fi in Europe. The decision does not cover the 5.8 GHz band.

[24] See US Drone Racing Association (USDRA) frequency chart, https://docs.google.com/spreadsheets/d/1FTN9rJjw9hnaYzmEEEigCw_nKGgrE0DNVHe8KLYswfg/edit#gid=309126581, and also their glossary, which defines "raceband" as "a set of 5.8 GHz frequencies commonly used in racing. They are spaced to avoid overlap with multiple pilots flying. Raceband frequencies are: 5658, 5695, 5732, 5769, 5806, 5843, 5880, and 5917". http://usdra.org/information/glossary/

[25] 2007/90/EC: http://www.erodocdb.dk/docs/doc98/official/pdf/ECCDec0408.pdf

ii) Removing outdoor restrictions on Wi-Fi access to the 5150-5350 MHz range. These outdoor restrictions are part of a binding EC Decision[26]. The requirement is unlikely to change before 2019[27] at the earliest.

iii) A longer term objective of opening up spectrum if possible at 5350-5470 MHz and 5850-5925 MHz. In the EU, 30 MHz at 5875-5905 is designated for Intelligent Transport Services (ITS) through a binding EC Decision[28]. The band 5350 – 5470 is not internationally harmonised – harmonisation is likely required before equipment is widely available[29].

3.60 Some respondents to the consultation, such as Cisco, Dynamic Spectrum Alliance and Sky also suggested that opening up the 5725-5850 MHz would be the most straightforward or fastest path to increasing spectrum for Wi-Fi. We agree with this view.

3.61 All of the above alternative options will require additional coexistence studies, which are currently being discussed internationally. We will continue to contribute to these international studies on coexistence and to keep these options under review.

Conclusions

3.62 Taking into consideration stakeholder responses on the priorities set out in the consultation, we continue to believe that 5.8 GHz has potentially large benefits for consumers. This is based on our view, having taking into account responses, that:

a) Consumer demand for Wi-Fi is likely to continue to increase;

b) Additional spectrum for Wi-Fi, in particular in the 5 GHz band is beneficial to meet this demand;

c) There is no compelling reason for not authorising the use of the 5.8 GHz band. Its use for Wi-Fi has relatively few coexistence issues compared to other parts of the 5 GHz band. Although there are other users in the sub-band, most of these access the frequencies on a shared basis and will continue to share after Wi-Fi is authorised; and

d) The 5.8 GHz band is the fastest and probably most straightforward option for making more spectrum available; it can be made available soon, because it does not require further international harmonisation.

3.63 We will proceed to make the 5.8 GHz band available to consumers of Wi-Fi and related technologies on the basis of technical parameters that take into account other users. The technical conditions will be technology neutral so, as well as Wi-Fi, we

[26] 2008/671/EC: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32008D0671
[27] EU Member States are unlikely to agree to this step while those technical conditions - which are in place to protect incumbent satellite services - remain in the Radio Regulations. The Regulations will not be changed before the 2019 World Radiocommunication Conference (WRC-19).
[28] 2007/90/EC: http://www.erodocdb.dk/docs/doc98/official/pdf/ECCDec0408.pdf
[29] This band will be studied in CEPT and the ITU as part of the WRC-19 preparation process. The results of these studies and any resulting harmonisation measures will depend on the Wi-Fi industry successfully demonstrating that there is demand for this additional spectrum, and developing and demonstrating that effective interference mitigation methods from Wi-Fi to the incumbent EESS and radiolocation users of the band can be properly implemented and are effective.

expect other similar (WAS/RLAN) technologies such as licence exempt LTE variants to be able to access the spectrum we are making available.

PART 2 - Notice of proposal to make Wireless Telegraphy Exemption Regulations 2017 - Consultation on Proposed Regulations and Technical Parameters

Section 4

General effect of the Proposed Regulations

4.1 In order to implement the decision which is set out in Part 1 of this document, we propose to make the Wireless Telegraphy (Exemption and Amendment) (Amendment) Regulations 2017. The Proposed Regulations are set out in Annex 7 of this document. Ofcom welcomes comments from stakeholders on the drafting of the Proposed Regulations.

4.2 The Proposed Regulations make reference to IR 2030, which is a separate document that will set out the applicable technical parameters with which individuals must comply when operating equipment in the 5725 – 5850 MHz frequencies. In order to make provision for those frequencies, the IR will need to be updated, as set out in Annex 9. Ofcom also welcomes comments from stakeholders on the the proposed technical parameters set out below and reflected in Annex 9.

The Legislative Framework

4.3 Ofcom is responsible for authorising use of the radio spectrum in the UK and achieves this by granting wireless telegraphy licences under the Wireless Telegraphy Act 2006 (the 'WTA'). Under section 8(1) of the WTA, it is an offence to install or use equipment to transmit without holding a licence granted by Ofcom, unless the installation or use of such equipment is exempted.

4.4 Under section 8(3) of the WTA, Ofcom may, by regulations exempt operators of radio equipment from requiring a licence, either absolutely or subject to such terms, provisions and limitations as may be specified[30].

4.5 As set out in our May 2016 consultation, the EU has made legislation about the use of the 5 GHz band through a series of 'Decisions' which are binding on Member States. EC Decision 2006/771/EC (as amended)[31] harmonises the use of the 5725-5875 MHz band for use by short-range devices (SRDs), including allowing low power Wi-Fi, ie. with a 25mW power limit. Article 2 of this Decision gives Member States the right to allow the use of the frequencies under less restrictive conditions.

[30] Such terms, provisions and limitations must, however, fall within the scope of Part A of the Annex to Directive 2002/20/EC of the European Parliament and of the Council.
[31] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013D0752

4.6 For the reasons set out in Part 1 of this document, we are satisfied that the requirements of section 8(3B) of the WTA have been satisfied, namely that the terms, provisions and limitations specified in the Proposed Regulations are:

- objectively justifiable in relation to the wireless telegraphy stations or wireless telegraphy apparatus to which they relate;
- not such as to discriminate unduly against particular persons or against a particular description of persons;
- proportionate to what they are intended to achieve; and
- transparent in relation to what they are intended to achieve.

4.7 Section 122 of the WTA sets out the statutory procedure for making Regulations. Section 122(4) provides that, before making Regulations, Ofcom must: a) give a notice of its "proposal to do so to such persons representative of the persons appearing to [it] to be likely to be affected by the implementation of the proposal as [it] thinks fit"; b) "publish notice of its proposal in such manner as [it considers] appropriate for bringing it to the attention of the persons who, in [its] opinion, are likely to be affected by it; and c) "consider any representations that are made to Ofcom before the time specified in the notice".

4.8 Section 122(5) of the WTA provides that a notice for the purposes of section 122(4) must state that: a) Ofcom proposes to make the regulations in question; b) set out the general effect of the regulations; c) specify an address from which a copy of the proposed regulations may be obtained; and d) specify a time before which any representations with respect to the proposal must be made to Ofcom.

4.9 Under section 122(6) of the WTA, Ofcom must allow at least a month for representation to be made, beginning with the day after the latest day on which the notice is given or published.

The Proposed Regulations and update to IR 2030 – general effect

4.10 A copy of the Proposed Regulations is set out in Annex 7.

4.11 Regulation 1 sets out the name of the Proposed Regulations and will make clear the date on which they are due to come into force.

4.12 Regulation 2(1) sets out that the Proposed Regulations will take effect by amending the 2010 Regulations. A copy of the 2010 Regulations is set out in Annex 9.

4.13 Regulation 2(2) of the Proposed Regulations amends Regulation 5 of the 2010 Regulations by substituting the publication date of the relevant interface requirements ("IR 2030 – UK Interface Requirements 2030 Licence Exempt Short Range Devices") for a date in 2017. The version of IR 2030 which will be published in 2017 will include new entries (as set out in Annex 9), making provision for equipment to be used in the 5725 – 5850 sub-band on the basis of the technical parameters specified.

4.14 In order to make the Proposed Regulations and update IR2030 as intended, the proposed new requirements will need to be notified to the European Commission in

accordance with the Radio Equipment Directive ("RED")[32]. The Commission and Member States have three months in which to comment on the draft technical standard before it may be adopted. We will therefore need to wait until this process is complete before we can determine whether or not it is appropriate to make the Proposed Regulations and update IR 2030 as proposed.

4.15 The Proposed Regulations (if made) will authorise, on a licence exempt basis, the use of the 5.8 GHz band. Equipment will be able to operate in these frequencies on the basis that:

- it does not cause or contribute to any undue interference to any wireless telegraphy; and that
- such use complies with the interface requirements that form part IR 2030.

4.16 In addition to the legal requirements set out in the Proposed Regulations and IR, Ofcom also intends to publish a Voluntary National Specification ("VNS"), setting out guidance for 'notified bodies[33]' and manufacturers which might assist them in the development of new equipment which may make the best use of the 5.8 GHz band. Although the VNS is not intended to prescribe legally binding technical standards (ie. it is simply guidance), we intend to notify this document to the European Commission at the same time as we notify the IR.

Use of WAS/RLAN devices in the 5.8 GHz band

4.17 We are proposing to allow new types of WAS/RLAN equipment (which includes Wi-Fi equipment and similar technologies) to operate on a licence-exempt, non-interference basis in the frequencies 5725 – 5850 MHz. For the reasons set out below, we intend to rely on the discretion given to Member States under Decision 2006/771/EC to set less restrictive conditions for the use of this equipment. We are now consulting on both the technical parameters for the use of the equipment, and on the Proposed Regulations which we are intending to make in order to give effect to the policy decisions set out earlier in this statement.

4.18 If Ofcom proceeds with making the regulations, the 5725 – 5850 sub-band will, in principle, be available to any type of device that currently uses Wi-Fi or related technologies (WAS/RLAN) – for example, smartphones, laptops, tablets and Wi-Fi routers, and future innovative devices. The additional spectrum will enable a larger number of Wi-Fi channels, reducing the likelihood of congestion.

5.8 GHz WAS/RLAN technical parameters

4.19 In making equipment exempt from licensing, Ofcom needs to specify the characteristics of the equipment that can be used. A key issue is a device's transmitting power. Radio signals from high-powered devices travel further, increasing the chances of interference with others using the same frequencies. If this

[32] Directive (EU) 2015/1535 of the European Parliament and of the Council, laying down a procedure for the provision of information in the field of technical regulations and of rules on Information Society services, 9 September 2015. See in particular, Articles 5 and 6.

[33] A notified body is an organisation designated by an EU country to assess the conformity of certain products before being placed on the market. These bodies carry out tasks related to conformity assessment procedures set out in the applicable legislation, when a third party is required. The European Commission publishes a list of such notified bodies.

occurs, the frequencies will become of limited use to other users in the geographic area.

4.20 Users of licence-exempt devices need to be aware that there are no guarantees that the spectrum will be free of interference. However, by defining the maximum transmit power, along with other characteristics, we can keep the probability of undue interference low.

4.21 WAS/RLANs which operate in the 5725 – 5850 sub-band must comply with the technical parameters set out in the Proposed Regulations. Given the work carried out internationally and our own further coexistence analysis as detailed in Annex 6, we consider it appropriate to adopt the limits summarised below in Table 1. In setting these limits, we aimed to authorise the least restrictive conditions which were also appropriately cautious in relation to interference to other services, based on studies to date. This is to maximise benefits to consumers of Wi-Fi services while avoiding negative impacts on other users.

Table 1: Summary of technical parameters for 5725-5850 MHz WAS/RLAN[34]

Radiated Power Limit:	200 mW EIRP
Location Restrictions:	No Fixed Outdoor[35]
Channel access and occupation rules:	Normal WAS/RLAN channel access and occupation rules

4.22 As set out in paragraph 4.16 above, in addition to the technical parameters which we propose to mandate in the Proposed Regulations and IR (Table 1), we also propose to issue general guidance in the form of a VNS. The VNS is intended to assist notified bodies and manufacturers in developing new equipment to make use of the 5.8 GHz band. Although compliance with the technical parameters set out in IR 2030 is a matter for operators to determine for themselves, the references in Table 2 for Dynamic Frequency Selection ('DFS') techniques may be helpful in providing a single, overall technique for achieving mitigation to prevent interference to radars.

Table 2: Summary of DFS techniques referenced in the VNS for 5725-5850 MHz WAS/RLAN[36]

DFS requirements inc. detection threshold	ETSI EN 301 893
and	
DFS detection radar patterns	ETSI EN 302 502

4.23 With respect to the detection of radar patterns (radar test signals), we propose that the requirements from ETSI EN 302 502 might be usefully applied. This is a standard currently applicable to higher power fixed broadband covering the 5725 – 5850 MHz,

[34] See annex 9 for our proposed changes to interface requirement 2030

[35] Aeronautical mobile use is not permitted. The apparatus may also be used airborne within an aircraft, only to establish a connection with a station or apparatus within the same aircraft.

[36] See annex 9 for our proposed changes to interface requirement 2030

and as such, the patterns already reflect the radar systems that use these specific frequencies.

