Ofcom
making communications work
for everyone

More spectrum for satellite connectivity

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

STATEMENT:

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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.

To meet growing demand for satellite services and in light of changing use in the band, we are enabling satellite operators to access an additional 250 MHz of spectrum in the Ku band between 14.25-14.5 GHz. Our decision doubles the uncoordinated satellite terminal capacity available, enhancing the range of services satellite operators are able to provide, and enabling more seamless satellite services, on land, in the air and at sea. Services include connecting more rural homes and businesses, commercial and passenger aircraft and ships, offshore energy facilities and utilities. In the future, these frequencies could also help connect road vehicles, trains and unmanned aircraft systems (i.e. drones) across the UK, including in hard to reach locations. This statement is in line with our wider priority to get everyone in the UK connected, enable wireless services in the wider economy and support investment in secure, strong networks. It also advances our spectrum management vision of innovative and efficient spectrum, and our Space spectrum strategy supporting growth in geostationary orbit (GSO) and non-geostationary orbit (NGSO) satellite services.

We will implement these changes by varying existing Satellite (Earth Station Network) licences (the ESN licence) on request. Licensees can request access to these frequencies immediately. We will protect existing users of the 14.25-14.5 GHz band – radio astronomy, fixed links and Crown users – via new provisions in the ESN licence.

What we have decided – in brief

- We will extend access to the frequencies available for satellite connectivity on land, in the air and at sea, to include 14.25-14.5 GHz.
- Anyone wishing to make use of the 14.25-14.5 GHz band can now request a variation to their existing licence(s) or apply for a new licence.
- We will introduce specific licence conditions in **ESN licences** to protect existing users:
- 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 two radio astronomy sites.
- to protect the fixed links remaining temporarily in the band until the end of 2024 (currently nine paired links though only one is expected to remain after 2023). The protection requirement for each fixed link is specified in the Notice annexed to this Statement.
- to protect Crown users, existing protections as set out in Schedule 3 of the ESN licence will be extended across the whole 14-14.5 GHz band.

The overview section in this document is a simplified high-level summary only. The decisions we have taken, and our reasoning are set out in the full document.

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. In line with our duties under the Wireless Telegraphy Act 2006 (see annex 1), and our objectives under our 2021 Spectrum management strategy[1], 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 Within this context, satellites play an important role in communications. They can provide fixed broadband connections to homes, communities, and businesses, especially in hard to reach locations. They are increasingly used to enable connectivity for air and maritime 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 the Internet of Things; and connectivity for the transport sector (for rail, road, and drones), and the energy and utilities sector.

2.3 We have just published our refreshed Space spectrum strategy[2] in response to the rapid changes in the space sector over recent years. Our decision to release an additional 250 MHz for new satellite services is one element of this strategy.

2.4 Ofcom's Space spectrum strategy seeks to ensure our approach to spectrum management enables the space sector to deliver even greater benefits in the future, and to use spectrum efficiently. Delivering on this objective involves finding the right balance between enabling new and innovative services whilst ensuring existing valuable services can continue. We aim to achieve this by focusing on three key areas:

- Communications – with a focus on NGSO satellite systems, we have already introduced a new NGSO licensing framework, and are pursuing improvements to international NGSO rules. We are also considering providing more spectrum to support satellite services.
- Earth observation and navigation – ensuring these satellite services receive appropriate protection from harmful interference.
- Understanding and enabling access to space – playing our role in supporting bodies responsible for addressing issues such as space debris and safe access to space.

Our consultation

2.5 In support of our wider objectives in the space sector, on 21 June 2022, we published a consultation examining how we propose to use the 14.25-14.5 GHz band in the UK (the 14 GHz consultation[3]). The consultation closed on 31 August, and we received 12

[1] Supporting the UK's wireless future: our spectrum management strategy for the 2020s
[2] Space spectrum strategy
[3] More spectrum for satellite connectivity: Extending access in the Ku band (14.25-14.5 GHz)

responses. One response was confidential and we published the 11 non-confidential responses on our website[4].

