Ofcom
making communications work
for everyone

Spectrum for Unmanned Aircraft Systems (UAS)

Approach to authorising the use of radio equipment on UAS

CONSULTATION:

Publication Date: 10 Jun 2022
Closing Date for Responses: 5 September 2022

Contents

Section

Annex

1. Overview

Unmanned Aircraft Systems (UAS), also known as drones or Remotely Piloted Aerial Systems, could bring significant innovations to several industries, ultimately delivering benefits to consumers and citizens. Wireless communications, and hence the use of radio spectrum, is essential to the operation of drones.

One of Ofcom responsibilities is to manage the UK's radio spectrum. We have been working with the Civil Aviation Authority (CAA) and with stakeholders to review our framework for authorising equipment that can be used on a drone, to help enable the development of this emerging industry. Drones currently use spectrum designated for model aircraft or Wi-Fi which do not require a Wireless Telegraphy Act licence, as these devices have been exempted from needing one by Ofcom. However, this regime is not suitable for some of the emerging use cases which would involve drones flying at higher altitudes and over longer ranges, sometimes going beyond visual line of sight. This is due to power limitations of the licence exempt devices that they use.

What we are proposing – in brief

We are proposing to introduce a new spectrum licence for drone operators, especially those looking to fly beyond visual line of sight using mobile or satellite technologies. Our proposed Unmanned Aircraft System (UAS) Operator Radio licence would authorise the licensed operator to use a range of technologies on their UAS/drone fleet that are not currently permitted today, including:

- mobile and satellite terminals for control and transmission of data and video; and
- safety equipment to enable the UAS to avoid collisions and integrate safely into the UK's airspace.

The proposed licence would cover a range of equipment that an operator may choose to use or be required to carry by the Civil Aviation Authority (CAA). If a licensee wishes to use a mobile technology that connects to a public mobile network they will need, before doing so, to obtain permission from the operator of the network they wish to use. We are proposing that the licence would be subject to an annual fee of £75.

Our proposed licence would not replace the current licence exemption regime for low power 2.4 GHz and 5 GHz equipment which most drones on the market currently fall under today.

In addition to a licence to use the spectrum, operators will continue to need to adhere to any air safety requirements regarding the operation of their UAS set by the CAA, the UK's aviation regulator.

Stakeholders are invited to respond by 5 September 2022.

1.1 This document consults on proposals to authorise the use of a range of radio equipment on a UAS.[1] This includes equipment to control the UAS as well as other related radio safety devices.

1.2 Where previously UAS were seen as small devices used for recreational purposes they are now increasing in size, complexity, range and used more commercially. As technology progresses, these devices are becoming increasingly automated, and may one day become fully autonomous without the need for a remote pilot.

1.3 For many years Ofcom has authorised the use of spectrum used to control model aircraft and UAS through our licence exemption regime. Typically, these devices either use the 35 MHz frequency band (designated for airborne model control) or the 2.4 GHz and 5 GHz frequency bands (using Wi-Fi or other low power radio network technologies). However, as the operational range and altitude of UAS flights are increasing, sometimes going beyond visual line of sight (BVLOS), this brings with it new challenges. This is because the current licence exempt equipment we authorise is not suitable for this use as it does not provide the necessary coverage. Working with stakeholders we have been looking at ways to resolve this issue.

1.4 The two leading solutions that meet the coverage needs of BVLOS are the use of satellite and/or mobile terminals. Presently, neither of these are permitted to be used airborne on a UAS. Satellite terminals are licensed for use on aircraft but the use of mobile terminals airborne is not. This is because airborne use of mobile terminals can cause interference or impact the technical quality of service of the host mobile network as well as some other users. Ofcom, along with other regulators in Europe, have been working on a set of proposals that could allow the use of mobile terminals airborne.

1.5 The CAA regulates the safety of aviation, including aircraft, associated equipment, and airspace. They also set out the rules governing how and where UAS can be flown safely. Along with Government, the CAA is currently developing a framework for UAS use and its integration into the overall UK airspace management regime. From this work it is likely that the CAA will provide a set of requirements relating to what radio equipment UAS must use to avoid collisions and integrate safely into the UK's airspace. This equipment would be vital for UAS to be operated safely at greater distances/altitudes and with other users of the airspace. We have been working closely with the CAA on these issues.

1.6 Although there is still some uncertainty surrounding the long term 'must carry' requirements that may be imposed on UAS operators by the CAA, we believe we should still proceed and develop an authorisation approach. Our proposals are designed to allow the commercial and operational use of radio equipment on a UAS. Establishing this new licensing regime should enable the CAA and the Department for Transport to further progress their wider airspace policy proposals.

1.7 Having considered the authorisation options available to us we are proposing that all equipment on a UAS, other than the current licence-exempt equipment such as Wi-Fi, be authorised via our proposed new UAS Operator Radio licence. The licence would cover a range of equipment that one may wish or be required to deploy on a UAS. The licence

[1] UAS is the preferred term but the term "drone(s)" is used interchangeably in this document.

would apply to all UAS devices used by a company or individual ("the operator"[2]). We are not proposing that each UAS would require an individual licence. We are proposing that the licence would be subject to an annual fee of £75.

1.8 Our proposed licence would cover a range of equipment that could be installed on a UAS. This includes devices that connect to public mobile and/or satellite networks to allow the UAS to be controlled and send back data or video. We are also proposing to authorise a number of systems designed to enable the safe flying of UAS, including electronic conspicuity and 'detect-and-avoid' systems. These are designed to make the UAS 'see' and 'be seen' by other airspace users. Our proposals are focused on equipment that can be carried today or in the near future and the approach we are proposing will allow us to include any new equipment on the licence should it be needed in the longer term.

1.9 Although the proposed licence provides the framework for authorisation of the use of mobile terminals on a UAS, this does not mean that mobile terminals can be used in practice on all mobile networks. Using a terminal airborne may have an impact on the mobile network, so we are proposing that the licensee would need to have obtained a written agreement from the mobile network operator prior to use. It would be up to each mobile operator to decide whether they wish to permit this use, as they may not be in a position to or want to allow such use on their networks at this time. If in the future the technology mitigates these problems, we will look to remove this requirement from the licence.

1.10 It should be noted that although we are proposing to authorise a range of equipment on a UAS, its use is subject to other non-spectrum related requirements. Many of these are set by the CAA and could include holding a Flight Radio Telephony Operators Licence (FRTOL) or being granted special permission by the CAA to allow the use of a mobile network for command and control, for example. The proposals in this document only cover the radio spectrum that can be authorised for use and do not supersede any aviation safety rules or requirements. Therefore, operators should be aware that a spectrum licence for their UAS does not necessarily indicate that the CAA has permitted the equipment to be carried. More information can be found on the CAA website.[3]

1.11 The overview section in this document is a simplified high-level summary only. The proposals we are consulting on, and our reasoning are set out in the full document.

[2] 'Operator' is a CAA defined term used in regulations for UAS use.
[3] CAA UAS information page https://www.caa.co.uk/consumers/remotely-piloted-aircraft/

2. Introduction

What is a UAS

2.1 Unmanned aircraft come in a variety of sizes, from small toys to large aircraft. Typically, an unmanned aircraft would have no pilot on board and would be controlled by a ground based remote pilot, with a communications system linking the two. This is collectively referred to as a UAS. UAS can also be known as a drone or as a Remotely Piloted Aircraft System (RPAS), but the term UAS also includes model aircraft. The traditional model aircraft usually uses a radio signal for commands from the pilot via 'traditional' control inputs, whereas drones are normally gyro-stabilised and can use Global Positioning System (GPS) for guidance in addition to acting on commands transmitted from the pilot.

What is the issue

2.2 For many years we have authorised the use of radio equipment on model aircraft and drones operating in visual line of sight via our licence exemption regime. This has been possible as these aircraft use low power equipment whose use would not be likely to cause interference to other users of the spectrum. New UAS technology and applications, especially the ability to fly greater distances and to transmit back more information, such as high quality video, have created new demands for spectrum to support beyond visual line of sight (BVLOS) usage.

2.3 Until now most model aircraft and drones have used the 35 MHz band (34.945 to 35.305 MHz, which has been designated for model control for over 30 years), and/or the 2.4 GHz and 5 GHz bands used for Wi-Fi and other RLAN devices. Our current licence exemption regime[4] permits airborne use in all of these frequency bands but at relatively low transmit power limits. However, these technologies are not able to support the longer distance, higher data requirements and safety systems that some UAS may need to use. This is because the power levels they operate at are not sufficient to provide the extended range required.

2.4 Simply increasing the permitted transmit power for these devices is not an option as they share the spectrum with many other types of devices such as Wi-Fi used in homes and Bluetooth. Increasing the power would cause interference to these devices and other UAS users. The extent of this problem is particularly severe because, since UAS necessarily involves airborne use, there are no obstacles in the way to prevent the transmissions travelling large distances. Instead, the industry is considering other technologies such as satellite and cellular mobile to meet its need for geographical coverage.

2.5 While satellite communication is already used in aircraft and is authorised via our Aircraft Radio licence[5], we do not permit its use in UAS. Similarly, mobile terminal devices are not

[4] See IR2030 Licence Exempt Short Range Devices
[5] Aircraft Radio and Aircraft (transportation) Radiocommunications Licences

currently permitted to be used airborne. Unlike satellite use, the airborne use of these mobile devices can impact the host network and has the potential to affect other services.

2.6 Furthermore, as UAS may be intended to travel longer distances at higher altitudes and within airspace used by others, safety considerations are paramount. The CAA, when approving BVLOS use of UAS, may require that the UAS is equipped with certain electronic conspicuity and detect-and-avoid devices. These are needed so that the UAS can make other users aware of its presence and avoid obstacles. Again, much of this equipment is authorised for aircraft but not for UAS use.

2.7 Currently, we have been authorising the use of a range of equipment for UAS trials under our Innovation and Trial (I&T) licensing framework.[6] This enables individuals and organisations to research, develop and test new types of radio equipment. It is through this process that all other requests for research and experimentation access are processed and coordinated to minimise the risk of interference to the incumbent user(s). However, these licences are only issued for a limited period of up to one year and on the basis that the equipment will not be used operationally or to provide a commercial service. This adequately addresses trials and demonstrations, but some operators are now seeking to deploy commercial services after receiving clearances from the CAA.