4.24 On matters *other* than the detection of radar test patterns (for example, detection thresholds), we propose that the requirements from ETSI EN 301 893 might be usefully applied, in the same way as they apply to the use of Wi-Fi/RLAN/WAS in the 5150 – 5350 MHz and 5470 – 5725 MHz bands.

4.25 We do not consider ETSI EN 302 502 to be relevant as far as detection thresholds and other requirements are concerned. This is because ETSI EN 302 502 was designed with higher power fixed equipment in mind.

4.26 Additionally, for those channels which fall within both the existing 5470-5725 MHz Wi-Fi band and the 5725-5850 MHz band (ie. the 5 MHz of frequencies between 5725 – 5730 MHz), we consider it appropriate to adopt the limits summarised below in Table 3.

Table 3: Summary of technical parameters for WAS/RLAN channels which have a bandwidth in both 5470-5725 MHz and 5725-5730 MHz only[37]

Radiated Power Limit	1 W EIRP
Location Restrictions	<none>
Channel access and occupation rules:	Normal WAS/RLAN channel access and occupation rules

4.27 As for the 5725 – 5850 MHz band above, we also propose to include guidance in the VNS as to how channels which fall within both the 5740 – 5725 MHz and 5725 – 5730 MHz bands may be best used. Again, compliance with the technical parameters set out in IR 2030 is a matter for operators to determine for themselves, however table 4 sets out the DFS techniques which may be helpful when operating in these frequencies.

Table 4: Summary DFS techniques referenced in the VNS for WAS/RLAN channels which have a bandwidth in both 5470-5725 MHz and 5725-5730 MHz only [38]

DFS requirements inc. detection threshold	ETSI EN 301 893
and	
DFS detection radar patterns	ETSI EN 301 893 & ETSI EN 302 502

[37] IEEE 802.11 channels in both the 5470-5725 and 5725-5730 MHz bands are:
Channel 138: 5650-5730 MHz
Channel 142: 5690-5730 MHz
Channel 144: 5710-5730 MHz.
See annex 7 for our proposed changes to interface requirement 2030
[38] See annex 9 for our proposed changes to interface requirement 2030

4.28 Again, the above references in Table 4 for DFS techniques, when parts of them are used together, may be helpful in providing a single, overall technique for achieving mitigation for preventing interference to radars, as required under the technical parameters set out in the IR (as updated).

4.29 Where overlapping channels that fall within frequencies 5725 MHz – 5730 MHz are being used at the higher radiated power level of 1 W EIRP, we would suggest that two forms of mitigation may be appropriate in order to meet the technical parameters set out in the IR (as updated). The detection thresholds for channels 138, 142 and 144 are taken from ETSI EN 301 893 (as applied to the 5740 – 5725 MHz band) and the radar test patterns to be detected are taken from both ETSI EN 301 893 and ETSI EN 302 502, as suggested for the 5725 – 5850 MHz band above. We believe that the detection thresholds from ETSI EN 301 893 are more appropriate than those in ETSI EN 302 502 because WAS/RLAN will be limited to a radiated power level of 1 W EIRP. This is the same radiated power level as existing WAS/RLAN equipment operating in the 5470-5725 MHz band and lower than the 4 W EIRP radiated power limit for 5.8 GHz BFWA.

4.30 The limits for the 5725 – 5730 MHz frequencies are, overall, more relaxed than those for channels which fall wholly within the 5725-5850 MHz band, but we believe this relaxation is justified because the consequent risk of interference to incumbent services is low, principally because these channels all have an upper edge at 5730 MHz and so only extend 5 MHz into the 5725-5850 MHz band. We discuss our coexistence analysis in greater detail in Annex 6.

Extent of application

4.31 The Proposed Regulations will apply in the United Kingdom, the Channel Islands and Isle of Man (subject to the agreement by the Islands Authorities).

Q1: Do you have any comments on the drafting of the Proposed Regulations?

Q2: Do you have any comments on the proposed technical parameters?

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 11 April 2017**.

A1.2 We strongly prefer to receive responses via the online form at https://www.ofcom.org.uk/consultations-and-statements/category-3/wireless-telegraphy-exemption-regulations-2017. We also provide a cover sheet (http://stakeholders.ofcom.org.uk/consultations/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 mds@ofcom.org.uk, as an attachment in Microsoft Word format, together with the cover sheet (http://stakeholders.ofcom.org.uk/consultations/consultation-response-coversheet/).

A1.4 Responses may alternatively be posted to the address below, marked with the title of the consultation.

Alberto Fernandes
3rd floor 03:154
Ofcom
Riverside House
2A Southwark Bridge Road
London SE1 9HA

A1.5 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.

A1.6 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.

A1.7 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.

A1.8 If you want to discuss the issues and questions raised in this consultation, please email mds@ofcom.org.uk.

Confidentiality

A1.9 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.

A1.10 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.

A1.11 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.

A1.12 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

A1.13 Following this consultation period, Ofcom plans to publish a statement.

A1.14 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

A1.15 Ofcom aims to make responding to a consultation as easy as possible. For more information, please see our consultation principles in Annex 2.

A1.16 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

A3.1 As required by Section 122 of the Wireless Telegraphy Act 2006, we must give notice of proposals that we intend to make regulations and to consider any representations that we receive. This document gives notice of our proposal to make the Wireless Telegraphy (Exemption and Amendment) (Amendment) Regulations 2017 (the 'Proposed Regulations').

Q1: Do you have any comments on the drafting of the Proposed Regulations?

Q2: Do you have any comments on the proposed technical parameters?

Annex 4

Impact Assessment

A4.1 Ofcom acts consistently with Government practice that, where a statutory regulation is proposed, a Regulatory Impact Assessment (RIA) should be undertaken. We also comply with our duty under section 7 of the Communications Act 2003 (the '2003 Act') to undertake impact assessments.

Introduction

A4.2 The analysis presented in this document represents an impact assessment, as relating to a new proposed set of regulations, the Wireless Telegraphy (Exemption and Amendment)(Amendment) Regulations 2017 (the 'Proposed Regulations'). It is consistent with Government practice on RIAs and Ofcom's duty under section 7 of the 2003 Act.

A4.3 You should send any comments on this impact assessment to us by the closing date for this consultation. We will consider all comments before deciding whether to implement our proposals.

A4.4 Impact assessments provide a valuable way of assessing different options for regulation and showing why the preferred option was chosen. They form part of best practice policy-making. This is reflected in section 7 of the Act, which means that generally we have to carry out impact assessments where our proposals would be likely to have a significant effect on businesses or the general public, or when there is a major change in Ofcom's activities.

A4.5 However, as a matter of policy Ofcom is committed to carrying out and publishing impact assessments in relation to the great majority of our policy decisions. For further information about our approach to 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

Background

A4.6 In the UK, we are responsible for authorising use of the radio spectrum and achieve this by granting wireless telegraphy ("WT") licences under the Wireless Telegraphy Act 2006 (the "WTA") and by making Regulations exempting users of particular equipment from the requirement to hold such a licence. Under section 8(1) of the WTA, it is an offence to install or use equipment to transmit without holding a licence granted by us, unless the use of such equipment is exempted. Ofcom may, under section 8(3) of the WTA, make regulations exempting operators of radio equipment from requiring a licence, either absolutely or subject to such terms, provisions and limitations as may be specified.

Proposal

A4.7 This RIA relates to the proposal to make regulations authorising the use of equipment in the 5.8 GHz band on a licence-exempt basis.

The citizen and/or consumer interest

A4.8 Our principal duty under section 3 of the 2003 Act is to further the interests of citizens in relation to communications matters; and of consumers in relevant markets, where appropriate by promoting competition. We take account of the impact of our decisions upon both citizen and consumer interests in the markets we regulate. We must, in particular, secure the optimal use for wireless telegraphy of spectrum and have regard to the principle under which all regulatory activities should be targeted only at cases in which action is needed.

A4.9 We have identified the following impacts on citizens and consumers in making the Proposed Regulations:

i) Opening up the 5.8 GHz band for consumers of Wi-Fi and related technologies is likely to benefit these consumers by helping meet their demand and avoiding congestion and delays in the services they use. We set out our provisional views in our May 2016 consultation, and after taking into account responses, have confirmed those views in Section 3 of this document.

ii) The measures proposed all concern the use of radio equipment on a licence exempt basis, which is likely to reduce the regulatory and administrative burden on Ofcom, consumers and other stakeholders and help secure the optimal use of spectrum;

iii) We have assessed the likelihood of interference into other spectrum users and included mitigation measures that aim for a low probability of harmful interference. These measures include a relatively low power limit, a ban on fixed outdoor use, and radar detection and avoidance (DFS). Our assessment is presented in Section 3 and Annex 6.

Equality Impact Assessment

A4.10 We are required by statute to assess the impact of all our functions, policies, projects and practices on race, disability and gender equality – an Equality Impact Assessment (EIA) is our way of fulfilling these obligations.

A4.11 We did not find any reason to suggest that the Proposed Regulations are likely to have a materially different impact against the above defined equality groups.

Ofcom's policy objective

A4.12 We seek wherever possible, to reduce the regulatory burden upon our stakeholders, in this instance users of the radio spectrum. One way in which we can do this is to remove the need for spectrum users to apply for individual licences to authorise the use of radio equipment. Exemption is realised by describing the details of equipment and the parameters under which it may be used in regulations that exempt the users of such equipment from the need to hold a licence, provided they comply with the terms of the regulations.

Options considered

A4.13 Having made the policy decision to open up the 5.8 GHz band to consumers, as detailed in the main body of this document, the options we identify here in this impact assessment are:

i) to make the Proposed Regulations, authorising devices to operate in the 5.8 GHz band on a licence-exempt basis; or

ii) to do nothing, which means that these devices would need to be authorised via a licence granted under the WTA.

Analysis of the different options

A4.14 The following section assesses the impact of the options open to Ofcom by reference to the principal changes that would be made by the Proposed Regulations.

To make the Proposed Regulations

A4.15 When considering the authorisation of devices, Ofcom can either licence them or make regulations to exempt them from licensing. Under section 8(3) of the WTA, Ofcom may, by regulations exempt operators of radio equipment from requiring a licence, either absolutely or subject to such terms, provisions and limitations as may be specified.

A4.16 Generally, licence exemption presents the lowest barrier to use of the additional spectrum band compared with other forms of authorisation, such as individual licences. Our analysis takes this proposition as a starting point and then assesses concerns over harmful interference or congestion to existing users (if any) or potential new users of the band.

A4.17 Harmful interference or congestion could negate the benefits of any reductions in the regulatory burden gained from exemption. We have addressed this risk by considering each other service in turn and by designing technical parameters that mitigate risks of harmful interference, as explained in section 3 and Annex 6 of this document.

A4.18 By making the regulations, additional capacity in Wi-Fi will be readily available to consumers and citizens across the UK. The benefits will include higher connection and fewer delays, because added bandwidth in Wi-Fi reduces the need for users to share channels. Channel sharing in Wi-Fi occurs by different users taking turns to use the available channels, which can introduce delays and slow down services.

A4.19 Businesses across the UK use Wi-Fi and will also benefit from licence exemption in the 5.8 GHz band, being able to use the additional bandwidth without the administrative cost and effort required to apply for a licence. Additional bandwidth may also reduce costs for some businesses, as it makes it possible to improve their Wi-Fi coverage without requiring additional equipment (or a greater density of access points) to achieve this goal.

A4.20 Because Wi-Fi is so widely used (currently 86% of UK households are connected to broadband; of these almost all use Wi-Fi), we believe that the aggregate benefit of the proposed regulations is likely to be considerable.

A4.21 There are one-off administrative costs associated with making the Proposed Regulations. However, we consider the implementation costs to be low, both in absolute terms and in comparison to licensing alternatives that might require the maintenance of a licensing scheme. Moreover, the costs such as they should also be offset by the benefits to businesses and consumers outlined above.

To do nothing

A4.22 If Ofcom was to decide not to proceed with making the Proposed Regulations, it is likely that citizens and consumers would not be able to benefit from the opportunities that this additional bandwidth for Wi-Fi and related technologies could provide. The only way for citizens and consumers to use the additional bandwidth would be under a licensing regime, which is unlikely to be attractive for consumers, when they can use other Wi-Fi channels without the need to apply for a licence.

A4.23 Businesses are more likely than consumers to be willing to apply for licences, as they are more likely to have the administrative resources to do so. Therefore it is more plausible that some business would benefit from the use of this spectrum under a licensing regime, but they are still likely to face additional administrative costs and the cost of the licence itself.

The preferred option

A4.24 Our preferred option is to proceed to make the Proposed Regulations as proposed.

Annex 5

Responses to the May 2016 consultation

Introduction

A5.1 This Annex presents a summary of the responses to our May 2016 consultation, in additional detail to that provided in Section 3. The full text of the non-confidential responses is also available on our website.