2.6 Having carefully considered these responses, this document sets out our decisions in relation to future use of the 14.25-14.5 GHz band. We summarise our proposals and stakeholders' responses to them in section 4.

What were we aiming to achieve?

2.7 Through our engagement with satellite operators we were aware that they considered the UK's current authorisation approach of limiting access (for uncoordinated satellite terminals) to the 250 MHz between 14-14.25 GHz, unduly constrained their operations compared to authorisations internationally. As a result, they were pressing for access to the whole 500 MHz between 14-14.5 GHz to:

- enhance and broaden the services they are able to provide (including inflight connectivity);
- simplify the regulatory and licensing regime (which also reduces their costs); and
- bring UK use into line with how the band is already authorised elsewhere.

2.8 We developed our proposals to support this growth and enable new satellite connectivity opportunities to homes and businesses across the UK. We noted that doubling the available capacity in the band could also deliver improved and innovative services for consumers. For example, boosting operators' ability to provide broadband to UK areas which are currently unserved or underserved by other technologies, and helping to close the gap on the remaining 0.3% of UK homes and businesses who do not yet have access to a decent broadband connection[5]. Furthermore, rail companies are 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.

2.9 We explained that it was now possible to make this additional spectrum available for satellite services in light of changing use of the band (i.e. with fixed links vacating the band). This development, combined with growing demand, meant the time was right to review use of the 14.25-14.5 GHz band. Our proposals would also align UK authorisations with how the band is used elsewhere (in Europe, United States and Asia Pacific).

How did we propose to achieve this?

2.10 We outlined a set of measures to ensure satellite services could coexist with incumbent users of the 14.25-14.5 GHz band, including radio astronomy between 14.47-14.5 GHz, and fixed links remaining in the band for a short period.

2.11 We said we would like to authorise access to the band under an existing Satellite Earth Station Network (ESN) licence, removing the requirement for satellite operators to coordinate individual terminals. We also sought to authorise mobile satellite services (MSS)

[4] 14 GHz consultation responses
[5] Connected Nations Update: Autumn 2022

on ships, planes and unmanned aircraft systems (i.e. drones), when used in conjunction with an ESN licence, by making the necessary adjustments to those respective licences.

Where would our proposals apply?

2.12 These authorisations would extend across the whole of the UK, with the potential for new satellite services available nationwide throughout the 14.25-14.5 GHz band – on land, in the air and at sea. The only exceptions to this are:

- two permanent exclusion zones around radio astronomy sites at Jodrell Bank and Cambridge in the top 30 MHz of the band, between 14.47-14.5 GHz;
- no permitted use of aeronautical terminals operating between 14.47-14.5 GHz;
- two further exclusion zones around two Crown sites (referenced in Schedule 3 of the ESN licence); and
- temporary protection zones to protect nine pairs of fixed links at various frequencies and locations, as explained in section 4.

When would our proposals take effect?

2.13 Under our proposals, licensees would be able to apply for new licences, or vary their existing licences, to use the frequencies immediately.

Structure of this document

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

- Section 3 recaps how satellite services might benefit from additional 14 GHz spectrum, and how the 14.25-14.5 GHz band is currently used;
- Section 4 revisits our consultation proposals, analyses stakeholders' responses and sets out our decisions, including our reasoning. We explain how we will manage coexistence with current services and the implications for spectrum authorisations; and
- Section 5 summarises our decisions and implementation approach.

3. Background

3.1 In our consultation, we explained how satellite technology is developing at speed, and the important role satellites play in communications, providing a wide range of connectivity benefits for citizens, consumers and businesses.

3.2 Satellite systems can operate in two ways: with either a large satellite in geostationary orbit (GSO)[6], or a constellation of smaller satellites in NGSO[7]. Until recently, GSO satellites have been the preferred means of delivering satellite services, but the deployment of new NGSO satellite communication systems is a key area of innovation in the space sector.

The Ku band is important for satellite connectivity

3.3 As one of the two global bands which can be used for satellite broadband services today (the other being the Ka band), the Ku band provides important satellite connectivity for the aviation, maritime, utilities and energy and broadcasting industries. [8] Demand for these satellite services is growing.

