Ofcom
making communications work
for everyone

More spectrum for satellite connectivity

Extending access in the Ku band (14.25-14.5 GHz)

CONSULTATION:

Publication date: 21 June 2022
Closing date for responses: 31 August 2022

Contents

Section

Annex

1. Overview

Ofcom is responsible for managing the UK's radio spectrum, which is the range of radio frequencies essential for all wireless communications.

We want to enable satellite operators to access additional capacity for a range of broadband services in hard-to-reach areas: connecting more rural homes and businesses, commercial aircraft, commercial and passenger ships, offshore energy facilities and utilities. Access to both Ku and Ka band is needed to meet growing demand for satellite services in these sectors. In the future these frequencies could also help connect road vehicles, trains and unmanned aircraft systems (i.e. drones) across the UK, including in remote locations. This will help meet our wider priority to get everyone connected, our spectrum management vision to support innovative and efficient spectrum use, and our space strategy supporting growth in GSO and NGSO satellite services.

We are proposing to extend access to satellite services under a Satellite (Earth Station Network) licence (an ESN licence) in the 14.25-14.5 GHz band to support the deployment of large numbers of terminals connecting to geostationary orbit and non-geostationary orbit satellite services.

14.25-14.5 GHz forms part of the uplink for the "Ku band", which is one of only two bands used to provide satellite broadband services (the other being the "Ka band"). The 14.25-14.5 GHz band is currently used for fixed wireless links, radio astronomy and fixed satellite services. With fixed links ceasing or migrating out of the band, we are able to propose doubling the existing Ku band capacity available under an ESN licence, enabling a much wider range of satellite services in this band.

In particular, the whole 500 MHz in the wider 14-14.5 GHz band is already authorised in this way in Europe, United States and across the Asia Pacific region. Our proposals would therefore bring the UK into line with international authorisations, providing more seamless services in the air and at sea.

What we are proposing – in brief

- To extend access to the frequencies available to satellite operators under an ESN licence to include 14.25-14.5 GHz.
- To introduce new conditions to protect existing radio astronomy sites in the 30 MHz between 14.47-14.5 GHz. For aeronautical terminals, no use will be permitted at 14.47-14.5 GHz, and for land and maritime terminals, use will be restricted around the radio astronomy sites.
- To also introduce temporary (bespoke) conditions to protect any fixed links remaining temporarily in the band. We expect to confirm which fixed links this condition would relate to through this consultation, and the anticipated duration for the protection. We intend to introduce specific protection for each remaining fixed link in our Statement.
- This spectrum will also provide additional uplink capacity from satellite terminals, supporting broadband services on aircraft, and ships, as well as to control unmanned aircraft systems. We therefore proposed the necessary adjustments to these other licences to facilitate such services.
- Subject to the outcome of this consultation, licensees wishing to access these frequencies would be able to request a variation to their licence or apply for a new licence.

The full list of our consultation questions relating to our proposals can be found in Annex 9**.** The deadline for responses is 5pm on 31 August 2022.

2. Introduction

2.1 The radio spectrum is a valuable and limited natural resource and demand is increasing as new wireless technologies and systems are created. We support innovation and new use cases to deliver improved services to UK consumers, while also ensuring existing services are appropriately protected and spectrum is used efficiently.

2.2 As new use cases emerge and consumer demand for satellite services increase, satellite operators have told us they are constrained by the UK's current approach to authorising Ku band frequencies. User terminals are currently only permitted between 14-14.25 GHz, and operators have requested access to the whole 500 MHz between 14-14.5 GHz. In-line with our wider objectives in the space sector, we are now prioritising work to examine how we use the 14.25-14.5 GHz band in the UK.

Purpose of this document

2.3 In this document we propose to extend spectrum access for satellite services within the 14.25-14.5 GHz band under a Satellite (Earth Station Network) licence (an ESN licence). As part of these proposals, we also consider how we can manage and protect incumbent users of the 14.25-14.5 GHz band, including radio astronomy, legacy fixed links, and permanent and transportable earth stations (PES and TES).

Satellite technology is developing at speed

2.1 Satellites play a wide range of roles in communications. They can provide fixed broadband connections to homes, communities, and businesses, especially in remote locations. They are increasingly used to enable connectivity for maritime and air passengers and crew, both as a stand-alone service or integrated with terrestrial services. Newer developments include using satellites to extend wireless networks for a variety of applications, including Internet of Things (IoT); and connectivity for the transport sector (rail, road vehicles and drones).

2.2 Satellite systems can operate in two ways: with either a large satellite in geostationary orbit (GSO), or a constellation of smaller satellites in non-geostationary orbit (NGSO). Technologies for both types of satellite service are developing at speed, which has implications for capacity and demand.

2.3 Until recently, GSO satellites have been the preferred means of delivering satellite services. GSO satellites remain in a stationary position relative to the earth (revolving at the same angular speed and direction), around 36,000 km above the earth's equator. Because of the distance of GSOs from gateway earth stations and user terminals, services which rely on them experience some delay in round trip communications (higher latency). Nevertheless, GSO satellite technology has pioneered developments in communications and the technology continues to improve.

2.4 New communications services based on constellations of NGSO satellites in low earth orbit (below 2,000 km) and medium earth orbit (2,000-35,786 km) are also developing at pace.

By connecting hundreds or thousands of satellites to gateway earth stations and user terminals in lower orbits, NGSO constellations can offer advantages over GSO systems:

a) lower latency and higher capacity communication services; and

b) better connectivity over the poles and in northern latitudes.

2.5 The newest generation of NGSO satellites began launching in 2018[1], and services including direct to home broadband and broadband for enterprises commenced in 2021. The range of services offered will expand as each company builds out its constellation. As we outlined in our 'NGSO satellite systems: Licensing updates' statement[2], we are keen to support wider access to NGSO services in the UK as part of our priority to get everyone connected.

Our proposed approach aligns with our strategic objectives

2.6 We have considered our proposals alongside our wider priorities, such as in our plan of work for 2022-23, our spectrum-specific objectives in our spectrum management strategy, and our proposed strategy for the space sector in our recent consultation.

Plan of work for 2022-23

2.7 In our plan of work for 2022-23, we committed to explore demand for access to the 14 GHz band, in response to the space sector's calls for this spectrum to be made available to support their growing needs[3].

Spectrum management strategy and spectrum vision

2.8 In July 2021, we set out our spectrum management vision for the 2020s, which outlined our strategic spectrum management objectives[4]. Our proposed approach in this consultation supports the following four objectives:

- continued improvements in the wireless communications used by everyone, wherever and whenever they use them;
- businesses, public sector, and other organisations with specialised requirements to be able to access the right wireless communication or spectrum options for them;
- providing flexibility in spectrum use to support innovation, with appropriate assurances for continued use; and
- encouraging sustained improvements in the efficiency of spectrum use.

2.9 Our strategy also highlighted the importance of spectrum sharing as a means of ensuring efficient use now and in the future. We seek to enable sharing for all of our spectrum authorisation proposals where possible. The implications for spectrum sharing in the 14.25-14.5 GHz band are examined in paragraph 4.17.

[1] To date, satellites have been launched by Kepler, OneWeb and SpaceX.
[2] Non-geostationary satellite systems: Licensing updates
[3] Plan of work 2022/23: making communications work for everyone (see page 48).
[4] Supporting the UK's wireless future: our spectrum management strategy for the 2020s

Space spectrum strategy

2.10 Taking account of our wider spectrum management strategy and space sector trends, our recent Space spectrum strategy consultation[5] proposed two objectives. That we aim for spectrum to:

- enable growth in the benefits that the space sector delivers for people and businesses in the UK; and
- focus on the opportunities and challenges raised by NGSO satellite communication systems.

2.11 We proposed to prioritise communications more broadly as an area of work in the space sector, because it is undergoing significant change and creating new spectrum management challenges. Specifically, we proposed to enable:

- better broadband options for residential consumers and businesses in places that are difficult to reach by fixed or mobile connections;
- better broadband connectivity (e.g. Wi-Fi) for passengers on aircraft and on ships;
- better mobile coverage, e.g. where satellites could have a role in providing backhaul for mobile base stations, including in the most remote locations; and
- IoT services delivered by satellite, including in remote locations.

2.12 One of the specific actions we highlighted to support GSO and NGSO satellite communications, was to examine options for the future use of 14.25-14.5 GHz.

2.13 Together, these high level and targeted objectives have informed our proposed approach for making more efficient use of the 14.25-14.5 GHz band, further details of which we discuss in Section 4.

Legal duties

2.14 Our legal framework derives from our duties and powers under both the Communications Act 2003 (the '2003 Act') and the Wireless Telegraphy Act 2006 (the '2006 Act').

2.15 This section also provides an overview of the main legislative provisions relevant to wireless telegraphy licensing and proposed variations. It is not a full statement of all the legal provisions which may be relevant to our functions and wireless telegraphy licensing.

Ofcom's duties when carrying out spectrum functions

2.16 In carrying out our spectrum functions we have a duty under section 3 of the 2006 Act to have regard, in particular, to:

- the extent to which the spectrum is available for use, or further use, for wireless telegraphy;
- the demand for use of that spectrum for wireless telegraphy; and
- the demand that is likely to arise in future for such use.

[5] Space spectrum strategy (2022)

2.17 We also have a duty to have regard, in particular, to the desirability of promoting:

- the efficient management and use of the spectrum for wireless telegraphy;
- the economic and other benefits that may arise from the use of wireless telegraphy;
- the development of innovative services; and
- competition in the provision of electronic communications services.

Ofcom's general duties

2.18 Our principal duty under section 3(1) of the 2003 Act, when carrying out our functions, is:

- 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.

2.19 In doing so, we are also required by section 3(2) to secure (among other things):

- the optimal use of spectrum, and
- the availability throughout the United Kingdom of a wide range of electronic communications services.

2.20 Section 3(4) also requires us to have regard to the following matters (amongst others):

- the desirability of promoting competition in relevant markets;
- the desirability of encouraging investment and innovation in relevant markets;
- 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
- 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.

Ofcom's powers to vary a spectrum licence

2.21 Our powers to carry out our spectrum functions are set out in the 2006 Act. Such powers include, under sections 9 and 10, the general power to revoke or vary any wireless telegraphy licences. Schedule 1 of the 2006 Act sets out a process for the variation of wireless telegraphy licences.

2.22 We have a duty set out in section 9(7) of the 2006 Act to ensure that wireless telegraphy licence conditions are objectively justified in relation to networks and services to which they relate, non-discriminatory, proportionate and transparent.

2.23 We have a broad discretion under paragraph 6 of Schedule 1 of the 2006 Act to vary licences, subject to certain limitations.

2.24 However, this process does not apply to a proposed licence variation that is made at the request or with the consent of the licensee.

Impact assessment

2.25 This document as a whole, including its annexes, comprises an impact assessment as defined in Section 7 of the Communications Act 2003. 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

2.26 We do not consider that our proposals have any equality implications under the Equality Act 2010 or the Northern Ireland Act 1998.

Structure of this document

2.27 The rest of this document is set out as follows:

- Section 3 describes how the 14.25-14.5 GHz band is currently used;
- Section 4 sets out our proposals for extending spectrum access for connectivity in the band;
- Section 5 explains our proposals for managing coexistence with current services;
- Section 6 notes the implications of these proposals for spectrum authorisations; and
- Section 7 provides a summary of our proposals and next steps.

3. Current use of the 14.25-14.5 GHz band

3.1 In this section we examine how these frequencies are allocated globally and how they are used at present in the UK, in order to assess the impact of extending access for satellite services in the 14.25-14.5 GHz band.

How the 14.25-14.5 GHz band is allocated internationally

3.2 Globally, the Ku band is an important band for fixed satellite services (FSS) in both GSO and NGSO. The 14-14.5 GHz band has a primary allocation (Earth-to-space) in all three International Telecommunication Union (ITU) regions for FSS uplinks. It also has a secondary allocation for mobile satellite services (MSS) Earth-to-space uplinks, where earth stations in motion (ESIMs) on land, water, or in the air, communicate with satellite systems. These two satellite allocations are used in combination to provide broadband in these frequencies (i.e. to ships and aircraft).

3.3 Most of Europe has followed a harmonised 2011 ECC Decision[6], making the full 500 MHz between 14-14.5 GHz available for satellite to facilitate ESIMs onboard aircraft. Furthermore, other ECC decisions on GSO and NGSO FSS satellite systems at 14-14.5 GHz have also been widely adopted enabling ESIMs on ships, on land and for land mobile applications.[7] This has been possible because the 14.25-14.5 GHz band is not used for fixed links across the majority of Europe, so most countries can allow use of the entire 14-14.5 GHz band by satellite systems under an ESN licence. Likewise, North America and much of the Asia Pacific region already use the Ku band uplink across the full 500 MHz (14-14.5 GHz) to provide inflight connectivity.[8]

3.4 There are a range of other ITU allocations in the frequencies between 14-14.5 GHz. However, not all services operate in the band and others are only minor users globally:

- Radio astronomy has a secondary allocation at 14.47-14.5 GHz, with observatories in a limited number of European countries including the UK. Satellite terminals must protect radio astronomy operating between 14.47-14.5 GHz (as stipulated in ITU Radio Regulation 5.504B)[9].
- The fixed service (i.e. fixed wireless links) has a primary allocation in this band, but has been discouraged by the CEPT[10]/European Research Council since 1996 in order to enable broader satellite use in this band[11]. Only a small number of CEPT countries, including the UK, still operate fixed links in it. The requirement to coordinate with large numbers of fixed links made it harder for satellite services to deploy terminals under an ESN licence.

[6] ECC Decision(05)11 and its implementation status
[7] See Implementation status pages for ECC Decision(17)04, ECC Decision(18)05, and ECC Decision(03)04.
[8] FCC 2002 News Release on Ku band NGSO FSS use and Service Rules and Procedures for AMSS.
[9] FSS is a primary service so does not in theory need to protect radio astronomy, however many terminals operate under both FSS and MSS allocation. Mobile terminals (ESIMs) are more likely to cause unpredictable interference to radio astronomy so need to protect it.
[10] CEPT (European Conference of Postal and Telecommunications) is the European forum on Communications matters.
[11] CEPT/ERC Recommendation 13-03

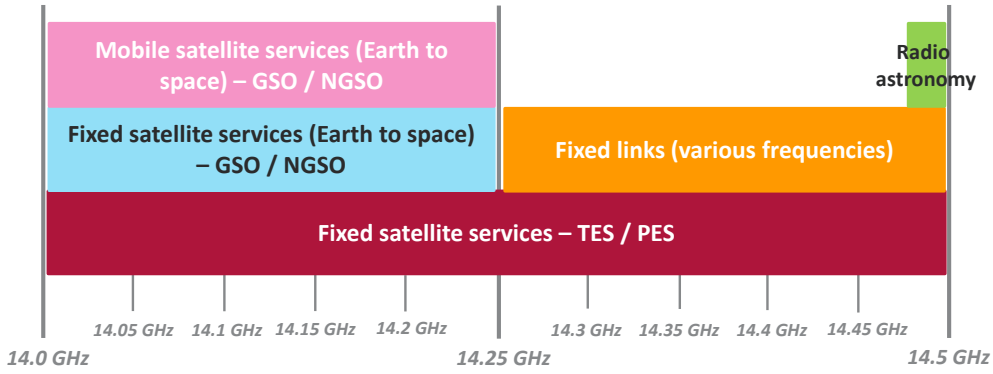
- Other ITU allocations include secondary radionavigation-satellite and space research services, but the band is not currently used by CEPT administrations for these services, and there are no records in the ITU Master Register indicating use of radionavigation in the band.

How the UK uses the 14.25-14.5 GHz band

3.5 Expansion of uncoordinated satellite services in the Ku band (14-14.5 GHz) was historically constrained in the UK to avoid interference with fixed links. However, as explained below, the picture here is changing, resulting more recently in a lightly used band that we assess could be further opened up to make more efficient use of the spectrum.

3.6 Figure 1 shows the services currently operating between 14-14.5 GHz in the UK.

Figure 1: Use of the 14-14.5 GHz band in the UK



Radio astronomy service

3.7 Radio astronomy is the study of naturally occurring radio emissions from stars, galaxies and other objects in the universe. Radio astronomy observations help us improve our understanding of the universe and to investigate cosmic phenomena. The frequencies used by radio astronomy are largely governed by the physical characteristics of extraterrestrial radiations and fundamental physical constants, which means that radio astronomers, unlike other spectrum users, have little choice about the frequencies they use.

3.8 In the Ku band, radio astronomers use 30 MHz between 14.47-14.5 GHz to conduct formaldehyde (H_2CO) line studies, which provide valuable information on understanding the physical conditions of the interstellar medium in space[12].

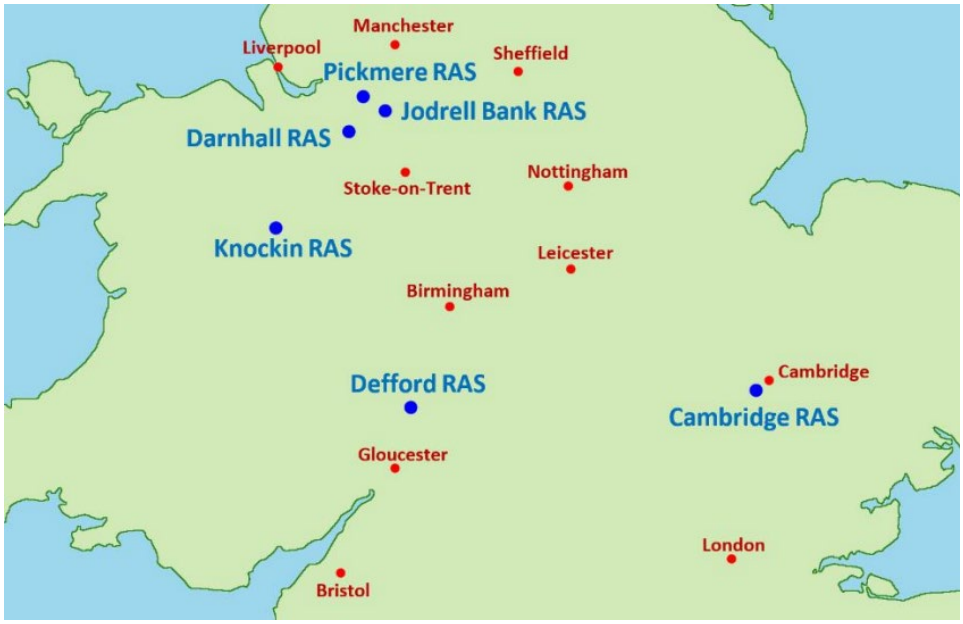
3.9 Much of the UK's radio astronomy research is undertaken across a network of six sites (see Figure 2). Collectively, they operate as e-MERLIN, the UK's national interferometer radio

[12] The interstellar medium is the region between stars that contain vast clouds of gases and solid particles.

telescope array operated by Jodrell Bank for the Science and Technology Council (STFC)[13]. e-MERLIN forms a key component of the global network of radio astronomy facilities[14].

3.10 However, observations in this band are currently made from two sites only – Jodrell Bank and Cambridge – which operate and observe independently. We understand that there is potential for measurements in this band to move from these two receivers to the e-MERLIN network of six dishes (subject to funding approval by the STFC). We discuss the implications of such a move for coexistence and licensing at paragraphs 5.19. and 6.15 respectively.

Figure 2: Map of UK radio astronomy sites



Fixed satellite services

3.11 Currently, only coordinated satellite earth stations are authorised to use the 14.25-14.5 GHz band. Satellite user terminals are not currently permitted to use the frequencies above 14.25 GHz unless they are licensed as PES.

Permanent earth stations

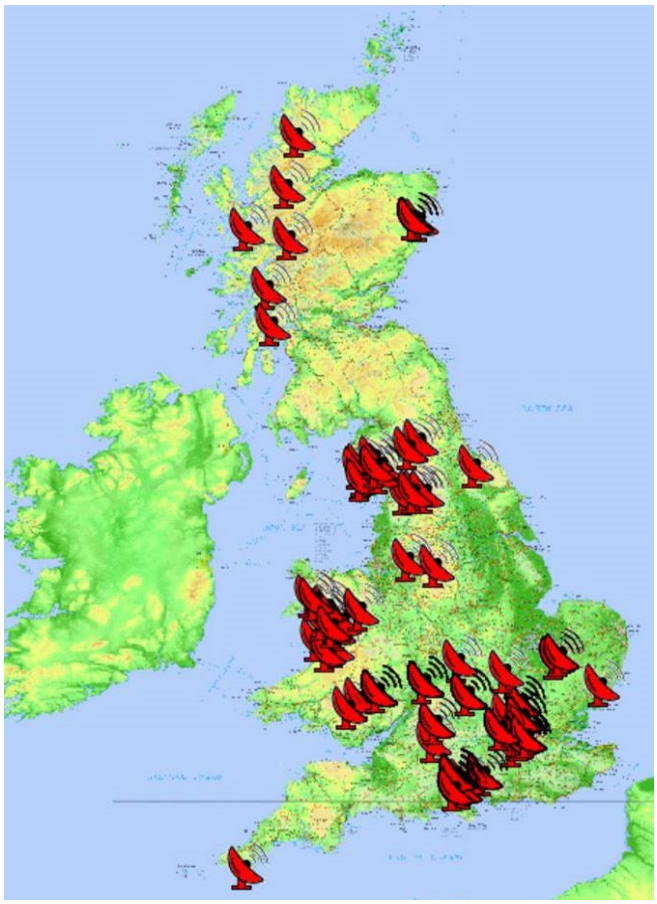
3.12 A PES is normally a large satellite earth station operating from a permanent, specified location for the purpose of providing wireless links with one or more GSO satellites in certain frequency bands allocated to the FSS. A PES is typically used to provide telephony and data backhaul, broadcast feeder links, private corporate networks and satellite telecommand and control.