A5.2 We organised this summary by broad themes that match the logic of our rationale to make 5.8 GHz available for Wi-Fi[39]:

a) Responses relating to **demand** for services provided by Wi-Fi;

b) Responses relating to how **demand for Wi-Fi services translate into demand for spectrum**;

c) Responses relating to **options** to improve the supply of spectrum.

A5.3 As we noted earlier, this document focuses on the 5.8 GHz band, but we will continue to consider alternative options, taking these responses into account.

Demand

A5.4 Ericsson pointed to its Mobility Report, published 1 June 2016, which indicated that mobile traffic in Western Europe will grow by a factor of 10 between 2015 and 2022. BT-EE's response highlighted Cisco's global analysis that traffic offload onto Wi-Fi networks now exceeds the traffic carried on the cellular networks. Cisco also predicts that this will continue to increase, reaching 55% offload in 2020. BT-EE in addition believed that the offload figure is likely to be much higher in the UK, based off Ofcom's analysis in 2012 that 81% of traffic on smartphones was carried over Wi-Fi rather than mobile networks.

A5.5 Stakeholder views on which scenarios would result in the greatest demand for high quality Wi-Fi services differed. Several responses suggested that this growth in demand would be primarily driven by video services, in particular for streaming high definition television services. Other applications stakeholders mentioned as contributing to future demand were Internet of Things, gaming, and augmented/artificial reality applications.

A5.6 Some stakeholders gave location or business-specific scenarios of high demand, rather than particular applications. For example, both Cisco and Ericsson believe that a large part of future growth in demand will be in residential areas, particularly in densely populated locations. Cisco said that that the greatest immediate pressure

[39] Questions 1, 2, 3 in the May 2016 Consultation relate to the different options identified and responses are summarised under (c); questions 4, 5, 6 and 7 relate to demand for Wi-Fi services and for Wi-Fi spectrum and responses summarised under (a) and (b); questions 8 and 9 refer to coexistence between Wi-Fi and other services. To the extent that responses relate to 5.8 GHz in particular, these were summarised in Section 3 of this document, or otherwise included under (c). The final question 10 merely asked whether respondents intendent to participate in international studies relating to extending use of Wi-Fi to additional spectrum band; 27 respondents said they would to some extent.

would be during routine 'peak' evening hours in these areas, estimating that "busy hour" internet traffic in the UK will grow 4.6-fold from 2015 to 2020 and will reach 117 Tbps. It also projected that the average household connected to the internet will generate 202.1 gigabytes of Internet traffic per month in 2020, up 139% from 84.5 gigabytes in 2015.

A5.7 Others said that that large indoor locations/venues would be under particular pressure for high quality Wi-Fi connections in the future, such as airports, shopping malls, and other businesses. Arqiva, which provides public access Wi-Fi networks to businesses including hotels, quoted a survey which suggested hotel consumers now consider free Wi-Fi as more important than breakfast.

A5.8 Some respondents, including Qualcomm and iWireless, noted that new technologies, such as Wi-Fi calling, LAA, LWA, and Multefire[40], would also further increase demand for consumer access to 5 GHz bandwidth.

A5.9 A small number of respondents questioned future growth forecasts for Wi-Fi. The UK Microwave Group for example agreed that demand for Wi-Fi would grow. They made reference to one of the drivers commonly cited for this growth, namely the Internet of Things (IoT), which is the idea that each consumer will have many devices connected to the internet. However, the UK Microwave Group also believe that forecasts for IoT growth are likely to be overstated and therefore demand will be lower than currently projected by industry. East Midlands Multi-Rotor believes that outdoor use would not be required with wider roll out of 4G services.

Demand for Wi-Fi translates into demand for spectrum

A5.10 Several respondents highlighted that technology developments to improve Wi-Fi services would also be dependent on additional spectrum being made available. For instance, Cisco said that a key driver of the need for additional spectrum is development of new technical standards. It gave the example of the 802.11ac standard (the standard currently used in most medium and high-end Wi-Fi equipment), which increases potential speed and spectrum efficiency of Wi-Fi, but which also requires spectrum of wider bandwidths to reach its full potential. Ericsson's response stated that improvements in spectrum efficiency has slowed in recent years, and therefore that additional spectrum will be required to deliver further increases in speed. Google also suggested that liberalising rules governing Wi-Fi will encourage deployment of more small networks that use the most advanced and spectrally-efficient wireless standards.

A5.11 Some respondents suggested that the relative benefits of densification and more spectrum would depend on circumstance. For example, BT-EE said that densification may help to meet demand in managed commercial environments, but that improved services in homes would require more spectrum.

A5.12 However, others questioned the extent to which densification could help to meet demand. Ericsson, Wi-Fi Alliance, and another Wi-Fi industry respondent noted that densification can be costly, and is not always a feasible option due to factors such as needing permission from site owners. iWireless suggested the benefits of

[40] Wi-Fi calling is a technology where voice calls are made over Wi-Fi networks. Licensed Assisted Access (LAA) and LTE Wi-Fi Aggregation (LWA) are technologies where a smartphone or other device can use mobile spectrum and Wi-Fi spectrum simultaneously, therefore achieving higher speeds. Multefire is an alternative to Wi-Fi technology that claims better performance.

densification would rely on co-ordination between users, and flagged that the benefits of densification may be offset by relaxing power limits.

A5.13 Regarding whether more spectrum than what we have proposed will be necessary to meet future demand, Wi-Fi Alliance pointed to a study that indicated 1280 MHz spectrum would ideally be needed in order to consistently deliver 1 Gbps to a three-story apartment block. It claimed this indicated that ideally 1280 MHz of spectrum should be made available to licence-exempt technologies in the 5 GHz band in order to support most scenarios. Arqiva said that our proposals in the 5 GHz band would be "the minimum that will be required to meet demand", but also remarked that it was unclear whether more spectrum than this would be required. Nonetheless, it suggested that Ofcom continue to assess the viability for Wi-Fi in other frequencies identified in the medium to long term, in anticipation of any further rise in consumer demand.

A5.14 A number of responses, largely from the amateur radio community, were sceptical of the need for more spectrum in the future and suggested that improvements in technology and densification would be sufficient to meet demand. Some respondents also said that demand would be better met using frequencies above 5 GHz spectrum.

A5.15 Other respondents like Microsoft, for example, noted that licence exempt spectrum in higher frequency bands such as 60 GHz would allow for very high speed communications within rooms, but would not be able to penetrate through walls unlike 5 GHz spectrum.

A5.16 We also asked stakeholders for views on what improvements consumers can expect as the number of devices increase and technology improves, and what difference additional spectrum would make in speeds and quality of experience.

A5.17 A common theme in stakeholders' responses was that additional 5 GHz spectrum would help to deliver improvements to the quality of service that consumers experience today. Some respondents noted that the speed consumers receive today depends on a number of factors, including home environment, proximity to access point and neighbouring networks. Wi-Fi Alliance and a Wi-Fi industry respondents suggested consumers can theoretically achieve 500 Mbps when close to an access point, with no competing devices or interference from neighbouring networks. However, they said that this can fall to much lower levels if the consumer is on the edge of coverage or there are a large number of users trying to access the network. They said that additional channels would lower the chance of access points interfering with one another.

A5.18 Some respondents said that currently authorised spectrum is sufficient for current demands, but that additional 5 GHz spectrum would be beneficial to meet future challenges. Respondents gave examples of developments which may impact on quality of service in the future, including denser deployments and spectrum sharing with new technologies such as license exempt variants of LTE.

A5.19 We have noted that some options for opening up more spectrum lead to greater amounts of contiguous spectrum, and asked respondents how important this is. Most respondents also agreed that more contiguous spectrum would be essential or help to meet current demand and support future growth. Some respondents said that spectrum efficiency was more important than contiguous spectrum, although others noted that contiguous spectrum would help to achieve more efficient use of spectrum.

A5.20 Ericsson's, for example, said that contiguous spectrum facilitates spectrum efficiency as it enables modern radio interfaces to adapt dynamically to minimise interference and maximise speeds. Cisco also highlighted that the 802.11ac standard, which increases spectral efficiency, and requires channels 80 or 160 MHz wide to achieve peak performance.

A5.21 Some respondents emphasised the benefits that contiguous spectrum would offer for meeting future demand for increased speed and new applications. For instance, Google claimed that 1 Gbps fixed broadband connection to the home would require a minimum 80 MHz channel to achieve the same speed over Wi-Fi, with 160 MHz being a more realistic requirement. Microsoft and a confidential Wi-Fi industry respondent mentioned the importance of larger channel sizes for delivering augmented or virtual reality applications, which the confidential respondent said could potentially require channel sizes larger than 160 MHz.

A5.22 BT-EE, however, noted that other technologies such as LTE-LAA might use 20 MHz channels, and so discouraged precluding other channels widths such as 60 MHz and 100 MHz. It did acknowledge, nonetheless, that contiguous channels were preferable and encouraged Ofcom to maximise the number of 80 MHz channels.

A5.23 Microsoft expressed concern that LAA-LTE currently lacks a fair sharing mechanism with Wi-Fi, and so may prevent large bandwidth Wi-Fi channels from being formed in high density deployments where multiple devices using one or the other standard are trying to access the same spectrum. This would mean therefore that higher bandwidth Wi-Fi channels may not be available everywhere, including locations where the larger channel size would provide benefits.

Options

Prioritise opening up 5725-5850 MHz for Wi-Fi, subject to appropriate protections to other users

A5.24 Around half of respondents to this question agreed with our proposal to prioritise making the 5725-5850 MHz (5.8 GHz) band available for Wi-Fi as soon as possible, while the other half disagreed.

A5.25 Responses were generally split along sectoral lines, with those from the amateur radio and FPV racing communities disagreeing strongly with this proposed priority. These respondents were concerned about the impact of Wi-Fi on both terrestrial and amateur satellite reception and drone racing in this band.

A5.26 The Radio Amateur Interest Group suggested that removing constraints in other parts of the 5 GHz band (e.g. 5150-5350 MHz) might offer a better near term option for increasing the 5 GHz band Wi-Fi spectrum usage. They also believed that re-examining the requirement for DFS should be a greater priority, as DFS has acted as a deterrent to greater commercial take up in the relevant parts of the band, and would also do so in any potential future operation in 5725-5850 MHz.

A5.27 Responses from the satellite operators were mixed. The EMEA Satellite Operators Association (ESOA) and Global VSAT Forum's (GVF) joint response agreed that, of the 5 GHz sub-bands under consideration, the 5725-5850 MHz sub-band is the less critical band for satellite services. Thuraya's view is that the 5.8 GHz band should be limited to indoor Wi-Fi use, on a secondary basis to fixed satellite services (FSS). The UK Space Agency (UKSA) disagreed with our proposal for 5.8 GHz, saying that existing space services should be the priority, and that a unilateral

approach to revise existing power limits within this band could cause interference to FSS users.

A5.28 Some respondents expressed concerns about the impact of our proposal on BFWA[41], including Countryside Broadband Limited and Vodafone. Vodafone recommended a cautious approach, liberalising the band first for indoor usage, with outdoor usage considered only after further field testing.

A5.29 Responses from internet service providers, manufacturers, technical solutions providers, and others who use and provide wireless connectivity services, tended to strongly support our proposal to prioritise the 5.8 GHz band for Wi-Fi.

A5.30 Several respondents noted that this spectrum is already authorised for Wi-Fi in other countries, and that there is already equipment on the market capable of operating in the 5.8 GHz band. Cisco suggested that this proposal would help to provide economies of scale, and therefore lower equipment costs for consumers.

A5.31 Some respondents emphasised the importance of harmonised regulations and standards in Europe in order to realise the full benefits of this proposal. BT-EE believe that manufacturers are unlikely to produce equipment without a revised ETSI standard. TalkTalk stressed that Ofcom should pursue harmonisation through CEPT, and that European harmonisation of equipment standards and spectrum use will support greater economies of scale.

A5.32 Some stakeholders, such as Cisco, Dynamic Spectrum Alliance and Sky suggested that opening up the 5725-5850 MHz would be the most straightforward or fastest path to increasing spectrum for Wi-Fi. Cisco further considered that 5725-5850 MHz would have fewer coexistence issues compared to other 5 GHz spectrum under consideration.

Proposal to re-examine the requirement for DFS across the 5 GHz band, subject to appropriate protections to other users

A5.33 The majority of stakeholders who responded on this issue agreed with our proposal to revisit the DFS requirements across the 5 GHz spectrum.

A5.34 A number of responses, including BT-EE and Google, noted that DFS regulations were developed over 10 years ago and that technologies have since advanced significantly. BT-EE said that DFS protections were developed based on theoretical studies, and that the detection threshold uses conservative assumptions. iWireless said that revised DFS requirements would be particularly beneficial indoors, where cellular is not always available and where walls limit impact of Wi-Fi on radars.