3.4 GSO and NGSO satellite operators in the UK are already authorised to use 14-14.25 GHz with coordinated satellite gateway earth stations (permanent and transportable earth stations, known as PES and TES respectively) or an ESN licence[9]. To date in the 14.25-14.5 GHz band, only PES and TES have been authorised in order to protect incumbent users of the band. This means satellite user terminals must acquire a PES licence (with associated costs) to operate from a fixed site, constraining large scale deployment of fixed terminals between 14.25-14.5 GHz. Earth Stations in Motion (ESIMs) have not been able to access these frequencies at all, constrained by historic fixed link use.

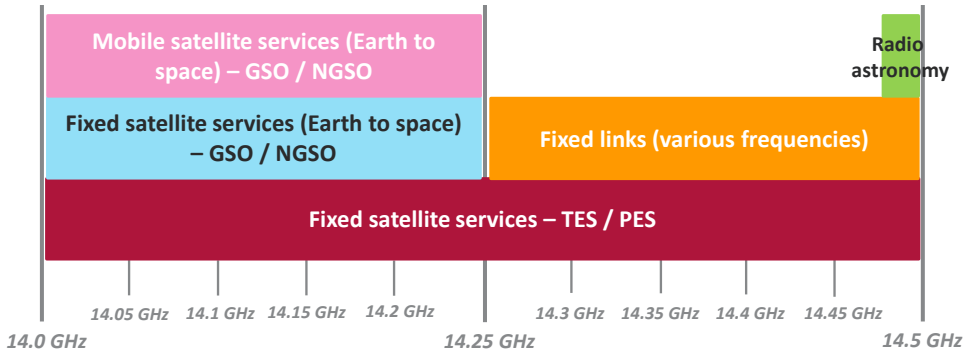
3.5 Our proposals to extend access to the 14.25-14.5 GHz band via an ESN licence would therefore remove such additional regulatory costs, and double the capacity available for GSO and NGSO satellite uplinks in Ku band. Reduced fixed links use in the band and the lack of evidence of demand for any other services, also provides an opportunity to expand the range of satellite services available in this band under an ESN licence.

[6] 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.
[7] NGSO satellites move in relation to the earth's surface and orbit much closer, in lower earth orbit (300-2000 km) or medium earth orbit (2000-35,786 km).
[8] 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).
[9] 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. moving terminals on aircraft, ships, or vehicles.

How the UK uses the 14.25-14.5 GHz band

3.6 We currently coordinate use in the 14.25-14.5 GHz band to prevent harmful interference from arising. Current users of the Ku band (14-14.5 GHz) are shown below in figure 1.