[13] STFC is part of UKRI (UK Research and Innovation), a non-departmental public body sponsored by the Department for Business, Energy and Industrial Strategy (BEIS).
[14] It is a key part of global facilities for Very-long-baseline interferometry (VLBI) and complements the capability of the Square Kilometre Array (SKA), in which the UK is investing around £300M over the next 10 years.

3.13 PES licences can incorporate any number of earth stations that are located within 500 metres of a nominated centre point for the licence. For licensing purposes, an earth station 'deployment' is a unique path between an earth station and satellite.

3.14 In early 2022, there were 68 PES licensees covering 167 earth station deployments in the 14.25-14.5 GHz band (see Figure 3). PES tend to be located away from populated areas.

Figure 3: UK PES deployments as of February 2022



Transportable earth stations

3.15 A TES is a high-power satellite earth station typically located on a vehicle to allow it to be moved to operate between a specified location to an FSS satellite. They are commonly used by the broadcasting industry, where they support newsgathering and special events, providing outside broadcast links (typically live) either back to a studio or directly to a broadcasting satellite. These links need to be highly reliable, so terminals typically need to operate at higher power levels.

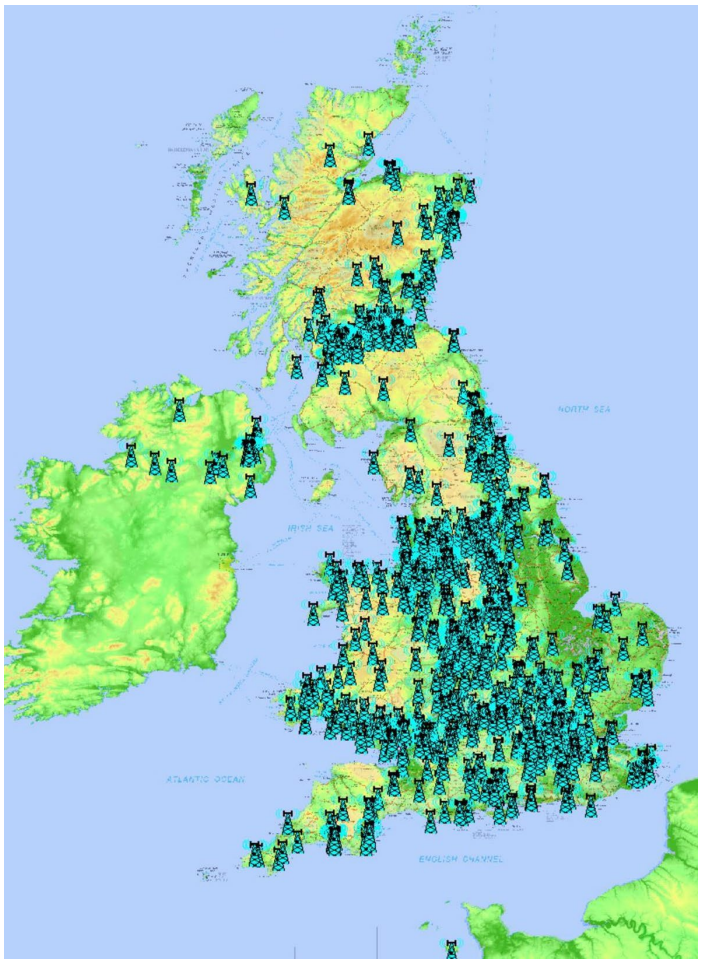
3.16 To transmit at a specific location, TES licensees must seek clearance from Ofcom. The clearance process assesses the potential for the TES to interfere with fixed links and checks if the high-power TES emissions (often with an EIRP[15] in excess of 55 dBW) pose a risk to

[15] EIRP (Equivalent isotropic radiated power) is the total radiated power from a transmitter antenna X numerical directivity of the antenna in the direction of the receiver.

airports and other sensitive sites. Once a clearance is approved, TES licensees are authorised to transmit.

3.17 TES are used widely across the UK. In 2021, there were 43 TES licensees who made 2689 clearance requests in the 14.25-14.5 GHz band, with 12,866 individual frequencies approved (see Figure 4). 80% of these TES clearance requests were made by Sky and STV.

Figure 4: Approved TES frequency locations in the UK in 2021



Crown use

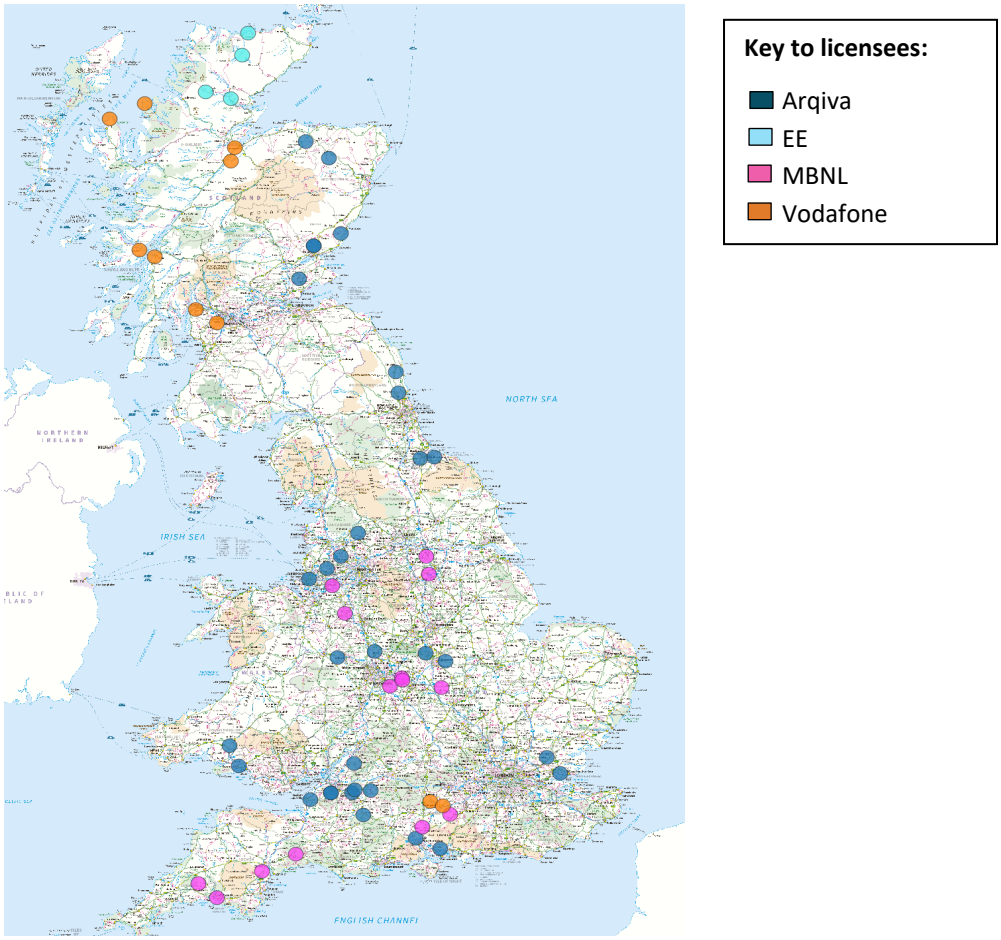
3.18 There are two Ministry of Defence (MOD) sites (at Bude, Cornwall and Menwith Hill, North Yorkshire) currently protected from licensees in the 14-14.5 GHz band.

Fixed links

3.19 Fixed wireless links, also known as microwave links or fixed links, provide wireless connectivity between two or more fixed locations using electromagnetic waves. Fixed links complement other connectivity methods such as fixed networks (e.g. fibre), where fibre is not available or cost effective. Fixed links typically operate in bi-directional pairs and are used to provide wireless connectivity for a range of uses such as mobile and emergency services backhaul, supplying utility services, and broadcasting distribution.

3.20 In the past, the 14.25-14.5 GHz band was quite heavily used by fixed links. However, after the Radiocommunications Agency closed the band to new fixed links in January 2003 (as well as to technical variations of existing fixed links), their number has been in decline; numbers have dropped from 100 paired links in 2018 to just 30 paired links now (see Figure 5 for locations). Each individual fixed link in this band has different technical parameters, and most use a 28 MHz bandwidth, though some operate over a smaller bandwidth of 3.5 or 7 MHz (see Annex 2 for specific details for each licensed link).

Figure 5: Locations of remaining fixed links in the 14.25-14.5 GHz band (note links operate in pairs)



3.21 Following discussions with the four remaining licensees of these fixed links (Arqiva, EE, Mobile Broadband Network Limited (MBNL) and Vodafone), we understand that most of these remaining fixed links will cease or be migrated from the 14.25-14.5 GHz band by the end of 2022. This is because existing fixed links are now end-of-life[16] and with the band closed, alternative solutions have been found.

3.22 We have, however, been informed that in the short term a small number of fixed links may remain in the 14.25-14.5 GHz band beyond 2022 until they can be migrated to alternative suitable frequencies.

[16] The fixed links in this band are all over 20 years old and sourcing components to repair them can be difficult as these frequencies are no longer used for fixed links globally.

How extending satellite access impacts these existing uses

3.23 We consider that all of the services described above are important and that they should continue to be authorised to use the 14-14.5 GHz band, notwithstanding fixed links will eventually be migrated to different frequencies or ceased. Therefore, our proposals need to consider how we will protect these services from interference. We anticipate no coexistence challenges for FSS services because satellite services are obliged to coordinate under the ITU Radio Regulations. However, new satellite services need to take account of radio astronomy operating between 14.47-14.5 GHz, fixed links remaining temporarily in the band, and Crown use.

Implications for remaining fixed links licensees

3.24 As explained at paragraph 3.21, according to licensees most fixed links will cease by the end of 2022. This means that a key coexistence issue (between fixed links and satellite services) will soon fall away, but in the short term some measures will be needed to temporarily protect the few fixed links that remain.

3.25 Therefore, to facilitate new use in the band, we are seeking to confirm with fixed links licensees which fixed links will cease, and which fixed links will remain (and for what duration) in the 14.25-14.5 GHz band. This is so we can make clear in licences where in the UK temporary protection for fixed links will apply, and which specific frequencies in the band would be affected (given that fixed links operate on different frequencies in different locations as shown in Annex 2). We will write to fixed links licensees to confirm their position.

3.26 We set out how we propose to protect radio astronomy and fixed links from interference from satellite services in Section 5.

4. Proposals for extending access for satellite connectivity in the 14.25-14.5 GHz band

4.1 Consistent with our aim to enable satellite systems (GSO and NGSO) to develop and grow, and our legal duties (including those which concern the benefits arising from innovation, spectrum efficiency and competition), we now propose to enable greater spectrum access for satellite services by extending existing ESN licences to also authorise user terminals in the 14.25-14.5 GHz band. This section outlines:

- the demand for greater access to the Ku band among satellite operators in the UK; and
- our proposal for extending access to the 14.25-14.5 GHz band.

The Ku band is important for satellite connectivity

4.2 As explained in Section 2, satellite technologies are developing at pace and the range and types of services they can provide are increasing. The Ku band is one of the two main bands capable of operating satellite broadband services today, the other being the Ka band[17]. Globally, the Ku band provides important satellite connectivity for the aviation, maritime, utilities and energy and broadcasting industries.

4.3 GSO and NGSO satellite operators in the UK are already authorised to use 14-14.25 GHz using PES, TES or an ESN licence. An ESN licence covers any number of satellite terminals operating in a network where data is routed by a satellite to and from a gateway earth station in order to connect to the internet or private network. These terminals can be static (e.g. for direct to home broadband solutions) or ESIMs i.e. terminals on aircraft, ships, rail or road vehicles.

4.4 To date, only coordinated satellite gateway earth stations (PES and TES) have been authorised to use 14.25-14.5 GHz in order to protect other users of the band. This means satellite user terminals must acquire a PES licence to operate from each fixed site. As a consequence, large scale deployment of fixed terminals in 14.25-14.5 GHz can be expensive and ESIMs cannot access these frequencies at all. Extending access to the 14.25-14.5 GHz band via an ESN would therefore remove these costs and expand the range of satellite services available.

4.5 The presence of fixed links in this band made it harder to allow for widespread use of terminals, particularly for services provided by ESIMs. Since the 14.25-14.5 GHz band was closed to new fixed links in 2003, the number of fixed links using the band has fallen from several hundred pairs to 30 pairs. This means that the band is only lightly used at present by other non-satellite services, providing the opportunity to expand the range of satellite services available in this band under an ESN licence.

[17] Ku band satellite services typically use 10.7-12.7 GHz (downlink) and 14-14.5 GHz (uplink). Ka band satellite services typically use 18-20 GHz (downlink) and 27.5-30 GHz (uplink).

4.6 In the NGSO licensing updates statement, we also noted that NGSOs have a greater risk of causing and experiencing interference due to greater numbers of satellites and the dynamic nature of their orbits. We assess that interference risk could be exacerbated as only half of the frequencies for which these constellations are designed are currently available in the UK. Extending access to 14.25-14.5 GHz would increase capacity available for GSO and NGSO satellite services and therefore allow NGSO operators to deploy with greater confidence.

Satellite operators have sought access to more spectrum in the Ku band

4.7 Satellite operators have expressed interest in gaining access to the 14.25-14.5 GHz band for several years, including in response to our 2016 Space spectrum strategy consultation[18]. At the time, we noted the potential cost of either clearing the remaining fixed links (165 at the time) or implementing sharing arrangements (and that providing access to Ka band was a higher priority) but agreed to keep the situation under review. This situation has now changed as most fixed links have been withdrawn (or soon will be). Added to this, the increased demand for access to these frequencies from new NGSO systems and growing numbers of commercial airlines seeking to provide broadband services to customers present a compelling opportunity to increase the utility of this band now.

4.8 GSO operators (serving the air and maritime markets) have indicated that having access to just half of the available uplink frequencies to deploy user terminals is constraining the availability of satellite services, because the satellites are designed to use the whole 500 MHz for uplink purposes. Access to an additional 250 MHz could therefore double the capacity available, increasing the number of consumers they can serve.

Extending access for satellite connectivity can deliver improved and innovative services to consumers

4.9 Existing ESN licensees in the adjacent 14-14.25 GHz band already provide satellite connectivity for many industries. Extending access to broadband connections into the 14.25-14.5 GHz band, particularly through NGSO services, could boost the capacity of satellites serving UK areas which are currently unserved or underserved by other technologies. This could help to close the gap on the remaining 0.4% of UK homes and businesses who do not yet have access to a decent broadband connection[19].

4.10 Broadband on commercial aircraft and on shipping and cruise ships is expanding rapidly. The numbers of aircraft or ships that can be served simultaneously is limited and as such, access to both Ku band and Ka band is important to support this burgeoning market. The additional frequencies we propose to authorise would bring the UK in line with existing authorisations for Ku band satellite services across the US, Europe, and Asia, providing a more seamless service to some of the millions of air and maritime passengers who travel to or through the UK each year.

[18] Space spectrum statement (2017)
[19] Connected Nations 2021: UK report

4.11 As well as extending coverage of existing services, granting satellite operators access to the 14.25-14.5 GHz band could encourage improvement and innovation. For example, rail companies have already started exploring satellite Wi-Fi services, and there is potential for the road vehicle industry to make use of satellite broadband, enabling consumers to stay connected on the move.

We are not proposing to authorise this band for services other than satellite

4.12 As part of our considerations, we looked at other potential uses of the 14.25-14.5 GHz band (i.e. fixed or mobile services).

4.13 With fixed links vacating the band following an earlier decision to close the band in the UK, and a greater focus on capacity for fixed links in higher mmWave bands[20], we are minded not to consider new fixed links as a potential user of the 14.25-14.5 GHz band.

4.14 Turning to demand for mobile data, we observed in our "Meeting Future Demand for Mobile Data" discussion paper that current spectrum holdings (and planned releases e.g. in mmWave spectrum) are likely to be broadly sufficient to meet future demand to 2030 should MNOs upgrade network technology, make full use of their existing spectrum holdings, and deploy new mmWave spectrum on densified small cell networks, particularly in busier areas[21]. However, we also acknowledged that requirements beyond 2030 are more uncertain, including the requirements of future mobile technologies like 6G, with no clear frequency bands yet identified. Given this uncertainty, we are minded not to consider mobile as a potential use for the 14.25-14.5 GHz band.

4.15 We note ongoing work at 3GPP[22] to integrate satellite and other non-terrestrial networks in 5G standards. We expect that future versions of 5G/6G to support closer integration of non-terrestrial and terrestrial networks, with the potential to enhance coverage. We will monitor this work to understand how future networks will develop and to explore if sharing between satellite and terrestrial mobile services might become easier as this work progresses.

Question 1: Have you identified an alternative use for the 14.25-14.5 GHz band which could lead to greater benefits for consumers and citizens than our proposal to extend satellite ESN authorisations? Please provide evidence to support your comments.

[20] Review of spectrum used by fixed wireless services
[21] Discussion paper: Meeting future demand for mobile data
[22] 3rd Generation Partnership Project (3GPP) unites seven telecommunications standard development organisations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC) to produce reports and specifications that define 3GPP technologies. Release 17, which was published in March 2022 includes specifications for satellite components in the 5G architecture Release 17 (3gpp.org).

Our proposal

4.16 Based on the considerations set out in this section, including the potential future benefits for UK citizens and consumers, we propose to extend the frequencies available in the ESN licence to include access to the 14.25-14.5 GHz band.

4.17 Our proposal supports our overall spectrum management vision, where we outlined our aim to:

- **provide flexibility in spectrum use to support innovation, with appropriate assurances for** continued use: by extending access and coverage for NGSO constellations and GSO systems, we are supporting innovation; and
- **encourage sustained improvements in the efficiency of spectrum use**: by considering current use, we have considered how to enable sharing with existing users within the 14.25-14.5 GHz band, and facilitated more efficient use of the spectrum band.

4.18 We also note existing satellites and terminals serving the UK could make use of the new frequencies immediately and at low incremental cost.

Question 2: Do you agree with our proposal to extend access to the 14.25-14.5 GHz band for satellite connectivity, for future broadband, air, sea, energy and transport uses? Please provide evidence to support your comments.

4.19 We next turn to examine the proposed protections for radio astronomy and fixed links, taking account of existing internationally agreed ITU recommendations and ECC decisions, in Section 5. We then set out how we propose to reflect our proposed approach in spectrum authorisations in Section 6.

5. Proposals for managing coexistence

5.1 As explained in Section 3, there are existing services in the 14.25-14.5 GHz band that would be impacted by interference from satellite services, if extended into the band. In this section, we set out our proposals for managing coexistence with those services.

Scope of the analysis undertaken

5.2 We are seeking to protect the following services currently operating in the 14.25-14.5 GHz band:

- radio astronomy operating at 14.47-14.5 GHz (at Jodrell Bank and Cambridge);
- any remaining fixed links still operating temporarily beyond 2022 (at various frequencies between 14.25-14.5 GHz), only at the specific locations for those links; and
- Crown use in the 14-14.5 GHz band.

5.3 As discussed in paragraph 3.23, existing FSS users (PES and TES) and new satellite users will be able to coexist without the need for additional protection beyond ITU coordination agreements.

5.4 In addition, the MOD have confirmed that existing protection for the two Crown sites should be extended across the whole 14-14.5 GHz band (existing protection arrangements are summarised at paragraph 5.30 below). We are satisfied these are appropriate and therefore no further analysis was undertaken in respect of these services.

Our proposed approach to coexistence analysis

5.5 Satellite terminals need to operate at higher powers than terrestrial networks in order to close the link with satellites in space, this can have an impact on the size of the protection areas required. In line with our Spectrum management strategy, we have sought to adopt a more realistic approach to our coexistence analysis.

5.6 Our starting point was to review existing international decisions and reports setting out agreed protection criteria for the 14-14.5 GHz band from GSO and NGSO FSS terminals. Our coexistence analysis was informed by the following:

- Recommendation ITU-R M.1643[23] – providing technical and operational requirements for MSS and FSS aeronautical ESIMs;
- ECC Report 026[24] – covering the compatibility of aeronautical GSO FSS terminals with existing services in Ku band; and

[23] ITU-R M.1643 - Technical and operational requirements for aircraft earth stations of aeronautical mobile-satellite service including those using FSS network transponders in the band 14-14.5 GHz (Earth-to-space). Approved 2003.
[24] ECC Report 026 - The compatibility & sharing of the aeronautical MSS with existing services in the band 14-14.5 GHz. Approved 2003.