A5.35 Some respondents said that the current regulations lead to poorer Wi-Fi service for consumers. Arqiva cited an example of a chipset it encountered in 2015 that was returning false positive readings and, therefore, shutting down the Wi-Fi connection instead of selecting alternative channels. Hewlett Packard Enterprise gave the example of large sporting venues which do not use the parts of the band where DFS is required over concerns including false positive detections and roaming delays. It said that this reduces performance for all users by forcing them to share a small number of channels. Countryside Broadband Limited's experience similarly is

[41] Broadband Fixed Wireless Access

that the level of BFWA equipment's false positives is too high, and can interrupt their customers' services.

A5.36 Some stakeholders, including Sky, Dynamic Spectrum Alliance and Nominet, suggested that newer dynamic spectrum management approaches may be an appropriate alternative to the current DFS approach. Google and Qualcomm also recommended the use of geolocation databases as a potential tool for coordinating Wi-Fi with DFS.

A5.37 A confidential respondent, however, believed that any proposed solutions should not rely on the use of regulatory databases. It urged Ofcom to look at how the DFS requirements can be harmonised world-wide to enable a single algorithm to be used, which it said would enable Wi-Fi silicon to be more efficient and provide a better experience for Wi-Fi users in the DFS bands.

A5.38 Sky and Dynamic Spectrum Alliance's responses cautioned against using simplistic coexistence solutions such as harsh power restrictions, which they said would not provide any added value for Wi-Fi due to the resultant limitations in range and speed.

A5.39 Most of the respondents that disagreed with this proposal did not give a reason for why they disagreed with our proposal. However, two satellite respondents (Airbus Defence and Space and UKSA) disagreed with our proposal to re-examine DFS, as they did not think that DFS adequately protects space services from Wi-Fi. UKSA recommended research into a more effective technology, rather than simply relaxing DFS requirements.

Other options: opening up 5850-5925 MHz; outdoor Wi-Fi use at 5150-5350 MHz; and opening up the 'centre gap' at 5350-5470.

A5.40 The majority of stakeholders generally agreed that Ofcom should pursue at least one of the other options we identified. However, stakeholders also had different views on the relative importance of the options.

A5.41 Several respondents, including Google, Cisco and a number of amateur radio respondents, supported liberalising the 5150-5350 MHz sub-band for outdoor use as a priority. Cisco noted that the US has already opened this spectrum for outdoor use and that, relative to the other 5 GHz sub-bands under consideration, there are fewer incumbency issues.

A5.42 However, TalkTalk saw the 5150-5350 MHz sub-band as a lower priority, stating that the risk of interference from outdoor systems into indoor systems would need to be fully assessed. While BT-EE recognised some of the benefits of allowing outdoor use in the 5150-5350 MHz sub-band, it also believes that there is more merit in retaining power limits on the use of these frequencies to enable shorter range networks to operate without the risk of interference from other more powerful devices. Its preference would therefore be to retain the current power limits in this sub-band, while higher power devices can still operate in other parts of the 5 GHz band.

A5.43 Globalstar, which provides mobile satellite services (MSS) using 5091-5250 MHz for feeder links, said that without appropriate safeguards, Ofcom's suggested changes would have a detrimental impact on its operations. In particular, it said that this proposal would impact on its MSS feeder uplink at 5150-5250 MHz. It also suggested, however, that outdoor Wi-Fi use may be possible in the 5150-5350 MHz

sub-band, provided appropriate mitigations were in place. It gave the example of the FCC's conditions for allowing outdoor Wi-Fi use in this sub-band in the US, which include specific antenna requirements and reporting obligations for significant access point deployments. Wi-Fi Alliance's response noted that, to date, Globalstar has not experienced disruptions to their operations at 5150-5250 MHz as a result of the US FCC regulatory action.

A5.44 NATS also said that any investigations relating to outdoor use or a power increase of Wi-Fi at 5150-5350 MHz should consider adjacent band compatibility with aeronautical safety services below 5150 MHz. NATS is a provider of air navigation services in the UK.

A5.45 BT-EE and Talk Talk encouraged consideration of 5850-5925 MHz and the 5350-5470 MHz 'centre gap' as greater priorities than outdoor Wi-Fi use at 5150-5350 MHz. BT-EE sees the centre gap as the "biggest prize", which would enable more contiguous spectrum across the existing bands. BT-EE also believes that opening up 5850-5925 MHz would be a "relatively easy" means to achieve additional spectrum for Wi-Fi at 5 GHz.

A5.46 However, satellite operators were generally opposed to the prospect of opening up the 5850-5925 MHz and the 'centre gap' sub-bands for Wi-Fi due to the satellite services in these frequencies. UKSA, for example, noted there were on-going sharing studies between satellite and Wi-Fi services in these two sub-bands. It said that it was therefore too early to draw firm conclusions about opening these sub-bands up.

A5.47 The ESOA & GVF's joint response noted the worldwide use of 5850-5925 MHz for FSS, and European use of 5350-5470 MHz for earth exploration satellite services (EESS). They said that there was a risk of interference to these services from Wi-Fi, and indicated there were other options that were potentially more "promising" than pursuing these two sub-bands, such as improving access and densification in existing Wi-Fi bands and opening up 5725-5850 MHz instead.

A5.48 Airbus Defence and Space raised specific concerns about the potential degradation of EESS synthetic aperture radar (SAR) images in 5350-5470 MHz as a result of Wi-Fi services in this band. SAR is used for a wide range of earth observation applications, including environmental monitoring, urban planning, tracking ships, and managing agricultural resources.

A5.49 Multiple stakeholders, including Huawei, Vodafone, and Ericsson also expressed concerns about the potential impact on intelligent transport systems (ITS) safety-related applications if Wi-Fi were authorised in the 5850-5925 MHz sub band. Vodafone highlighted intelligent transport systems are due to see rapid growth with connected and driverless cars, while Huawei said the potential risk of interference of Wi-Fi to ITS equipment would impact on the operation of road safety systems, as well as industry investment. Cisco, Wi-Fi Alliance, and Microsoft, however, noted that the US is investigating solutions to enable sharing between ITS and Wi-Fi.

A5.50 Some respondents also suggested looking at alternative bands to the ones we have proposed for Wi-Fi access. For example, some amateur radio respondents and techUK suggested we adjust the upper limit of the existing 5470-5725 MHz Wi-Fi band by 5 MHz to 5730 MHz which would allow the use of an extra 80 MHz Wi-Fi channel[42]. This channel would be only partially co-channel with terrestrial radio

[42] IEEE Channel 138 (5650-5730 MHz)

amateur use and would not be co-channel with the amateur satellite downlink. Wireless Broadband Alliance suggested that Ofcom explore whether there are spectrum sharing opportunities adjacent to the 5 GHz band, such as in the 6 GHz band. It said that this could lead to the rapid expansion of larger channels (e.g. 80 MHz and 160 MHz) available to licence exempt devices.

Annex 6

RLAN / FSS Coexistence

Introduction

A6.1 In this Annex we discuss our assessment of Wi-Fi coexistence with the Fixed Satellite Service in 5725-5850 MHz. We start by reviewing the work which has been done so far and the recommendations underlying this work. We then build on these studies to explain why we think Wi-Fi can share in this band with a low risk of interference to satellite services.

Background

A6.2 We based our analysis on previous sharing studies carried out in ITU-R and CEPT. We use a methodology that makes reference to, and analyses the three different studies carried out which are:

- *Report ITU-R S.2367* – Sharing and compatibility between International Mobile Telecommunication systems and fixed-satellite service networks in the 5 850 - 6 425 MHz frequency range;

- *ECC Report 244* – Compatibility studies related to RLANs in the 5725-5925 MHz band;

- *Annex 25 of the last WP 5A Chairman's Report* – Use of aggregate RLAN measurements from airborne and terrestrial platforms to support studies under WRC-19 agenda item 1.16.

A6.3 In order to put the sharing analysis carried out in the first two theoretical studies into context, we need to look at the overall big picture and methodology of how the apportionment of interference is allocated in the main ITU-R recommendation being used in these two studies. That methodology comes from Recommendation ITU-R S.1432-1 and in this recommendation the sources of interference that are recommended to be taken account of are the following:

- emissions from FSS systems operating in the same band;

- emissions from other radio services sharing the same frequency allocations on a primary basis;

- emissions from other radio services sharing the same frequency allocations on a non-primary basis;

- emissions from unlicensed devices;

- unwanted emissions (e.g. out-of-band and spurious emissions);

A6.4 Furthermore, it recommends that the maximum allowable interference from all the above sources (aggregate) should be limited to 32% or 27% of the clear-sky satellite system noise and those figures were derived by summing the respective apportionments (below) depending on whether or not frequency re-use was practiced;

- 25% for other FSS systems for victim systems not practicing frequency re-use;
- 20% for other FSS systems for victim systems practicing frequency re-use;
- 6% for other systems having co-primary status;
- 1% for all other sources of interference,

A6.5 When analysing these three studies in order to arrive at a useful range of results we had to make a choice on which study should be used to form the baseline analysis. We decided to use the studies contained in ECC Report 244 as the baseline study, because this the most recent ECC report focusing on WAS/RLAN coexistence with other services on 5725-5925 MHz (which includes the band of interest for this document, 5725-5850 MHz).

Our analysis of coexistence in 5725-5850 MHz

A6.6 5.8 GHz (5725-5850 MHz) has the potential to become harmonised worldwide for Wi-Fi and is already used for Wi-Fi in many major administrations including the US, China, Canada, and Australia. This band is not currently used for Wi-Fi in region 1 where there is a co-primary allocation to FSS uplinks. This co-primary allocation for FSS uplinks in 5.8 GHz does not exist in region 2 or 3 and is only allocated for FSS uplinks above 5850 MHz in those regions.

A6.7 We will continue to actively participate in the international discussions to see if we can make this band available for Wi-Fi and contributed to the modelling and debate at CEPT in SE24 and PTD and at the ITU in WP5A. This is because the risk of interference does not come from any individual administration opening the band for Wi-Fi, but only if all of Africa and Europe opens the band for Wi-Fi.

Predicting the volume of future Wi-Fi data consumption dominates the modelling uncertainties but we believe we can sensibly bound these uncertainties

A6.8 Predictions always involve a certain amount of uncertainty. We found that the two most important factors in predicting how much data users might be using during the busiest times of day ("the busy hour activity factor") and the extent to which higher power, outdoor networks might be deployed for providing public access mobile data.

A6.9 We believe that the highest predictions for Wi-Fi mobile data usage during the busiest times of day in these international studies represent a theoretical maximum rather than a realistic upper bound. We have, therefore, in our own assessment, considered some of the lower to more central values from the international studies. We believe that these values reflect realistic scenarios also cover a range of results for more optimistic to more conservative RLAN deployment scenarios[43].

[43] The worst case considered in the international studies considered 75% of all Wi-Fi networks across Europe to be participating in the "busy hour" and for all of these networks to be fully loaded. For a contention based protocol like Wi-Fi "fully loaded" means an activity factor of 30%. We believe that these values are unrealistic and that the lower values considered in the international studies are more realistic. For example, 50 to 62.7% of Wi-Fi networks might be participating in the "busy hour" at any one time because enterprise Wi-Fi networks (peaking during business hours) will tend to be active at different times of day to residential networks (peaking during late evening). We also believe that not

A6.10 We believe that our assessment is corroborated by our airborne measurement and analysis work of 2.4 GHz Wi-Fi in 2015[44] and early 2016[45]. We have presented this work in the international groups we mentioned before and received feedback which challenged our work in three main areas: firstly, how certain we were of our measurement accuracy; secondly, how we can relate measurements of 2.4 GHz Wi-Fi today to predict 5.8 GHz Wi-Fi in the future and; thirdly, how we can relate measurements from an aircraft to geostationary satellites. We acknowledge these uncertainties and have sought to characterise and, where possible, minimise them. Our assessment is that, within the bounds of these uncertainties, our airborne measurement work still supports our original analysis and that the lower to more central scenarios considered in the international studies are the most realistic.

Large numbers of high power, outdoor access points could significantly increase the coexistence risk so we propose no fixed outdoor Wi-Fi use in this band

A6.11 We acknowledge that the modelling is particularly sensitive to the number of higher power (1 W EIRP), outdoor Wi-Fi access points that could be deployed in the future and that fairly small variations in the total population of these devices can have a significant impact on aggregate Wi-Fi emissions towards satellites[46]. We believe that higher power, outdoor Wi-Fi access points represent a very small proportion of the total access point population today, but that this could change in the future with the introduction of new technologies such a license exempt variants of LTE which might be deployed alongside LTE small cells on outdoor locations such as lampposts. For this reason, we believe it is sensible, for the moment, to allow no fixed outdoor use of the 5.8 GHz band and to limit EIRP to a maximum of 200 mW. We believe that this would still allow Wi-Fi to meet demand in the majority of mainstream scenarios where spectrum is constrained today such as in shopping centres and transport hubs.

A6.12 In Table 2 below we show the impact that different regulatory regimes for Wi-Fi might have on the exceedance of the protection criteria of the most sensitive satellites in 5.8 GHz assuming a comprehensive Wi-Fi roll-out across Europe and Africa.

all networks are going to be simultaneously fully loaded and that an average activity factor of 3 to 10% is more realistic.