Our aim

2.8 As access to spectrum is a key element to the future success of UAS, we want to ensure that we have the appropriate framework in place that would permit the deployment of equipment whilst at the same time protecting existing users of the spectrum. We want to increase opportunities for people and businesses to access spectrum for innovation purposes. It is clear that certain equipment that UAS operators may wish to use is not covered by our current authorisation regime. Therefore, we have been working with network operators, the UAS industry, Government, the CAA and other spectrum administrations across Europe to look at possible solutions to these issues.

2.9 We also note that the UK Government's industrial strategy has an ambition for the UK to be the leading location for technology companies, and that UAS play an important part of this strategy.[7] As part of this work the CAA and the Department for Transport (DfT) are working on the wider issues of airspace policy and safety relating to UAS. They are considering the rules governing their use especially for BVLOS operations, and how they can integrate with other airspace users. The proposals in this document only cover the radio spectrum that can be authorised for use and do not supersede any aviation safety rules.

Legal Framework

2.10 Ofcom is responsible for authorising use of the radio spectrum. Since the radio spectrum is a finite resource crucial to delivering all wireless services, Ofcom is responsible for ensuring

[6] Innovation licensing including 5G - Ofcom
[7] Department for Transport, "Taking Flight: the future of drones in the UK", 2018

that it is used in the best interests of people and businesses in the UK. We authorise the use of the radio spectrum either by granting wireless telegraphy licences under the Wireless Telegraphy Act 2006 (the "WT Act") or by making regulations exempting the use of particular equipment from the requirement to hold such a licence.

2.11 It is unlawful and an offence to install or use wireless telegraphy apparatus without holding a licence granted by Ofcom, unless the use of such equipment is exempt. In Annex 1 we set out in more detail the relevant legal framework, which we have taken into account in making the proposals set out in this document. This annex should be treated as part of this document.

2.12 In addition to Ofcom's legal framework covering the authorisation of radio spectrum, UAS operators are also subject to other regulatory requirements. These are administered by the CAA and cover what can be flown, by whom and where. Examples include the requirement to seek a specific approval for operating a UAS BVLOS, where the safety risks involved are substantially higher than flying a UAS within visual distances. These requirements could involve passing tests and labelling equipment. Also, to use some equipment a Flight Radio Telephony Operator's Licence (FRTOL) or other appropriate qualification may be required. For more information on the regulations concerning drone use visit the CAA website.[8]

2.13 Operators will also need to adhere to any data protection or privacy laws that may be in place. Any photos or recordings may be covered by the General Data Protection Regulation (GDPR). More information regarding this can be found on the Information Commissioner's Office website.[9]

[8] CAA information on Remotely piloted aircraft and drones
[9] Information Commissioner's Office additional considerations for technologies other than CCTV

3. UAS technologies

Why do UAS need spectrum

3.1 To operate a UAS, radio spectrum is needed to perform a number of different tasks, including:

- Command and control – for the remote pilot to control the UAS and send navigation commands;
- Relaying of payload data – for data and video to be sent from the UAS to the remote pilot/operator;
- Electronic Conspicuity – technology to make other airspace users aware of the UAS's location and flight path;
- Detect and Avoid – the capability for the UAS to avoid objects or other aircraft to a level at least equivalent to the 'see and avoid' principle[10] in crewed aviation; and
- Communications, navigation and surveillance – depending on the airspace in which the UAS is being flown and also on the capability of other systems on the UAS, Air Traffic Controllers may need to maintain oversight and control of the flight.

3.2 The extent to which these systems may be required depends on the airspace in which the UAS is flown and on CAA requirements, and so engagement with CAA would be required before any operation is contemplated. To use some of this equipment there may also be a requirement for the operator to hold a FRTOL.

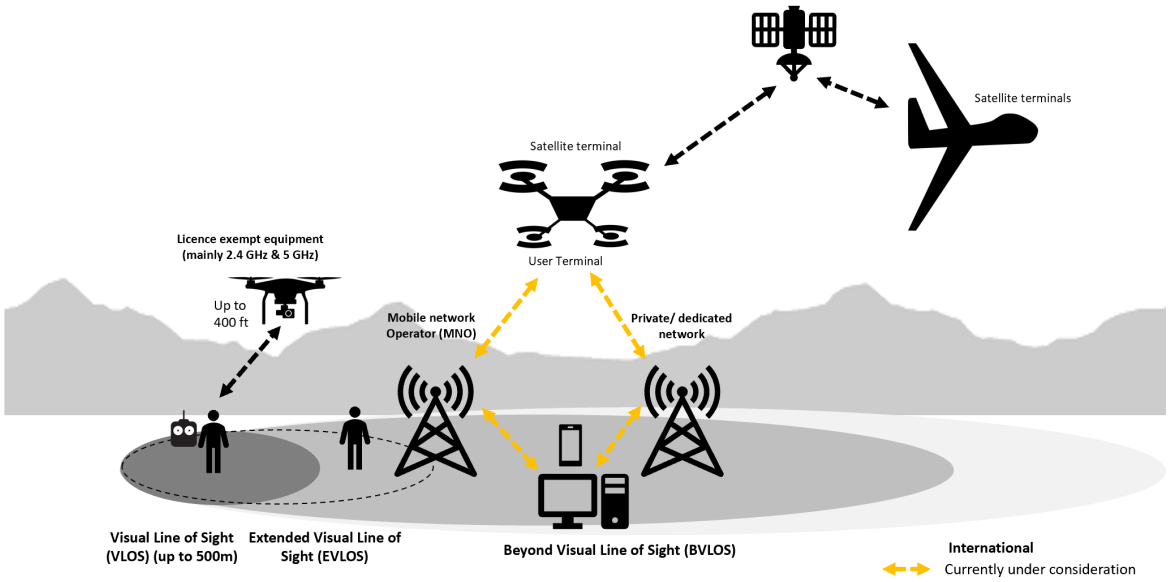
Control and payload

3.3 There needs to be a way for a remote pilot[11] to be able to control the drone or model aircraft while it is flying, and this needs radio spectrum. The remote pilot has to be able to send commands to the UAS to control it, and the UAS to send responses back to the control system. In order to assist with flying many UAS send back real time video to the remote pilot. Additionally, the UAS may need to send data or images it has collected back to the operator.

3.4 As discussed earlier, while much of this application is currently being supported through the use of licence exempt technologies alternative solutions are likely to be needed in some cases. Figure 1 below depicts the various different technologies that can provide communication links between the remote pilot/operator and the UAS.

[10] CAP722 Chapter 3 Unmanned Aircraft System Operations in UK Airspace – Guidance (caa.co.uk)
[11] Term 'Remote Pilot' means the individual who operates the flight controls of the UAS, monitors its course and is able to intervene and change course by operating its flight controls.

Figure 1: Communication links for UAS command, control and payload



Licence exempt devices

3.5 The airborne use of certain equipment is already allowed under our existing licence exemption regulations. These provide the technical and operational requirements that equipment must meet in order to be used without a licence. Most of these are set out in our Radio Interface Requirement IR 2030.[12] This includes specific frequencies for model control, Wi-Fi/RLAN and short-range devices.

3.6 35 MHz is a frequency band that is designated for model aircraft use only and has been available for use for over 30 years. The low frequency provides good coverage but limited data capacity. Most consumer UAS do not use this frequency band but instead use 2.400 to 2.4835 GHz ('2.4 GHz') and 5.725 to 5.875 GHz ('5.8 GHz'), which are used for a wide range of devices including Wi-Fi, Bluetooth and other data networks. 2.4 GHz can provide greater range whereas 5.8 GHz can provide greater data capacity. In many cases UAS use both frequency bands, 2.4 GHz for control and 5.8 GHz for payload. As the equipment is licence-exempt, the permitted power levels are quite low and could suffer from interference, especially in areas where many other devices are present.

Licence exemption proposal

3.7 As the airborne use of this equipment is already permitted and is extensively used, we are not proposing to change these arrangements. The use of this equipment will continue to be on a licence exempt basis therefore operators of drones using only this equipment will not be required to obtain a licence from Ofcom to operate (this covers most consumer drones currently available).

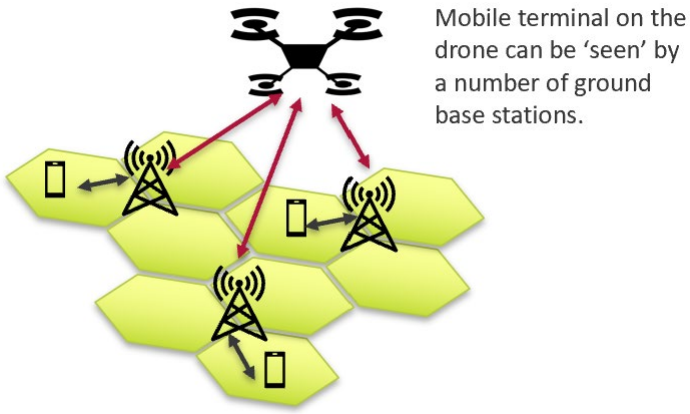
[12] Ofcom IR 2030 published April 2021

Mobile

3.8 With the development of emerging mobile technologies and use cases there is now interest in using 4G and 5G technologies for control and payload for UAS. The industry is also considering whether these technologies can play a wider role in the management of the airspace as part of an integrated air traffic control regime. The widespread coverage that mobile network operators (MNOs) are able to provide, the ability to transmit high data throughput, the availability of equipment and size/weight of the terminals all make using mobile networks/technology appealing to the UAS industry.

3.9 At present, a UAS is not permitted to use mobile terminal user equipment (UE) airborne. This is because of the high potential for an airborne UE to cause interference to the network and also to some systems operating in adjacent bands. It also impacts on the technical quality of service of the network. The problem to the host network is due to the greater number of base stations in line of sight of the airborne UAS, and the greater distances over which signals can carry when the transmitter is in the air with an unobstructed path. This is shown in Figure 2.

Figure 2: Impact of airborne UE on terrestrial mobile network



3.10 Increasing interest in Europe and beyond in UAS connectivity via mobile networks has led to the inclusion of drone-specific functionality in standardisation work by members of the 3rd Generation Partnership Project (3GPP), the global standards body for mobile telecommunications. Together with this standardisation activity, within the European spectrum management framework (CEPT[13]), the ECC Project Team 1 (ECC PT1[14]) has worked on compatibility of airborne use of mobile (referred to as 'aerial user equipment' or 'aerial UE') with systems in adjacent frequency bands.