- ECC Report 271[25] – covering the compatibility of NGSO FSS terminals with radio astronomy and fixed links in Ku band.

5.7 We then considered their implementation in relation to UK national circumstances, and decided to carry out more detailed coexistence analysis for the following reasons:

- to account for terrain (and clutter)[26] when determining the size of protection areas around radio astronomy and fixed links;
- to ensure the power flux density (PFD) mask would sufficiently protect fixed links from aeronautical ESIMs;
- to ensure our protection criteria accounted for interference from terminals operating to GSO satellites (given ECC Report 271 only applies to NGSOs).

5.8 Lastly, we considered the various ways satellite user terminals could operate in this band, that is, on land, in the air and at sea. Each use can interfere with existing services in different ways, and therefore require different conditions of use. This meant we had four coexistence scenarios to consider: aeronautical ESIMs; stationary land earth stations (ES); land ESIMs; and maritime ESIMs.

5.9 For simplicity, we are proposing to amalgamate the protections for land ES, land ESIMs and maritime ESIMs. This means for each type of service we propose to protect, there is one condition for aeronautical ESIMs and one condition which applies to all other terminals.

5.10 We have also compared the interference area for both GSO and NGSO terminals, and propose to adopt the larger interference area for simplicity (generally this was for GSO terminals).

5.11 We provide a high-level summary of the results of our analysis below, first for radio astronomy and then fixed links. We explain our methodology and coexistence analysis for each of these services, against each coexistence scenario, in detail in Annex 6.

Radio astronomy

5.12 We examined the two single dish receivers making radio astronomy observations between 14.47-14.5 GHz at Jodrell Bank and Cambridge.

Coexistence analysis for aeronautical ESIMs with radio astronomy

5.13 We examined PFD masks proposed in ECC Report 026, ECC Report 271 and ITU-R M.1643 for aeronautical use. While both ITU-R M.1643 and ECC Report 271 recommend a PFD limit, ECC Report 271 makes clear that “compliance with the PFD mask can only be achieved by avoiding transmissions within the 14.47-14.5 GHz band when the aircraft enters in visibility of radio astronomy sites performing observations in this band".

[25] ECC Report 271 - Compatibility and sharing studies related to NGSO satellite systems operating in the FSS bands 10.7-12.75 GHz (space-to-Earth) and 14-14.5 GHz (Earth-to-space). Approved 2018, last updated 2019.
[26] Terrain affects the resulting protection area because terrain along the signal path influences how much the signal decreases along that path.

5.14 Given radio astronomy sites could take measurements of space objects in any part of the sky (so could be pointing in any direction) and that all aircraft operating at cruise altitude will therefore be within line of sight of one or both radio astronomy sites, we propose to restrict the use of aeronautical ESIMs between 14.47-14.5 GHz when in UK airspace.

Coexistence analysis for land ES, land ESIMs and maritime ESIMs with radio astronomy

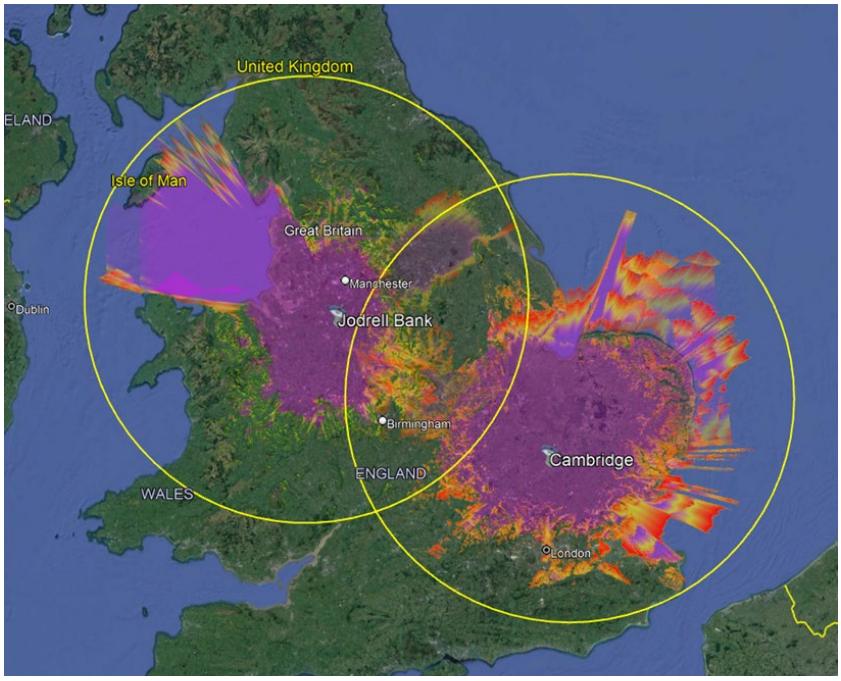
5.15 Our analysis (see Annex 6) shows that large protection areas would be necessary to protect both Jodrell Bank and Cambridge radio astronomy sites from land ES and ESIMs, and maritime ESIMs. These protection areas are smaller than the recommendations of ECC Report 271, as that report did not take account of UK topography. We found the greatest impact to radio astronomy sites is caused by GSO terminals (following a comparison between GSO and NGSO terminal interference plots) so propose to adopt a protection area reflecting GSO parameters that will apply to both GSO and NGSO terminals.

5.16 Due to UK terrain, the interference areas are not symmetrical around each of the radio astronomy sites. By offsetting the centre of the interference area (away from the site) we can more closely match the interference area which has the overall result of reducing the size of the protection area.

5.17 We therefore propose to protect radio astronomy sites with the following exclusion zones (also shown in Figure 6):

- For Jodrell Bank, a 175 km radius from focus point SJ5739392556 (this includes the Isle of Man and surrounding waters within this area); and
- For Cambridge, a 175 km radius from focus point TL5439992385.

Figure 6: Proposed radio astronomy exclusion zones for Jodrell Bank and Cambridge from GSO and NGSO land and maritime terminals



5.18 Our proposals require much larger protection areas than are typically in place around radio astronomy sites through Recognised Spectrum Access licences (normally c.50 km). This is because sharing is in-band and the potential for interference from satellite terminals is greater as they operate at higher power levels than typical terrestrial use. Single dish receivers at Jodrell Bank and Cambridge also require more stringent levels of protection than radio astronomy measurements performed using an array of radio telescopes like e-MERLIN, which tend to be more resilient to interference.

5.19 We have only conducted analysis on existing radio astronomy use, that is for the two single receivers. As we noted in paragraph 3.10, radio astronomy measurements in 14.47-14.5 GHz may move across to the e-MERLIN network array (subject to funding approval), in which case we would need to reassess the protection requirements. Practically, we expect this would result in greatly reduced protection areas (for the reasons explained above) but would extend to an additional four sites (covering the six radio astronomy sites shown in Figure 2). To determine the revised protection areas at the six radio astronomy sites, we would adopt the same principles and methodology as set out above and in Annex 6.

5.20 If we are made aware of a decision which changes the radio astronomy sites making observations at 14.47-14.5 GHz before we publish our Statement, we propose to set out the revised six protection areas in our Statement. If no outcome is known by that time, we explain our proposed approach for addressing the authorisation implications of a decision happening in the future in paragraph 6.15.

Fixed links

5.21 There are 30 remaining fixed links in the UK operating in pairs using 7-28 MHz channels across the whole 250 MHz of the 14.25-14.5 GHz band. However, licensees have told us most of the fixed links will be retired by the end of 2022. We are seeking to confirm which fixed links will remain temporarily and would require protecting through this consultation.

5.22 We applied our modelling approach to an example paired link in the Highlands (Gairloch to Isle of Skye), which we understand will remain temporarily after 2022 to support the emergency services. We propose to adopt the same principles and methodology (as outlined in Annex 6) to determine the protection areas for any other remaining fixed links and intend to include these in our Statement.

Coexistence analysis for aeronautical ESIMs with fixed links

5.23 As part of our analysis, we reviewed the PFD mask recommendations in ITU-R M.1643, ECC Report 026 and ECC Report 271 for aeronautical ESIMs; the recommendations differ according to whether they relate to GSO or NGSO satellite services. We modelled interference from both GSO and NGSO aeronautical ESIMs into fixed links and found that the more stringent PFD for GSO satellites (in ITU-R M.1643) would be necessary to protect fixed links (see Annex 6).

5.24 We therefore propose that when within UK air space, aeronautical ESIMs (for both GSO and NGSO terminals) should not exceed the PFD mask on designated frequencies for specified fixed links as follows:

$-132 + 0.5 \cdot \theta$ dB(W/(m^2 · MHz)) for $\theta \leq 40°$
-112 dB(W/(m^2 · MHz)) for $40 < \theta \leq 90°$
(where θ is the angle of arrival of the radiofrequency wave (degrees above the horizontal)).

Coexistence analysis for land ES, land ESIMs and maritime ESIMs with fixed links

5.25 Our analysis shows that both land and maritime terminals can cause interference to fixed link receivers (and this is different for each fixed link). As part of our approach, we modelled likely interference to receivers from both GSO and NGSO terminals. After comparing the interference plots, we found that whilst the impact areas differ slightly, both have a similar impact on fixed links. We therefore overlaid both GSO and NGSO interference in determining our protection criteria for fixed links (as shown in Annex 6).

5.26 The NGSO protection criteria considered in ECC Report 271 recommended protection areas with a 58-77 km length along each fixed link in a "smooth earth" scenario, but also noted they should be determined on a case-by-case basis, and take account of actual fixed link parameters and surrounding terrain. Our analysis suggests we can produce more accurate, bespoke protection areas for each fixed link, specific to the UK.

5.27 For the Gairloch to Isle of Skye link, our modelling found that due to high terrain, the main beam overshoots and the interference areas are longer than those envisioned in ECC Report 271. However, by adapting our protection area to the shape of the interference area, we can propose "bespoke" exclusion zones. The combined interference areas and proposed exclusion zones for the Gairloch and Isle of Skye receivers are shown in figures 7 and 8 respectively.

Figure 7: Combined interference area and proposed exclusion zone to protect Gairloch fixed link receiver from GSO and NGSO land and maritime terminals

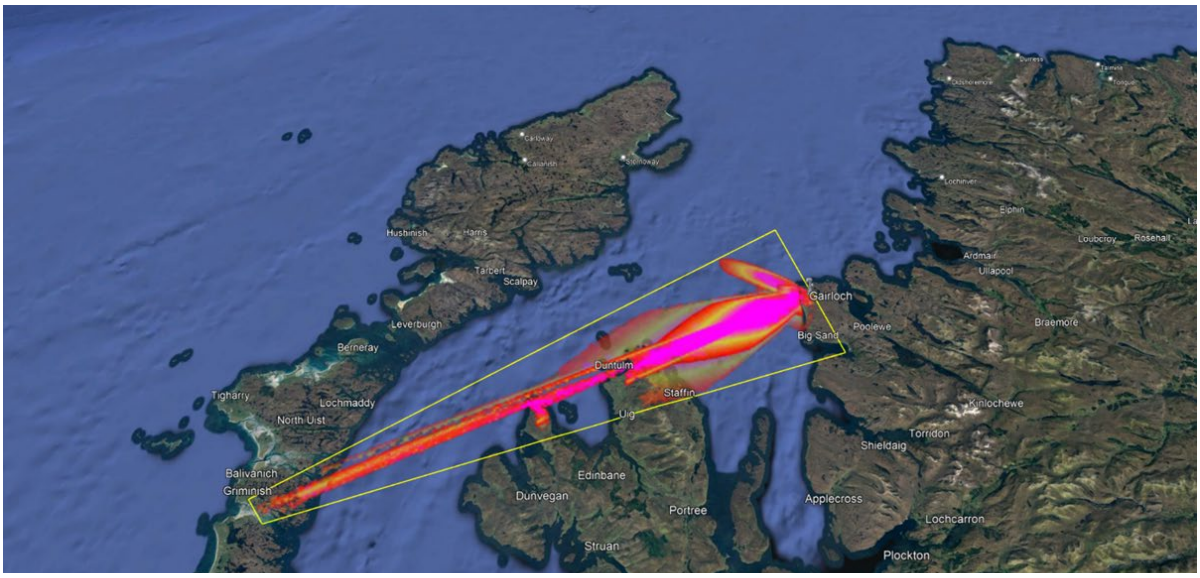
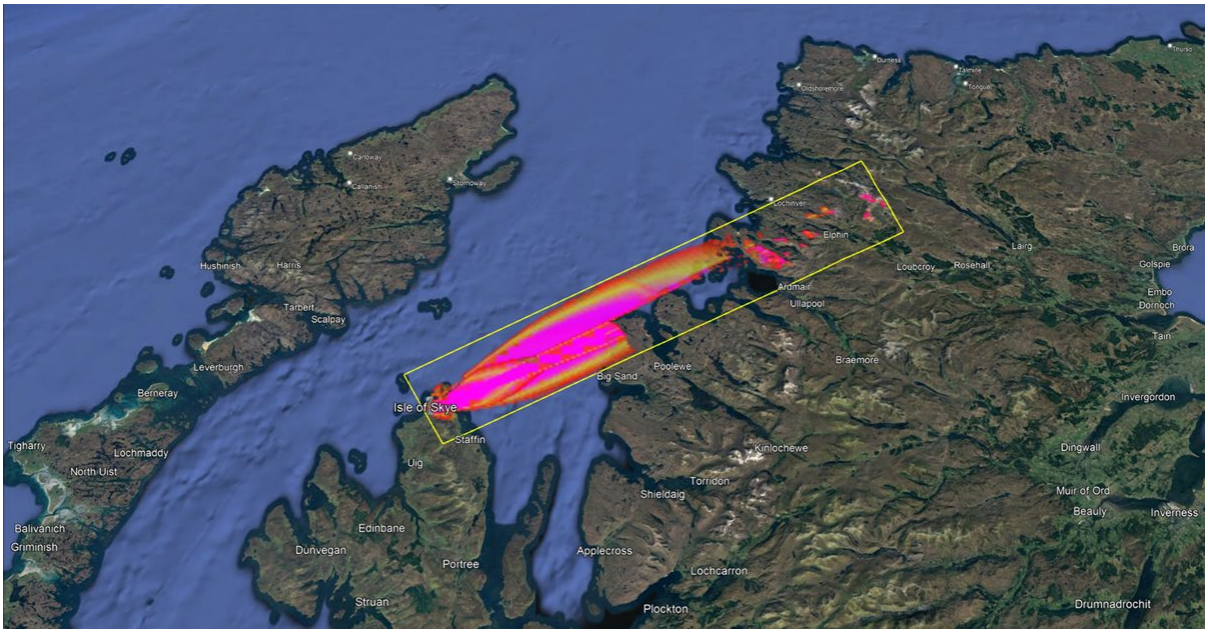


Figure 8: Combined interference area and proposed exclusion zone to protect Isle of Skye fixed link receiver from GSO and NGSO land and maritime terminals



5.28 Therefore, for land ES and ESIMs and maritime ESIMs, we propose to implement bespoke exclusion zones (and frequency range) where these terminals must not transmit, as they apply to each bi-directional paired link remaining in the 14.25-14.5 GHz band. The exclusion zones are determined by the area formed within the Ordnance Survey (OS) national grid references (NGR) specified.

5.29 For the purposes of consultation, our proposed exclusion zones for the example Gairloch and Isle of Skye fixed link receivers, and relevant frequency range where land and maritime terminals must not transmit, are shown in Table 1.

Table 1: Proposed fixed link exclusion zones for Gairloch and Isle of Skye receivers from GSO and NGSO land and maritime terminals

Fixed link receiver location (NGR)	Frequency range (GHz)	Proposed exclusion zone area- length x width (km)
Gairloch at NG 75600 90000	14.305-14.333	Bespoke trapezium – 106 km x 34 km (widest point) (see figure 7), covering the area formed within the following four NGR points: NB7228407904, NG7936474883, NF8143745693, NF7860350086.
Isle of Skye at NG 41600 73890	14.445-14.473	Bespoke rectangle – 104 km x 20 km (see figure 8), covering the area formed within the following four NGR points: NC3070732585, NC3528011256, NG4435766759, NG3676382388.

Crown use

5.30 The ESN licence already restricts use of Ku band frequencies (14-14.25 GHz) within close proximity to Crown users[27], located at the two locations (as defined by NGR points SE 20900 56100 and SS 20500 12600). Specifically:

- No use is permitted when satellite terminals transmit at a location up to (and including) 5 km from the two locations above without prior consent from Ofcom and "registration" on licence.
- Where satellite terminals transmit with EIRP between 50-55 dBW, no use is permitted between 5-7 km from the two locations above without prior consent from Ofcom and "registration".
- Satellite terminals can operate when transmitting at a location more than 7 km from the two locations defined above.

5.31 Following discussions with MOD, we propose to extend the existing protection to apply to Crown sites across the whole 500 MHz, between 14-14.5 GHz.

Summary of proposed protection requirements

5.32 We summarise the various protection requirements for radio astronomy and fixed link (example provided for Gairloch to Isle of Skye) from GSO and NGSO land, maritime and aeronautical terminals, in Table 2.

5.33 We propose to confirm each of the bespoke exclusion zones for any fixed links temporarily remaining in the band after 2022, in our Statement later this year. In doing so, we propose to adopt the same principles and methodology as for the Gairloch to Isle of Skye fixed link example discussed above (and detailed in Annex 6).

5.34 Our proposed protection requirements should not materially affect the rollout of satellite services authorised under an ESN licence:

- for fixed links, we expect these to be temporary and low in number. In the interim, restrictions will be localised at designated frequencies;
- for radio astronomy, the restrictions only affect the top 30 MHz. We note the size of exclusions zones would greatly reduce if measurements were moved to e-MERLIN in the future; and
- existing protection for Crown use between 14-14.25 GHz will be extended up to 14.5 GHz in two locations, up to 7 kms around each site.

[27] See conditions 2.4(i) and 2.4(j) of Schedule 1 to the ESN licence.

Table 2: Summary of proposed protection requirements for radio astronomy and fixed links

	Service		Proposed protection requirements	
	Site/location	**Frequency band (GHz)**	**FSS land ES and FSS/mss land and maritime ESIM terminals**	**FSS/mss aeronautical ESIM terminals**
Radio astronomy	Jodrell Bank and Cambridge	14.47-14.5	Must not transmit between 14.47-14.5 GHz within a 175 km radius[28] from focus points (NGRs): SJ5739392556, TL5439992385.	Must not transmit between 14.47-14.5 GHz.
Fixed links: bespoke example provided for Gairloch and Isle of Skye receivers	Gairloch	14.305-14.333	Must not transmit between the specified frequencies within the **106 km x 34 km** (widest point) **trapezium** and area formed by the following four NGRs: NB7228407904, NG7936474883, NF8143745693, NF7860350086.	Must not exceed the PFD limit below, when transmitting between **14.25-14.5 GHz**: $-132 + 0.5 \cdot \theta$ dB(W/(m^2 · MHz)) for $\theta \leq 40°$ -112 dB(W/(m^2 · MHz)) for $40 < \theta \leq 90°$ where θ is the angle of arrival of the radiofrequency wave (degrees above the horizontal)
	Isle of Skye	14.445-14.473	Must not transmit between the specified frequencies within the **104 km x 20 km rectangle** and area formed by the following four NGRs: NC3070732585, NC3528011256, NG4435766759, NG3676382388.	

Question 3: Do you agree with our proposed protection requirements for a) radio astronomy users of 14.47-14.5 GHz; b) remaining fixed link users (at specified frequencies and locations) and c) Crown users?

5.35 These proposed protection requirements will be included in ESN licences (and apply in other licences, if requested by licensees) as explained in Section 6.

[28] For Jodrell Bank, this includes the Isle of Man and surrounding waters within this area.

6. Implications for authorisations

6.1 Our proposals to extend access to the 14.25-14.5 GHz band for satellite connectivity would need to be reflected in licences, should they proceed. The proposals would primarily affect ESN Licences but would also have implications for Ship Radio Licences, Aircraft Radio Licences and the newly proposed Unmanned Aircraft System (UAS) Operator Radio Licences. We set out what our proposals would mean for affected licensees below, including how existing services would be protected from interference.

Implications for ESN licences

6.2 We propose to extend access to the authorised frequencies in Ku band for ESN licensees (i.e. amend frequencies in ESN licences from 14-14.25 GHz to 14-14.5 GHz). This means that existing licence conditions applying to 14-14.25 GHz would now apply to the whole 14-14.5 GHz band, and licensees would have access to an additional 250 MHz to provide satellite connectivity. The proposed variations are highlighted in yellow in Annex 3.

Extending access to the whole Ku band uplink: 14-14.5 GHz

6.3 To give effect to our proposals, we would amend frequencies in ESN licences, from 14-14.25 GHz to 14-14.5 GHz in the following paragraphs of Condition 2 of Schedule 1:

- 2.1(a) – relating to extending access for GSO terminals;
- 2.2(c) – relating to extending access for NGSO land terminals;
- 2.4(h) – relating to extending existing protection for Crown use; and
- 2.4(i) – also relating to extending existing protection for Crown use.