[44] "2.4 GHz Wi-Fi Airborne Measurements", Ofcom, 22 April 2016, https://www.ofcom.org.uk/__data/assets/pdf_file/0028/76573/airborne_measurements_over_london.pdf

[45] "2.4 and 5 GHz Wi-Fi Airborne Measurements over Northampton", Ofcom, 22 April 2016, https://www.ofcom.org.uk/__data/assets/pdf_file/0029/78383/airborne_measurements_over_northampton.pdf

[46] Our modelling assumes a 17 dB building penetration loss at 5.8 GHz which means that, all other things being equal, one outdoor access point contributes the same a 50 indoor access points towards total aggregate interference to satellites.

Table 2: Exceedance of the protection criteria for the most sensitive satellites in 5.8 GHz for a range of regulatory scenarios

Regulatory Limits	1 W EIRP indoor & outdoor		200 mW EIRP indoor & outdoor		200 mW EIRP no fixed outdoor	
Selection of modelling parameters	opti-mistic	conser-vative	opti-mistic	conser-vative	opti-mistic	conser-vative
Ratio of outdoor Wi-Fi access points as a proportion of the total AP population (%)	5.3	5.3	2	5	1[47]	1
Exceedance of protection criteria for the most sensitive satellites in the 5.8 GHz band (dB)	(-2.0)	7.1	(-6.4)	5.2	(-7.6)	1.5
	✓	✗	✓	✗	✓	✗

However, it is important to understand these protection criteria in context to understand what needs to be true for harmful interference to satellites to occur

A6.13 A breach of the protection criteria does not mean that harmful interference will necessarily occur to satellites because a number of other things have to be true first. The protection criteria for satellites allow for a 20 to 25% rise in satellite system noise attributable to satellite coordination, 6% from other co-primary services (e.g. Wi-Fi) and 1% from all other sources. If all of this interference budget is used, then this would cause a total rise in the satellite system noise of 1.2 dB. This means that the following needs to be true for harmful interference to occur:

There has to be a great increase in the number of satellites in this band

The majority of the interference budget is given over to intersatellite coordination which must be used *as well* as the 6% for Wi-Fi in order to raise the satellite system noise by 1.2 dB. We found 48 filings in this band for satellites visible from the UK (65°W to 65°E) but we cannot be certain how many of these satellites are real satellites and how many are "paper satellites". We note that none of the respondents to our May 2016 consultation identified satellites or satellite systems which used 5725-5850 MHz. We believe that there are a number of factors which are likely to make this band less popular for satellites in the future:

- **Identification for Wi-Fi.** Outside of region 1, this band is used for Wi-Fi and once it becomes clear that this band will become used for Wi-Fi worldwide it will become less attractive for new satellites.
- **Identification for ISM.** This band is already identified for ISM and is used for a large number of other services including short range devices and broadband fixed wireless access. Similar to the identification for Wi-Fi, this will additionally make the band unattractive for satellites.

These satellites must be operating close to their minimum signal to noise ration

The least sensitive satellites in 5.8 GHz are some 10 dB less sensitive than the most sensitive satellites considered in Table 2. This means that the more sensitive satellites will "hear" any interference first and will have to be running at a very slim signal-to-noise ratio for a 1.2 dB rise in noise to impact the services they can deliver.

[47] Note that for the indoor-only case we have assumed an outdoor population of 1% which accounts for mobile devices being used outdoors to communicate with an indoor access points and a small number of non-compliant Wi-Fi access points using 5.8 GHz outdoors.

The more conservative modelling assumptions have to be true	The coexistence modelling gives a range of possible values based on what 5.8 GHz deployments might look like in the future. The more conservative assumptions must be true for the protection criteria to be exceeded. As discussed previously, the risk of interference is an aggregate of all Wi-Fi use and so will rise slowly over a number of years rather than appearing suddenly.
Europe and Africa will likely follow our lead	The UK cannot cause interference to 5.8 GHz satellites on its own but it is fairly likely that Europe and Africa will follow our lead. This is likely to be driven by the potential for 5.8 GHz to become a worldwide Wi-Fi band.

A6.14 If the more sensitive satellites began to detect interference, then satellite operators could report this to administrations and ask for action to be taken. This action could include “grandfathering” the band, preventing new Wi-Fi devices from accessing 5.8 GHz and halting the rise in aggregate interference to satellites. However, to be effective this action would have to be taken at regional level or higher level in Europe and Africa and we believe that this is unlikely to be enacted in practice once 5.8 GHz has become established as a worldwide Wi-Fi band.

Table 3: Modelling assumptions used for the coexistence scenarios in Table 2

	1 W EIRP indoor & outdoor				200 mW EIRP indoor & outdoor				200 mW EIRP indoor only			
	optimistic		conservative		optimistic		conservative		optimistic		conservative	
	value	log.	value	log.	value	log.	value	log.	value	log.	value	log.
STEP 1: Per RLAN Contribution to Aggregate Interference												
RLAN EIRP Distribution (per device average) (dBm)	-	-	-	-	18.9	*18.9*	18.9	*18.9*	18.9	*18.9*	18.9	*18.9*
Outdoor / Indoor Ratio	-	-	-	-	2.0%	-	5.0%	-	1.0%	-	1.0%	-
Building Penetration Loss for Indoor RLANs (dB)	-17.0	*9.2*	-17.0	*9.2*	-17.0	*-14.0*	-17.0	*-11.6*	-17.0	*-15.3*	-17.0	*-15.3*
Activity Factor	3.0%	*-15.2*	10.0%	*-10.0*	3.0%	*-15.2*	10.0%	*-10.0*	3.0%	*-15.2*	10.0%	*-10.0*
Busy Hour Population	50.0%	*-3.0*	62.7%	*-2.0*	50.0%	*-3.0*	62.7%	*-2.0*	50.0%	*-3.0*	62.7%	*-2.0*
Band Loading Factor	50.0%	*-3.0*	74.0%	*-1.3*	50.0%	*-3.0*	74.0%	*-1.3*	50.0%	*-3.0*	74.0%	*-1.3*
Channelisation Factors	6.2%	*-12.1*	6.2%	*-12.1*	6.2%	*-12.1*	6.2%	*-12.1*	6.2%	*-12.1*	6.2%	*-12.1*
Average EIRP Per RLAN, Per 40 MHz Channel (dBm)		-24.1		-16.2		-28.5		-18.1		-29.7		-15.1
STEP 2: Propagation Towards Satellites[1]												
RLAN APs in satellite footprint (Europe ONLY, 2025)	300	*84.8*	400	*86.0*	300	*84.8*	400	*86.0*	300	*84.8*	400	*86.0*
Free Space Path Loss (dB)	-199.8	*-199.8*	-199.8	*-199.8*	-199.8	*-199.8*	-199.8	*-199.8*	-199.8	*-199.8*	-199.8	*-199.8*
Antenna Discrimination towards GEO satellites (dB)	-4.0	*-4.0*	-4.0	*-4.0*	-4.0	*-4.0*	-4.0	*-4.0*	-4.0	*-4.0*	-4.0	*-4.0*
STEP 3: Satellite Protection Criteria												
Interference Apportionment to Europe RLANs	3.0%	*-15.2*	3.0%	*-15.2*	3.0%	*-15.2*	3.0%	*-15.2*	3.0%	*-15.2*	3.0%	*-15.2*
STEP 4: Satellite Protection Criteria Exceedances												
Exceedance of Satellites A & D Prot. Crit. (dB)		**(-2.0)**		**7.1**		**(-6.4)**		**5.2**		**(-7.6)**		**1.5**
Exceedance of Satellite B Protection Criteria (dB)		**(-12.1)**		**(-3.0)**		**(-16.5)**		**(-4.9)**		**(-17.6)**		**(-8.6)**
Exceedance of Satellite F Protection Criteria (dB)		**(-12.8)**		**(-3.6)**		**(-17.1)**		**(-5.6)**		**(-18.4)**		**(-9.2)**
Exceedance of Satellite G Protection Criteria (dB)		**(-5.5)**		**3.6**		**(-9.9)**		**1.7**		**(-11.1)**		**(-2.0)**

Our analysis of coexistence in the “overlapping” channels

A6.15 The RLAN “overlapping channels” fall mostly into the 5470-5725 MHz band, with 5 MHz falling in the 5725-5850 MHz band as shown in Figure 6.1 below. We have proposed a higher radiated power limit for these channels only (1 W EIRP).

A6.16 In the worst case, the FSS receiver could be using its lowest frequency range 5725-5765 MHz and would be partially co-channel with the “overlapping channels”. In this case, the FSS receiver would be co-channel with 5 MHz of the “overlapping channels”, 5725-5730 MHz, and co-channel with 30 MHz of 5.8 GHz channels, 5735-5765 MHz, as shown in Figure 1. We can use the values we calculated from our previous work, see Table 3, to understand what the combined contribution of these emissions might be within the FSS receiver.

A6.17 We summarise our results below in Table 4. These results show us that the exceedance risk to the FSS receiver using 5725-5765 MHz increases by less than 1 dB relative to the FSS receiver using any other spectrum in 5730-5850 MHz.

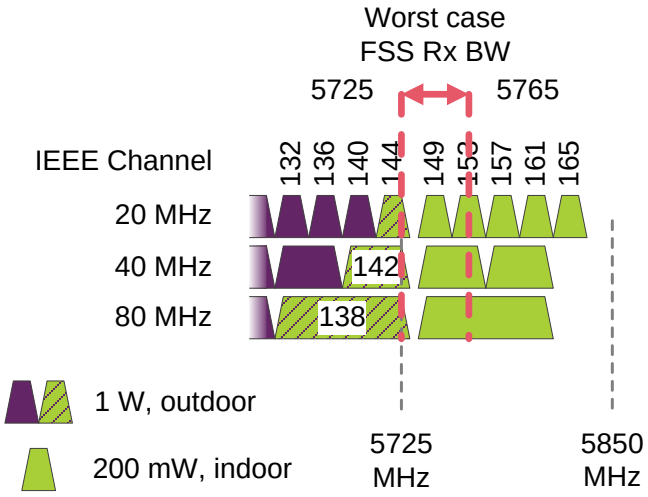


Figure 6.1: In the worst case, the FSS receiver bandwidth is partially co-channel with the “overlapping channels”, 138, 142 and 144[48].

[48] RLAN channels in both the 5470-5725 and 5725-5850 MHz bands are:
Channel 138: 5650-5730 MHz
Channel 142: 5690-5730 MHz
Channel 144: 5710-5730 MHz

Table 4: Exceedance of satellites A & D protection criteria (dB) for different regulatory conditions, considering more optimistic and more conservative scenarios.

	5.4 GHz 5470-5725 MHz 1 W EIRP	"overlapping channels" 5725-5765 MHz mixed regs. [a]	5.8 GHz 5730-5850 MHz 200 mW EIRP No fixed outdoor
Optimistic	(-2.0)	(-6.8)	(-7.6)
Conservative	7.1	2.4	1.5

[a] Calculated using $\boldsymbol{p_{overlapping} = 10 \cdot \log_{10}\left(\left(\frac{5}{40}\right) \cdot 10^{p_{5.4GHz}/10} + \left(\frac{30}{40}\right) \cdot 10^{p_{5.8GHz}/10}\right) dB}$

Annex 7

The Proposed Regulations

STATUTORY INSTRUMENTS

2017 No.

ELECTRONIC COMMUNICATIONS

The Wireless Telegraphy (Exemption and Amendment) (Amendment) Regulations 2017

Made - - - -	*xxxxxxxxx2017*
Coming into force - -	*xxxxxxxxx2017*

The Office of Communications ("OFCOM") make the following Regulations in exercise of the powers conferred by sections 8(3) and 122 of the Wireless Telegraphy Act 2006([49]) (the "Act").

Before making these Regulations, OFCOM have given notice of their proposal to do so in accordance with section 122(4)(a) of the Act, published notice of their proposal in accordance with section 122(4)(b) of the Act, and have considered the representations made to them before the time specified in the notice in accordance with section 122(4)(c) of the Act.

Citation and commencement

1.—(1) These Regulations may be cited as the Wireless Telegraphy (Exemption and Amendment) (Amendment) Regulations 2017 and shall come into force on xxxx 2017.

Amendment of the Wireless Telegraphy (Exemption and Amendment) Regulations 2010

2.—(1) The Wireless Telegraphy (Exemption and Amendment) Regulations 2010([50]) shall be amended in accordance with the following provisions of these Regulations.

(2) In regulation 5 (short range devices), for ""IR 2030—UK Interface Requirements 2030 Licence Exempt Short Range Devices", published by OFCOM in June 2014", substitute ""IR 2030—UK Interface Requirements 2030 Licence Exempt Short Range Devices", published by OFCOM in xxxx 2017".