[13] The European Conference of Postal and Telecommunications Administrations (CEPT) is a European organisation with at present 48 member countries.
[14] The ECC PT1 is responsible for international mobile telecommunications issues, including compatibility studies, development of band plans etc.

Technical assessment

3.11 Studies in Europe (CEPT) have looked at the compatibility of 'aerial UE' with systems operating in frequencies adjacent to mobile bands. ECC PT1 produced ECC Report 309[15] on compatibility in the mobile bands of aerial UE[16] with other systems in adjacent bands. ECC PT1 is currently working on an additional report in relation to the use of Active Antenna Systems (AAS).[17]

3.12 Based on technical work by ECC PT1, we considered the implications in a UK context. Our analysis found that for the majority of the mobile bands there was no need to introduce specific measures to achieve compatibility with the incumbent user or adjacent services. However, there are some areas where there is a potential risk of interference, and some mitigation may be required. These are outlined below.

Impact on MNO network

3.13 As set out in the Executive Summary of ECC Report 309, analysis in 3GPP[18] showed that, provided no more than 33% of UEs in a cell are aerial UE, the effect of aerial UE transmissions on the network is manageable with no additional measures required. Above that value, measures need to be taken which require drone identification.

3.14 In the development and evolution of 5G standards, 3GPP Release 17[19] includes the ability for drone identification – this is not just identification of whether the connected device is a drone but also whether it is airborne. This Release will also enable enhanced positional accuracy down to the order of cm. Both of these features will be further enhanced and refined in Release 18 (5G Advanced) which is expected to be completed by the end of 2023. It is expected that MNOs will need to implement these releases before they can fully identify and manage drones on their network although, in the interim, other solutions may be possible to allow controlled UAS deployments on the network.

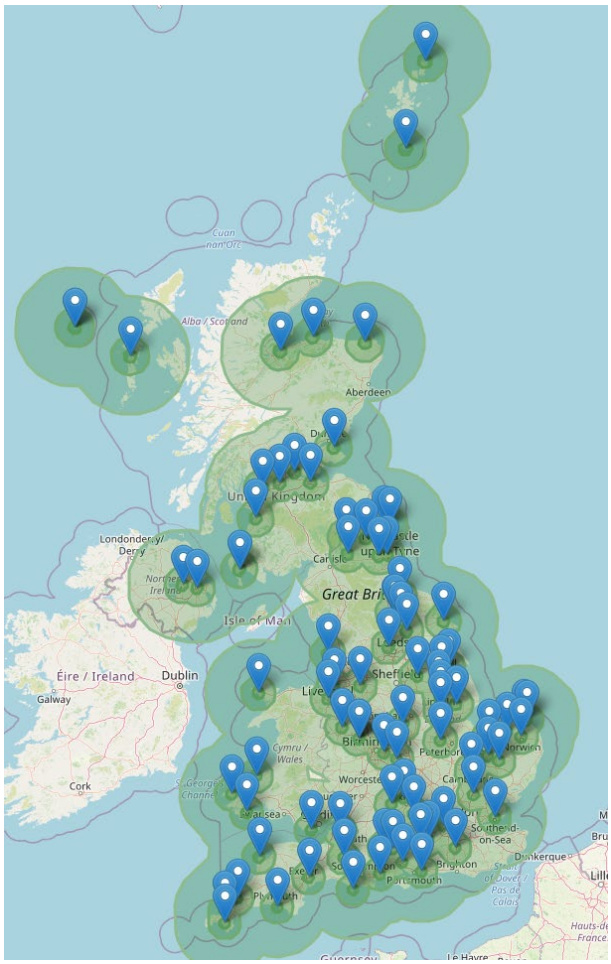
Interference to Air Traffic Control Radar

3.15 Both the ECC PT1 and our own analysis have shown that there are potential problems with interference to Air Traffic Control (ATC) radars in the 2.7 to 2.9 GHz band if a UAS uses a UE connecting to the 2.6 GHz band. We do not believe that the UE use of 3.4 GHz would be problematic for ATC radars due to greater frequency separation and the 3.4 GHz band edge limits set for UK mobile network deployment. This analysis was based on the 2.6/3.4 GHz radar coordination notices[20] which set power flux density (PFD) limits that must be met at the radar face to protect them from aggregate interference from mobile network base station deployments in the 2.6 and 3.4 GHz bands.

[15] ECC Report 309 https://docdb.cept.org/download/1411
[16] The report says that the term UE is equally applicable to equipment either in unmanned aircraft or in crewed aircraft such as helicopters
[17] PT1 is currently working on a report covering the case of aerial UE working with base stations with AAS in the 1.8, 2 and 2.6 GHz mobile bands.
[18] 3GPP TR 36.777 V15.0.0: "Enhanced LTE support for Aerial Vehicles"
[19] 3GPP Release 17
[20] 2.6/3.4GHz radar coordination notices

3.16 Our calculations[21] showed that if a UAS was using the 2.6 GHz band, a no-transmit zone of 78km around each of the 90 or so radars on the UK protected radar list[22] would be needed. This is based on the assumption that the spurious emission performance of the aerial UE just meets the limit of -30dBm/MHz, as set out in the relevant standard.[23] As can be seen in Figure 3, these zones overlap to cover almost all of the UK. We understand that equipment can and often does perform better than the standard, and we therefore calculated the distances based on spurious emission limits of -40dBm/MHz and -50dBm/MHz. This calculation showed a marked improvement over equipment meeting the standard but still required separation distances of 8km.

Figure 3: Map showing ATC Radar deployments and protection distances



[21] Calculations and methodology set out in Annex 3
[22] Protected Radars List, published Ofcom January 2021
[23] ETSI TS 136 101 - V16.7.0 - LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception (3GPP TS 36.101 version 16.7.0 Release 16) Table 6.6.3.1-2

Mobile authorisation proposal

3.17 We are proposing to allow the use of aerial UEs but, due to the potential for interference and impact it would have on the technical quality of service, we are not proposing that this will be on a licence exempt basis. Instead, we propose to permit this use via a licence.

3.18 Furthermore, in order to protect the host mobile network(s) from interference and the impact this has on the technical quality of service on the network, the use of an aerial UE on a UAS would be subject to the operator obtaining written permission from the MNO(s) whose network(s) they intend to use, for example, this could be in the form of a specific UAS contract between the parties. Only with such a permission will they be authorised to use a UE airborne on that network. It would therefore be up to each MNO to decide whether or not it wishes to permit airborne use on its network.

3.19 We did consider whether we should include such a provision in the licence or alternatively leave it solely to the commercial agreements between the MNOs and their end users. To leave it purely to contractual terms would likely require the MNOs to change their terms and conditions to exclude aerial use and possibly vary all existing customers licences. Having considered this, we do not believe this approach would be proportionate at this point in time. If we see evidence that UAS operators are facing particular difficulties in gaining MNO agreement for the use of aerial UEs, we may revisit this question. In this regard we are considering whether, for example, to require MNOs to notify Ofcom if they have refused permission to access their network.

3.20 With the implementation of future mobile standards by the networks, the proposed requirement to obtain written permission from the network may become obsolete. Once the networks have in place sufficient mechanisms to identify, monitor and mitigate any impact that the use of aerial UE would have on their network we will review this licence condition. If it is no longer deemed necessary, we would propose to remove this requirement from the licence.

3.21 We have not been able to establish whether the majority of UE likely to be fitted to a UAS will perform significantly better than the ETSI standard of -30dBm/MHz. Given that the distances needed to protect ATC radars vary based on equipment performance this makes implementing any mitigation proposals difficult. This is because it would have to rely on end users knowing what the out of band performance of the UE is and then applying the appropriate exclusion zone. From initial discussions with a number of stakeholders and our own research, this information is not always supplied for the equipment without having to approach the manufacturer directly. Due to the risks that this introduces to an important safety service we are proposing to exclude the use of the 2.6 GHz band for aerial UE use. We are not proposing to specify how this should be implemented, be it through software, hardware or through the MNO's network management. It would be up to the operator to clearly demonstrate that its use complies with this requirement.

3.22 In the event that specialist airborne UE standards are developed for equipment to comply with a clear out-of-band emission limit then we would reconsider this decision. However, we are still likely to require the imposition of no transmit zones close to the radars.

Satellite

3.23 Airborne use of satellite terminals is only permitted via our Aircraft Radio Licence. However, this licence is not available to UAS operators as it applies only to registered aircraft or gliders. This means that there is no current authorisation for the commercial and operational use of a satellite terminal on a UAS, because:

a) the existing licence exemption for satellite terminals covers only land mobile satellite service use (see Wireless Telegraphy (Exemption) Regulations 2003, as amended, which references IR2016[24]) and so does not extend to airborne use; and

b) Aircraft Radio Licences can only be issued in respect of aircraft which have been registered in the UK (i.e. which have a tail number G-XXXX – see Licensing Procedures Regulations[25]).

Satellite proposal

3.24 As the equipment is already used airborne in aircraft, we see no technical reason why we cannot extend the use of the same equipment for a UAS. We are therefore proposing to include use of satellite terminals within the licensing solution we set out in the next section. The UAS operator would only be allowed to use a satellite terminal that is part of a network that has been authorised by Ofcom.

Alternative dedicated/private networks

3.25 Although the use of mobile and satellite networks appears to be the UAS industry's preferred approach to control and payload, we are aware of other solutions in different frequency bands. However, these are at an early stage of development and may not come into operational use in the near future or at all. We are aware of two bands where there is ongoing work looking at the possibilities for it to be used for UAS:

- 1880 to 1920 MHz; and
- 5030 to 5091 MHz.

3.26 We have yet to see any demand in the UK from operators wishing to deploy their own dedicated networks to support UAS deployments. However, the aim of our proposed authorisation approach is not to exclude these other solutions should they develop. We are following these discussions, but at this stage will not be including these bands in the proposed authorisation approach set out in this document.