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



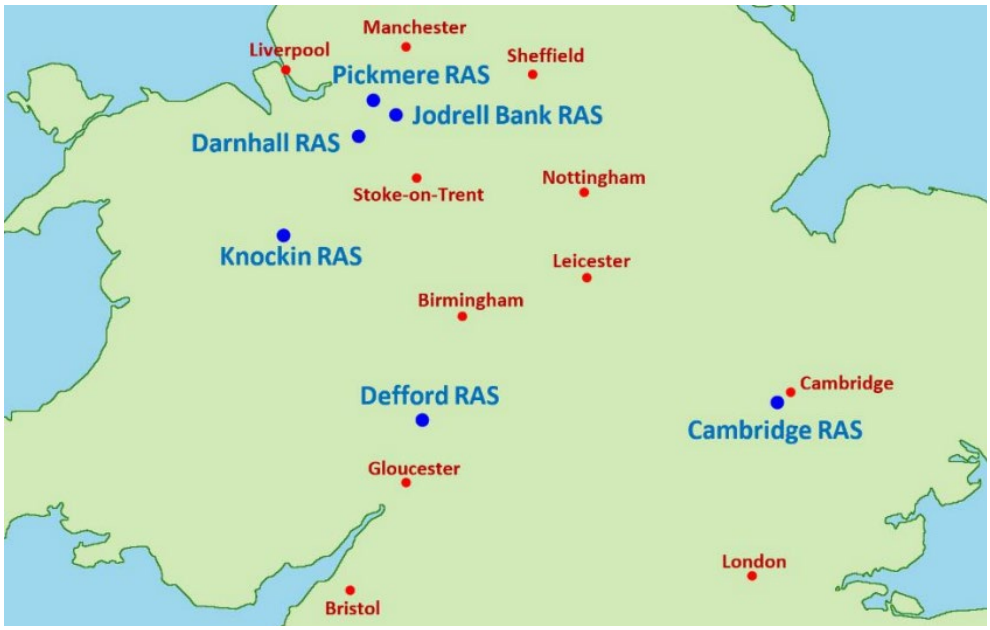
Radio astronomy service

3.7 In the Ku band, radio astronomers use 30 MHz between 14.47-14.5 GHz to conduct formaldehyde (H_2CO) line studies, providing valuable information for understanding the interstellar medium[10] in space, regarding the structure of the galaxy and life cycle of stars.

3.8 Much of the UK's radio astronomy research is undertaken across a network of six sites (see figure 2). Collectively, they can operate as e-MERLIN[11], the UK's national interferometer radio telescope array operated by Jodrell Bank for the Science and Technology Council (STFC)[12]. However, observations in this band are currently made from two sites only – Jodrell Bank and Cambridge – which operate and observe independently.

[10] The interstellar medium is the region between stars that contain vast clouds of gases and solid particles.
[11] e-MERLIN forms a key component of the global network for very-long-baseline interferometry (VLBI) radio astronomy facilities and complements the capability of the Square Kilometre Array (SKA). VLBI is a type of interferometry used to collect astronomical signals from multiple radio telescopes, to allow simultaneous observations of an object to be combined with improved angular resolution, for example in imaging distant cosmos. The SKA project is part of an international effort to build the world's largest radio telescope, in which the UK is investing around £300M over the next ten years. It will enable astronomers to monitor the sky in unprecedented detail, and much faster than any existing system.
[12] 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).

Figure 2: Map of UK radio astronomy sites



Fixed satellite services (FSS)

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

Permanent earth stations

3.10 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[13]. PES tend to be located away from populated areas.

3.11 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. In early 2022, there were 68 PES licensees covering 167 earth station deployments in the 14.25-14.5 GHz band.

Transportable earth stations

3.12 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 and a satellite[14]. To transmit at a specific location, TES licensees must seek clearance from Ofcom, to assess the potential for interference with fixed links or the risk posed to airports and other sensitive sites. Once a clearance is approved, TES licensees are authorised to transmit.

[13] Typically providing services such as telephony and data backhaul, broadcast feeder links, and telecommand and control.
[14] TES 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 operate at higher power levels.

3.13 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. 80% of these TES clearance requests were made by Sky and STV.

Fixed links

3.14 Fixed links provide wireless connectivity between two or more fixed locations using radio waves[15]. Fixed links complement other connectivity methods such as fixed networks (e.g. fibre), where fibre is not available or cost effective.

3.15 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 (and technical variations of existing links) in January 2003, their number has been in decline; from 100 paired links in 2018 to just 30 paired links at the time of our consultation.

3.16 Since then, there has been a further reduction of links in the band, with only **nine paired links remaining** – one Vodafone[16] and eight Arqiva links (see locations in figure 3).[17]

3.17 Licensees have indicated that these remaining fixed links will be removed from the 14.25-14.5 GHz band by the end of 2024 – Arqiva expect their eight paired links will be removed by the end of 2023, and Vodafone has consented to have their licence revoked with effect from 31 December 2024. The plan for removing the remaining fixed links is set out in paragraph 5.15.

[15] Fixed links typically operate in bi-directional pairs and are used to provide connectivity for a range of uses such as mobile and emergency services backhaul, supplying utility services, and broadcasting distribution.
[16] We note two additional Vodafone licences relating to fixed links are no longer carrying live data. Vodafone have indicated those licence will soon be cancelled, and those fixed link receivers do not require protection.
[17] All EE and Mobile Broadband Network Limited (MBNL) licences have now cancelled.