Philip Marnick
Group Director of Spectrum Group

([49]) 2006 c.36; sections 12, 13(2) and 122 were extended to the Bailiwick of Guernsey by article 2 of the Wireless Telegraphy (Guernsey) Order 2006 (S.I. 2006/3325); to the Bailiwick of Jersey by article 2 of the Wireless Telegraphy (Jersey) Order 2006 (S.I. 2006/3324); and to the Isle of Man by article 2 of the Wireless Telegraphy (Isle of Man) Order 2007 (S.I. 2007/278).
([50]) S.I. 2010/2512 as amended by S.I. 2011/3035, S.I. 2013/1253, and S.I. 2014/1484.

Xth xxxx 2017 For and by the authority of the Office of Communications

EXPLANATORY NOTE

(This note is not part of the Regulations)

These Regulations amend the Wireless Telegraphy (Exemption and Amendment) (Amendment) Regulations 2010 (S.I. 2010/1484 as amended by S.I. 2011/3035, S.I. 2013/1253, and S.I. 2014/1484.).

These Regulations extend the exemption for establishing, installing and using short-range devices to include the 5725 – 5850 MHz frequency band.

A full regulatory impact assessment of the effect that these Regulations will have on the costs to business is available to the public from the Office of Communication's ("OFCOM") Library at Riverside House, 2A Southwark Bridge Road, London, SE1 9HA (Tel: 020 7981 3000) and on OFCOM's website at www.ofcom.org.uk. Copies of this assessment have also been placed in the library of the House of Commons.

Annex 8

The 2010 Regulations which the Proposed Regulations will amend

Wireless Telegraphy (Exemption and Amendment) Regulations 2010

2010 No 2512

ELECTRONIC COMMUNICATIONS

Wireless Telegraphy (Exemption and Amendment) Regulations 2010

Made 14th October 2010

Coming into force 1st November 2010

The Office of Communications ("OFCOM") make the following Regulations in exercise of the power conferred by section 8(3) of the Wireless Telegraphy Act 2006("the Act").

Before making these Regulations OFCOM have given notice of their proposal to do so in accordance with section 122(4)(a) of the Act, published notice of their proposal in accordance with section 122(4)(b) of the Act and have considered the representations made to them before the time specified in that notice in accordance with section 122(4)(c) of the Act.

1 Citation and commencement

These Regulations may be cited as the Wireless Telegraphy (Exemption and Amendment) Regulations 2010 and shall come into force on 1st November 2010.

2 Interpretation

In these Regulations--

"the Act" means the Wireless Telegraphy Act 2006; and

"GHz" means gigahertz.

3 Revocations and amendments

(1) The Regulations specified in the Schedule are revoked to the extent specified.

(2) The Wireless Telegraphy (Exemption) Regulations 2003 are amended as follows--

(a) in Regulation 3, for the definition of "relevant apparatus", for "Schedules 3 to 11" substitute "Schedules 3 to 10".

(b) in Schedule 3 (network user stations)--

(i) in Part III paragraph 3 sub-paragraph (c), under the last entry in the column, insert--

"880.1-914.9 (MTx)
925.1-959.9 (BTx)
1710.1-1785 (MTx)
1805.1-1880 (BTx)"

(ii) in Part IV (interface requirement), for "June 2005", substitute "October 2010".

4 Railway level crossing radar

The establishment, installation and use of wireless telegraphy stations and wireless telegraphy apparatus complying with the publication "IR 2080--UK Interface Requirement 2080, Railway Level Crossing Radar Sensor Systems", is exempt from the provisions of section 8(1) of the Act, if--

(a) it does not cause or contribute to any undue interference to any wireless telegraphy; and

(b) it is not established, installed or used within twenty kilometres of any of the following locations (expressed by latitude and longitude coordinates)--

(i) 02° 18' 22.8" W 53° 14' 06.7" N;

(ii) 00° 02' 12.4" E 52° 10' 00.0" N;

(iii) 02° 08' 40.1" W 52° 06' 02.0" N;

(iv) 02° 32' 08.5" W 53° 09' 22.7" N;

(v) 02° 59' 49.6" W 52° 47' 25.1" N; and

(vi) 02° 26' 43.5" W 53° 17' 19.1" N.

5 Short range devices

The establishment, installation and use of wireless telegraphy stations and wireless telegraphy apparatus complying with an interface requirement which forms part of the publication ["IR 2030--UK Interface Requirements 2030 Licence Exempt Short Range Devices", published by OFCOM in June 2014], is exempt from the provisions of section 8(1) of the Act, if--

(a) it does not cause or contribute to any undue interference to any wireless telegraphy; and

(b) in cases where the interface requirement does not state that airborne use is permitted, use is not airborne.

6 Fixed wireless systems

The establishment, installation and use of wireless telegraphy stations and wireless telegraphy apparatus complying with the publication "IR 2078, UK Interface Requirement 2078, Fixed Wireless Systems in the frequency band 57.1 to 63.9 GHz", is exempt from the provisions of section 8(1) of the Act, if--

(a) it does not cause or contribute to any undue interference to any wireless telegraphy;

(b) use is not airborne; and

(c) any stations or apparatus operating in the frequency band 59 to 63.9 GHz are not established, installed or used within six kilometres of any of the following locations (expressed by latitude and longitude coordinates)--

(i) 07° 23' 36.6" W, 57° 21' 3.6" N;

(ii) 04° 58' 21" W, 51° 37' 16.8" N; and

(iii) 00° 36' 22.8" W, 52° 38' 1.8" N.

7 High density fixed satellite service systems

The establishment, installation and use of wireless telegraphy stations and wireless telegraphy apparatus complying with the publication "IR 2066, UK Interface Requirement 2066, High Density Fixed Satellite Service Systems", is exempt from the provisions of section 8(1) of the Act, if--

(a) it does not cause or contribute to any undue interference to any wireless telegraphy; and

(b) use is not airborne.

[8 Personal locator beacons]

[The use of wireless telegraphy apparatus in the frequency band 406 to 406.1 megahertz complying with the publication "IR 2084 - UK Interface Requirement 2084 Cospas-Sarsat locator beacons for use on land (December 2011)" published by OFCOM in December 2011, is exempt from the provisions of section 8(1) of the Act, if--

(a) it does not cause or contribute to any undue interference to any wireless telegraphy;

(b) use is not airborne; and

(c) it is not used on board a ship.]

[9 Earth stations on mobile platforms]

[The use of wireless telegraphy apparatus complying with the publication "IR 2093--UK Interface Requirement 2093 Earth Stations on Mobile Platforms (ESOMPs)" published by Ofcom in February 2014, is exempt from the provisions of section 8(1) of the Act, if--

(a) it does not cause or contribute to any undue interference to any wireless telegraphy;

(b) it is not used on board an aircraft and use is not otherwise airborne;

(c) it is not used on board a ship.]

[10 Citizens' Band Radio Equipment]

[The use of wireless telegraphy apparatus complying with the publication "IR 2027.2--UK Radio Interface Requirement 2027.2 for AM/SSB and DSB use in the Citizens' Band Radio Service" published by Ofcom in June 2014, is exempt from the provisions of section 8(1) of the Act, if it does not cause or contribute to any undue interference to any wireless telegraphy.]

Ed Richards

Chief Executive of the Office of Communications

For and by authority of the Office of Communications

14th October 2010

SCHEDULE

REVOCATIONS

Regulation 3

Regulations revoked	*References*	*Extent of revocation*
The Wireless Telegraphy (Short-Range Devices)(Exemption) Regulations 2009	SI 2009/1812	The whole Regulations
The Wireless Telegraphy (Exemption) Regulations 2003	SI 2003/74	Regulation 4(3)(d) Regulation 4(4)(c) Schedule 6 Schedule 8 Schedule 9 Schedule 11

EXPLANATORY NOTE

(This note is not part of the Regulations)

These Regulations exempt the establishment, installation and use of wireless telegraphy stations and wireless telegraphy apparatus from the requirement to be licensed under section 8(1) of the Wireless Telegraphy Act 2006 (c 36).

Regulation 3(1) revokes the Wireless Telegraphy (Short Range Devices) (Exemption) Regulations 2009 (SI 2009/1812) and Regulation 3(2)(a) amends the Wireless Telegraphy (Exemption) Regulations 2003 (SI 2003/74), to remove provisions that are replaced by Regulations 5, 6 and 7 as set out below.

Regulation 3(2)(b) amends Schedule 3 of SI 2003/74, adding new frequencies to the list of frequencies within which UMTS user terminals are permitted to operate.

Regulation 4 exempts railway level crossing radar (a safety device), subject to terms and limitations including three exclusion zones.

Regulation 5 of these Regulations re-enacts, with modifications of substance, Schedules 6 and 9 of SI 2003/74 and SI 2009/1812. It extends the exemptions provided to give effect to EU obligations which are contained in Commission Decision 2010/368/EU amending Decision 2006/771/EC on harmonisation of the radio spectrum for use by short-range devices. In addition, it extends exemptions for underwater devices, inductive devices, vehicle radar, wireless cameras, technologies at 2.4 GHz and 5.8 GHz, Wireless Access Systems at 5 GHz, and technologies at 869.3 to 869.4 MHz.

Regulations 6 and 7 of these Regulations re-enact, with modifications, Schedules 8 and 11 of SI 2003/74. They make the following changes of substance. Regulation 6 of these Regulations replaces Schedule 8 of SI 2003/74, extending the exempt frequency band of operation from 58.9 GHz to 63.9 GHz, subject to six exclusion zones. Regulation 7 of these Regulations replaces Schedule 11 of SI 2003/74, increasing the permitted power in the frequency band 29.4625 to 30 GHz from 50 dbW to 55 dbW.

Interface requirements are published by OFCOM in accordance with Article 4.1 of Directive 1999/5/EC of the European Parliament and of the Council on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity. Copies of interface requirements referred to in these Regulations may be obtained from OFCOM at Riverside House, 2a Southwark Bridge Road, London SE1 9HA and are available on the OFCOM website at http://www.ofcom.org.uk.

A full regulatory impact assessment of the effect that these Regulations will have on the costs to business is available to the public from OFCOM's website at http://www.ofcom.org.uk or from the OFCOM library at Riverside House, 2A Southwark Bridge Road, London SE1 9HA (Tel: 020 7981 3000). Copies of this assessment have also been placed in the libraries of both Houses of Parliament.

Annex 9

Proposed updates to Interface Requirement 2030

We are proposing a modification and addition of a new row to Interface Requirement 2030 (IR 2030) which will be referred to in the Proposed Regulations. The technical parameters set out in IR2030 will form part of the requirements with which individuals must comply when operating in the 5725 – 5850 MHz frequencies. Modifications and additions are in red. All other requirements remain the same. The current version of IR 2030 can be found on our website.[51]

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

Proposed modification of row IR2030/8/2 currently covering the 5470 – 5725 MHz band

Interface Number / Notification number / Date	Normative Part								Informative Part
	Application	Comments to application	Frequency band	Comments to Frequency band	Transmit power / Power density	Comment to Transmit power / Power density	Channelling	Channel access and occupation rules	Reference
IR2030/8/2 2010/0168/UK Oct 2010	Wireless Access Systems (WAS)	Aeronautical mobile use is not permitted. The apparatus may also be used airborne within an aircraft, only to establish a connection with a station or apparatus within the same aircraft.	5470-572~~5~~30 MHz		Maximum mean e.i.r.p. of 1W and Maximum mean e.i.r.p. density of 50mW/MHz in any 1 MHz band			Techniques to access spectrum and mitigate interference that provide at least equivalent performance to the techniques described in harmonised standards adopted under Directive ~~1999/5/EC~~ 2014/53/EU must be used.	Where the band 5470 – 5725 MHz is used, Dynamic Frequency Selection and Transmit Power Control are assumed to be implemented as specified in EN 301 893 EC Decision 2005/513/EC. Where the band 5725 – 5730 MHz is used, see footnote[52] for information. Nominal Centre Frequency (MHz) 5500, 5520, 5540, 5560, 5580, 5600, 5620, 5640, 5660, 5680, 5700, 5720

[52] Although a matter for users to determine, if Dynamic Frequency Selection and Transmit Power Control are implemented as elements of the techniques to access spectrum and mitigate interference referred to under 'Channel access and occupation rules', one possible approach may be to apply Dynamic Frequency Selection and Transmit Power Control as specified in EN 301 893 (applied to this band in the same way as applied to the 5150 – 5350 and 5470 – 5725 bands); and Dynamic Frequency Selection detection radar test signals as specified in EN 302 502 (as applied to WAS equipment).