[24] UK Interface Requirements 2016
[25] Wireless Telegraphy (Licensing Procedures) Regulations 2010

1880 to 1920 MHz

3.27 CEPT has set up a working group FM59[26] to look at spectrum solutions for UAS that are not related to the use of mobile networks. This work follows on from ECC Report 268[27] which looked at the technical, regulatory and spectrum needs for UAS.

3.28 Work is ongoing to explore spectrum for 'governmental' drones which would cover law enforcement, disaster relief and emergency response. The 1880 to 1920 MHz band has been identified as a possible solution. Co-existence with systems in these bands including DECT in 1880 to 1900MHz and Future Railway Mobile Communication Systems (FRMCS) in 1900 to 1910MHz[28] has been studied and the findings were published in ECC Report 332.[29]

3.29 In the UK the 1880 to 1900 MHz is allocated and used by DECT technology, and 1899.9 to 1920 MHz has been awarded and is licensed to three MNOs. Therefore, the spectrum is not currently available to be used by UAS in the UK. This may change in the future as we are planning to consult in the first half of 2022 on the future use of the 1900 to 1920 MHz, including on a proposal to revoke the licences.[30]

5030 to 5091 MHz

3.30 The International Telecommunication Union (ITU) identified the 5030 to 5091 MHz band as spectrum that could be used for line-of-sight (LoS) and BVLOS UAS command and control radio links. Appropriate allocation of this band was included in the ITU Radio Regulations at its World Radiocommunication Conference in 2012 (WRC-12). In the UK, 5030 to 5091 MHz was used for microwave landing systems (MLS), but here and in many other countries these systems are no longer in operation.

3.31 Work is still ongoing in a number of countries and within the International Civil Aviation Organisation (ICAO)[31] on developing technical standards and licensing arrangements for the operation of UAS in this frequency band. Other administrations such as the Federal Communications Commission (FCC)[32] and the Australian Communications and Media Authority (ACMA)[33] have recently looked at the potential for these bands to be used by UAS.

3.32 In the UK we have yet to consider the future use and authorisation arrangements to access the band. We will consider undertaking further work in this area if there is clear commercial demand for this band to be used by UAS.

---

[26] https://www.cept.org/ecc/groups/ecc/wg-fm/fm-59/client/introduction/
[27] ECC Report 268, published 9 February 2018
[28] Harmonised across the European Union
[29] https://docdb.cept.org/download/3697
[30] Annual Licence Fees for 2100 MHz spectrum published Ofcom December 2021
[31] https://www.icao.int/
[32] Wireless Telecommunications Bureau Office of Engineering and Technology report, published August 2020
[33] New arrangements for remotely piloted aircraft systems consultation, published ACMA April 2021

Other bands

3.33 We are aware of the growing interest in the use of UAS and that in future other frequency bands may be of interest. Through our Innovation and Trial licensing regime we have authorised some trials in other frequency bands such as 3.8 to 4.2 GHz, made available by our Shared Access licensing framework.[34] We will continue to follow the progress of these other potential alternatives. However, at this stage we are not proposing to include them in this consultation.

Electronic Conspicuity

3.34 Electronic Conspicuity (EC) is a term used for a range of technologies that can help aircraft to be visible to other aircraft in the same airspace. These include transponders and radios. At the most basic level, aircraft equipped with an EC device can effectively signal their presence to other airspace users. Many EC devices can also receive these signals which then alerts a pilot to the presence of other aircraft. This may assist other pilots to see the aircraft and take any necessary action to avoid a collision.

3.35 UAS will be expected to co-exist with manned aircraft, and EC is one way for all aircraft to be able to identify and respond to one another. The full adoption of EC technologies in the future would mean that all users operating in a designated block of airspace can be detected electronically which may help mitigate any potential mid-air collisions.

Aeronautical systems

3.36 Manned and unmanned aircraft have equal rights to use UK airspace. To manage air traffic, a combination of surveillance technologies are used, such as ground-based radar (both primary and secondary surveillance), transponders,[35] Airborne Collision Avoidance System (ACAS/TCAS II), Automatic Dependent Surveillance-Broadcast (ADS-B) and Wide Area Multilateration (WAM).

3.37 The global standard frequency for Secondary Surveillance Radar (SSR) used to interrogate aircraft is 1030 MHz with the aircraft replying on 1090 MHz via on-board transponder. ADS-B also operates at 1090 MHz and is an automatic system through which the aircraft broadcasts information without being first interrogated. However, the use of these technologies on UAS (assuming large numbers are in operation) could lead to the spectrum becoming congested in low level airspace. For this reason, the ICAO has issued a letter to States prohibiting the use of 1090 MHz below 500 feet. The UK is currently exploring the use of additional spectrum allocation in aeronautical bands (978 MHz) to mitigate the risk of spectrum overloading at 1090 MHz.

3.38 The CAA is continuing to develop the framework for EC solutions for use on a UAS and this may take a number of years before it is completed. However, some EC equipment is already authorised via our Aircraft (transportable) licence for use on a UAS, provided that

[34] Ofcom Shared Access licensing

[35] CAA rules stipulate that aircraft, including UA, intended to be operated in an area where surveillance services are required (non-segregated and non-class G airspace) must be equipped with a functioning SSR Mode S transponder),

the EC device is programmed with a 24-bit ICAO identity code issued by the CAA.[36] This is the only equipment that can be used on a UAS under this licence.

Equipment in non-aeronautical spectrum bands

3.39 As well as EC equipment operating on 1090 MHz, there are other systems which can provide a similar level of conspicuity to the systems mentioned above. Some examples of these are Universal Access Transceiver (UAT) which operates on 978 MHz, FLARM which operates on 868 MHz and PilotAware which operates on 869.5 MHz. In order to increase voluntary uptake of EC installations within the UAS and General Aviation communities, CAA has offered a rebate scheme for those users wishing to install these devices.[37] Work on electronic conspicuity is ongoing in the CAA.

Electronic Conspicuity proposals

3.40 Working with the CAA, which sets the safety requirements, we are proposing to licence a range of EC devices as part of our proposed licence. As some of the same EC devices are already authorised for aircraft, and in some cases on UAS, through our Aircraft (transportable) licence, we are proposing to include these under our new UAS authorisation regime. However, non-aeronautical spectrum EC devices that are already authorised under the existing licence exemption framework will remain so.

Detect and avoid equipment

3.41 In addition to EC devices that make other users of the airspace aware of the UAS presence, other systems may be required in the future to help UAS to detect and avoid obstacles, other aircraft, or other dangers. Commercial aircraft already deploy a variety of systems including various radar systems, voice communications and emergency beacons. The CAA is continuing to work on the framework for including UAS in an integrated air traffic management regime and part of this will consider how this can be achieved.

Detect and avoid proposals

3.42 Given the current uncertainty over the future requirements for detect and avoid equipment, we are not proposing to include this equipment in the proposed licence at this time. We will continue to monitor developments in this area and will add any equipment to the licence as and when required.

[36] The provision of Air Traffic Services (ATS) in an SSR Mode S environment relies on a unique ICAO 24-bit Aircraft Address (24-bit AA) for selective interrogation of individual aircraft. The 24-bit AA is also an essential element of the airborne collision and avoidance system, ACAS II. https://www.caa.co.uk/commercial-industry/airspace/communication-navigation-and-surveillance/spectrum/spectrum-and-frequency-management/

[37] https://www.caa.co.uk/General-aviation/Aircraft-ownership-and-maintenance/Electronic-Conspicuity-devices/. This contains a non-exhaustive list of EC equipment

Other equipment proposals

3.43 Depending on the operational scenario and any CAA requirements, 'standard' aircraft communication and navigation radio systems may also need to be fitted to UAS. Examples of these include:

- VHF communications (117.975 to 137MHz) - needed to speak to air traffic control or other users but any use would require CAA approval first and may only be applicable to specific technical deployments. To use the equipment there may also be a requirement for the operator to hold a FRTOL;
- AreaNAV/DME (960 to 1215MHz) - needed on larger platforms;
- ATC transponder, ACAS/TCAS II, ADS-B – needed if the UAS is flying in controlled airspace. For the ATC transponder and ADS-B the aircraft transmits responses or broadcasts on 1090MHz – with ACAS/TCAS II, the aircraft transmits interrogations on 1030MHz and responses on 1090MHz; and
- Radio altimeter – this may be needed on larger UAS.

4. Authorisation proposals

Authorisation options

4.1 Ofcom is responsible for authorising use of the radio spectrum. We authorise its use by either granting wireless telegraphy licences under the WT Act or by making regulations exempting the use of particular equipment from the requirement to hold such a licence. As mentioned previously, much of the equipment that may be needed to be used on a UAS is not currently authorised for operational or commercial use. This section sets out our proposed authorisation framework to permit the range of technologies set out in section 3 to be used on a UAS.

To exempt or to license

4.2 The default position, as set out in the WT Act, is that we must exempt equipment from licensing if certain criteria listed in the legislation are met.[38] If those conditions are not met, we are still able to proceed with exempting the devices, but we are not obliged to. The conditions that need to be met are if the equipment installation or use is not likely to:

- involve undue interference with wireless telegraphy;
- have an adverse effect on technical quality of service;
- lead to inefficient use of the part of the electromagnetic spectrum available for wireless telegraphy;
- inhibit the development of effective arrangements for the sharing of frequencies;
- endanger safety of life;
- prejudice the promotion of social, regional or territorial cohesion; or
- prejudice the promotion of cultural and linguistic diversity and media pluralism.

4.3 As set out in section 3, there are clear risks of interference to other services and impacts on the technical quality of service, especially regarding use of the mobile networks and some other aeronautical systems. We have also considered the safety of life considerations surrounding the flying of UAS and the need for some equipment to be used only if the operator has an appropriate certificate issued by the CAA. For these reasons, we do not believe that exempting all of the equipment on UAS is appropriate and therefore we propose to license this equipment in a similar way that equipment is authorised on aircraft.

4.4 However, as set out in section 3, existing licence exempt equipment already used on UAS and in some aircraft will remain licence exempt. This would cover the use of the 2.4/5 GHz Wi-Fi systems as well as the EC devices using the 860 to 870 MHz band.

[38] See Section 8 of the Wireless Telegraphy Act 2006

Question 1: Do you agree with the proposal to license drone equipment rather than to licence exempt? If you disagree, please provide the evidence that would support any disagreement with the proposals.