6.4 As explained in paragraph 6.7 below, to protect radio astronomy we propose to restrict aeronautical terminals from using the top 30 MHz of the band (14.47-14.5 GHz). This means only 470 MHz will be available for aeronautical terminals in the Ku band, rather than the whole 500 MHz. We therefore propose to make the following additional amendments to the authorised frequencies in Condition 2 of Schedule 1:

- insert a new 2.1(b) – limiting access for GSO aeronautical terminals to 14-14.47 GHz only;

> b) for aeronautical station(s), not transmit within the frequency range 14.47-14.5 GHz

- renumber existing provision 2.1(b) as 2.1(c); and
- 2.3(e) – relating to NGSO aeronautical terminals, limiting access to 14-14.47 GHz only.

Protecting radio astronomy and fixed links

6.5 As summarised in Table 2 in Section 5, we have assessed the need for exclusion zones to protect radio astronomy operating between 14.47-14.5 GHz and any fixed links remaining temporarily in the 14.25-14.5 GHz band.

6.6 The proposed protection criteria relate to the four ways satellite terminals might operate in the 14-14.5 GHz band, as explained at paragraph 5.7: aeronautical ESIMs, land ES, land ESIMs, and maritime ESIMs. They apply to both GSO and NGSO satellite terminals.

6.7 For radio astronomy, to protect sites at Jodrell Bank and Cambridge, we propose to:

- restrict aeronautical terminals from transmitting between 14.47-14.5 GHz (see conditions 2.1(b) and 2.3(e)); and
- restrict land and maritime terminals transmitting in 14.47-14.5 GHz within a 175 km radius from focus points (NGRs) SJ5739392556 and TL5439992385 (see condition 2.5(k)).

6.8 For fixed links, since the restrictions are temporary and bespoke for each fixed link remaining in the band, we do not propose to include the exclusion zones in the ESN licence itself. Instead, we propose to require ESN licensees to protect fixed links in accordance with a separate Notice (see condition 2.5(l)).

6.9 We propose for this Notice to have an end date, to list each fixed link that will require temporary protection, and that link's corresponding bespoke exclusion zone. The format of the Notice is outlined in Annex 4, and includes the example fixed link exclusion zone for Gairloch to Isle of Skye.

6.10 We therefore propose to add the following protection condition in ESN licences as a new paragraph 2.5 of Schedule 1. This new condition would only apply to satellite earth stations that transmit in the newly added 14.25-14.5 GHz frequencies.

New condition 2.5 – Protection of radio astronomy and fixed links in the 14.25-14.5 GHz band

k) To protect radio astronomy operating between 14.47-14.5 GHz, a land or maritime station shall not transmit from a location within a 175 km radius of the national grid references below:

• Jodrell Bank – NGR for focus point SJ5739392556;

• Cambridge – NGR for focus point TL5439992385.

l) Licensees shall protect fixed links at 14.25-14.5 GHz in accordance with the Notice issued by Ofcom.

6.11 For clarification, we also propose to amend paragraph 3.1(d) of Schedule 1, so that it refers specifically to the UK Interface Requirement (IR) for ESN licensees – UK IR 2077[29], as follows:

Amended paragraph 3.1(d)

The apparatus used for transmission complies with the Radio Equipment Directive and UK Interface Requirement 2077.

[29] UK Interface Requirement 2077. This document contains the requirements for authorising and using ESN terminals in the specified frequency bands.

6.12 We propose that all new ESN licensees would receive these proposed changes to the ESN licence as standard, following our Statement later this year. Existing licensees would be able to request a variation to their ESN licence to gain access to the additional 250 MHz (between 14.25-14.5 GHz) but in doing so would also need to accept the protection condition for radio astronomy and fixed links as set out above. Licensees can request this variation to their ESN licence by emailing spectrum.licensing@ofcom.org.uk.

Updating UK Interface Requirement 2077

6.13 When ESN licences are amended, we also need to reflect any relevant changes in IR 2077. We therefore propose to amend IR 2077, in particular to reflect the amended frequencies in row 3 of tables 3.1 and 3.2 of IR 2077.

Potential future changes to radio astronomy observation sites

6.14 With regard to condition 2.5(k), we also propose to make provision in ESN licences to insert additional radio astronomy sites (i.e. sites part of the e-MERLIN array as shown in Figure 2), should we need to reflect such a change to the way UK radio astronomy observations are made in the 14.47-14.5 GHz band. We note that although any such change would add additional sites to be protected, the size of the protection area for each site would be greatly reduced, as explained at paragraph 5.19. We would therefore expect the potential change to improve ESN licensees' ability to transmit at 14.47-14.5 GHz in the future.

6.15 Should a decision be made to change the radio astronomy sites making observations at 14.47-14.5 GHz, our proposed approach for addressing the authorisation implications is as follows:

- If we are made aware of such a decision before we publish our Statement, we propose to set out the revised six exclusion zone distances in our Statement, alongside the corresponding six radio astronomy sites in ESN licences under condition 2.5(l).
- If the decision is made after we publish our Statement, we propose to take steps to update the standard terms and conditions of ESN licences issued to any new licensees to reflect the protection requirements necessary for all six e-MERLIN radio astronomy sites. Existing ESN licensees are advised that they are on notice that this condition may be subject to a future variation, should such a decision be taken. We would look to address the matter in the next variation to ESN licences following that decision, and the variation may need to be implemented before observations are moved to the e-MERLIN sites.

Implications for existing licensees' authorisations

6.16 Other licensees may deliver satellite connectivity in conjunction with ESN licensees. For example, inflight connectivity on aircraft, connectivity on ships, or for drones carrying out monitoring or surveillance.

6.17 We propose to extend access in the Ku band to the whole 500 MHz from 14-14.5 GHz in those licences already permitting use between 14-14.25 GHz. This proposal applies to the following licences:

- Aircraft radio licence (applicable only where "WAS[30]/Wi-Fi" equipment is authorised under the licence)[31];
- Unmanned aircraft system (UAS) operator radio licence[32]; and
- Ship radio licence (applicable only where "ESV"[33] equipment is authorised under the licence).

Aircraft radio licences (with WAS/Wi-Fi enabled equipment)

6.18 This licence currently permits use between 14-14.5 GHz (under condition C1 row 7, and condition C3), so we do not propose to vary the Aircraft radio licence. However, although we are not changing the way that this equipment is authorised, when the aircraft is in or over the UK or Crown Dependencies, the satellite connectivity on the aircraft **must be provided by an authorised ESN licensee** (as required by condition C3(a)).

6.19 Therefore, for aircraft wishing to provide inflight connectivity by accessing the additional 220 MHz from 14.25-14.47 GHz, the appropriate satellite ESN licensee must ask us to vary their ESN licence, as explained from paragraph 6.3 above. Inflight connectivity in the 14.25-14.47 GHz band would be possible once the relevant ESN licence has been varied.

Unmanned aircraft system operator radio licences

6.20 The UAS operator radio licence is a new (draft) licence and its format is currently subject to consultation. The draft licence terms are similar to the Aircraft radio licence above, except that the draft currently only permits use over 250 MHz between 14-14.25 GHz.

6.21 Therefore, we propose to enable UAS licensees to take advantage of satellite connectivity across the whole aeronautical band, between 14-14.47 GHz. As that licence is still under consultation, we will explain our approach to its variation (should it proceed) in our Statement.

Ship radio licences (with ESV enabled equipment)

6.22 The conditions applying to Ship radio licensees are set out in a separate publication: "Ship Radio: Terms, conditions and limitations"[34]. Our proposals relate only to licences where ESV equipment in the 14-14.5 GHz band is authorised, and are explained below.

6.23 There is already an existing condition 8 of Schedule 3 which permits Earth Stations on a Vessel (ESVs) to transmit at 14-14.25 GHz (see condition 8(c)(a) of Schedule 3). We propose to remove the conditions at 8(c)(a) and 8(i) referencing the 14-14.25 GHz band, and replace it with a new provision for the whole 14-14.5 GHz band (condition 9). We consider this is necessary because some of the technical restrictions are inconsistent with the current ESN licence (requiring terminals to operate at lower power for example).

[30] Wireless access system
[31] Aircraft radio licence – see WAS/Wi-Fi condition from page 11.
[32] Spectrum for Unmanned Aircraft Systems (UAS) consultation
[33] Earth Station on a Vessel
[34] Ship radio licence: Terms, conditions and limitations publication – see ESV condition from page 16.

6.24 Proposed new condition 9, set out in full at Annex 5, would apply to equipment transmitting on frequencies between 14-14.5 GHz (Earth to space). We propose for the condition to require that the earth station equipment:

- only be used under a ship radio licence;
- must only be used within UK territorial waters (and those of its Crown Dependencies) if authorised under an ESN licence (or be appropriately authorised to operate, when in the territorial waters of other administrations);
- must not transmit with an EIRP greater than 55 dBW;
- must operate in accordance with the technical parameters specified, for GSO satellites;
- must clearly identify all transmissions; and
- must conform to Interface Requirement IR 2077;

6.25 As for ESN licensees above, we propose that all new Ship radio licensees would receive these proposed changes to the Ship radio licence as standard, following our Statement later this year. Existing licensees would be able to request a variation to their Ship radio licence to gain access to the additional 250 MHz (between 14.25-14.5 GHz). Licensees can request this variation to their Ship radio licence using the online licensing portal[35].

6.26 In addition, for ships to access the additional 250 MHz from 14.25-14.5 GHz, the appropriate satellite ESN licensee must ask us to vary their ESN licence, as explained from paragraph 6.3 above. Maritime connectivity in the 14.25-14.5 GHz band would only be possible once both the Ships radio and ESN licences have been varied.

Existing 14.25-14.5 GHz licensees

6.27 We anticipate no change to existing fixed links, radio astronomy, TES, PES authorisations as a result of these proposals. Though we also note that declining fixed links in the 14.25-14.5 GHz band has an advantage for TES (and PES) licensees in that it gives them greater freedom to operate.

6.28 We also propose to work with fixed link licensees to revoke by consent fixed link licences that are no longer required, on a date agreed with licensees.

Question 4: Do you agree with our proposed authorisation approach and draft licence conditions for a) ESN licences, and b) other licensees wishing to take advantage of enhanced satellite connectivity (i.e. aircraft, ships, unmanned aircraft systems).

[35] Ship radio licensing portal

7. Summary of proposals and next steps

Summary of our proposals

Authorisation proposal

7.1 In this consultation we propose to extend access to the frequencies available in the ESN licence to include the 14.25-14.5 GHz band.

Protection requirements

7.2 Existing services in the 14.25-14.5 GHz band (i.e. radio astronomy operating at 14.47-14.5 GHz, and fixed links operating from various locations throughout the band) would need to be protected from satellite services authorised under an ESN licence. We propose for the protection for fixed links to be temporary and bespoke for each specified fixed link, as we understand the links are all planned to cease or eventually migrate from the 14.25-14.5 GHz band.

7.3 We summarise the various protection requirements for radio astronomy and fixed links (example provided for Gairloch to Isle of Skye) from GSO and NGSO land, maritime and aeronautical terminals in Table 3 below.

Table 3: Summary of proposed protection requirements for radio astronomy and fixed links

	Service		Proposed protection requirements	
	Site/location	**Frequency band (GHz)**	**FSS land ES and FSS/mss land and maritime ESIM terminals**	**FSS/mss aeronautical ESIM terminals**
Radio astronomy	Jodrell Bank and Cambridge	14.47-14.5	Must not transmit between 14.47-14.5 GHz within a 175 km radius[36] from focus points (NGRs): SJ5739392556, TL5439992385.	Must not transmit between 14.47-14.5 GHz.
Fixed links: bespoke example provided for Gairloch and Isle of	Gairloch	14.305-14.333	Must not transmit between the specified frequencies within the **106 km x 34 km** (widest point) **trapezium** and area formed by the following four NGRs:	Must not exceed the PFD limit below, when transmitting between **14.25-14.5 GHz**:

[36] For Jodrell Bank, this includes the Isle of Man and surrounding waters within this area.

	Service		Proposed protection requirements	
	Site/location	Frequency band (GHz)	FSS land ES and FSS/mss land and maritime ESIM terminals	FSS/mss aeronautical ESIM terminals
Skye receivers			NB7228407904, NG7936474883, NF8143745693, NF7860350086.	-132 + 0.5 · θ dB(W/(m^2 · MHz)) for θ ≤ 40° -112 dB(W/(m^2 · MHz)) for 40 < θ ≤ 90° where θ is the angle of arrival of the radiofrequency wave (degrees above the horizontal)
	Isle of Skye	14.445-14.473	Must not transmit between the specified frequencies within the **104 km x 20 km rectangle** and area formed by the following four NGRs: NC3070732585, NC3528011256, NG4435766759, NG3676382388.	

7.4 We propose to confirm each of the bespoke exclusion zones for any fixed links temporarily remaining in the band after 2022 in our Statement later this year. In doing so, we propose to adopt the same principles and methodology as for the Gairloch to Isle of Skye fixed link example discussed above (and detailed in Annex 6).

Licensing proposals

7.5 To gain access to the additional 250 MHz between 14.25-14.5 GHz, existing licensees would need to request a licence variation. The proposed licence conditions would apply to all new licences as standard. The specific licensing changes are summarised below:

Satellite earth station network licence

7.6 To give effect to our proposals, we propose to amend ESN licences as shown in Annex 3 (changes are highlighted in yellow).

7.7 Specifically, we propose to amend frequencies from 14-14.25 GHz to 14-14.5 GHz where relevant in Condition 2 of Schedule 1.

7.8 For radio astronomy, to protect sites at Jodrell Bank and Cambridge, we propose to:

- restrict aeronautical terminals from transmitting between 14.47-14.5 GHz. This will be reflected in the frequencies authorised at conditions 2.1(b) and 2.3(e) rather than inserting a new protection condition; and

- restrict land and maritime terminals transmitting between 14.47-14.5 GHz within a 175 km radius of focus points (NGRs) SJ5739392556 (Jodrell Bank) and TL5439992385 (Cambridge) (see condition 2.5(k));

7.9 For fixed links, since the restrictions are temporary and bespoke for each fixed link remaining in the band, we do not propose to include the protection criteria in the ESN licence itself. Instead, we propose to require ESN licensees to protect fixed links in accordance with a separate Notice (see condition 2.5(l) and Annex 4). The Notice will:

- restrict aeronautical terminals from exceeding the specified PFD limit when transmitting between 14.25-14.5 GHz; and
- restrict land and maritime terminals transmitting between the specified frequencies (for that fixed link) within the bespoke area formed by the specified NGRs. For the Gairloch to Isle of Skye example, these bespoke areas are described in Table 3.

Aircraft radio licences (with WAS/Wi-Fi enabled equipment)

7.10 Use is already permitted between 14-14.5 GHz provided it is done in conjunction with an authorised ESN licence, so we do not propose to vary the Aircraft radio licence. However, inflight connectivity in the 14.25-14.47 GHz band would only be possible once the relevant ESN licence is varied.

Unmanned aircraft system operator radio licence

7.11 The unmanned aircraft system (UAS) operator radio licence is a new (draft) licence. We propose to enable UAS licensees to take advantage of satellite connectivity across the whole aeronautical band, between 14-14.47 GHz, but as that licence is still under consultation, we will explain our approach to its variation (should it proceed) in our Statement.

Ship radio licence (with ESV enabled equipment)

7.12 We also propose to extend the frequencies available in the Ship Radio Licence. Specifically, we propose to remove the conditions at 8(c)(a) and 8(i) referencing the 14-14.25 GHz band, and replace it with a new provision for the whole 14-14.5 GHz band (condition 9).

7.13 We propose for condition 9 to require that the earth station equipment:

- only be used under a ship radio licence;
- must only be used within UK territorial waters (and those of its Crown Dependencies) if authorised under an ESN licence (or be appropriately authorised to operate, when in the territorial waters of other administrations);
- must not transmit with an EIRP greater than 55 dBW;
- must operate in accordance with the technical parameters specified, for GSO satellites;
- must clearly identify all transmissions;
- must conform to Interface Requirement IR 2077.

7.14 Maritime connectivity in the 14.25-14.5 GHz band would only be possible once both the Ships radio and ESN licences are varied.

Updating Interface Requirement 2077

7.15 We propose to reflect these proposals in IR 2077, in particular to amend the frequencies in tables 3.1 and 3.2.

Question 5: Do you have any other comments on our proposals?

Next steps

Responding to this consultation

7.16 We are seeking input from stakeholders in several areas. The full list of our consultation questions relating to our proposals can be found in Annex 9**. The deadline for responses is 5pm on Wednesday 31 August 2022.**

Setting out our decisions

7.17 We will carefully consider all stakeholder responses as we formulate our decisions on these proposals. We will also consider relevant responses from stakeholders to our recent consultation on our Space spectrum strategy, where we noted access to the 14.25-14.5 GHz band was a now a high priority action.

7.18 We expect to publish our Statement along with the reasoning for our decisions before the end of 2022.

Notifying Interface Requirement 2077

7.19 Giving effect to these proposals would also require that we notify the European Commission of a change to the frequencies included in IR 2077. This notification is required because Northern Ireland continues to be part of the EU single market. The EC has three months to comment on our proposals.

7.20 We expect to start this process as soon as possible after the consultation period has closed to reduce any delay to implementing our proposals. We anticipate the notification period to complete around the end of 2022. Licensees would be able to make licence variation requests once this notification period has passed. We expect to confirm a more precise timeframe in our Statement.

A1. Responding to this consultation

How to respond

A1.1 Ofcom would like to receive views and comments on the issues raised in this document, by 5pm on 31 August 2022.

A1.2 You can download a response form from https://www.ofcom.org.uk/consultations-and-statements/category-1/extending-access-in-ku-band. You can return this by email or post to the address provided in the response form.

A1.3 If your response is a large file, or has supporting charts, tables or other data, please email it to 14ghz@ofcom.org.uk, as an attachment in Microsoft Word format, together with the cover sheet (see also Annex 3). This email address is for this consultation only and will not be valid after 2022.

A1.4 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.

A1.5 We will publish a transcript of any audio or video responses we receive (unless your response is confidential)

A1.6 We do not need a paper copy of your response as well as an electronic version. We will acknowledge receipt of a response submitted to us by email.

A1.7 You do not have to answer all the questions in the consultation if you do not have a view; a short response on just one point is fine. We also welcome joint responses.

A1.8 It would be helpful if your response could include direct answers to the questions asked in the consultation document. The questions are listed at Annex 9. It would also help if you could explain why you hold your views, and what you think the effect of Ofcom's proposals would be.

A1.9 If you want to discuss the issues and questions raised in this consultation, please contact the 14 GHz project team in Spectrum Group by email to 14ghz@ofcom.org.uk.

Confidentiality

A1.10 Consultations are more effective if we publish the responses before the consultation period closes. In particular, this can help people and organisations with limited resources or familiarity with the issues to respond in a more informed way. So, in the interests of transparency and good regulatory practice, and because we believe it is important that everyone who is interested in an issue can see other respondents' views, we usually publish responses on the Ofcom website at regular intervals during and after the consultation period.

A1.11 If you think your response should be kept confidential, please specify which part(s) this applies to, and explain why. Please send any confidential sections as a separate annex. If you want your name, address, other contact details or job title to remain confidential, please provide them only in the cover sheet, so that we don't have to edit your response.

A1.12 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and try to respect it. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.

A1.13 To fulfil our pre-disclosure duty, we may share a copy of your response with the relevant government department before we publish it on our website. This is the Department for Business, Energy and Industrial Strategy (BEIS) for postal matters, and the Department for Culture, Media and Sport (DCMS) for all other matters.

A1.14 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

A1.15 Following this consultation period, Ofcom plans to publish a statement by December 2022.

A1.16 If you wish, you can register to receive mail updates alerting you to new Ofcom publications.

Ofcom's consultation processes

A1.17 Ofcom aims to make responding to a consultation as easy as possible. For more information, please see our consultation principles in Annex 7.

A1.18 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.