Proposed modification addition of new row to cover the 5725 – 5850 MHz band

Interface Number / Notification number / Date	Normative Part								Informative Part
	Application	Comments to application	Frequency band	Comments to Frequency band	Transmit power / Power density	Comment to Transmit power / Power density	Channelling	Channel access and occupation rules	Reference
XXYYYYY	Wireless Access Systems (WAS)	Equipment must not form part of a fixed outdoors installation when operating in 5730 – 5850 MHz Aeronautical mobile use is not permitted. Equipment may be used airborne, within an aircraft, only to establish a connection with a station or apparatus within the same aircraft.	5725 – 5850 MHz		Maximum mean e.i.r.p of 200 mW and maximum mean e.i.r.p density of 10 mW/MHz in any 1 MHz band			Techniques to access spectrum and mitigate interference that provide at least equivalent performance to the techniques described in harmonised standards for the 5150 – 5350 MHz and 5470 – 5725 MHz bands adopted in accordance with EC Decision 2005/513/EC and Directive 2014/53/EC must be used.	See footnote[53] for information. Nominal Centre Frequency (MHz) 5745, 5765, 5785, 5805, 5825

[53] Although a matter for users to determine, if Dynamic Frequency Selection and Transmit Power Control are implemented as elements of the techniques to access spectrum and mitigate interference referred to under 'Channel access and occupation rules', one possible approach may be to apply Dynamic Frequency Selection and Transmit Power Control as specified in EN 301 893 (applied to this band in the same way as applied to the 5150 – 5350 and 5470 – 5725 bands), except with respect to Dynamic Frequency Selection detection radar test signals; where Dynamic Frequency Selection detection radar test signals as specified in EN 302 502 (as applied to WAS equipment) may be applied."

Annex 10

Voluntary National Specification

A10.1 We are proposing the following Voluntary National Specification for publication.

VNS [….] – Voluntary National Specification [….]

5.8 GHz Wireless Access Systems operating in the 5725 – 5850 MHz band and systems where channels overlap into the 5725 – 5730 MHz band

DRAFT

Publication date: TBC

Section 1 ***of draft VNS***

Forward

1.1 This Voluntary National Specification ('VNS') is intended to provide guidance on equipment which may be suitable for operating in the 5725 – 5850 MHz band under the licence exemption specified in the Wireless Telegraphy (Exemption and Amendment) (Amendment) Regulations 2017[54] ('the 5.8 WAS/RLAN Regulations') and Interface Requirement 2030.

1.2 ETSI is finalising draft ETSI harmonised standard EN 301 893 for 5 GHz high performance RLAN. This standard covers radio equipment capable of operating in the 5150 – 5350 and 5470 – 5725 bands. However, the frequency band 5725 – 5850 MHz is not within scope of EN 301 893. This VNS is intended to provide guidance in cases where RLAN products operate in the frequency band 5725 – 5850 MHz, and hence are fully or partially outside the scope of EN 301 893.

1.3 This VNS is likely to be superseded if the scope of ETSI EN 301 893 is updated to cover the 5725 – 5850 MHz frequency range. We will keep this situation under review.

1.4 This VNS should not be relied upon as legal advice, or understood as modifying any legal obligations which may otherwise apply. In particular, this VNS is not intended to provide guidance on meeting the requirements of the Radio Equipment Directive 2014/53/EU. Manufacturers and Economic Operators should therefore refer to Radio Equipment Directive 2014/53/EU and seek their own independent advice as to their legal responsibilities. Ofcom makes no representation or warranty, express or implied, with respect to the information contained in the VNS and any liability is therefore expressly disclaimed.

[54] SI Reference to be inserted once the Regulations are made

Section 2 ***of draft VNS***

Scope

2.1 This VNS gives guidance on the minimum technical characteristics for 5.8 GHz Wireless Access Systems ('WAS') including Radio Local Access Network ('RLAN') equipment.

2.2 This VNS covers radio equipment capable of operating in all or parts of the frequency bands given in table 1.

Table 1: Service Frequency bands

	service frequency bands
Transmit	5 725 MHz to 5 850 MHz
Receive	5 725 MHz to 5 850 MHz

2.3 This VNS also covers WAS/RLAN equipment in the 5470 – 5730 MHz band where nominal channel bandwidth(s) as prescribed in 4.2.2 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11) fall partly within the 5725 – 5850 MHz band (overlapping channels).

2.4 An overview and intention of 5.8 GHz WAS/RLAN technical rules and parameters can be found in Annex 2.

References

2.5 [Draft] ETSI EN 301 893 V2.0.7 (2016-11)

2.6 [Draft] ETSI EN 302 502 V2.0.8 (2016-12).

Definitions

Overlapping channels: WAS/RLAN equipment in the 5470 – 5730 MHz band where nominal channel bandwidth(s) as prescribed in 4.2.2 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11) fall partly within the 5725 – 5850 MHz band within the frequency range 5725 – 5830 MHz**.**

Non-overlapping channels: WAS/RLAN equipment in the 5725 – 5850 MHz band where nominal channel bandwidths as prescribed in 4.2.2 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11) fall fully within the 5725 – 5730 MHz band.

Refer to section 3.1 of [Draft] ETSI EN 301 893 V2.0.7 (2016) for other definitions.

Symbols

dB	decibel
dBm	dB relative to 1 mW
fc	Carrier frequency
GHz	gigahertz
Hz	hertz
kHz	kilohertz
L	Radar burst length
MHz	megahertz
ms	millisecond
Samples/s	Samples per second
mW	milliwatt
n	Number of channels
g	Channel number

Refer to section 3.2 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11).

Abbreviations

WAS	Wireless Access Systems
RLAN	Radio Local Area Network
e.i.r.p.	equivalent isotropically radiated power
TPC	Transmit Power Control

Refer to section 3.3 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11) for other symbols.

Section 3 *of draft VNS*

Minimum technical characteristics of equipment

3.1 This gives guidance on the minimum technical characteristics for WAS/RLAN equipment operating in the 5.8 GHz band for both non-overlapping and overlapping channels. Table 2 gives detailed guidance on limits for the key technical parameters of WAS/RLAN equipment that may be considered.

Table 2: Minimum technical characteristics of equipment

<table>
<tr><th>Parameter</th><th>Reference</th><th>Limits</th><th>Additional information</th></tr>
<tr><td>Nominal Centre frequencies</td><td>4.2.1 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)</td><td>Use 4.2.1 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11). Use the following equations in place of equation (1) of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)

$fc_n = 5\ 160 + (g \times 20)$ MHz,

where $25 \leq g \leq 28$

and

$fc_n = 5\ 160 + 5 + (g \times 20)$ MHz

where $29 \leq g \leq 33$</td><td>Refer to Figure 3 for channelling and channel bonding. While channel numbers (g) follow the format in EN 301 893 it has a direct relationship to the IEEE channel numbering shown in Figure A1</td></tr>
<tr><td>Nominal Channel Bandwidth and Occupied Channel Bandwidth</td><td>4.2.2 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)</td><td>Use 4.2.2 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)</td><td></td></tr>
<tr><td>RF output power, transmit power control and power density for non-overlapping channels in the 5725 – 5850 MHz band</td><td>4.2.3 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)</td><td>Use 4.2.3 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11), use the following tables in place of tables 2 and 3 from [Draft] ETSI EN 301 893 V2.0.7 (2016-11),

Table 2: Mean e.i.r.p. limits for RF output power and power density at the highest power level

<table>
<tr><th colspan="2">Mean e.i.r.p. limit (dBm)</th><th colspan="2">Mean e.i.r.p. density limit (dBm/MHz)</th></tr>
<tr><th>with TPC</th><th>without TPC</th><th>with TPC</th><th>without TPC</th></tr>
</table>
</td><td></td></tr>
</table>

<table>
<tr>
<td></td>
<td></td>
<td>
<table>
<tr><td>23</td><td>20</td><td>10</td><td>7</td></tr>
</table>

Table 3: Mean e.i.r.p. limits for RF Output Power at the lowest power level of the TPC range

<table>
<tr><th>Frequency range</th><th>Mean e.i.r.p. (dBm)</th></tr>
<tr><td>5 725 MHz to 5 850 MHz</td><td>17</td></tr>
</table>
</td>
<td></td>
</tr>
<tr>
<td>RF output power, transmit power control and power density for overlapping channels in the 5470 – 5730 MHz band</td>
<td>4.2.3 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)</td>
<td>Use 4.2.3 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11). Refer to the limits for the 5470 – 5725 MHz band</td>
<td>Devices using overlapping channels in the 5470 – 5730 MHz, can transmit up to 30 dBm / 1 W e.i.r.p.</td>
</tr>
<tr>
<td>Transmitter unwanted emissions</td>
<td>4.2.4 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)</td>
<td>Use 4.2.4 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)</td>
<td>Where the 5 GHz RLAN bands are referred to this also includes the 5725 – 5850 MHz band</td>
</tr>
<tr>
<td>Receiver spurious</td>
<td>4.2.5 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)</td>
<td>Use 4.2.5 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)</td>
<td></td>
</tr>
<tr>
<td>Dynamic Frequency Selection</td>
<td>4.2.6 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)

4.2.6 [Draft] ETSI EN 302 502 V2.0.8 (2016-12)</td>
<td>Use 4.2.6 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11).

For devices using non-overlapping channels in the 5725 – 5850 MHz band, apply tables D.3 a), D.3 b) and D4 from Annex D of [Draft] ETSI EN 302 502 V2.0.8 (2016-12) instead of tables D.3, D4 and D.5 from Annex D of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)

For devices using overlapping channels in the 5470 – 5730 MHz band apply both tables D.3 a), D.3 b) and D4 from Annex D of [Draft] ETSI EN 302 502 V2.0.8 (2016-12) as well as tables D.3, D4 and D.5 from Annex D of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)</td>
<td>For non-overlapping channels in the 5725 – 5850 MHz band the radar signatures from [Draft] ETSI EN 302 502 V2.0.8 (2016-12) need to be applied

For overlapping channels in the 5470 –</td>
</tr>
</table>

			5850 MHz band the radar signatures from both [Draft] ETSI EN 301 893 V2.0.7 (2016-11) and [Draft] ETSI EN 302 502 V2.0.8 (2016-12) need to be applied.
Adaptivity	4.2.7 [Draft] ETSI EN 301 893 V2.0.7 (2016-11)	Use limits from 4.2.7 [Draft] ETSI EN 301 893 V2.0.7 (2016-11). Refer to Figure 3 in Annex 1 of this VNS instead of Figure 3 in 4.2.7.3.2.3 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)	
Receiver Blocking	4.2.8 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)	Use limits from 4.2.8 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)	
User Access Restrictions	4.2.9 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)	Use limits from 4.2.9 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)	
Geo-location	4.2.10 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)	Use limits from 4.2.10 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)	

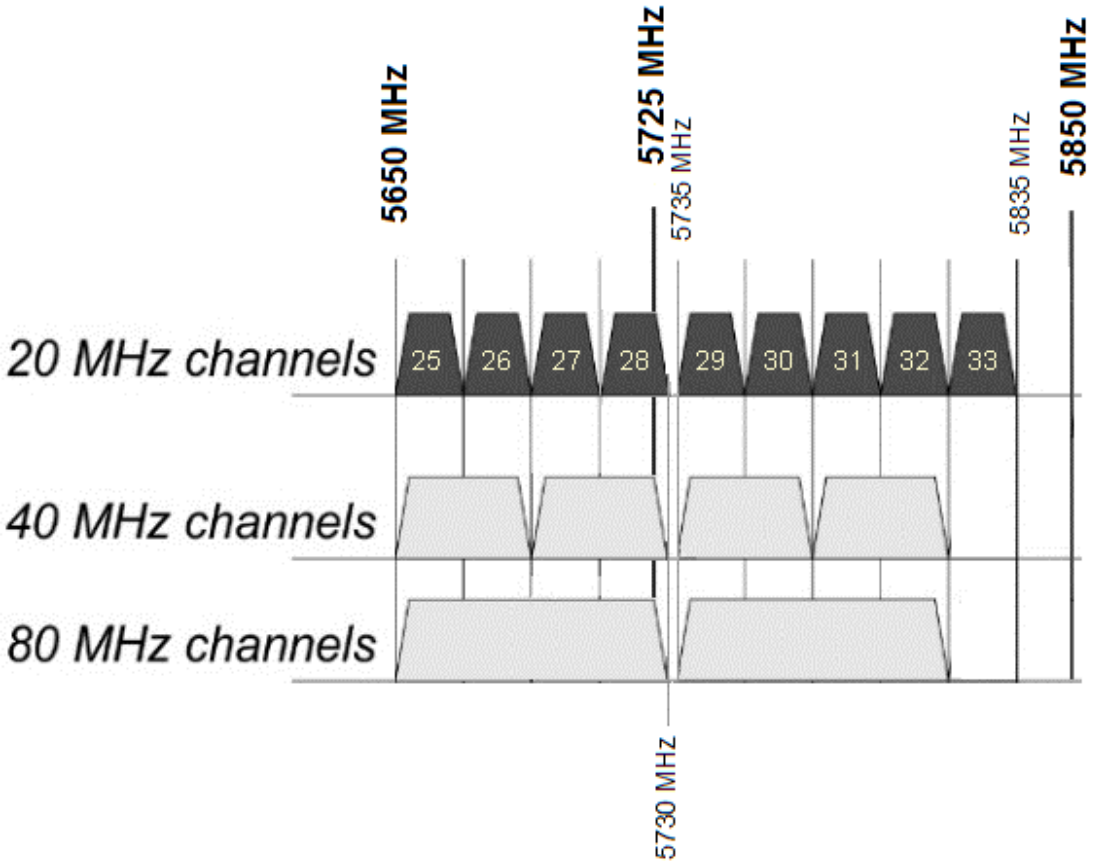
3.2 Where the 5150 – 5350 MHz and 5470 – 5725 MHz frequency ranges are referred to in [Draft] ETSI EN 301 893 V2.0.7 (2016-11) and [Draft] ETSI EN 302 502 V2.0.8 (2016-12), appropriate translation may be needed for the 5725 – 5850 MHz band.