Licensing options

4.5 Licensing enables us to ensure that an operator is aware of the conditions and obligations placed on it regarding the use of the radio equipment. This is especially important when imposing any restrictions on the equipment's use such as 'no transmit zones' or steps that need to be taken in order to use certain technologies. Authorisation via a licence would make it clear what frequencies can be used and who is ultimately responsible for the use of spectrum by the UAS.

4.6 In looking at the most suitable approach for licensing UAS equipment we considered the following options:

- License each piece of equipment individually;
- License all the equipment on an individual drone; or
- License equipment for an operator's drone fleet.

4.7 We considered that requiring a UAS operator to need to obtain a licence for each piece of equipment would be a significant administrative burden both to the user and to Ofcom. This would require multiple licences to be obtained for each UAS and would incur considerable costs due to the requirement to create new licence categories and to process each application for a licence. In light of this, we do not believe that such an authorisation approach would be appropriate in this case.

4.8 The licensing of all the equipment on a UAS would mirror the method currently used to authorise equipment on an aircraft. Each aircraft has its own licence that details all of the equipment on board. This approach would have many benefits as it would require only one application per UAS and would follow mature processes that we have in place. It would also allow flexibility for additional equipment to be included in the licence, making it easier to enable the deployment of any new technology, or to implement safety requirements from the CAA.

4.9 However, the aircraft licensing approach relies on the aircraft being individually identifiable via its aircraft registration number, make and model. This combination enables us to link the licence to the aircraft. However, for UAS there is presently no such central registration system, making the identification of a specific UAS difficult. This raises potential issues if an operator has a fleet of identically equipped UAS. For this reason, we do not believe that this approach would work.

4.10 The final option we considered was to license each UAS operator to cover all equipment that it would be responsible for. This option would align with the CAA's approach, under which all UAS operators are required to register and be issued with an Operator ID. This approach would provide the same oversight and control benefits regarding the use of UAS that individual licensing would provide but would further reduce the administrative burden on both the UAS operators and on Ofcom. It would also remove the requirements to create

an identification system, for spectrum licensing purposes, in order to be able to uniquely identify each UAS.

Our preferred option

4.11 Our preferred approach would be to license each UAS operator rather than each UAS. The licence would cover the use of all UAS which the operator is responsible for and would cover a range of equipment that may be required to be fitted. We believe this approach would provide the necessary regulatory oversight to ensure compliance with any conditions that we may need to impose. Furthermore, under this approach, further equipment can be added to the licences as and when the CAA finalises its framework for UAS.

Question 2: Do you agree with the on the proposed authorisation approach for UAS? If you disagree, please provide the evidence that would support any disagreement with the proposals.

Proposed UAS operator licence

4.12 The following sections set out our proposed licence terms and conditions. Most of these would still apply if we decided to adopt one of the other licensing approaches set out above.

4.13 A draft template of the proposed licence is set out at Annex 2. In preparing this draft licence we have tried to keep the format and the provisions similar to other licences that we issue and only deviate from them where necessary.

4.14 To summarise, we are proposing that the licence would:

a) consist of two elements: the licence document containing the licensee information and the Wireless Telegraphy Conditions Booklet;

b) be valid for an indefinite period but subject to the payment of £75 every year;

c) cover deployments only in the UK (this could be extended to the Channel Islands and Isle of Man if they wish to consider this in the future); and

d) contain a technical schedule setting out a range of equipment which can be deployed on the operator's UAS.

Licence format

4.15 We are proposing that, like most other licences that Ofcom issues, our proposed licence will consist of two separate parts:

a) The **licence document:** this will include information specific to a licensee and will cover:

i) Licence Details and Validity: information such as the licensee's address details, licence number and the date their licence was issued.

ii) Radio Equipment: the radio equipment authorised under the licence.

iii) Use of Radio Equipment: will set out those specific terms and conditions relating to the use of the equipment on a UAS which do not apply to other licence types that Ofcom issues.

b) **Wireless Telegraphy (WT) Licence Conditions Booklet**: This includes the standard terms and conditions applicable to the installation and use of many licences that Ofcom issues. These standard terms and conditions are available on our website in the Wireless Telegraphy Licence Conditions Booklet OfW 597.[39] It covers amongst other things:

i) The process for varying or revoking a licence;

ii) How any changes to the licence need to be notified to Ofcom;

iii) The requirements for licence fee payment;

iv) General provisions regarding the use of radio equipment;

v) Ofcom's powers to access and inspect the equipment;

vi) If required, Ofcom's powers to require licensees to modify, restrict or stop using the radio equipment; and

vii) Requirements on licensees to ensure that the public is protected from Electromagnetic Fields (EMF).

4.16 These two documents together would form the licence. Licensees would be required to comply with all the terms and conditions in both the licence document and the separate WT Licence Conditions Booklet. Licensees would be issued with their own licence document and would be able to access the WT Licence Conditions Booklet online.

4.17 We have used this same approach for several years in relation to many other licence types. We believe that this approach of publishing standard terms and conditions on our website will make them more accessible and user-friendly.

Non-technical licence conditions

4.18 As mentioned above, the standard non-technical licence conditions will be set out in the WT Licence Conditions Booklet. We have set out below the additional non-technical licence conditions which are specific to this proposed licence.

Geographical boundaries

4.19 The licence would allow use of equipment within the United Kingdom and territorial seas. The proposed authorisation could also be extended in the future should the Channel Islands and the Isle of Man should they wish to do so in the future.

[39] Wireless Telegraphy Licence Conditions Booklet OfW 597

Licence duration

4.20 The licences would be for an indefinite duration, subject to the payment of an annual licence fee.

Fees

4.21 We propose that the new licence would be subject to a fee, payable every year, which would be cost-based. In line with our framework for setting cost-based fees, we would set these fees to reflect our spectrum management costs applicable to these licence products.

4.22 As this would be a new licence, we do not have actual cost data for the licence to base our fee calculation on. We also do not know what the likely take-up of the new licence would be, and therefore how many licences we would issue.

4.23 We have considered carrying out a detailed bottom-up estimation of costs. However, this would be a complex exercise and because specific fixed and common costs typically make up a significant proportion of the total costs, the resulting estimates would be highly sensitive to the assumption on the likely number of licences issued, which is highly uncertain. Given these limitations, we consider that this would not be proportionate or appropriate outside the context of a wider, comprehensive fee review.

4.24 Instead, we propose to use the actual per-licence costs associated with a similar licence product. We have looked at our existing licence products and we believe that the Aeronautical Station (Recreational Aviation) light licensing products[40] is the closest to the licensing regime that we are proposing. This is because, like our proposed licence, they entail a degree of flexibility for the licensee without the need for full coordination and are available for use on a national basis. Given these similarities, we propose to use the costs associated with the Aeronautical Station (Recreational Aviation) licence to determine what our licence fee should be. As the fee for the Aeronautical Station (Recreational Aviation), which is £75, has been determined on a cost recovery basis, we think it represents a suitable basis for determining a cost-based fee for the new licence product.

Special conditions relating to the use of certain radio equipment

4.25 Certain equipment may only be used by a person who holds (or is under the direct supervision of a person who holds) a valid Flight Radio Telephony Operator Licence (FRTOL) issued by the CAA (or equivalent licence issued by a national aviation authority), unless such a requirement has been exempted under the Air Navigation Order 2016.

4.26 An aerial UE may only be used on a UAS if written consent has been provided by the MNO. This must be obtained prior to being used. Use of these devices would also likely need to comply with any terms and conditions specified by the MNO.

[40] Aeronautical licence products from Ofcom.

Question 3: Do you have any comments on the proposed licence conditions?

Technical conditions

4.27 We propose that the licence would cover a range of potential equipment that users may wish to deploy on a UAS. Operators would not need to apply to Ofcom to install or remove additional equipment provided it is listed in the licence. Schedule 2 of the proposed licence would cover a range of technologies that we have agreed with the CAA that could be authorised and used on a UAS either now or in the near future. We are proposing that the licence covers the list of equipment set out in Table 1:

Table 1: Proposed list of authorised equipment to be used on a UAS

System	Frequency	Requirements
High Frequency (HF) Communications	2.85 to 22 MHz	
Very High Frequency (VHF) Navigation / Marker	108 to 117.575 MHz	
VHF Communications	117.975 to 137 MHz	Analogue voice communications with 8.33 kHz channelization, VHF Data Link Modes 2 & 4 with 25 kHz channelization. When operating on the emergency frequency (121.5 MHz), the auxiliary frequency for search and rescue operations (123.1 MHz) or the airport fire service frequency (121.6 MHz), the equipment may operate 25 kHz channel spacing on these frequencies.
Instrument Landing System	328.6 to 335.4 MHz	
Ultra-High Frequency (UHF) radio equipment	453.0125 to 462.4875 MHz	
Mobile Network User Terminal (UE)	703 to 733 MHz & 758 to 788 MHz (700 MHz band) 791 to 821 MHz & 832 to 862 MHz (800 MHz band)	The Licensee must have written permission for airborne use of its User Terminal (UE) from the mobile network(s) to which that UE connects. The Licensee must adhere to any terms and conditions imposed on it by the network operator(s) in respect to its use on that/(those) network(s). **All airborne UE transmissions in the 2500 to 2690 MHz (2.6 GHz band) are prohibited.** The Licensee must ensure that under no circumstance should the UE be able to connect to services operating in this band.