A1.19 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

A2. Fixed link in the 14.25-14.5 GHz band

Table A1: Bi-directional links operating in the UK, shown in respective pairs, with centre frequencies

Licence	Licensee	Frequency (GHz)	Bandwidth (MHz)	National grid reference	Location
0467488/1	Arqiva	14.2910	28	NJ 32100 49700	Moray, Scotland
0467488/1	Arqiva	14.4310	28	NJ 54700 32600	Aberdeenshire, Scotland
0467457/1	Arqiva	14.3190	28	NO 25200 05900	Fife, Scotland
0467457/1	Arqiva	14.4590	28	NO 39400 40700	Angus, Scotland
0469751/1	Arqiva	14.4590	28	NO 39400 40700	Angus, Scotland
0469751/1	Arqiva	14.3190	28	NO 66300 53500	Angus, Scotland
0464702/1	Arqiva	14.4310	28	NU 19100 08100	Shilbottle, Northumberland
0464702/1	Arqiva	14.2910	28	NZ 21800 86400	Pegswood, Northumberland
1095297/1	Arqiva	14.2910	28	NZ 43300 16900	Stockton-on-Tees, NE
1095297/1	Arqiva	14.4310	28	NZ 57000 18400	Lackenby, NE
0464088/1	Arqiva	14.3190	28	SD 52300 01600	St Helens, NW
0464088/1	Arqiva	14.4590	28	SJ 34800 90400	Liverpool, NW
0466355/1	Arqiva	14.2910	28	SD 66000 14400	Winter Hill, Belmont, NW
0466355/1	Arqiva	14.4310	28	SD 82500 38400	Pendle, Lancashire
0466003/1	Arqiva	14.3995	7	SJ 62800 08200	Wrekin Hill, Telford
0466003/1	Arqiva	14.2595	7	SJ 98700 14300	Hednesford, Staffordshire
0471175/1	Arqiva	14.3190	28	SK 48400 12700	Markfield, Leicestershire
0471175/1	Arqiva	14.4590	28	SK 67600 04200	Harborough, Leicestershire
0465079/1	Arqiva	14.4310	28	SN 57600 15300	Carmel transmitter, Wales
0465079/1	Arqiva	14.2910	28	SS 67200 94000	Kilvey Hill, Swansea, Wales
0463899/1	Arqiva	14.2910	28	ST 36100 58800	Hutton, Somerset
0463899/1	Arqiva	14.4310	28	ST 56200 66100	Chew Magna, Somerset
1095303/1	Arqiva	14.4590	28	ST 56200 66100	Chew Magna, Somerset
1095303/1	Arqiva	14.3190	28	ST 76900 65500	Bathampton, Somerset
1095301/1	Arqiva	14.2910	28	ST 78800 96500	Woodmancote, Gloucestershire
1095301/1	Arqiva	14.4310	28	ST 94760 68620	Naish Hill transmitter, Wiltshire
0471587/1	Arqiva	14.2910	28	ST 79400 69200	Batheaston, Somerset
0471587/1	Arqiva	14.4310	28	ST 87700 42800	Crockerton transmitter, Wiltshire
0472337/1	Arqiva	14.3190	28	SU 38400 18100	Toothill Observatory, Hampshire
0472337/1	Arqiva	14.4590	28	SU 62654 06975	Paulsgrove, Portsmouth
0466992/1	Arqiva	14.4310	28	TL 66000 03400	Margaretting, Essex
0466992/1	Arqiva	14.2910	28	TQ 79000 86700	Castle Point, Essex
0459589/1	EE	14.2595	7	NC 70200 40790	B871, Highlands, Scotland
0459589/1	EE	14.3995	7	NC 75600 63800	Kirtomy, Highlands, Scotland
0427248/1	EE	14.39425	3.5	NC 34500 02400	A837, Scottish Highlands

Licence	Licensee	Frequency (GHz)	Bandwidth (MHz)	National grid reference	Location
0427248/1	EE	14.25425	3.5	NH 59300 95300	Invershin, Scottish Highlands
0938401/1	MBNL	14.4310	28	SE 49100 14300	Shinwell, Yorkshire
0938401/1	MBNL	14.2910	28	SK 51900 95900	Conisbrough, Yorkshire
0938339/1	MBNL	14.4590	28	SJ 57500 83100	Daresbury, Halton, NW
0938339/1	MBNL	14.3190	28	SJ 69800 54600	Crewe, Cheshire
0937705/1	MBNL	14.4310	28	SP 13300 77700	Blossomfield, West Midlands
0937705/1	MBNL	14.2910	28	SP 25400 86600	Maxstoke, Warwickshire
0938348/1	MBNL	14.2910	28	SP 25700 84300	Great Packington, Warwickshire
0938348/1	MBNL	14.4310	28	SP 64100 76600	Cold Ashby, Northamptonshire
0937747/1	MBNL	14.4310	28	ST 22200 01400	Stockland Hill transmitter, Devon
0937747/1	MBNL	14.2910	28	SX 89500 83600	Teignbridge, Devon
0938274/1	MBNL	14.2910	28	SU 45000 29600	Sparsholt, Hampshire
0938274/1	MBNL	14.4310	28	SU 72300 43200	Alton, Hampshire
0938444/1	MBNL	14.3190	28	SX 27300 70700	Caradon Hill transmitter, SW
0938444/1	MBNL	14.4590	28	SX 45800 55600	Plymouth
0950787/1	Vodafone	14.3190	28	NG 41600 73890	A855, Scottish Highlands
0950787/1	Vodafone	14.4590	28	NG 75600 90000	Camas Mor, Scottish Highlands
0950547/1	Vodafone	14.3505	7	NH 58900 29500	B862, Scottish Highlands
0950547/1	Vodafone	14.4905	7	NH 62700 43400	Inverness, Scottish Highlands
0950757/1	Vodafone	14.3190	28	NM 70300 35800	Craignure, Scotland
0950757/1	Vodafone	14.4590	28	NM 85000 29000	Oban, Scotland
0950773/1	Vodafone	14.3085	7	NS 25100 73600	Greenock, Scotland
0950773/1	Vodafone	14.4485	7	NS 45490 59690	Renfrewshire, Scotland
0949709/1	Vodafone	14.4590	28	SU 52700 56800	Kingsclere, Hampshire
0949709/1	Vodafone	14.3190	28	SU 64900 52600	Riverdene, Hampshire

A3. Draft Satellite (Earth Station Network) Licence

A3.1 The proposed changes to the ESN licence are highlighted in yellow throughout this annex.

Wireless Telegraphy Act 2006

Satellite (Earth Station Network)

Sector/class/product	**<Product>**
Licence number	**<Lic_No>**
Licensee	**<Lic_Name>**
Licensee address	**<Address>**
Trading as	**<Tradename>**
Licence first issue date	**<Issue_Date>**
Licence version date	**<Date>**
Payment interval	**<Year>**

1. This Licence is issued by the Office of Communications ("Ofcom") on **<Date>** 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 **<Lic_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) (hereinafter together called "the radio equipment") subject to the terms set out below and subject to the terms of the General Licence Conditions booklet (Version OfW 597).

ISSUED BY OFCOM

Satellite (Earth Station Network) Licence

SCHEDULE 1 TO LICENCE NUMBER <Lic_No>

TERMS, PROVISIONS AND LIMITATIONS COVERED BY THIS LICENCE

This schedule forms part of Licence **<Lic_No>**, issued to **<Lic_Name>**, the Licensee on **<Issue_Date>**, and describes the terms and equipment specifications covered by this Licence.

1. The Licensee may establish and use:

1.1. Permanent, transportable or mobile sending and receiving network earth station(s) ("the station(s)") for the purpose of providing wireless telegraphy links between the station(s) and geostationary or non-geostationary satellite(s).

2. Limitations on use

2.1. The stations(s) operating with geostationary satellites shall:

a) transmit within one or more of the following frequency ranges: 14.0-14.5 GHz, 27.5-27.8185 GHz, 28.4545-28.8265 GHz, 29.4625-30 GHz;

b) for aeronautical stations, not transmit within the frequency range 14.47-14.5 GHz;

c) transmit only to the satellite and its associated orbital longitude specified in Schedule 2.

2.2. Land station(s) operating with non-geostationary satellites shall:

d) transmit within one or more of the following frequency ranges: 14.0-14.5 GHz, 27.5-27.8185 GHz, 28.4545-28.8265 GHz, 29.5-30 GHz;

e) transmit only to the satellite network specified in Schedule 2.

2.3. Aeronautical station(s) operating with non-geostationary satellites shall:

f) transmit within the frequency range 14.0-14.47 GHz;

g) transmit only to the satellite network specified in Schedule 2.

2.4. Additionally:

h) stations(s) that transmit with e.i.r.p. greater than 55 dBW shall operate only with prior consent from Ofcom and registration of the station(s) against the Licence;

i) station(s) that transmit within the frequency range 14.0-14.5 GHz inclusive shall not operate at any location that is less than or equal to 5 km from the two geographical locations specified in Schedule 3 without prior consent from Ofcom and registration of the station(s) against the Licence;

j) station(s) that transmit with e.i.r.p. greater than 50 dBW and less than 55 dBW (50 dBW < e.i.r.p. < 55 dBW) in the frequency range 14.0-14.5 GHz inclusive shall not operate at any location that is greater than 5 km and less than or equal to 7 km from the two geographical locations specified in Schedule 3 without prior consent from Ofcom and registration of the station(s) against the Licence; and

k) station(s) shall not operate within the perimeter fence of any of the aerodromes specified in Schedule 4 without prior consent from the Civil Aviation Authority or stated Airport Authority.

2.5 Protection of radio astronomy and fixed links in the 14.25-14.5 GHz band

k) To protect radio astronomy operating between 14.47-14.5 GHz, a land or maritime station shall not transmit from a location within a 175 km radius of the national grid references below:

- Jodrell Bank – focus point of circle is NGR SJ5739392556;
- Cambridge – focus point of circle is NGR TL5439992385.

l) Licensees shall protect fixed links at 14.25-14.5 GHz in accordance with the Notice issued by Ofcom.

3. Apparatus

3.1. The Licensee shall ensure that:

a) The wireless telegraphy apparatus comprised in the station(s) ("the apparatus") is so designed, constructed, maintained and operated, that its use does not cause any undue interference to other users of the spectrum;

b) The apparatus complies with (and is maintained in accordance with) the relevant performance specification(s) published by the operator(s) of the geostationary or non-geostationary satellite(s);

c) The earth stations operating with non-geostationary satellites shall ensure compliance with the equivalent power flux-density limitations specified in Article 22 of the ITU Radio Regulations; and

d) The apparatus used for transmission complies with the Radio Equipment Directive and UK Interface Requirement 2077.

4. Additional conditions for mobile operation

a) The radio equipment shall be established or installed so that transmissions from the radio equipment may only be made when the radio equipment's operation is enabled by the crew of the vehicle, aircraft, vessel or train upon which it is mounted, and under the operational control of the network control facility. The radio equipment shall provide the crew with a means immediately to terminate transmissions;

b) Where an aircraft or vessel is registered in the United Kingdom, Channel Islands or the Isle of Man, the Licensee shall ensure that all radio equipment on board

that aircraft is endorsed by either a separate licence or exemption under the Wireless Telegraphy Act 2006;

c) Transmissions from the radio equipment shall automatically be terminated on loss or significant degradation of the downlink signal from the relevant satellite;

d) For operation with geostationary satellites, the radio equipment shall employ a stabilised platform with the ability to maintain a pointing accuracy +/-0.2 degrees towards the relevant geostationary satellite throughout transmissions; and

e) For operation with geostationary satellites, the maximum EIRP at angles greater than or equal to 2.5 degrees from the antenna main beam axis shall not exceed 20 dBW/40 kHz from any individual station.

5. National and international obligations

a) The relevant satellite data shall have been submitted to ITU in accordance with established ITU procedures; and

b) All transmissions from the radio equipment must be terminated prior to any change of location; unless the apparatus used for transmission is designed for mobile operation and incorporates a stabilised platform or is operating under a specific exemption authorised by Ofcom.

6. Requirements specific to Satellite (Earth Station Network) Licences

a) The Licensee shall keep a record of the operational characteristics of all terminals in the network, including the locations of fixed installations or, for mobile operation, details of the vehicles, aircraft, vessels or trains on which the terminals are installed and the associated route or defined area of operation, which Ofcom may wish to have access to for enforcement purposes;

b) The radio equipment shall implement independent local control and monitoring functions at the terminal, and be authorised, supervised and administered by a network control and monitoring centre;

c) The Licensee shall have the facility to disable individual terminal transmission; and

d) For satellite networks in MESH configuration, the network operator must nominate and notify Ofcom of those earth station(s) located in the UK which have independent centralised control and monitoring functionality and possess the capability to suppress transmissions from any earth station within the network. Earth stations that are capable of dynamic assignment as point-to-multipoint and point-to-point configuration may only be licensed as permanent earth stations.

7. Additional conditions for operation with non-geostationary satellites

7.1. The radio frequencies authorised by this Licence must be used in common with other non-geostationary satellite systems authorised under wireless telegraphy licences granted by Ofcom. The names of these licensees shall be notified by Ofcom to the Licensee from time to time, and together with the Licensee are described as the "NGSO Licensees".

7.2. The Licensee shall cooperate with all NGSO Licensees such that each satellite system (comprising the satellites, earth stations and user terminals) can co-exist and operate within the United Kingdom without causing harmful radio interference to each other, such that network services can be provided to end users.

7.3. In the event that –

a) one (or more than one) of the NGSO Licensees suffers a material and recurring (or ongoing) degradation of services to its users at a specific region or location in the United Kingdom; and

b) the degradation of services is resulting from radio transmissions from the earth stations, the satellite or any other part of the satellite system operated by any of the NGSO Licensees, including the Licensee;

Ofcom may by notice instruct the Licensee to cease or change the use of particular equipment or particular radio frequencies which are authorised under a wireless telegraphy licence (including but not limited to radio frequencies authorised under this Licence) and are used by any part of the satellite system.

7.4. Any such cessation or change must be for the purposes of ensuring that such interference is avoided and the degradation of services to users at the particular regions or locations is resolved.

7.5. Following receipt of such notice, for such period of time as may be specified in the notice, the Licensee may only operate in accordance with the terms and conditions of the notice.

8. Interpretation

8.1. In this and subsequent schedule(s):

l) "earth station" means a radio transmitter located on the surface of the earth or mounted on a vehicle, aircraft, vessel or train and intended for communication with one or more satellites;

m) "geostationary satellite" means a satellite in geostationary orbit which remains approximately in a fixed position relative to a position on the surface of the earth;

n) "non-geostationary satellite" means a satellite that does not remain fixed relative to a position on the surface of the earth; and

o) "IR" means the United Kingdom Radio Interface Requirement published by Ofcom in accordance with Article 8 of the Radio Equipment Directive (Directive

2014/53/EU of the European Parliament and of the Council on the harmonisation of the laws of the Member States relating to the making available of radio equipment on the market (known as the Radio Equipment Directive)).

Notes

1. This Licence does not remove any other obligations that the Licensee may have in relation to satellite filings made under the ITU Radio Regulations.

2. This Licence does not affect the requirement, when necessary, to obtain licences or authorisations under other Acts, such as the Broadcasting Act.

3. Some terminal installations require local authority planning approval. Advice should be sought from the Department for Business, Enterprise and Industrial Strategy and the appropriate local authority planning department.

4. The Licensee must apply for a variation of the Licence from Ofcom before making any changes which may contravene the conditions of the Licence.

5. Technical terms used in clause 2 shall have the meanings assigned to them in the ITU Radio Regulations.

6. For radio equipment installed on aircraft, licensees are advised that they must comply with Civil Aviation Authority (CAA) airworthiness requirements and regulations.

7. Further information, in respect of airworthiness requirements and certification requirements before installation, can be obtained by contacting the CAA:

   Civil Aviation Authority
   Tel: 0330 022 1500
   http://www.caa.co.uk

SCHEDULE 2

Licence No	<Lic No>	Licence version date	<Date>	Payment interval	<1 Year>

Earth Station Network Name	Emergency Telephone Number (24 hours)
<Network_name>	<Emergency_telephone>

Network Type	Satellite Type	Satellite / Satellite Network Name	Geostationary Orbital Longitude (degrees)
<Network_type>	<Geostationary/Non-Geostationary>	<Sat_name>	<Orbit_long>

Frequency band
14.0 – 14.25 GHz
27.5 – 27.8185 GHz
28.4545 – 28.8265 GHz
29.4625 – 30 GHz (GSO)
29.5 – 30 GHz (NGSO)

Operations are subject to the provision of Article 4.4 of the ITU Radio Regulations (non-interference basis to users of this spectrum) prior to international coordination.

SCHEDULE 3

Restrictions on equipment to be located within 7 km of the following National Grid References apply - see Schedule 1, Sections 2 h) and i) for further details.

SE 20900 56100
SS 20500 12600

SCHEDULE 4

Permission to operate equipment subject to this Licence from any location within the perimeter fence of the aerodromes listed below must be obtained from either the CAA or the Airport Authority.

CAA Contact: 0330 022 1500

Aerodrome name	Address	Postcode	Telephone	UK/CI/NI	Easting	Northing	Aerodrome POC
Aberdeen / Dyce	Aberdeen Airport	AB21 7DU	01224 723714	UK	387997	812609	Duty Tels Officer
Alderney	Alderney Airport	GY9 3AJ	01481 822851	CI	556723	5506468	Senior Air Traffic Controller
Belfast Aldergrove	Belfast International Airport	BT29 4AB	028 9448 4281	NI	315195	380283	Duty Air Traffic Engineer
Belfast City	Belfast City Airport	BT3 9JH	028 9045 4871	NI	337483	376510	ATC Supervisor
Benbecula	Benbecula Aerodrome	HS7 5LA	01870 602051	UK	78483	855733	Senior Air Traffic Controller
Biggin Hill	Biggin Hill Airport	TN16 3BN	01959 574677	UK	541691	161064	ATS Manager
Birmingham	Birmingham International Airport	B26 3QJ	0121 780 0922	UK	417220	284022	Duty Engineering Officer
Blackpool	Blackpool Airport	FY4 2QY	01253 343434	UK	332307	431071	Senior Telecommunications Officer
Bournemouth	Bournemouth International Airport	BH23 6SE	01202 364150	UK	411201	97844	ATS Manager
Bristol	Bristol Airport	BS48 3DY	08701 212747	UK	350055	165098	Air Traffic Engineering Manager
Cambridge	Cambridge Airport	CB5 8RX	01223 293737	UK	548723	258544	Senior Air Traffic Controller
Cardiff	Cardiff International Airport	CF62 3BD	01446 712562	UK	306643	167265	Duty Engineering Officer
Carlisle	Carlisle Airport	CA6 4NW	01228 573629	UK	348265	560609	Senior Telecommunications Officer
Coventry	Coventry Airport	CV8 3AZ	02476 308638	UK	435519	274761	Senior Air Traffic Engineer
Cranfield	Cranfield Aerodrome	MK43 0AL	01234 754761	UK	494909	242446	Manager ATS
Dundee	Dundee Airport	DD2 1UH	01382 643242	UK	336868	729382	Senior Air Traffic Controller
Doncaster/Sheffield	Robin Hood Airport	DN9 3RH	01302 624870	UK	46603	39807	ATC Manager
East Midlands	East Midlands Airport	DE74 2SA	01332 852910	UK	445367	326168	Duty Engineering Officer
Edinburgh	Edinburgh Airport	EH12 9DN	0131 317 7638	UK	314389	673842	Duty Air Traffic Engineer

Aerodrome name	Address	Postcode	Telephone	UK/CI/NI	Easting	Northing	Aerodrome POC
Exeter	Exeter Airport	EX5 2BD	01392 367433	UK	300326	93702	Senior Air Traffic Controller
Farnborough	Farnborough Airport	GU14 6XA	01252 526015	UK	485452	153678	Senior Air Traffic Controller
Filton	Filton Aerodrome	BS99 7AR	0117 969 9094	UK	359103	180229	Senior Air Traffic Controller
Glasgow	NATS, Control Tower	PA3 2SG	0141 840 8029	UK	247869	666993	Manager Engineering
Gloucestershire	Gloucestershire Aerodrome	GL51 6SR	01452 857700	UK	388598	221747	Duty Aerodrome Controller
Guernsey	Guernsey Airport	GY8 0DJ	01481 237766	CI	528960	5476102	Senior Air Traffic Controller
Hawarden	Hawarden Airport	CH4 0DR	01244 522012	UK	334748	364998	Senior Air Traffic Controller
Humberside	Humberside Airport	DN39 6YH	01652 682022	UK	509295	409914	Air Traffic Manager
Inverness	Inverness Airport	IV2 7JB	01667 464293	UK	277380	851836	ATC Inverness
Isle of Man	Isle of Man Airport	IM9 2AS	01624 821600	UK	228463	468452	Senior Air Traffic Engineer
Jersey	Jersey Airport	JE1 1BW	01534 492226	CI	558699	5451100	Senior Air Traffic Controller
Kirkwall	Kirkwall Airport	KW15 1TH	01856 886205	UK	348020	1008196	Senior Air Traffic Controller
Land’s End / St Just	Land’s End Aerodrome	TR19 7RL	01736 788944	UK	137630	28983	Senior Air Traffic Controller
Leeds Bradford	Leeds Bradford International Airport	LS19 7TU	0113 391 3277	UK	422418	441129	Duty Air Traffic Engineer
Liverpool	Liverpool Airport Plc	L24 1YD	0151 288 4300	UK	343507	382196	Senior Air Traffic Controller
London City	London City Airport	E16 2PX	020 7646 0205	UK	542674	180487	Duty Air Traffic Engineer
London Gatwick	London (Gatwick) Airport	RH6 0NP	01293 601060	UK	526676	140318	Duty Air Traffic Engineer
London Luton	London Luton Airport	LU2 9LY	01582 395029	UK	512422	220804	Duty Air Traffic Engineer
London Stansted	London Stansted Airport	CM24 1QW	01279 669316	UK	553916	223081	Duty Air Traffic Engineer
Londonderry /Eglinton	City of Derry Airport	BT47 3PY	028 7181 1099	NI	253681	422039	Senior Air Traffic Engineer
Manchester	Manchester Airport	M90 1QX	0161 499 5025	UK	381796	384132	Duty Air Traffic Engineer
Manchester Woodford	Manchester Woodford	SK7 1QR	0161 439 3383	UK	390174	382355	Senior Air Traffic Controller
Manston	Kent International Airport	CT12 5BP	01843 825063	UK	633140	165662	Senior Air Traffic Controller
Newcastle	Newcastle Airport	NE13 8BZ	0191 214 3244	UK	419802	571483	Senior Air Traffic Controller
Northolt	RAF Northolt	HA4 6NG	020 8833 8228	UK	509755	184987	Air Traffic Supervisor