Figure 3: Locations of remaining fixed links in the 14.25-14.5 GHz band (links operate in pairs)

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 14-14.25 GHz band.

4. Stakeholder responses on extending spectrum access for satellite connectivity

4.1 We asked five consultation questions covering the future use of the 14.25-14.5 GHz band. We received 12 responses to our consultation questions and summarise these below, along with our views on these responses and our decisions.

We considered extending access for satellite connectivity to be the best use of this band

Our proposal

4.2 In view of the benefits of extending satellite services in this band, including potential future benefits for UK citizens and consumers (as set out in sections 2 and 3 above), we proposed to extend the frequencies available in the ESN licence to include access to the 14.25-14.5 GHz band.

4.3 We considered whether there might be other potential uses of the 14.25-14.5 GHz band (i.e. fixed or mobile services), but found there was little emerging evidence for alternative use cases. Bearing in mind that the band is already internationally harmonised for inflight connectivity, and that existing satellites and terminals serving the UK could make use of the new frequencies immediately and at low incremental cost, we proposed that satellite connectivity was likely to be the best use of these frequencies.

4.4 We asked:

> 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 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.

4.5 Questions 1 and 2 are combined in this section because stakeholders built on their question 1 response in question 2, so we deal with these together below.

Stakeholder views

4.6 All stakeholders responding to question 2 (ten responses[18]) agreed that satellite connectivity is the best use of the 14.25-14.5 GHz band. Satellite stakeholders noted that proceeding with our proposals will remove barriers currently constraining growing

[18] The ten stakeholders were: BT, BBC, Global Satellite Operator's Association (GSOA), Global VSAT Forum (GVF), OneWeb, SES, SpaceX, UK Chamber of Shipping, Viasat and one confidential respondent.

demand, given that next generation satellite networks rely on having access to the full 500 MHz in Ku band. The benefits we noted in our consultation were restated by respondents including:

- the ability to support high speed, low latency broadband, especially in hard to reach areas and offshore locations, and on moving vehicles including planes and ships;
- that it aligns the UK's authorisation approach with other CEPT countries;
- that access could be made immediately available; and
- that removing the requirement to coordinate terminals reduces operational and licensing complexity (given the Ku band is the preferred band for VSATs[19]);

4.7 Respondents also raised the important role that NGSO satellites are expected to play in:

- connecting government agencies and first responders following disasters;
- transforming the exchange of information in the maritime sector;
- strengthening resilience in existing communication networks; and
- improving broadcast contribution, especially in areas requiring rapid deployment or where terrestrial connectivity is poor (e.g. warzones).

4.8 We received nine responses to question 1 about alternative use of the band. Four respondents (BT, a confidential respondent and two radio astronomy respondents[20]) identified no alternative use, however the SKAO and RAS mentioned that radio astronomy was also a beneficial (incumbent) user of the band.

4.9 In addition, building on their responses to question 2, five satellite industry stakeholders (GSOA, GVF, OneWeb, SES, and Space X) noted the important benefits of the band for satellite connectivity, in particular for MSS.

4.10 Four stakeholders (GSOA, GVF, OneWeb and SES) asserted that the mobile industry has not yet demonstrated it will need, or had efficiently used, IMT[21] frequencies already identified by the WRC, and that this should be examined before looking to 14.25-14.5 GHz for IMT. [22]

4.11 We also received concerns (summarised at paragraphs 4.29-4.30) about the compatibility of GSO and NGSO systems, and how Ofcom's NGSO licensing approach will protect existing GSO satellite services, as NGSO networks rollout in larger numbers. We respond to these concerns from paragraph 4.43.

Our response

4.12 We note the benefits from improving satellite services, and the wide support for our proposals to extend access in the 14.25-14.5 GHz band for satellite connectivity. We also note that no alternative uses leading to greater benefits were identified.

[19] Very small aperture terminals.
[20] Square Kilometre Array Observatory (SKAO) and the Royal Astronomical Society (RAS)
[21] International Mobile Telecommunications
[22] For example, 17.5 GHz of spectrum was allocated for IMT at World Radiocommunications Conference (WRC)-19, but most has not yet been deployed for 5G.