System	Frequency	Requirements
	880 to 915 MHz & 925 to 960 MHz (900 MHz band) 1710 to 1781.7 MHz & 1805 to 1876.7 MHz (1800 MHz band) 1920 to 1980 MHz & 2110 to 2170 MHz (2100 MHz band) 2350 to 2390 MHz (2.3 GHz band) 3410 to 3800 MHz (3.4-3.8 GHz band)	
Area Navigation (NAV)/Distance Measuring Equipment (DME)	960 to 1215 MHz	
Air Traffic Control (ATC) Transponder	1030/1090 MHz	No FRTOL needed if the operator has no control over the operation of the Transponder, other than to switch it on and off.
TCAS/ACAS	1030/1090 MHz	
Electronic Conspicuity Device (ECD)		The ECD must identify the UAS and must be operated in accordance with the latest version of CAP 1391, published by the CAA.
Distance Measurement Equipment	1165 to 1215 MHz	
Satellite Earth Station Communication	14 to 14.25 GHz	(a) Satellite Earth Station may be used only if authorised to do so under a “Satellite (Earth Station Network)” Licence issued to the operator of the earth station network; (b) The Satellite Earth Station may transmit with an e.i.r.p. no greater than 55 dBW (c) If operating to a geostationary satellite, the Satellite Earth Station must employ a stabilised platform and must maintain a pointing accuracy +/− 0.2 degrees towards the relevant geostationary satellite throughout transmissions; (d) At angles greater than or equal to 2.5 degrees from the antenna main beam axis, the e.i.r.p. of the Satellite Earth

System	Frequency	Requirements
		Station, if operating to a geostationary satellite, shall not exceed 20 dBW/40 kHz; (e) All transmissions from the Satellite Earth Station must be clearly identifiable; (f) The Satellite Earth Station must at all times operate such that it conforms to Interface Requirement IR 2077, published by Ofcom; (g) The Satellite Earth Station shall meet the conditions given in footnotes 5.504B, 5.504C, 5.508A and 5.509A of the Radio Regulations so as not to cause harmful interference to terrestrial fixed and radio astronomy stations.
	1525 to 1660.5 MHz	
Radio altimeters	4200 to 4400 MHz	
Aeronautical mobile airport communication system	5091 to 5150 MHz	
ESOMP	27.5 - 27.8185 GHz, 28.4545 - 28.8265 GHz and 29.4625 - 30 GHz for transmission (Earth-to-space) 17.3 - 20.2 GHz for reception (space-to-Earth)	The operation of the ESOMP Equipment shall comply with the Radio Equipment Regulations 2017 and with the technical and operational criteria contained within the UK Interface Requirement 2093. The Licensee must have written permission for airborne use of its User Terminal (UE) from the satellite network(s) to which that UE connects. The Licensee must adhere to any terms and conditions imposed on it by the network operator(s) in respect to its use on that/(those) network(s).

Question 4: Do you have any comments on the proposed list of equipment and associated conditions?

Other authorisation terms

4.28 A WT Act licence issued by Ofcom only covers the authorisation of radio equipment on a UAS and does not address the flight safety aspects of use. It does not constitute permission to disregard the legitimate interests of other statutory bodies such as the CAA, Police and Emergency Services, Highways England, Data Commission or local authorities.

4.29 The ability to use the frequency bands authorised to the MNOs on a UAS is subject to the MNO agreeing to this and the operator obtaining written permission to do so. Any such

agreement may be subject to additional requirements that the network operator may impose on the use of their frequencies airborne on a UAS.

5. Our assessment and provisional conclusion

Ofcom's assessment framework

5.1 The radio spectrum is a finite national resource of considerable economic and social value. In considering the introduction of a new licence product we take into account our duties and, in light of those duties, in particular:

- securing optimal spectrum use;
- the impact on spectrum users in the same and adjacent bands;
- promoting competition;
- encouraging innovation and investment; and
- benefits for consumers and citizens.

5.2 We have considered both the likely impact on competition of making these changes and the likely impact on spectrum management, in particular the impact on existing licensed or exempted users of the adjacent spectrum bands.

Initial assessment

Securing optimal use of spectrum

5.3 In securing our principal duty to further the interests of citizens in relation to communications matters and consumers in relevant markets, we are further required to secure the optimal use for wireless telegraphy of the electro-magnetic spectrum. Ofcom's general policy is to set restrictions that are the minimum necessary to provide adequate protection against undue interference. This is because optimal use of the radio spectrum is more likely to be secured if users decide, rather than Ofcom dictates, the way in which technology is used or a service is provided in a particular frequency band.

5.4 Almost all of the equipment that we are proposing to authorise under this licence is already used airborne today on aircraft. These proposals would extend the use of these existing technologies to cover use on UAS, including satellite terminals. In addition, the use of UE on UAS has been studied and the technology has been developed to enable mobile networks to provide this service. This would allow the existing spectrum bands allocated to MNOs to be used to offer these services making greater use of the spectrum they hold.

Impact of proposed licence changes on other users of the radio spectrum

5.5 As discussed in section 3 of this document the use of equipment on UAS will not impact on other users of the radio spectrum with the exception of aerial UE use in the 2.6 GHz band. Airborne use of UE transmitting in the 2.6 GHz band can have an impact on the ATC radars in the adjacent band. As set out in paragraphs 3.15 to 3.20, the use of the 2.6 GHz band must be coordinated with ATC radar otherwise it can cause interference to these systems. As our analysis showed the protection distances varies greatly depending on the performance of the equipment and for this reason, we have proposed at this time not to allow access the 2.6 GHz band.

5.6 The analysis undertaken has also shown that the airborne use of a UE can cause quality of service impacts on the host mobile network. To ensure that this can be managed, the airborne use of any UE would only be permitted with the express permission of the host MNO(s).

Promote competition

5.7 We have a principal duty to further the interests of citizens in relation to communications matters and to further the interests of consumers in relevant markets, where appropriate by promoting competition.

5.8 Our proposals would enable a range of technologies to be deployed allowing the market to decide. For command and control of drones, users would have access to a range of technologies from licence-exempt Wi-Fi, satellite communications or mobile networks. For electronic conspicuity, we are also proposing to authorise a range of technologies that have been permitted/recommended for use on UAS by the CAA. Therefore, we do not consider that our proposals would have an adverse impact on competition between differing solutions. The flexible licensing regime we propose would enable us to include additional equipment as new technologies are deemed safe to use on UAS by the CAA.

Encouraging innovation and investment

5.9 We have also had regard to the economic and other benefits that may arise from the use of UAS, and the ability for them to provide new innovative services. The proposed licensing regime would allow for the commercial operational use of this equipment. This should help encourage innovation and investment.

Benefit to citizens and consumers

5.10 UAS have the potential to provide benefits to UK citizens and consumers. For example, during the recent pandemic UAS have been trialed to deliver vital supplies to remote locations where alternative options would either take too long or be too costly.[41] In other areas, drones are being used by the police and search and rescue teams to help them find missing persons.[42]

Provisional conclusion

5.11 We have considered our authorisation approach for UAS in light of our relevant licensing functions and statutory duties. Our provisional conclusion, which is subject to this consultation, is that it is appropriate to introduce a new licence to allow the operational use of a variety of radio equipment on a UAS.

5.12 In our view, our proposed introduction of a UAS operator licence product is:

[41] Ofcom article "Ofcom helps hospitals with drone deliveries" June 2020
[42] Maritime and Coastguard Agency article "Drones could form key part of next generation of UK search and rescue" February 2020

- **objectively justified** in that it would enable optimal use of spectrum and encourage investment and innovation in new services;
- **not unduly discriminatory** against particular persons or against a particular description of persons, in that these proposed licences would be available to all;
- **proportionate** to what it is intended to achieve, in that we are proposing to impose licensing requirements which are the minimum necessary to provide adequate protection against undue interference and a licence product which minimizes administrative burdens on licensees and limits their and our costs; and
- **transparent in relation to what it is intended to achieve**, in that the proposals, and our underlying objectives and reasoning, are described and explained in this consultation document.

5.13 We consider that our proposed changes would further the performance of our general duties in section 3 of the 2003 Act, as citizens and consumers will likely benefit from new services that UAS could help deliver in the future. We describe above the factors we have taken into account in reaching our provisional conclusion, which reflect the matters set out in section 3 of the WT Act and (insofar as they are relevant) in section 3 of the 2003 Act, and the requirements of section 4 of the 2003 Act.

Question 5) Do you agree with Ofcom's assessment on whether to introduce UAS operator licences? If you disagree, please provide further information.

Impact Assessment

5.14 This document represents an impact assessment as defined in section 7 of the Communications Act 2003. Impact assessments provide a valuable way of assessing different options for regulation. They form part of best practice policy making.

5.15 In preparing this document, we have considered the citizen and consumer interests relating to authorising equipment for drones. We have also considered the impact on existing users, and on service providers and users of devices.

5.16 Ofcom is an evidence-based organisation and welcomes responses to this consultation. Any comments about our assessment of the impact of our proposals should be sent to us by the closing date for this consultation. We will consider all comments before deciding whether to implement our proposals. For further information about our approach to impact assessments, see the guidelines 'Better policy making: Ofcom's approach to impact assessments' on our website.

Equality Impact Assessment

5.17 Ofcom is separately required by statute to assess the potential impact of all our functions, policies, projects and practices on the following equality groups: age, disability, gender, gender reassignment, pregnancy and maternity, race, religion or belief, and sexual orientation. Equality impact assessments also assist us in making sure that we are meeting our principal duty of furthering the interests of citizens and consumers regardless of their background or identity. We consider that our proposals would not be detrimental to any of these equality groups.

5.18 We have not carried out separate equality impact assessments in relation to the additional equality groups in Northern Ireland: religious belief, political opinion and dependants. This is because we anticipate that our proposals would not have a differential impact in Northern Ireland compared to consumers in general. We welcome any stakeholder views on this assessment.

Views sought by

5.19 Stakeholders have until **5pm on 5 September 2022** to provide comments on the proposals in this document. The full set of questions can be found in Annex 8.

5.20 After the consultation has closed, we will consider the responses received. Our aim is to publish our final decision on this matter by **November 2022**.

A1. Legal Framework

The legislative framework

A1.1 Ofcom is responsible for authorising use of the radio spectrum. We permit the use of the radio spectrum by granting wireless telegraphy licences under the WT Act or by making statutory regulations exempting users of particular equipment from the requirement to hold such a licence. It is unlawful and an offence to install or use wireless telegraphy apparatus without holding a licence granted by Ofcom, unless the use of such equipment is exempted.

A1.2 Ofcom's statutory powers and duties in relation to spectrum management are set out primarily in the Communications Act 2003 (the "2003 Act") and the WT Act. Amongst our functions are the making available of frequencies for use for particular purposes and the granting of rights of use of spectrum through wireless telegraphy licences and licence-exemptions.

A1.3 Our principal duties under the 2003 Act, when carrying out our functions and exercising our powers, are to further the interests of citizens and consumers, where appropriate by promoting competition. In doing so, we are also required (among other things) to secure the optimal use of spectrum and the availability throughout the United Kingdom of a wide range of electronic communications services.