Aerodrome name	Address	Postcode	Telephone	UK/CI/NI	Easting	Northing	Aerodrome POC
Norwich	Norwich Airport	NR6 6JA	01603 420645	UK	622014	313753	Tels/Engineering
Oxford/ Kidlington	Oxford Airport	OX5 1RA	01865 844272	UK	446949	215594	Senior Air Traffic Controller
Pembrey	Pembrey Airport	SA16 0HZ	01554 891534	UK	240360	204220	Senior Air Traffic Controller
Plymouth	Plymouth City Airport	PL6 8BW	01752 515341	UK	250511	60229	Senior Air Traffic Controller
Prestwick	Glasgow Prestwick International Airport	KA9 2PL	01292 511107	UK	236746	626815	Senior Air Traffic Controller
Redhill	Terminal Building	RH1 5YP	01737 823377	UK	530105	147698	Senior Air Traffic Controller
Scatsta	Scatsta Aerodrome	ZE2 9QP	01806 242791	UK	438844	1172284	Senior Air Traffic Controller
Scilly Isles / St Mary’s	St Mary's Airport	TR21 0NG	01720 422677	UK	92020	10300	Senior Air Traffic Controller
Shoreham	Shoreham Airport	BN4 5FJ	01273 467377	UK	519999	105406	Senior Air Traffic Controller
Southampton	Southampton Airport	SO18 2NL	023 8062 7113	UK	445278	116962	Duty Air Traffic Engineer
Southend	London Southend Airport	SS2 6YF	01702 608120	UK	586898	189290	Senior Air Traffic Controller
Stornoway	Stornoway Aerodrome	HS2 0BN	01851 707415	UK	145851	933141	Senior Air Traffic Controller
Sumburgh	Sumburgh Airport	ZE3 9JP	01950 460173	UK	439533	1110613	Senior Air Traffic Controller
Swansea	Swansea Aerodrome	SA2 7JU	01792 204063	UK	256904	191635	Senior Air Traffic Controller
Teesside	Teesside International Airport Ltd	DL2 1LU	01325 332811	UK	437041	512801	Senior Air Traffic Controller
Warton	British Aerospace	PR4 1AX	01772 852374	UK	341805	427980	Senior Air Traffic Controller
Wick	Wick Aerodrome	KW1 4QP	01955 602215	UK	336317	952799	Senior Air Traffic Controller
Wolverhampton	Wolverhampton Aerodrome	DY7 5DY	01384 221378	UK	382473	291103	Senior Air Traffic Controller
Wycombe Air Park / Booker	Wycombe Air Park	SL7 3DP	01494 529261	UK	482630	190993	Senior Air Traffic Controller
Yeovil / Westland	Yeovil Aerodrome	BA20 2YB	01935 475222	UK	353823	115831	Senior Air Traffic Controller

A4. Draft Notice for ESN licensees

Requirement to protect fixed links at 14.25-14.5 GHz

A4.1 As shown in Annex 3, we propose to insert a new condition 2.5(l) in ESN licences that "Licensees shall protect fixed links at 14.25-14.5 GHz in accordance with the Notice issued by Ofcom". This annex sets out the proposed provisions for that Notice below.

A4.2 In the Notice, we propose to temporarily protect remaining fixed links in the 14.25-14.5 GHz band. As explained in paragraph 5.28 and Table 1, each bi-directional paired link will have its own specific exclusion zone, taking account of local topography and the technical parameters of those fixed links.

A4.3 As we explain at paragraph 3.25, we are still determining which fixed links will be protected by this Draft Notice. For the purposes of consultation, we have provided an example for the Gairloch to Isle of Skye link, which is expected to temporarily remain in operation after 2022 to support the emergency services network.

DRAFT NOTICE

REQUIREMENT FOR SATELLITE (EARTH STATION NETWORK) LICENCES TO PROTECT FIXED LINKS AT 14.25-14.5 GHZ

1. This notice is made pursuant to the Satellite (Earth Station Network) Licence.

2. This Notice will apply until such time as Ofcom notifies licensees that it is no longer required. Ofcom may vary this Notice from time to time, to remove references to fixed links that are no longer in operation.

3. A land or maritime station shall not transmit within the area comprised of the Ordnance Survey national grid references (NGRs) in column 2 of the table below on any of the corresponding frequencies adjacent to those NGRs as listed in column 3.

Fixed link location (UK national grid reference)	Exclusion zone (area within the following NGRs)	Corresponding frequencies (GHz)
Gairloch: NG7560090000	NB 7228407904, NG 7936474883, NF 8143745693, NF 7860350086	14.305-14.333
Isle of Skye: NG4160073890	NC 3070732585, NC 3528011256, NG 4435766759, NG 3676382388	14.445-14.473
[for other fixed links remaining between 14.25-14.5 GHz, add relevant link location and exclusion zone NGRs]		[add frequencies specific to each link]

4. An aeronautical station transmitting in the frequency range 14.25-14.5 GHz shall not produce a power flux density on the territory of the UK exceeding:

$-132 + 0.5 \cdot \theta$	dB(W/(m^2 • MHz))	for	$\theta \leq 40°$
-112	dB(W/(m^2 • MHz))	for	$40 < \theta \leq 90°$

where θ is the angle of arrival of the radio frequency wave in degrees above the horizontal.

A5. Draft provision for Ship radio licence – Terms, conditions and limitations

A5.1 Where Ship radio licensees (with ESV equipment enabled) request a variation to their licence, as explained from paragraph 6.22, we propose to make the following variation (by consent) to the Ship radio: Terms, conditions and limitations publication.

A5.2 Remove condition 8(c)(a) and 8(i) of Schedule 3 – which will remove the 14-14.25 GHz band from condition 8 (Earth Station on Vessels) of Schedule 3.

A5.3 Insert a new condition 9 in Schedule 3, as follows:

9. Satellite Earth Station equipment in the Ku band (14-14.5 GHz)

(a) In relation to the use of the Earth Station equipment ("ES equipment") installed or used on the Ship to which this licence refers and transmitting on frequencies between 14-14.5 GHz (Earth to space), the following terms and conditions shall apply:

a. The ES equipment may be used only under a Ship Radio Licence and not a Ship Portable Radio Licence.

b. The ES Equipment shall be operated on a 'non-interference non-protected' basis, that is, use of ES equipment must not cause harmful interference to and may not claim protection from, other authorised use of radio operating in accordance with Article 5 of the Radio Regulations, wherever that other service may be operating;

c. When the ship is within the territorial seas of the United Kingdom, Channel Islands or the Isle of Man, the ES equipment 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;

d. The ES equipment may transmit with an e.i.r.p. no greater than 55 dBW;

e. If operating to a geostationary satellite, the ES equipment must employ a stabilised platform and must maintain a pointing accuracy +/− 0.2 degrees towards the relevant geostationary satellite throughout transmissions;

f. At angles greater than or equal to 2.5 degrees from the antenna main beam axis, the e.i.r.p. of the ES equipment, if operating to a geostationary satellite, shall not exceed 20 dBW/40 kHz;

g. All transmissions from the ES equipment must be clearly identifiable;

h. The ES equipment must at all times operate such that it conforms to UK IR 2077;

(b) Operation of the ES equipment within the territorial waters of administrations other than the United Kingdom, Channel Islands or the Isle of Man is subject to the relevant regulations and authorisations of those administrations.

(c) Insofar as it applies in this licence to the installation and use of ES equipment:

"Satellite (Earth Station Network) Licence" means the licence issued by Ofcom to the satellite network operator under the WT Act;

"Earth Station" means a station for transmitting and receiving wireless telegraphy located on the surface of the earth and intended for communication with one or more satellites;

"Geostationary Satellite" means a satellite having the earth as its primary body and which remains approximately in a fixed position relative to the earth;

"UK IR 2077" means the UK Interface Requirement 2077 – Satellite Earth Station Networks, published by Ofcom in accordance with the Radio Equipment Directive.

A6. Technical annex

A6.1 This annex sets out our coexistence analysis examining the impact that FSS terminals (Earth-to-space) operating in the 14.25-14.5 GHz band might have on existing services. We aim to identify the requirements necessary to protect these existing services.

Scope of the analysis

A6.2 We are seeking to protect the following services currently using the 14.25-14.5 GHz band:

- radio astronomy operating at 14.47-14.5 GHz (from sites at Jodrell Bank and Cambridge);
- any remaining fixed links still operating temporarily (at various frequencies between 14.25-14.5 GHz), only at the specific locations for those links; and
- Crown use in the 14-14.5 GHz band.

A6.3 The MOD have confirmed that existing protection for the two Crown sites should be extended across the whole 14-14.5 GHz band (existing protection arrangements are summarised at paragraph 5.30 of this document). We are satisfied these are appropriate and therefore no further analysis was undertaken in respect of these services.

Our approach to coexistence analysis

A6.4 We reviewed existing ECC reports, ECC decisions and ITU-R recommendations as set out in paragraph A6.5 below, along with UK licensing data to identify relevant protection criteria that would ensure protection of fixed links and radio astronomy in the 14.25-14.5 GHz band. However, in contrast to the ECC reports, our coexistence analysis considers the UK national circumstances, so encompasses terrain data, clutter and the actual parameters of the fixed link receivers. We also tailor our proposals to best protect existing services from both GSO and NGSO terminals.

Relevant International regulations, reports and recommendations

A6.5 We identified the following ITU Radio Regulations, recommendations and ECC reports relevant to this work[37]:

For terminals operating to GSO satellites:	For terminals operating to NGSO satellites:
• Recommendation ITU-R M.1643 - Technical and operational requirements for aeronautical ESIMs using the 14-14.5 GHz band (Earth-to-space) • ECC Decision 03(04) - Free circulation of VSATS in Ku band operating to GSO (relating to ECC report 026 for aeronautical ESIMs)	• **ECC Decision 18(05)** - Free circulation of ESIMs in Ku band operating to NGSO (relating to **ECC report 279**) • **ECC Decision 17(04)** - Fixed terminals in Ku band operating to NGSO (relating to **ECC report 271**)

[37] For GSO: ITU-R M-1643, ECC Decision 03(04, and ECC report 026. For NGSO: ECC Decision 18(05), ECC report 279, ECC Decision 17(04), and ECC report 271.

A6.6 We also used the following recommendations[38] informing technical characteristics and propagation modelling to support our own analysis:

Technical characteristics and interference limits	Propagation models
• ITU-R RA.769-2 - contains very widely used protection criteria for radio astronomy measurements and covers both GSO and NGSO satellites. • ITU-R S.580-6 - radiation diagrams for use as design objectives for antennas of earth stations operating with GSO satellites. • ITU-R ST.1650 - sets out minimum distances beyond which ESIMs located on board vessels would not cause unacceptable interference to terrestrial service in the bands 5925-6425 MHz and 14-14.5 GHz.	• **ITU-R P.452-16**: is used to evaluate interference between stations on the surface of the Earth at frequencies above about 0.1 GHz. • **P.525-4:** calculation of free space attenuation. • **ITU-R P.676-12** attenuation by atmospheric gasses terrestrial and slant path).

A6.7 We considered the various ways satellite user terminals could operate in this band, as each can interfere with services in different ways, and therefore require different conditions of use. We identified four coexistence scenarios: aeronautical ESIMs; land ES; land ESIMs; and maritime ESIMs. For simplicity, we combined results for land ES, land ESIMs and maritime ESIMs into one protection condition. This means for each service, there is one condition for aeronautical ESIMs and one condition which applies to all other terminals (land ES, land ESIMs and maritime ESIMs).

A6.8 A summary of our methodology and coexistence analysis is provided below, first for radio astronomy and then fixed links. We used proprietary software in general use at Ofcom to conduct this analysis. The resulting protection requirements are then explained for each coexistence scenario: aeronautical and land/maritime terminals.

A6.9 For simplicity, we propose one protection for both GSO and NGSO terminals. After comparing the interference area for both GSO and NGSO terminals, we adopt the larger of the two in our proposals (generally this was for GSO terminals).

Protecting radio astronomy in the 14.47-14.5 GHz band

A6.10 There are two radio astronomy sites in the UK (Jodrell Bank and Cambridge) that perform observations in the top 30 MHz of the band (14.47-14.5 GHz), which we propose to protect from FSS satellite services operating in the 14.25-14.5 GHz band.

[38] Recommendations: ITU-R RA.769-2, ITU-R S.580-6, ITU-R SF.1650, ITU-R P.452-16, P.525, and ITU-R P.676-12.

Existing protection requirements for radio astronomy in 14.25-14.5 GHz

A6.11 Radio astronomy sites could be protected from various types of FSS terminals as follows:

a) **Aeronautical terminals –** ITU-R RA.769-2 indicates that a power flux density threshold level of -169 dBW/m^2 should not be exceeded at the radio astronomy receiver. ECC report 271 suggests compliance with this mask can only be achieved by avoiding transmissions between 14.47-14.5 GHz when the aircraft is operating within line-of-sight of radio astronomy sites performing observations in this band.

b) **Land and maritime terminals –** ITU-R RA.769-2 indicates that the received interfering power should not exceed -214 dBW in a 150 kHz channel. ECC report 271 suggests radio astronomy sites can be protected by exclusion areas around the sites where transmissions must cease on channels overlapping with the 14.47-14.5 GHz band. Single entry analysis[39] was performed as follows:

i) **Land ES:** for terminals with an EIRP density towards the horizon of -20 dBW/40 kHz the size of the area can be up to 340 km.

ii) **Land ESIM:** for terminals with an EIRP density towards the horizon of -33 dBW/40 kHz the size of the area can be up to 200 km.

iii) **Maritime ESIM:** for terminals with an EIRP density towards the horizon of -33 dBW/40 kHz the size of the area can be up to 200 km.

Methodology for additional radio astronomy analysis

Aeronautical terminals

A6.12 We examined PFD masks proposed in ECC Report 271 and ITU-R M.1643 as each recommend a different PFD limit. We have adopted the more stringent recommendation to cease transmissions rather than use a PFD mask as ECC Report 271 makes clear that "compliance with the PFD mask can only be achieved by avoiding transmissions within the 14.47-14.5 GHz band when the aircraft enters in visibility of radio astronomy sites performing observations in this band".

A6.13 Adopting this recommendation meant no further analysis was required for aeronautical terminals.

Land and maritime terminals

A6.14 We used the details provided in ECC report 271 to assess the protection required for terminals connecting to NGSO satellites. There is no corresponding ECC report for GSO which covers land and maritime terminals, so we have applied our own methodology used for coordinating licensed FSS GSO terminals with co-primary services (as explained in

[39] Two NGSO systems were examined but the system with the highest power was adopted in order to understand the worst-case scenario. This assumes -20 dBW/40 kHz for land terminals and -33 dBW/40 kHz for land and maritime ESIMs (with a normal bandwidth of 20 MHz).

paragraph A6.15(c) below). We did not separately model GSO land ESIMs (and for our results assume land ES interference will also apply to land ESIMs).

A6.15 Our methodology to ascertain the interference area is as follows:

a) In each scenario the radio astronomy receivers were modelled as zero gain omni antennas (in line with ITU-R RA 769-2). The elevation axis height we used along with the Ordnance Survey NGR of both radio astronomy sites is as follows:

   i) Jodrell Bank: NGR location SJ 79650 70950; 50.5 metres; and

   ii) Cambridge: NGR location TL 39400 54000; 24 metres.

b) To ascertain the required protection area around each radio astronomy receiver, an area analysis facility in the software was used to calculate single-entry interference from the satellite terminal. The single-entry interference criteria was set at -214 dBW /150 kHz, and our interference areas were plotted where this level was exceeded.

c) In addition, for GSO terminals, we plotted three interference areas operating to 57^{o} W, 5^{o} W, 46^{o} E, and overlaid the three results in Google Earth. We considered this would be a more realistic worst-case scenario, than an omni antenna with the max power towards the horizon. The terminal was placed at 0.5km intervals for GSO and 1km intervals for NGSO throughout an area around each site to determine how close the terminal could get without exceeding the interference criteria. We modelled the propagation loss using ITU-R P452-16 (2% time as specified in ITU-R Rec RA 769) and an Ofcom 50m terrain database (based on UK Ordnance Survey data).

d) **NGSO land ES and maritime ESIM**, we assumed that an NGSO land ES and maritime ESIM interferer has an EIRP density towards the horizon of -20 dBW/40 kHz and -33 dBW/40 kHz respectively. For these FSS terminals, a zero gain omni antenna was assumed for the ES and the power adjusted to that in a 150 kHz bandwidth channel (-14.26 dBW) as specified in ITU-R RA 769-2. We assumed the height of an NGSO land ES to be 20m (as set out in ECC report 271), and an NGSO maritime ESIM to be up to 40m above sea level (as used in ITU-R SF.1650).

e) **For GSO land ES and maritime ESIMs**: we used licensing data[40] to ascertain a typical terminal gain for licensed VSATs[41] already operating in 14.25-14.5 GHz. There is no requirement for GSO terminals to have a full sky view (as required by NGSO terminals), so we chose a compromise height above ground of 4m. We used an EIRP of 55 dBW (the maximum power permitted in the current ESN licence), with an antenna gain of 41.2 dBi (1m antenna), a standard ITU-R S.580-6 roll offand assumed a carrier bandwidth of 2.5 MHz. We also assumed height of up to 40m for a GSO maritime ESIM (from ITU-R SF.1650). Our software automatically adjusts for a 150 kHz radio astronomy channel bandwidth.

[40] Obtained from our licensing database.
[41] Very small aperture terminals.

Results of our coexistence analysis for radio astronomy

A6.16 Our coexistence analysis shows that both FSS land and maritime terminals can cause interference to both radio astronomy sites, even when they transmit over 100 km away.

A6.17 We sought to compare the interference plots of GSO and NGSO terminals (see figures A6.1-A6.4 and A6.5-A6.8 for Jodrell Bank and Cambridge respectively). For GSO, we show interference for the worst-case angle (of those discussed at paragraph A6.15(c)) – this was 46^{o} E for Jodrell Bank and 57^{o} W for Cambridge. Each colour shows a different interference level - purple indicates -210 dBW, yellow -213.8 dBW and red -214 dBW.