4.13 We agree that radio astronomy is a beneficial user of the band (in its existing allocation between 14.47-14.5 GHz) and highlighted its importance in our consultation. We set out how we will protect that use from paragraph 4.48 below.

Our decision

4.14 We have concluded that satellite services are the best use of the 14.25-14.5 GHz band, given the support from stakeholders for extending access in this band for satellite connectivity, and that we did not receive any objections to our proposals. We have therefore decided to proceed with our plans to provide more spectrum to improve broadband, air, sea, energy and transport satellite services.

Our analysis determined that some restrictions would be necessary to protect incumbent users

Our proposal

4.15 We explained there are existing services in the 14.25-14.5 GHz band that could be impacted by interference from satellite services:

- radio astronomy operating at 14.47-14.5 GHz (at Jodrell Bank and Cambridge);
- fixed links (at various frequencies and locations between 14.25-14.5 GHz); and
- Crown use operating at two sites in the 14-14.5 GHz band.

4.16 We took account of existing international recommendations and reports[23] examining the impact of satellite terminals on other services in the 14-14.5 GHz band, and undertook further analysis to assess the protection requirements for fixed links and radio astronomy, taking account of UK national circumstances such as terrain and clutter. Our analysis also considered the various ways satellite user terminals could operate in this band, producing four coexistence scenarios: aeronautical ESIMs; stationary land earth stations (ES); land ESIMs; and maritime ESIMs. For simplicity:

- we amalgamated similar results, producing one condition for aeronautical ESIMs and one condition which applies to all other terminals.
- we adopted a combined interference area, after comparing modelled GSO and NGSO interference patterns for land and maritime terminals.

4.17 This analysis produced protection requirements for radio astronomy and fixed links from GSO and NGSO land, maritime and aeronautical terminals, which are summarised in table 1 below. As we had not yet confirmed which fixed links were expected to temporarily remain in the band, we provided an example exclusion zone for the Gairloch to Isle of Skye receivers. We noted we would confirm each of the bespoke exclusion zones for other

[23] Recommendation ITU-R M.1643 – providing technical and operational requirements for MSS and FSS aeronautical ESIMs; ECC Report 026 – covering the compatibility of aeronautical GSO FSS terminals with existing services in Ku band; and ECC Report 271 - covering the compatibility of NGSO FSS terminals with radio astronomy and fixed links in Ku band.

remaining fixed link receivers in our Statement, adopting the same principles and methodology as for the Gairloch to Isle of Skye example.

Table 1: Summary of proposed protection requirements for radio astronomy and fixed links

	Service		Protection requirements	
	Site/location	**Frequency band (GHz)**	**FSS land ES and FSS/mss land and maritime ESIM terminals**	**FSS/mss aero 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 [24] from focus points (NGRs [25]): SJ5739392556, TL5439992385.	Must not transmit between 14.47-14.5 GHz.
Fixed links: **Bespoke example 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 [26] 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 radio frequency 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.	

4.18 The MOD supported extending existing protection for the two Crown sites as set out in Schedule 3 of the ESN licence across the whole 14-14.5 GHz band.

[24] For Jodrell Bank, this includes the Isle of Man and surrounding waters within this area.
[25] Ordnance Survey national grid references
[26] Power flux density

4.19 We asked:

> 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?

Stakeholder views

General views on the protection requirements – for radio astronomy, fixed links and Crown use

4.20 All respondents (except the BBC) responded to question 3. Five stakeholders (BT, RAS, SKAO, UK Chamber of Shipping and the confidential respondent) simply agreed that our proposed protections, for fixed links, radio astronomy and Crown use, were appropriate.