Annex 1 ***of draft VNS***

Channel Bonding

A1.1 This Annex gives an alternative to Figure 3 in 4.2.7.3.2.3 of [Draft] ETSI EN 301 893 V2.0.7 (2016-11)

Figure 3: Channel Bonding



Annex 2 *of draft VNS*

Overview and Intention of 5.8 GHz WAS/RLAN technical parameters

A2.1 This gives and informative overview and intention of the technical characteristics and parameters for 5.8 GHz WAS / RLAN.

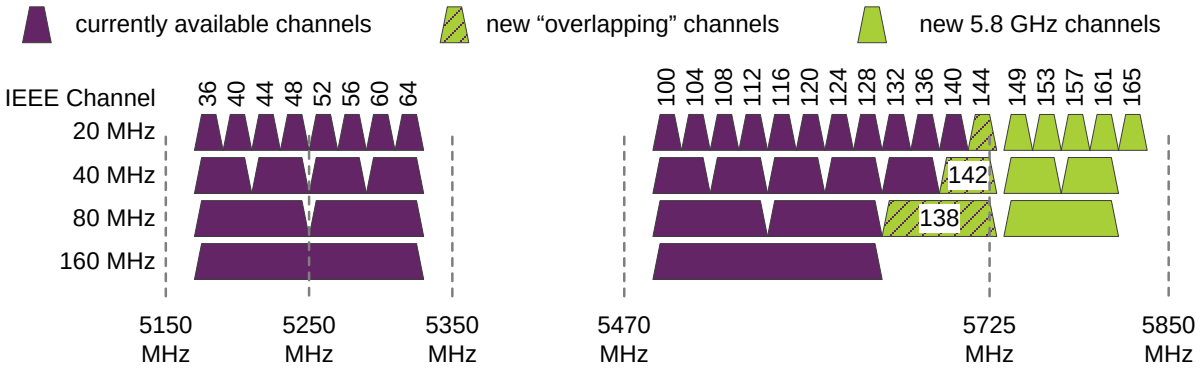


Figure A1: Existing 5 GHz RLAN channels and the new channels we are making available (note different channel labels from 4.2.1 and figure 3a)

A2.2 Users of licence-exempt devices need to be aware that there are no guarantees that the spectrum will be free of interference. However, by defining the maximum transmit power, along with other characteristics, this keeps the probability of undue interference low.

A2.3 WAS/RLANs which operate in the 5725 – 5850 sub-band must comply with the technical parameters set out in the Regulations and IR2030. The limits are summarised below in Table A1. In setting this limit, we aimed to authorise the least restrictive conditions which were also appropriately cautious in relation to interference to other services, based on studies at the time. This is to maximise benefits to consumers of Wi-Fi services while avoiding negative impacts on other users.

Table A1: Summary of technical parameters for 5725-5850 MHz WAS/RLAN[55]

Radiated Power Limit:	200 mW EIRP
Location Restrictions:	No Fixed Outdoor[56]
Channel access and occupation rules:	Normal WAS/RLAN channel access and occupation rules

[55] See Interface requirement 2030

[56] Aeronautical mobile use is not permitted. The apparatus may also be used airborne within an aircraft, only to establish a connection with a station or apparatus within the same aircraft.

A2.4 Although compliance with the above technical parameters is a matter for manufacturers and operators to determine for themselves, certain Dynamic Frequency Selection ('DFS') techniques may useful in meeting those requirements. The references set out in Table A2 may be helpful in providing a single, overall technique for achieving mitigation for preventing interference to radars.

Table A2: Summary of DFS techniques which may be usefully applied for 5725-5850 MHz WAS/RLAN[57]

DFS requirements inc. detection threshold	ETSI EN 301 893
and	
DFS detection radar patterns	ETSI EN 302 502

A2.5 On matters *other* than the detection of radar test patterns (for example, detection thresholds), the requirements from ETSI EN 301 893 might be usefully applied, in the same way as they apply to the use of Wi-Fi/RLAN/WAS in the 5150 – 5350 MHz and 5470 – 5725 MHz bands.

A2.6 With respect to the detection of radar patterns that should be detected, the requirements of ETSI EN 302 502 (5.8 GHz) standard might usefully be applied. This is a standard currently applicable to higher power fixed broadband covering the 5.8 GHz band, and as such, the patterns already reflect the radar systems that use these specific frequencies.

A2.7 ETSI EN 302 502 is not relevant as far as detection thresholds and other requirements are concerned. This is because ETSI EN 302 502 was designed with higher power fixed equipment in mind.

A2.8 On everything other than radar patterns, the requirements from ETSI EN 301 893 (5.4 GHz), which is a standard designed for Wi-Fi/RLAN/WAS. This will also ensure that equipment used in the 5.8 GHz band will comply with the RED.

A2.9 Additionally, for those channels which fall in both the existing 5470-5725 MHz Wi-Fi band and the 5725-5850 MHz band, the limits summarised below in Table A3 apply.

[57] See Interface requirement 2030

Table A3: Summary of 'normative' technical parameters for WAS/RLAN channels which have a bandwidth in both 5470-5725 MHz and 5725-5730 MHz only[58][59]

Radiated Power Limit	1 W EIRP
Location Restrictions	<none>
Channel access and occupation rules:	Normal WAS/RLAN channel access and occupation rules

A2.10 Again, compliance with the technical parameters set out above is a matter for manufacturers and operators to determine for themselves, however certain DFS techniques may be usefully applied when using frequencies which fall within both the 5740 – 5725 MHz and 5725 – 5730 MHz bands. Table 4 sets out the DFS techniques which may be usefully applied when operating in these frequencies.

Table A4: Summary of DFS techniques which may be usefully applied for WAS/RLAN channels which have a bandwidth in both 5470-5725 MHz and 5725-5730 MHz only [60]

DFS requirements inc. detection threshold	ETSI EN 301 893
and	
DFS detection radar patterns	ETSI EN 301 893 & ETSI EN 302 502

A2.11 Where overlapping channels that fall within frequencies 5725 MHz – 5730 MHz are being used at the higher radiated power level of 1 W EIRP, we would suggest that two forms of mitigation may be appropriate in order to meet the above channel access and occupation rules. The detection thresholds for channels 138, 142 and 144 (equivalent channels: 28, 28+29 or 25+26+27+28 refer figure 3) are taken from ETSI EN 301 893 (as applied to the 5740 – 5725 MHz band) and the radar patterns (radar test signals) to be detected are taken from both ETSI EN 301 893 and ETSI EN 302 502, as suggested for the 5725 – 5850 MHz band above. We believe that the detection thresholds from ETSI EN 301 893 are more appropriate than those in ETSI EN 302 502 because WAS/RLAN will be limited to a radiated power level of 1 W EIRP. This is the same radiated power level as existing WAS/RLAN equipment operating in the 5470-5725 MHz band and lower than the 4 W EIRP radiated power limit for 5.8 GHz BFWA.

A2.12 These limits for the 5725 – 5730 MHz frequencies are, overall, more relaxed than those for channels which fall wholly within the 5725-5850 MHz band, but this relaxation is justified because consequent the risk of interference to incumbent services in these 'overlapping channels is low, principally because these channels all

[58] IEEE 802.11 channels in both the 5470-5725 and 5725-5730 MHz bands are:
Channel 138: 5650-5730 MHz
Channel 142: 5690-5730 MHz
Channel 144: 5710-5730 MHz
See Interface requirement 2030

[60] See Interface requirement 2030

have an upper edge at 5730 MHz and so only extend 5 MHz into the 5725-5850 MHz band.

Annex 11

Glossary

4G	Fourth generation mobile phone standards and technology.
CEPT	European Conference of Postal and Telecommunications Administrations.
Communications Act	The Communications Act 2003, which came into force in July 2003.
dBm	The power ratio in decibels (dB) of the measured power referenced to one milliwatt (mW).
DFS	Dynamic Frequency Selection. A system that makes Wi-FI routers change frequency when a radar using the same frequency is near.
Earth stations	A station located either on the earth's surface or within the major portion of the Earth's atmosphere and intended for radio communication with one or more satellites or space stations.
EC	European Commission.
ECC	The Electronic Communications Committee (ECC) considers and develops policies on electronic communications activities in European context, taking account of European and international legislations and regulations.
EESS	Earth Exploration Satellite Service. A satellite radio communication service which obtains information relating to the characteristics of the Earth and its natural phenomena from active or passive sensors on the satellite, and distributes this information to earth stations.
EIRP / e.i.r.p	Equivalent Isotropically Radiated Power. This is the product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain).
ETSI	European Telecommunications Standards Institute.
EU	European Union.
Fixed link	A terrestrial based wireless system operating between two or more fixed points.
Frequency band	A defined range of frequencies that may be allocated for a particular radio service, or shared between radio services.
FSS	Fixed Satellite Service. Two-way communication links between earth stations, usually at fixed locations, and one or more satellites.
GHz	Gigahertz. A unit of frequency of one billion cycles per second.

IEEE	Institute of Electrical and Electronics Engineers.
IEEE-802.11	An evolving family of specifications for wireless local area networks (WLANs) developed by a working group of the Institute of Electrical and Electronics Engineers (IEEE).
ISM Bands	The Industrial, Scientific & Medical bands are radio bands reserved internationally for industrial, scientific and medical purposes other than telecommunications.
ITU	International Telecommunications Union - Part of the United Nations with a membership of 193 countries and over 700 private-sector entities and academic institutions. ITU is headquartered in Geneva, Switzerland.
ITU-R	International Telecommunications Union Radiocommunication Sector, which focuses on radio spectrum and satellite orbits.
ITU-R Region 1	Article 5 of the ITU Radio Regulations divides the world into three regions for the allocation of frequencies. Region 1 includes Europe, Africa, parts of the Middle East, the former Soviet Union and Mongolia.
MHz	Megahertz. A unit of frequency of one million cycles per second.
MSS	Mobile Satellite Service. Two-way communication links between portable user terminals and one or more satellites.
mW	milliwatt. A derived unit of power in the International System of Units (SI). A Milli-Watt is one thousandth (1x10-3) Watts.
Notified bodies	A notified body is an organisation designated by an EU country to assess the conformity of certain products before being placed on the market. These bodies carry out tasks related to conformity assessment procedures set out in the applicable legislation, when a third party is required. The European Commission publishes a list of such notified bodies.
PMSE	Programme Making and Special Events. A class of radio application that supports a wide range of activities in entertainment, broadcasting, news gathering and community events.
Radio Spectrum	The portion of the electromagnetic spectrum below 3000 GHz used for radiocommunications.
RED	Radio Equipment Directive 2014/53/EU of the European Parliament and of the Council. It creates a set of rules for placing radio equipment on the European market, and putting them into service.
Region 1	See ITU-R Region 1.

RLAN (or WLAN)	Radio Local Area Network. A radio access system used to provide wireless access between computer devices. RLANs are intended to cover smaller geographic areas like homes, offices and to a certain extent buildings being adjacent to each other.
TPC	Transmit Power Control. A technical mechanism used to prevent too much unwarranted interference between different wireless networks.
U-NII	Unlicensed National Information Infrastructure radio band. U-NII is an FCC regulatory domain for 5- GHz wireless devices. It operates over four ranges: U-NII Low (U-NII-1): 5.15-5.25 GHz, U-NII Mid (U-NII-2): 5.25-5.35 GHz, U-NII Worldwide (U-NII-2e): 5.47-5.725 GHz, and U-NII Upper (U-NII-3): 5.725 to 5.850 GHz.
WAS	Wireless Access Systems (WAS) are end-user radio connections to public or private core networks.
Wi-Fi	Commonly used to refer to radio local area network (RLAN) technology, specifically that conforming to the IEEE 802.11 family of standards. Such systems typically use one or more access points connected to wired Ethernet networks which communicate with wireless network adapters in end devices such as PCs. It was originally developed to allow wireless extension of private LANs but is now also used as a general public access technology via access points known as "hotspots".
WRC	World Radiocommunication Conference. The WRC reviews and revises the Radio Regulations. They are held every three to four years. The last four conferences were held in 2003, 2007, 2012 and 2015. The next WRC will be held in Geneva in 2019 is referred to as WRC-19.