Jodrell Bank interference plots (figures A6.1-A6.4)

Figure A6.1: NGSO land terminal

Figure A6.2: NGSO maritime terminal

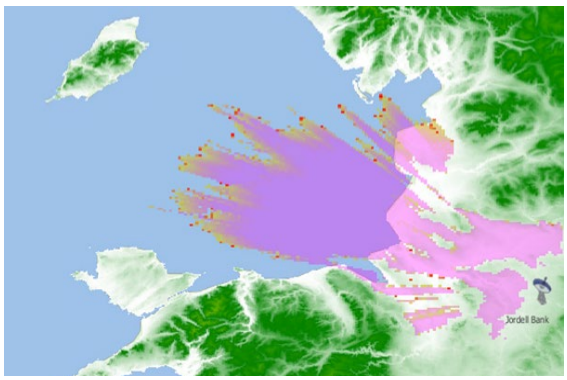


Figure A6.3: GSO land terminal (46^{o}E)

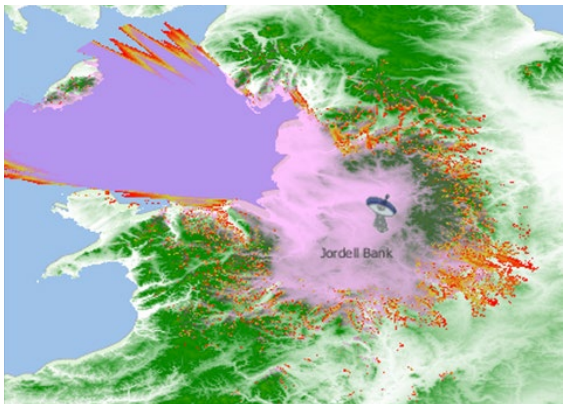
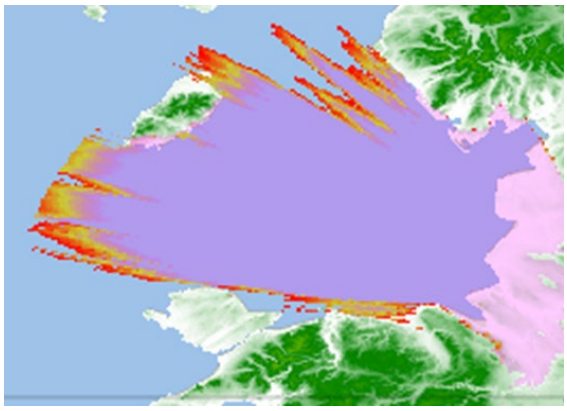


Figure A6.4: GSO maritime terminal (46^{o}E)



Cambridge interference plots (figures A6.5-A6.8)

Figure A6.5: NGSO land terminal

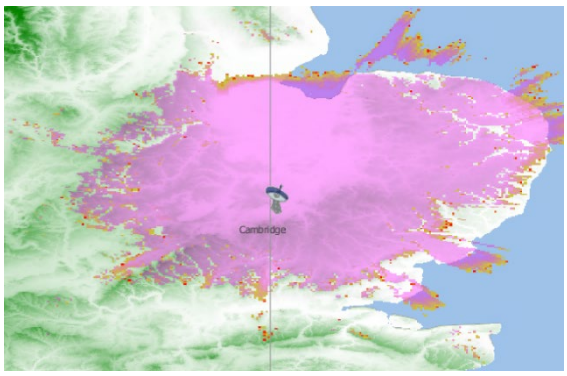


Figure A6.6: NGSO maritime terminal

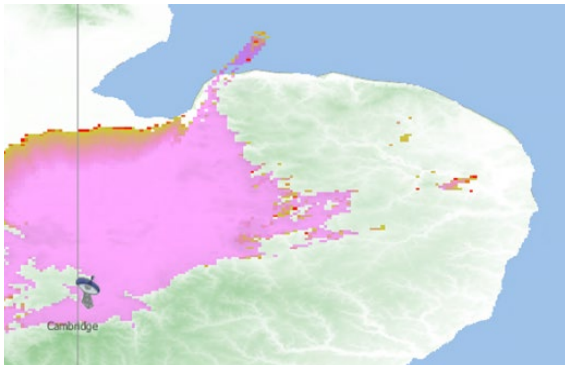


Figure A6.7: GSO land terminal (57°W)

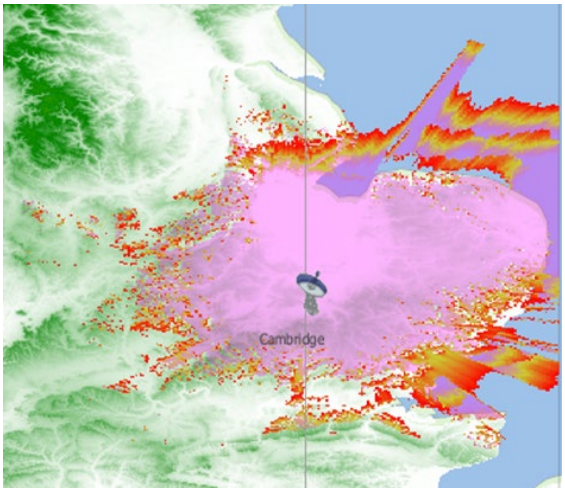
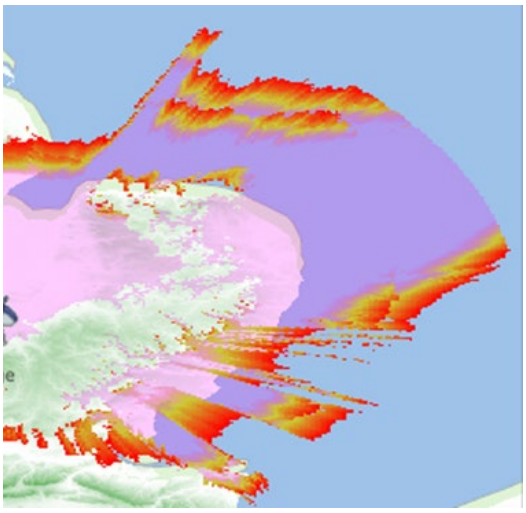
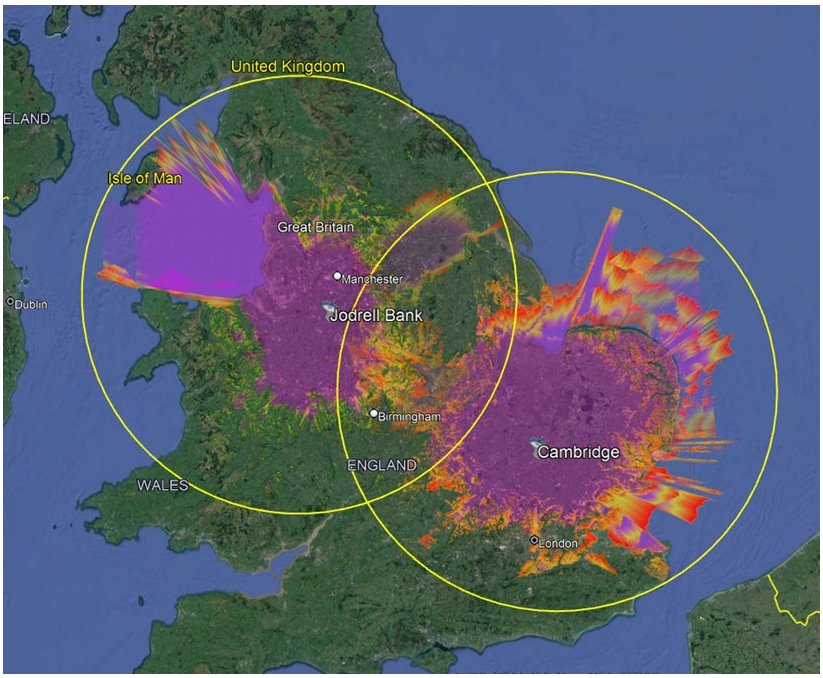


Figure A6.8: GSO maritime terminal (57°W)



A6.18 We overlaid these individual interference plots for GSO and NGSO land and maritime terminals, as shown in figures A6.1-A6.8, in Google Earth to provide a combined interference area within which radio astronomy measurements would be degraded (see Figure A6.9). The interference areas for both Jodrell Bank and Cambridge are dominated by GSO terminals, indicating that interference from GSO terminals into radio astronomy is the worst case. We therefore propose to adopt GSO interference areas for modelling FSS land and maritime protection criteria.

Figure A6.9: Proposed radio astronomy exclusion zones of 175 km radius for Jodrell Bank and Cambridge from GSO and NGSO land and maritime terminals



A6.19 Due to UK terrain, the interference areas are not symmetrical around each of the radio astronomy sites. By offsetting the centre of the proposed exclusion zone (away from the site) we can more closely match the interference area which has the overall result of reducing the size of the exclusion zone.

A6.20 Given the size of the interference area is similar for both radio astronomy sites, we propose to adopt the same size exclusion zone of 175 km radius from the designated focus points: NGRs SJ 5739392556 (Jodrell Bank) and NGR TL 5439992385 (Cambridge). The proposed exclusion zone for Jodrell Bank includes the Isle of Man which means that land terminals on the Isle of Man and maritime terminals on surrounding waters within the area (as shown in Figure A6.9) must also avoid transmissions in the 14.47-14.5 GHz band.

Summary of proposed protection requirements for radio astronomy

A6.21 To protect radio astronomy in the 14.47-14.5 GHz band, the following protection requirements should apply to respective FSS terminals using the 14.25-14.5 GHz band:

- **Aeronautical ESIMs** – FSS/mss aeronautical ESIMs must not transmit in the 14.47-14.5 GHz band.
- **Land (ES and ESIMs) and maritime ESIMs** – GSO and NGSO land (ES and ESIMs) and maritime ESIMs must not transmit in the 14.47-14.5 GHz band within a 175 km radius from the designated focus points (NGRs) SJ 5739392556 (Jodrell Bank) and NGR TL 5439992385 (Cambridge).

Protecting fixed links in the 14.25-14.5 GHz band

A6.22 There are currently 30 pairs of fixed links in the band, details of these links can be found in Annex 2. We expect most fixed links to migrate or cease from the 14.25-14.5 GHz band by the end of 2022 but set out below how we would protect any that remain temporarily.

Existing protection requirements for fixed links in 14.25-14.5 GHz

A6.23 ECC report 271 (for NGSO terminals) and ITU-R M.1643 (for GSO aeronautical terminals) suggest fixed link receivers could be protected from various types of FSS terminals as described below:

a) **Aeronautical terminals** - Both ITU-R M.1643 and ECC report 271 give a PFD mask for GSO and NGSO terminals respectively, as shown below. PFD masks on the ground are typically applied to the terminal on the aircraft.

- **ITU-R M.1643** - developed in 2003 and widely adopted

  $-132 + 0.5 \cdot \theta$ dB(W/(m^2 · MHz)) for $\theta \leq 40°$
  -112 dB(W/(m^2 · MHz)) for $40 < \theta \leq 90°$
  (where θ is the angle of arrival of the radio-frequency wave in degrees above the horizontal)

- **ECC report 271** - relaxes the mask by 10 dB for all elevation angles[42]) and reduces number of aircraft simultaneously in view of the fixed link.

  -122 dB(W/(m² · MHz)) for $\theta \leq 5°$
  $-127 + \theta$ dB(W/(m² · MHz)) for $5° < \theta \leq 40°$
  -87 dB(W/(m² · MHz)) for $40° < \theta \leq 90°$
  (where θ is the angle of arrival of the radio-frequency wave in degrees above the horizontal).

b) **Land and maritime terminals** - Fixed link receivers can be protected by exclusion areas around the sites where transmissions must cease on channels overlapping with the fixed link receiver frequencies. For the following land and maritime terminals, ECC report 271 recommends:

i) **Land ES**: assuming a smooth earth, 37 dBi fixed link main beam and an EIRP density towards the horizon of -20 dBW/40 kHz, a protection area of 58-77 km in the direction of the main beam (decreasing rapidly down to 11 km outside the pointing direction of the fixed link receiver).

ii) **Land ESIM**: again assuming a smooth earth, 37 dBi fixed link main beam and an EIRP density towards the horizon of -33 dBW/40 kHz, a protection area of around 33 km in the direction of the main beam (decreasing rapidly down to 2 km outside the pointing direction of the fixed link receiver).

iii) **Maritime ESIM**: a PFD limit at shore of -116 dBW/m²/MHz at 80m above sea level with an associated percentage of time of 0.06% or 4.5%, depending on the retained short-term protection criterion. This PFD applies to all FSS maritime ESIMs.

[42] Even so, it is still able to meet the protection criteria with an additional margin, due to relaxations in the assumptions of the number of aircraft operating in the sky around the FL with the same carrier.

Methodology for additional fixed links analysis

Parameters for fixed links

A6.24 The list of remaining fixed links in the band are set out in Annex 2. To derive the interference areas for our modelling, we obtained technical data for our analysis, including the receiver sensitivity levels (RSLs) and antenna patterns for the receivers, from licensing data. We provide our analysis for an example fixed link in the Highlands (between Gairloch and Isle of Skye) in this annex, as we understand it is one that needs to remain in the band temporarily. The parameters for this example fixed link are provided in Table A2 below.

Table A2: Parameters for Gairloch to Isle of Skye fixed link

Receiver NGR	Receiver Frequency (GHz)	Receiver bandwidth (MHz)	Receiver Antenna Gain (DBi)	Receiver Antenna Height (m)	Receiver Antenna Elevation Angle	Receiver Antenna code	Receiver Antenna Azimuth Angle	Receiver Branch Loss (dB)	Receiver Feeder Loss (dB)	Receiver Sensitivity Level (dBm)	W/U	Link availability
NG 75600 90000	14.319	28	36.3	13	-0.35	A/14/H/94/040/AA	241.4	0	3	-75	26	99.99
NG 41600 73890	14.459	28	42.1	14	0.02	A/14/H/95/005/AA	60.93	0	6.5	-75	26	99.99

A6.25 We accounted for both long-term (50% propagation time) and short-term (anomalous propagation, time based on link availability) when assessing interference into fixed links. The link availability for all links is 99.99%.

A6.26 The bandwidth for fixed links in this band are typically 28 MHz (though some are smaller, only 3.5 MHz or 7 MHz). For the Gairloch to Isle of Skye link, bandwidth of 28 MHz, RSL of -75 dBm and a wanted to unwanted (W/U) of 26 dB was modelled. As a consequence, we determined the long-term interference criteria to be -131 dBW. For the short-term criteria, the link fade margin is taken into account. We adopted a minimum fade margin of 10 dB as it was the lowest margin for all the links considered. This reduced the unwanted levels to -121 dBW for our example fixed link for 0.01% propagation time.

Aeronautical ESIMs

A6.27 Given that aeronautical ESIMs operate across borders, we examined both PFD masks set out in international recommendations, as described in paragraph A6.23 above. To consider the impact of aeronautical ESIMs on remaining fixed links in the UK, we examined:

- **Intercontinental flights** - we assess the Gairloch to Isle of Skye fixed link as one likely to be impacted, given a great circle path from New York to Copenhagen cuts across the northern tip of the Hebrides and Sutherland and Caithness, as shown in Figure A6.10. We modelled an aeronautical ESIM approaching and departing the Hebrides along a 400 km segment of this flight path at a cruising altitude of 10 km and plotted the C/I[43]

[43] We plotted the C/I along the flight path using ITU-R P. 525 and ITU-R P.676-12 to account for various path losses.

in the fixed link receivers. As the PFD mask is in dBW/MHz, we adjusted the wanted value for the link, C, from -75 dBm to -89.47 dBm, i.e. the receive power in 1 MHz.

Figure A6.10: New York to Copenhagen flight path

- **Domestic flights -** we assess the most vulnerable links will be those in a north-south flight path such as London-Edinburgh. We simulated two routes (LHR to Edinburgh and Norwich to Edinburgh) against a nearby fixed link, with the C/I plotted against two cruising altitudes of 3km and 5 km.

Land and maritime terminals

A6.28 We used the details provided in ECC report 271 to assess the protection required for terminals connecting to NGSO satellites. There is no corresponding ECC report for GSO which covers land and maritime terminals, so we have applied our own methodology used for coordinating licensed FSS GSO terminals with co-primary services (as explained in paragraph A6.15(c) above). We did not separately model GSO land ESIMs (and for our results assume land ES interference will also apply to land ESIMs).

A6.29 Our methodology to ascertain the interference area is as follows:

a) For interference from NGSO terminals, ECC report 271 suggests an EIRP density towards the horizon of -20 dBW/40 kHz for land ES, and -33 dBW/40 kHz for maritime ESIMs. To apply a normal bandwidth of 20 MHz, we therefore scaled the EIRP density, for land ES to 7 dBW/20MHz and for maritime ESIM to -6.01 dBW/20 MHz.

b) For interference from GSO terminals into fixed link receivers, we plotted three interference areas with FSS terminals operating to 57^{o} W, 5^{o} W and 46^{o} E, representative of a 10^{o} elevation angle toward east and west along with a max elevation at the Gairloch to Isle of Skye link. We used an EIRP of 55dBW/2.5MHz with an antenna gain of 41.2 dBi (and assuming 1m antenna) based on an ITU-R S.580-6 antenna pattern. We also assumed a terminal height of 4m for land ES and 40m for maritime ESIMs.

c) Again, we used the area analysis facility in the software to calculate the single-entry interference from the FSS terminal into the fixed link receiver. We have shown long-term interference only, since our modelling produced larger interference areas than short-term criteria. The terminal was placed at 0.5km intervals for both GSO and NGSO throughout an area around each site to determine how close the terminal could get

without exceeding the interference criteria. We modelled the propagation loss using ITU-R P452-16 (using 50%/0.01% time for long/short term criteria respectively) and an Ofcom 50m terrain database (based on UK Ordnance Survey data).

Results of our coexistence analysis for fixed links

A6.30 Our coexistence analysis shows that FSS aeronautical, land and maritime terminals can cause interference to fixed link receivers (and this is different for each fixed link).

Aeronautical terminals

A6.31 Our modelling of international and domestic flight paths suggests that the PFD mask recommended by ITU-R M.1643 provided the greatest protection for fixed links:

- **International**: The C/I plots in figure A6.11 indicate that when the PFD mask from ECC Report 271 is used, the W/U (C/I) criteria of 26 dB is exceeded for c.60 seconds in the receiver on Isle of Skye. However, when the ITU-R M.1643 PFD mask is used, both the Highlands receivers meet the W/U criteria (as shown in figure A6.12).

Figure A6.11: C/I plot of NY to Copenhagen route using ECC report 271 PFD at an altitude of 10 km

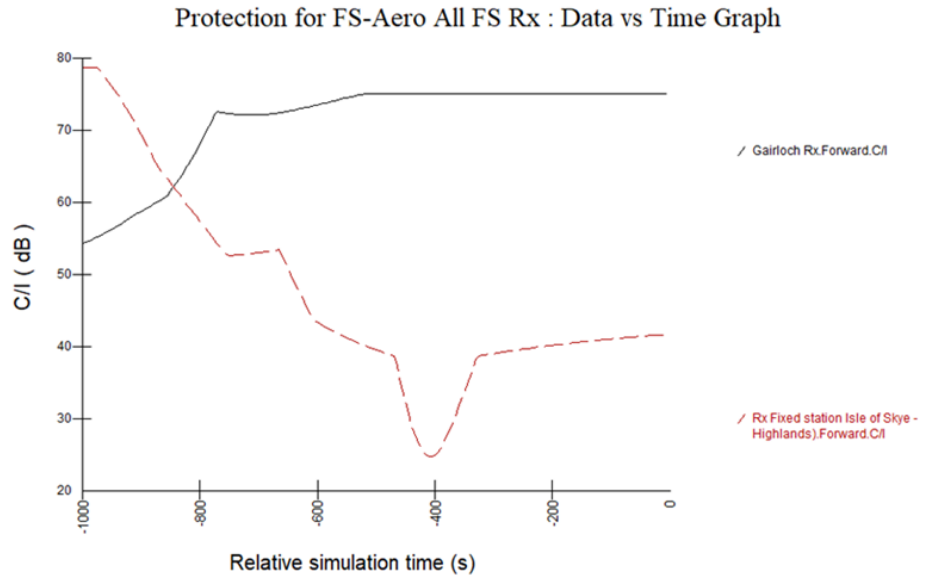
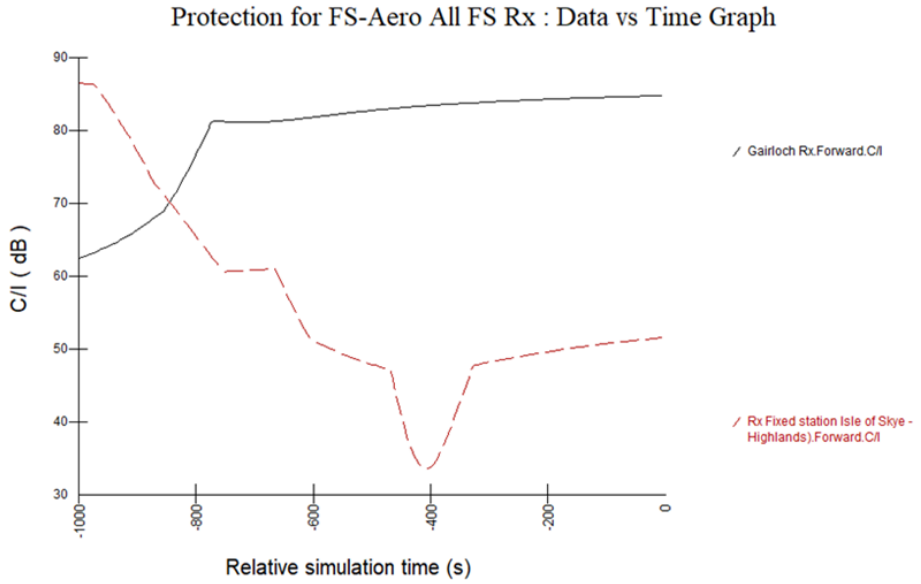


Figure A6.12: C/I plot of NY to Copenhagen route using ITU-R M.1643 PFD at an altitude of 10 km



- **Domestic**: We found similar results in our domestic simulations; the ECC report 271 PFD mask exceeds the criteria of 26 dB for both cruise altitudes, while the criteria are marginally met when the ITU-R M.1643 PFD mask is used.

A6.32 For aeronautical terminals, we therefore propose to use the PFD mask provided in ITU-R M.1643 (and mirrored in ECC report 26):

$-132 + 0.5 \cdot \theta$ dB(W/(m2 · MHz)) for $\theta \leq 40°$
-112 dB(W/(m2 · MHz)) for $40 < \theta \leq 90°$
(where θ is the angle of arrival of the radio-frequency wave in degrees above the horizontal).

Land and maritime terminals

A6.33 We modelled likely interference to fixed link receivers from both GSO and NGSO land and maritime terminals. Each colour shows a different interference level (purple -125 dBW, yellow -128 dBW and red -131 dBW):

- **Land**: the four interference plots in figures A6.13-A6.16 below show our analysis for an example link between Gairloch and the Isle of Skye, for i) NGSO land terminals, and GSO land terminals operating to ii) 46° E, iii) 5° W and iv) 57° W respectively.