A1.4 We must also have regard to: (i) the desirability of promoting competition in relevant markets; (ii) the desirability of encouraging investment and innovation in relevant markets; (iii) the different needs and interests, so far as the use of the electro-magnetic spectrum for wireless telegraphy is concerned, of all persons who may wish to make use of it; and (iv) the different interests of persons in the different parts of the United Kingdom, of the different ethnic communities within the United Kingdom and of persons living in rural and in urban areas.

A1.5 Additionally, in carrying out our spectrum functions we have a duty under section 3 of the WT Act to have regard in particular to: (i) the extent to which the spectrum is available for use, or further use, for wireless telegraphy; (ii) the demand for use of that spectrum for wireless telegraphy; and (iii) the demand that is likely to arise in future for such use.

A1.6 We also have a duty to have regard to the desirability of promoting: (i) the efficient management and use of the spectrum for wireless telegraphy; (ii) the economic and other benefits that may arise from the use of wireless telegraphy; (iii) the development of innovative services; and (iv) competition in the provision of electronic communications services.

A1.7 Under section 8(1) of the WT Act, it is unlawful to establish or use a wireless telegraphy station or install or use wireless telegraphy apparatus except under and in accordance with a wireless telegraphy licence granted under the WT Act.

A1.8 Under sections 8(3) – 8(3B) of the WT Act, Ofcom may make regulations exempting from the licensing requirements under section 8(1), the establishment, installation or use of

wireless telegraphy stations or wireless telegraphy apparatus of such classes or description as may be specified in the regulations, either absolutely or subject to such terms, provisions and limitations as may be specified.

A1.9 Under section 8(4) of the WT Act, we must make regulations to exempt equipment if its installation or use is not likely to:

- involve undue interference with wireless telegraphy;
- have an adverse effect on technical quality of service;
- lead to inefficient use of the part of the electromagnetic spectrum available for wireless telegraphy;
- inhibit the development of effective arrangements for the sharing of frequencies;
- endanger safety of life;
- prejudice the promotion of social, regional or territorial cohesion; or
- prejudice the promotion of cultural and linguistic diversity and media pluralism.

A1.10 In accordance with the requirements of section 8(3B) of the WT Act, the terms, provisions and limitations specified in the regulations must be:

- 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.

A1.11 We have formulated our proposals by reference to our statutory duties. For the reasons set out in this document, our provisional assessment is that they are consistent with those duties and the terms, provisions and limitations would meet the requirements of section 8(4) of the WT Act.

A1.12 In our view, the proposals set out in this document are:

- **objectively justified** in that they address the risks of undue interference that might otherwise arise from the use of equipment on drones;
- **not unduly discriminatory** against particular persons or against a particular description of persons in that they would apply to all drone operators;
- **proportionate** to what they are intended to achieve, in that they would be necessary to ensure that use of the relevant equipment would not be likely to have relevant adverse effects; and
- **transparent** in relation to what they are intended to achieve, in that they are described and explained in this document.

A2. Proposed draft licence

Unmanned Aircraft Systems (UAS) Operator Radio Licence

Licensee Details and Validity	
Product name	
Licence number	[Licence number]
Date of Issue	[Date licence first issued]
Licence start Date	[Licence start date appears here]
Payment Interval	1 year
Licence Expiry Date	[Licence expiry for short-term licences only]
Licensee Name	[Licensee name]
Licensee address	[Licensee address line(s)]

1. This Licence is issued by the Office of Communications ("Ofcom") and replaces any previous authority granted in respect of the service subject to this Licence by Ofcom or by the Secretary of State.

2. This Licence authorises [licensee name] ("the Licensee") to establish, install and/or use radio transmitting and/or receiving stations and/or radio apparatus as described in the schedule(s) (together called "the Radio Equipment") subject to the terms set out below and subject to the terms of the Wireless Telegraphy Licence Conditions Booklet OfW 597.

3. The schedules (and any subsequent schedule(s) Ofcom may issue as a variation to this Licence at a later date) as well as Wireless Telegraphy Licence Conditions Booklet OfW 597 are incorporated into and form part of this Licence.

Schedule 1

Radio Equipment

1. In this Licence, the Radio Equipment means the equipment listed in Schedule 2.

Use of Radio Equipment

2. The Radio Equipment may only be used:
    a. in accordance with Condition 4 of the Wireless Telegraphy Licence Conditions Booklet OfW 597 and the terms and conditions set out below and in any subsequent schedules;
    b. If it conforms to Radio Equipment Regulations 2017 or has the appropriate approval, granted by (or on behalf of) the CAA.

3. Certain Radio Equipment may only be used by a person who holds (or is under the direct supervision of a person who holds) a valid Flight Radio Telephony Operator Licence (FRTOL) issued by the CAA or equivalent licence issued by a national aviation authority, unless such a requirement has been exempted under the Air Navigation Order 2016.

Schedule 2

System	Frequency	Requirements
High Frequency (HF) Communications	2.85 to 22 MHz	
Very High Frequency (VHF) Navigation / Marker	108 to 117.575 MHz	
VHF Communications	117.975 to 137 MHz	Analogue voice communications with 8.33 kHz channelization, VHF Data Link Modes 2 & 4 with 25 kHz channelization. When operating on the emergency frequency (121.5 MHz), the auxiliary frequency for search and rescue operations (123.1 MHz) or the airport fire service frequency (121.6 MHz), the equipment may operate 25 kHz channel spacing on these frequencies.
Instrument Landing System	328.6 to 335.4 MHz	
Ultra-High Frequency (UHF) radio equipment	453.0125 to 462.4875 MHz	
Mobile Network User Terminal (UE)	703 to 733 MHz & 758 to 788 MHz (700 MHz band) 791 to 821 MHz & 832 to 862 MHz (800 MHz band) 880 to 915 MHz & 925 to 960 MHz (900 MHz band) 1710 to 1781.7 MHz & 1805 to 1876.7 MHz (1800 MHz band) 1920 to 1980 MHz & 2110 to 2170 MHz (2100 MHz band) 2350 to 2390 MHz (2.3 GHz band)	The Licensee must have written permission for airborne use of its User Terminal (UE) from the mobile network(s) to which that UE connects. The Licensee must adhere to any terms and conditions imposed on it by the network operator(s) in respect to its use on that/(those) network(s). **All airborne UE transmissions in the 2500 to 2690 MHz (2.6 GHz band) are prohibited.** The Licensee must ensure that under no circumstance should the UE be able to connect to services operating in this band.

System	Frequency	Requirements
	3410 to 3800 MHz (3.4-3.8 GHz band)	
Area Navigation (NAV)/Distance Measuring Equipment (DME)	960 to 1215 MHz	
Air Traffic Control (ATC) Transponder	1030/1090 MHz	No FRTOL needed if the operator has no control over the operation of the Transponder, other than to switch it on and off.
TCAS/ACAS	1030/1090 MHz	
Electronic Conspicuity Device (ECD)		The ECD must identify the UAS and must be operated in accordance with the latest version of CAP 1391, published by the CAA.
Distance Measurement Equipment	1165 to 1215 MHz	
Satellite Earth Station Communication	14 to 14.25 GHz	(a) Satellite Earth Station may be used only if authorised to do so under a "Satellite (Earth Station Network)" Licence issued to the operator of the earth station network; (b) The Satellite Earth Station may transmit with an e.i.r.p. no greater than 55 dBW (c) If operating to a geostationary satellite, the Satellite Earth Station must employ a stabilised platform and must maintain a pointing accuracy +/− 0.2 degrees towards the relevant geostationary satellite throughout transmissions; (d) At angles greater than or equal to 2.5 degrees from the antenna main beam axis, the e.i.r.p. of the Satellite Earth Station, if operating to a geostationary satellite, shall not exceed 20 dBW/40 kHz; (e) All transmissions from the Satellite Earth Station must be clearly identifiable; (f) The Satellite Earth Station must at all times operate such that it conforms to Interface Requirement IR 2077, published by Ofcom; (g) The Satellite Earth Station shall meet the conditions given in footnotes 5.504B, 5.504C, 5.508A and 5.509A of the Radio Regulations so as not to cause harmful interference to terrestrial fixed and radio astronomy stations.
	1525 to 1660.5 MHz	

System	Frequency	Requirements
Radio altimeters	4200 to 4400 MHz	
Aeronautical mobile airport communication system	5091 to 5150 MHz	
ESOMP	27.5 - 27.8185 GHz, 28.4545 - 28.8265 GHz and 29.4625 - 30 GHz for transmission (Earth-to-space) 17.3 - 20.2 GHz for reception (space-to-Earth)	The operation of the ESOMP Equipment shall comply with the Radio Equipment Regulations 2017 and with the technical and operational criteria contained within the UK Interface Requirement 2093 The Licensee must have written permission for airborne use of its User Terminal (UE) from the satellite network(s) to which that UE connects. The Licensee must adhere to any terms and conditions imposed on it by the network operator(s) in respect to its use on that/(those) network(s).

A3. 2.7GHz radar exclusion zone analysis

A3.1 The protection from emissions from UE in the 2.6 GHz and 3.41 to 3.6 GHz bands is derived from the Radar Coordination Notice applicable to mobile network deployment in the 2.6[43] and 3.4 GHz bands[44] in respect of radars operating in the 2.7 to 3.1 GHz band.

A3.2 For the single entry approach:

A3.3 $\boldsymbol{Isolation_{dB} = Threshold_{dBm/MHz} - EIRP_{dBm/MHz} + G\_Rx_{dBi},\alpha}$
where

$\boldsymbol{Isolation_{dB}}$ is the isolation measured in dB not exceed not to generate harmful interference. The exclusion distance (in km) is calculated assuming the losses are due to Free Space Path Loss.

$\boldsymbol{Threshold_{dBm/MHz}}$ is given by ITU recommendations or relevant documents

$\boldsymbol{G\_Rx_{dBi}}$,α is the receiver antenna gain for a given elevation/azimuth

$\boldsymbol{P\_Tx_{dBm/MHz}}$ is the interfering power in the receive band. This can be:

For out of band emissions: a relative value 30 dB below the in-band power value. We apply the ACLR as stated in ETSI (ETSI TS 136 101 V14.3.0)

For emissions in the spurious domain: an absolute value of -30 dBm/MHz according to ETSI standards. (ETSI EN 301 908-13)

For both, we apply lower values as a sensitivity analysis.