Figure A6.13: NGSO land terminal interference plot for Gairloch to Isle of Skye fixed link

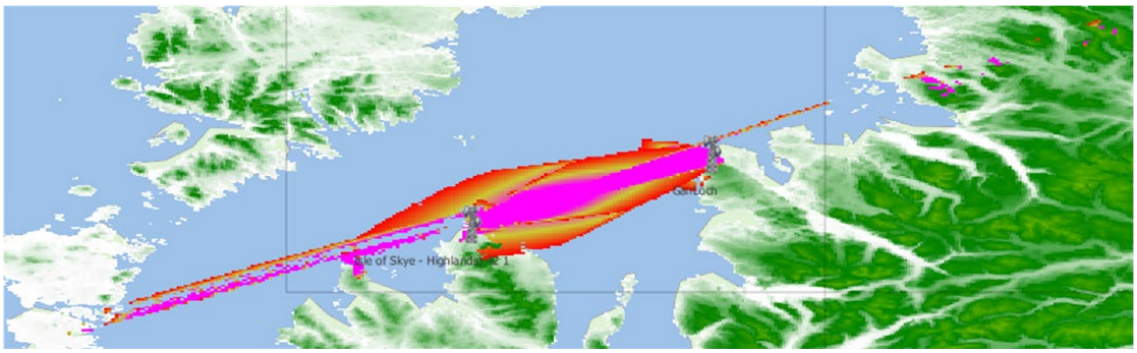


Figure A6.14: GSO land terminal interference plot for Gairloch to Isle of Skye fixed link, operating to GSO satellite at 46° E

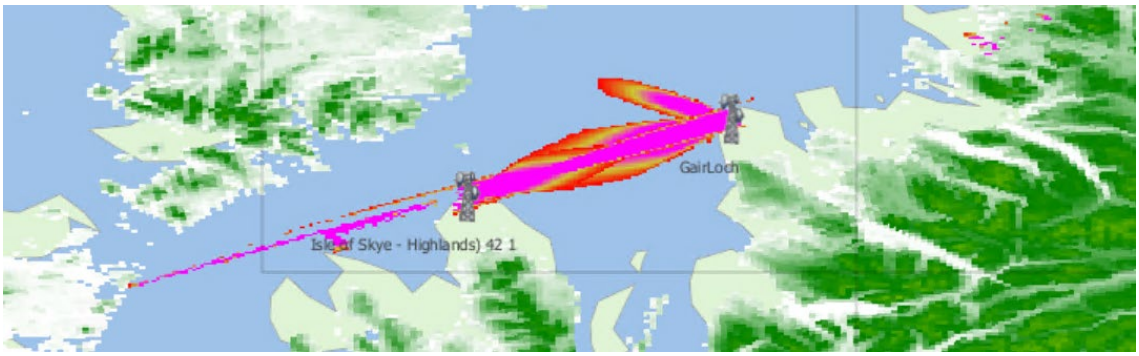


Figure A6.15: GSO land terminal interference plot for Gairloch to Isle of Skye fixed link, operating to GSO satellite at 5° W

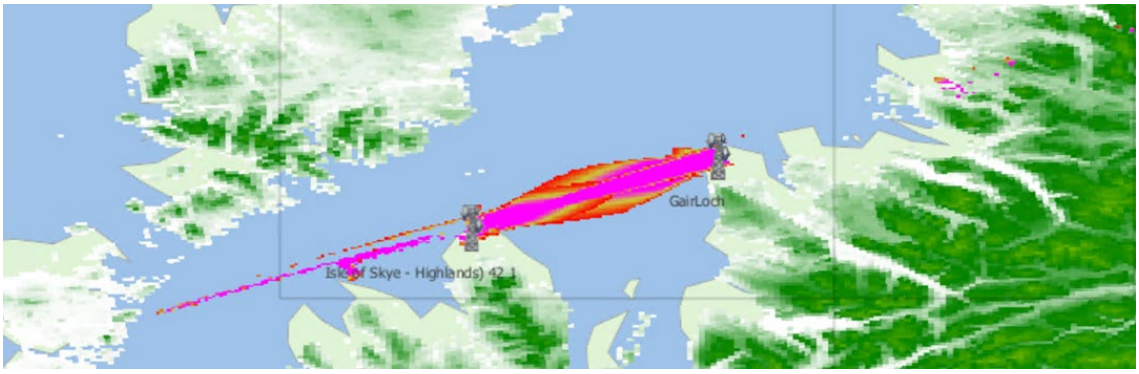
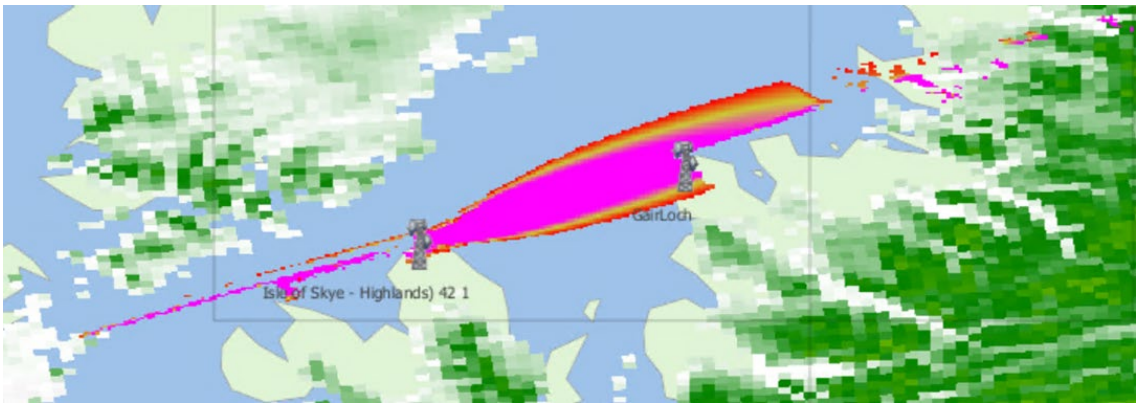


Figure A6.16: GSO land terminal interference plot for Gairloch to Isle of Skye fixed link, operating to GSO satellite at 57° W



- **Maritime**: The four interference plots in figures A6.17-A6.20 below show our analysis for the same example link between Gairloch and the Isle of Skye, for i) NGSO maritime terminals, and GSO maritime terminals operating to ii) 46° E, iii) 5° W and iv) 57° W respectively.

Figure A6.17: NGSO maritime terminal interference plot for Gairloch to Isle of Skye fixed link

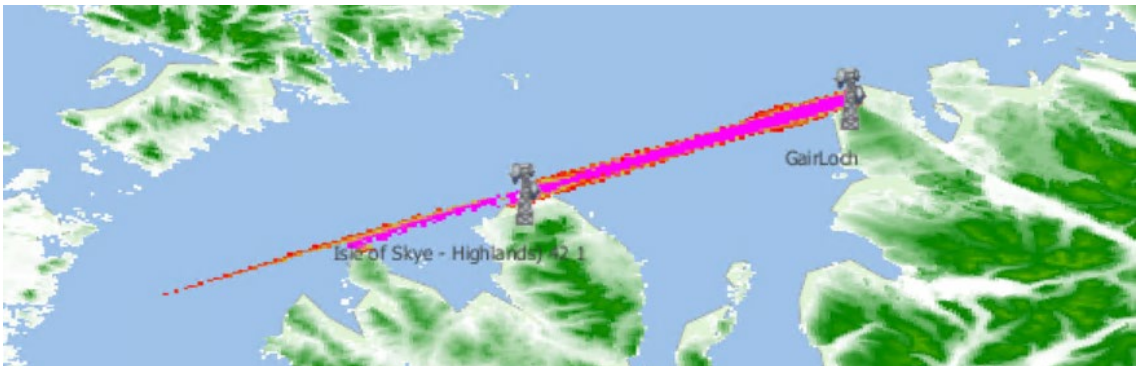


Figure A6.18: GSO maritime terminal interference plot for Gairloch to Isle of Skye fixed link, operating to GSO satellite at 46°E

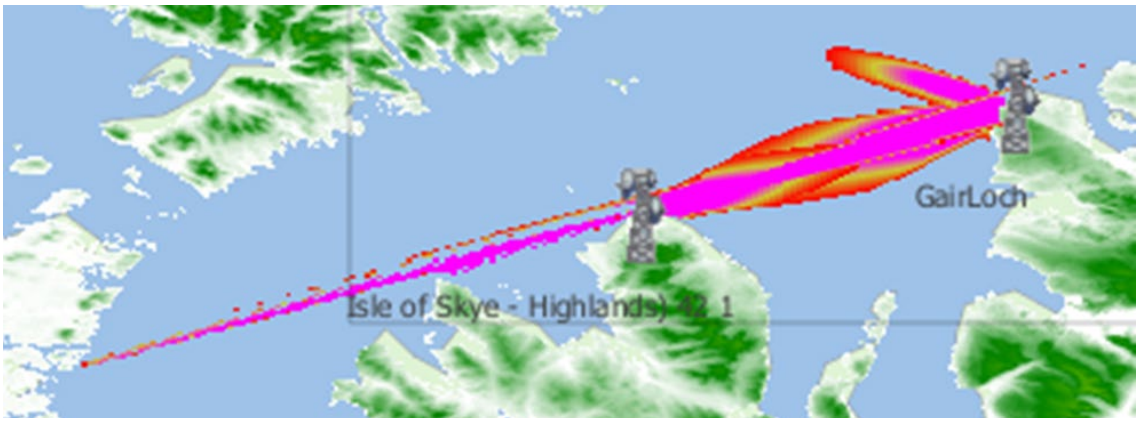


Figure A6.19: GSO maritime terminal interference plot for Gairloch to Isle of Skye fixed link, operating to GSO satellite at 5°W

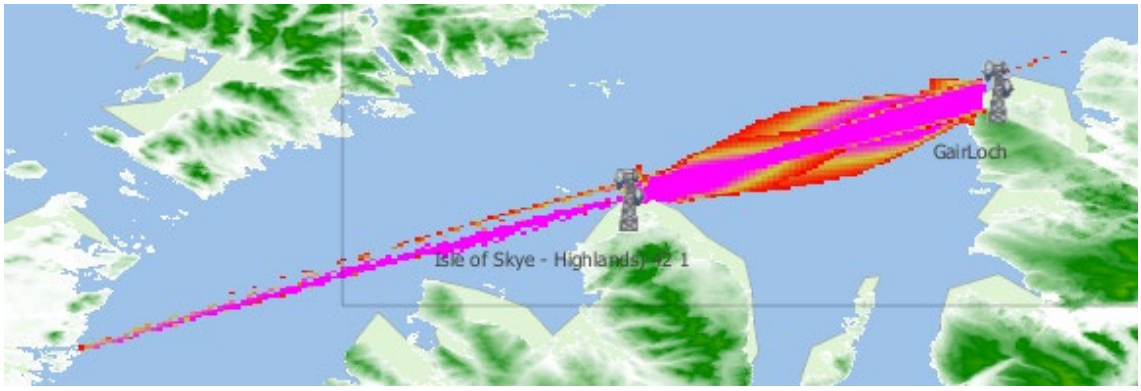
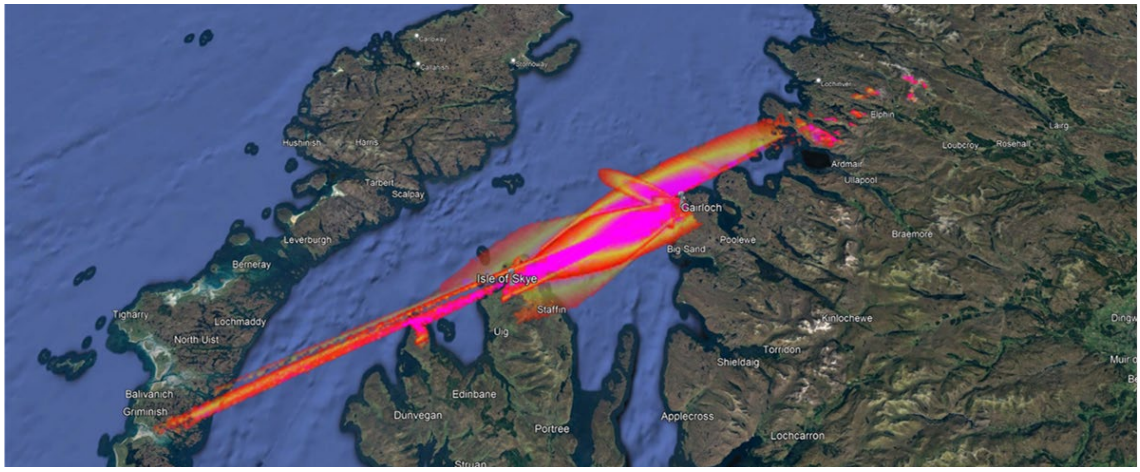


Figure A6.20: GSO maritime terminal interference plot for Gairloch to Isle of Skye fixed link, operating to GSO satellite at 57°W

A6.34 We overlaid these eight interference plots for GSO and NGSO land and maritime terminals for the Gairloch to Isle of Skye receiver in Google Earth to provide a combined interference area within which fixed link receivers would likely be degraded (see figure A6.21).

Figure A6.21: Combined interference area for Gairloch to Isle of Skye fixed link from GSO and NGSO land and maritime terminals



A6.35 Comparing the various interference plots of figures A6.13-A6.20 above, the impact areas differ slightly but both have a similar impact on fixed links. The interference areas are

dominated by GSO terminals, indicating that interference from GSO terminals into fixed links is the worst case. We therefore propose to adopt GSO interference areas for determining land and maritime protection requirements for fixed links.

A6.36 Due to local terrain, the main beam overshoots so the interference areas are longer than those envisioned in ECC Report 271. By adapting the protection area to the shape of the interference area, we can propose "bespoke" exclusion zones. The combined interference areas and proposed exclusion zones for the Gairloch and Isle of Skye receivers are shown below, in figures A6.22 and A6.23 respectively.

Figure A6.22: Combined interference area and proposed exclusion zone to protect Gairloch receiver from GSO and NGSO land and maritime terminals

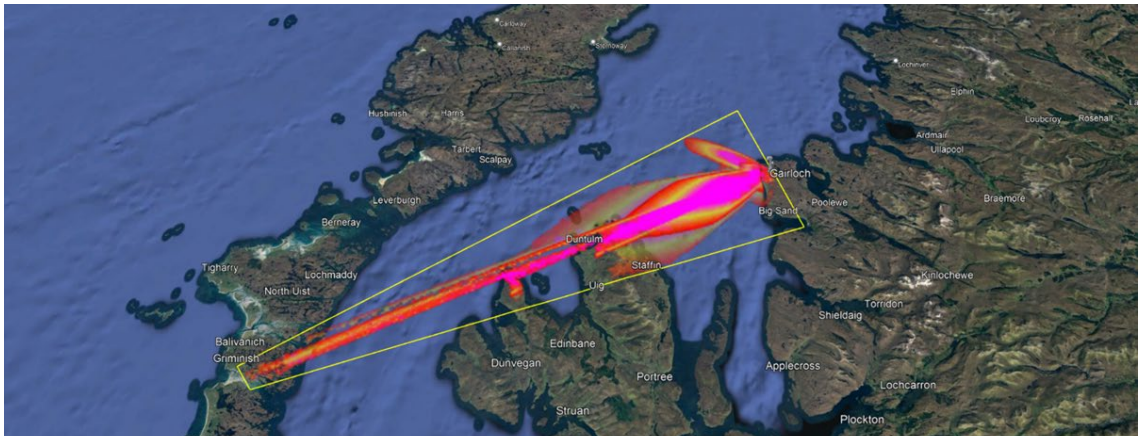
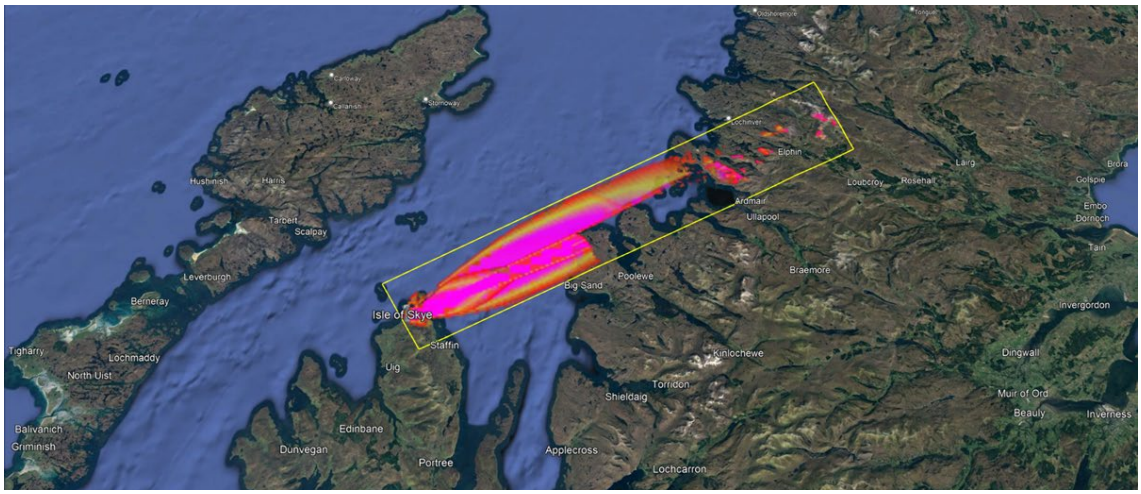


Figure A6.23: Combined interference area and proposed exclusion zone to protect Isle of Skye receiver from GSO and NGSO land and maritime terminals



A6.37 Therefore, for land and maritime terminals, we propose to implement bespoke exclusion zones (and frequency range) where these terminals must not transmit, and which better reflect the interference pattern at each fixed link receiver. The exclusion zones are determined by the area formed within the Ordnance Survey NGRs specified. Our proposals for the example Gairloch and Isle of Skye receivers are shown in Table A2 below.

Summary of proposed protection requirements for fixed links

A6.38 To protect fixed links in the 14.25-14.5 GHz band, the following protection requirements should apply to respective terminals using the 14.25-14.5 GHz band.

- **Aeronautical ESIMs** – when within line-of-sight of fixed links, the aeronautical ESIMs should not exceed the PFD mask on designated frequencies for specific fixed links as follows.

  $-132 + 0.5 \cdot \theta$ dB(W/(m^2 · MHz)) for $\theta \leq 40°$
  -112 dB(W/(m^2 · MHz)) for $40 < \theta \leq 90°$
  (where θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal))

- **Land (ES and ESIMs) and maritime ESIMs** – must cease transmissions on designated frequencies for specified fixed links when transmitting within the exclusion zone, covering the area formed by the specified NGR points. For example, to protect the fixed link pair between Gairloch and Isle of Skye, land ES and land/maritime ESIMs must cease transmissions on the frequencies and in the proposed exclusion zone in Table A2:

Table A2: Proposed bespoke exclusion zone for Gairloch and Isle of Skye receivers

Fixed link receiver location	Centre frequency (GHz)	Bandwidth (MHz)	Proposed exclusion zone - length x width and NGR points
Gairloch NG 7560090000	14.319	28	Bespoke trapezium – 106 km x 34 km (widest point) (see figure A6.22, covering the area formed within NGR points: NB7228407904, NG7936474883, NF8143745693, NF7860350086.
Isle of Skye NG 4160073890	14.459	28	Bespoke rectangle – 104 km x 20 km (see figure A6.23, covering the area formed within NGR points: NC3070732585, NC3528011256, NG4435766759, NG3676382388.

(NB specific fixed links to be protected to be confirmed in our Statement)

A7. Ofcom's consultation principles

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

Before the consultation

A7.1 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

A7.2 We will be clear about whom we are consulting, why, on what questions and for how long.

A7.3 We will make the consultation document as short and simple as possible, with an overview of no more than two pages. We will try to make it as easy as possible for people to give us a written response.

A7.4 We will consult for up to ten weeks, depending on the potential impact of our proposals.

A7.5 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.

A7.6 If we are not able to follow any of these seven principles, we will explain why.

After the consultation

A7.7 We think it is important that everyone who is interested in an issue can see other people's views, so we usually publish the responses on our website at regular intervals during and after the consultation period. 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.

A8. 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	o
Name/contact details/job title	o
Whole response	o
Organisation	o
Part of the response	o

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 aims to publish responses at regular intervals during and after the consultation period. 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)

A9. Consultation questions

We are seeking comments from stakeholders on our proposals for extending access for satellite connectivity in the 14.25-14.5 GHz band in relation to the following questions:

Question 1: Have you identified an alternative use for the 14.25-14.5 GHz band which could lead to greater benefits for consumers and citizens than our proposal to extend satellite ESN authorisations? Please provide evidence to support your comments.

Question 2: Do you agree with our proposal to extend access in the 14.25-14.5 GHz band for satellite connectivity, for future broadband, air, sea, energy and transport uses? Please provide evidence to support your comments.

Question 3: Do you agree with our proposed protection requirements for a) radio astronomy users of 14.47-14.5 GHz; b) remaining fixed link users (at specified frequencies and locations) and c) Crown users?

Question 4: Do you agree with our proposed authorisation approach and draft licence conditions for a) ESN licences, and b) other licensees wishing to take advantage of enhanced satellite connectivity (i.e. aircraft, ships, unmanned aircraft systems).

Question 5: Do you have any other comments on our proposals?