A3.4 We assume interference from UAS will be no worse than the apportionment of a single operator base station operating at a maximum LTE bandwidth of 20 MHz.

A3.5 $Radar\ Protection\ threshold\ (\frac{dBm}{MHz}/m^2) = -131 + 10 * \log(\frac{20\ MHz}{120})$ = - 138.78 $(\frac{dBm}{MHz}/m^2)$
This is equivalent to -138.78 + $20\log\left(\frac{c}{f}\right) + 10\log(4\pi)$ = -168.86 (dBm/MHz) (at 2.7GHz, assuming a 0 dBi UAS antenna)

A3.6 We assume three different emission levels in the spurious domain: the value from the ETSI standard (-30 dBm/MHz), -40 dBm/MHz and -50 dBm/MHz.

A3.7 We then calculate the distance needed, using the free space path loss model, to produce the isolation required to reduce the level of spurious emission transmitted from the user equipment to the level at the radar face given in the coordination notice.

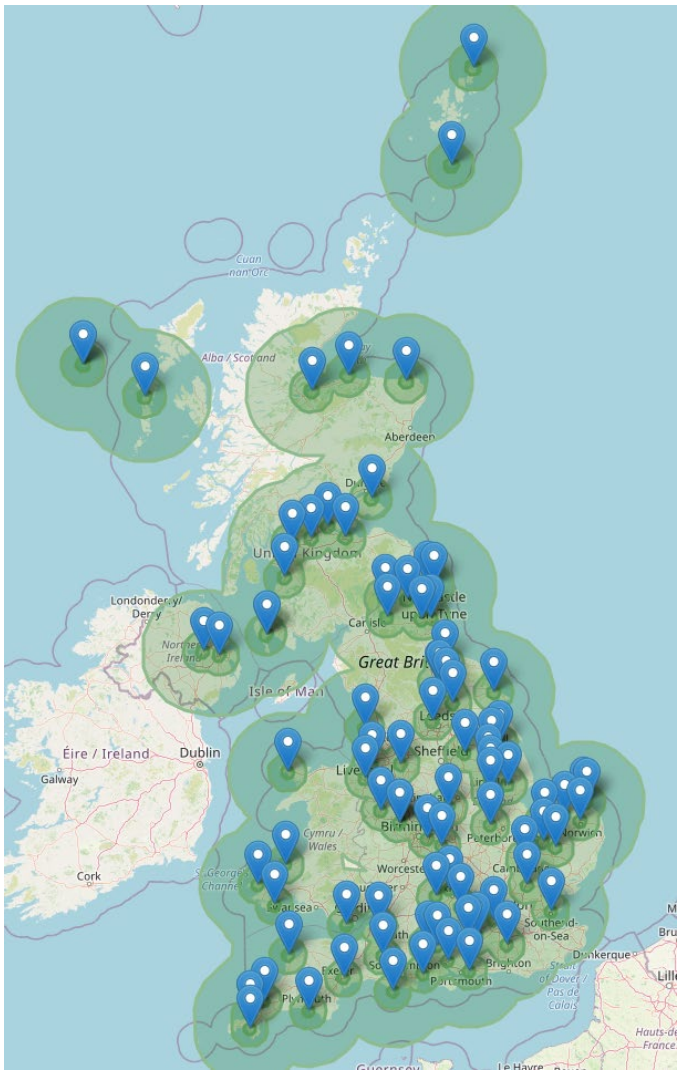
[43] https://www.ofcom.org.uk/__data/assets/pdf_file/0026/56951/final_radar_coordination.pdf
[44] https://www.ofcom.org.uk/__data/assets/pdf_file/0018/114264/3.4-Radar-Co-ordination.pdf

Table A1: Calculation of required separation distances

(2600 MHz) Isolation for Spurious Emissions Limits (dB/MHz)			Ground distance based on FSPL (km) for emissions		
-30	-40	-50	of -30 dBm/MHz	of -40 dBm/MHz	of -50 dBm/MHz
138.86	128.86	118.86	78	25	8

A3.8 These distances of 78km, 25km and 8km around each of the radars on the Protected Radar List, are depicted in Figure A3.1.

Figure A3.1: Map showing ATC Radar deployments and protection distances



A4. Responding to this consultation

How to respond

A4.1 Ofcom would like to receive views and comments on the issues raised in this document, by 5pm on 5th September 2022.

A4.2 You can download a response form from https://www.ofcom.org.uk/consultations-and-statements/category-1/spectrum-for-unmanned-aircraft-systems. You can return this by email or post to the address provided in the response form.

A4.3 If your response is a large file, or has supporting charts, tables or other data, please email it to uas@ofcom.org.uk as an attachment in Microsoft Word format, together with the cover sheet. This email address is for this consultation only, and will not be valid after 5th September 2022.

A4.4 Responses may alternatively be posted to the address below, marked with the title of the consultation:

Spectrum Management & Authorisation
Ofcom
Riverside House
2A Southwark Bridge Road
London SE1 9HA

A4.5 We welcome responses in formats other than print, for example an audio recording or a British Sign Language video. To respond in BSL:

- Send us a recording of you signing your response. This should be no longer than 5 minutes. Suitable file formats are DVDs, wmv or QuickTime files. Or
- Upload a video of you signing your response directly to YouTube (or another hosting site) and send us the link.

A4.6 We will publish a transcript of any audio or video responses we receive (unless your response is confidential)

A4.7 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.

A4.8 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.

A4.9 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 8. 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.

A4.10 If you want to discuss the issues and questions raised in this consultation, please email uas@ofcom.org.uk.

Confidentiality

A4.11 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 the Ofcom website as soon as we receive them.

A4.12 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.

A4.13 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.

A4.14 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 in our Terms of Use.

Next steps

A4.15 Following this consultation period, Ofcom plans to publish a statement by November 2022.

A4.16 If you wish, you can register to receive mail updates alerting you to new Ofcom publications.

A5. Ofcom's consultation processes

A5.1 Ofcom aims to make responding to a consultation as easy as possible. For more information, please see our consultation principles in Annex 6.

A5.2 If you have any comments or suggestions on how we manage our consultations, please 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.

A5.3 If you would like to discuss these issues, or Ofcom's consultation processes more generally, please contact the corporation secretary:

Corporation Secretary
Ofcom
Riverside House
2a Southwark Bridge Road
London SE1 9HA
Email: corporationsecretary@ofcom.org.uk

A6. Ofcom's consultation principles

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

Before the consultation

A6.1 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

A6.2 We will be clear about whom we are consulting, why, on what questions and for how long.

A6.3 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.

A6.4 We will consult for up to ten weeks, depending on the potential impact of our proposals.

A6.5 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.

A6.6 If we are not able to follow any of these seven principles, we will explain why.

After the consultation

A6.7 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.

A7. Consultation coversheet

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)

A8. Consultation questions

A8.1 Ofcom invites third parties to respond to the questions set out below. Please provide Ofcom with available supporting evidence where possible.

Question 1: Do you agree with the proposal to license drone equipment rather than to licence exempt? If you disagree, please provide the evidence that would support any disagreement with the proposals.

Question 2: Do you agree with the on the proposed authorisation approach for UAS? If you disagree, please provide the evidence that would support any disagreement with the proposals.

Question 3: Do you have any comments on the proposed licence conditions?

Question 4: Do you have any comments on the proposed list of equipment and associated conditions?

Question 5: Do you agree with Ofcom's assessment on whether to introduce UAS operator licences? If you disagree, please provide further information.

A9. Glossary

3GPP	The 3rd Generation Partnership Project, comprising of a number of standards organisations which develop protocols for mobile telecommunications.
ATC	Air Traffic Control.
Autonomous Aircraft	An unmanned aircraft that does not allow pilot intervention in the management of the flight.
Autonomous operation	An operation during which an unmanned aircraft operates without the remote pilot being able to intervene.
CAA	Civil Aviation Authority. The UK's aviation regulator.
CEPT	European Conference of Postal and Telecommunications Administrations.
Downlink	Space to Earth communication going from a satellite down to a ground (or air or sea) based earth station.
Frequency band	A defined range of frequencies that may be allocated for a particular radio service, or shared between radio services.
GHz	Gigahertz. A unit of frequency of one billion cycles per second.
ICAO	International Civil Aviation Organisation.
Model aircraft	Any unmanned aircraft being flown purely for the recreational sport of model aircraft flying. This includes shop bought or home built aircraft, which are flown 'manually' rather than with any automation other than for flight stabilisation purposes. A model aircraft may be flown under the auspices of an association, or individually.
MNO	Mobil Network Operator. A telecommunications service provider that provides wireless voice and data communication for its subscribed mobile users. MNOs own or control all the elements necessary to sell and deliver services to an end user, including spectrum allocation, infrastructure, and customer services. There are four MNOs in the UK: EE (owned by BT), Vodafone, O2 (now a joint venture with Virgin Media) and Three (owned by Hutchinson 3G)
Operator	Any legal or natural person operating or intending to operate one or more UAS.
Radio Spectrum	The portion of the electromagnetic spectrum below 3000 GHz used for radiocommunications.
Remote Pilot	The individual who operates the flight controls of the unmanned aircraft by manual use of the controls, or when the small unmanned aircraft is

	flying automatically, monitors its course and is able to intervene and change its course by operating its flight controls.
Small Unmanned Aircraft	Any unmanned aircraft, other than a balloon or a kite, having a mass of not more than 20 kg without its fuel but including any articles or equipment installed in or attached to the aircraft at the commencement of its flight.
Uplink	Earth to space communication going up from a ground (or aircraft or ship) based station to a satellite.
Unmanned Aircraft	Any aircraft operating or designed to operate autonomously or to be piloted remotely without a pilot on board.
Unmanned Aircraft System (UAS)	An unmanned aircraft and the equipment to control it remotely.
UE	User Equipment
VHF	Very High Frequency (i.e., 30 MHz to 300 MHz).
Wi-Fi	Wireless Connectivity (i.e., technology allowing a PC, laptop, mobile phone, or tablet to be connected to the internet).
WT Act	Wireless Telegraphy Act 2006. We authorise the use of the radio spectrum by granting wireless telegraphy licences under the WT Act.