4.21 The six satellite industry respondents (GVF, GSOA, OneWeb, SES, SpaceX, and Viasat) recognised the importance of protecting existing uses but sought modifications to our protection requirements which they generally considered to be too conservative given that the ECC decisions and ITU-R Recommendation establish a baseline operational limit (i.e. a worst case scenario). SES advised that factoring deployment information specific to each satellite system into our analysis would allow these limits to be refined to make more efficient use of the spectrum and not overly constrain satellite operations. Likewise, SpaceX argued that operators should not be overly constrained by exclusions zones, and that the findings of ECC report 271 should be adopted (where operators demonstrate compliance with identified protection criteria by submitting contouring that is based on their specific system's ES properties).

4.22 We received no comments on our proposals to extend the existing protections for Crown users at two MOD sites of up to 7 km, across the full 14-14.5 GHz band.

Specific views on the radio astronomy protection requirements

4.23 The RAS outlined radio astronomers' plans to extend observations in the band at additional radio astronomy sites, except Defford[27], and set out its views on the desirability of receiving single dish protection at all five UK radio astronomy sites. It also raised the challenge of radio interference from satellite constellations in both uplink and downlink transmissions affecting radio astronomy observations, noting it was vital for radio astronomy facilities to be afforded adequate protection from terrestrial and space-based sources, in order to operate at full capacity. Viasat also warned of the risks from large NGSO constellations harming ground-based astronomy.

4.24 Regarding the proposed 175 km radius protection zones around Jodrell Band and Cambridge applying to land and maritime ES and ESIMs, SES and the GSOA queried the requirement for land and maritime ESIMs operating under a primary FSS allocation to protect radio astronomy sites operating on a secondary allocation.

[27] The Defford site is unable to undertake measurements in higher frequencies, including the 14 GHz band.

4.25 SpaceX probed whether its NGSO terminals should be subject to restrictions it considers to be overly conservative, given the ability of its constellations to flexibly share spectrum through advance beam forming and digital processing technologies, which help it to dynamically avoid interference. Instead, SpaceX requested that smaller exclusion zones be applied to NGSO terminals based on terminal height and EIRP[28] specific to an operator's user terminals (given its terminals are typically under 20m high). Alternatively, it sought permission for operators to coordinate directly with radio astronomers in the 14.47-14.5 GHz band to agree coordination zones, which it considered more efficient.

4.26 Several satellite stakeholders disagreed that a UK-wide exclusion zone applying to aeronautical terminals was necessary to protect radio astronomy (GVF, GSOA, SES, OneWeb). They considered our approach to be too restrictive given that modern FSS terminals on aircraft have the ability to both avoid interference and take action if interference is detected[29]. Instead, they suggested that aeronautical terminals only needed to be muted in areas near radio astronomy sites, within an area up to 340 km (as they believe ECC report 271 concludes). It was also noted that in the US, a maximum radius of 160 km applies around radio astronomy sites, with most sites only needing 50 km.

Specific views on the fixed links protection requirements

4.27 Regarding the proposed protection zones for fixed links remaining temporarily in the band, some satellite respondents disagreed with the aeronautical protections and considered them overly restrictive (GSOA, OneWeb and SES). The GSOA and OneWeb suggested that the PFD mask in ECC report 271 should be adopted (rather than ITU-R M.1643 developed 20 years ago specifically for aeronautical terminals operating to GSO networks), as ECC report 271 reflects more recent studies[30] of both GSO and NGSO aeronautical operations on fixed links. SES further noted that the protection requirements may render aeronautical services impractical in the band. It pointed out that the PFD mask covers a worst-case scenario in which the pointing direction of the receiving terrestrial station is not known. By taking account of the link's location and pointing direction, more refined PFD limits could be established to reduce the size of protections zones.

4.28 Five satellite respondents (GVF, GSOA, OneWeb, SES and SpaceX) also sought clarification that fixed link protections would only apply at defined coordinates to those fixed links still operating. They requested we establish a clear, timed plan for the removal of those links temporarily remaining. SES further suggested that all fixed links should be transitioned out by 31 December 2023, to provide certainty of availability to satellite operators.

[28] Equivalent isotropic radiated power.
[29] Terminals are able to use their antenna system software to self-monitor, mute transmission and geofence as appropriate, along with the Network Control and Monitoring Centre (NCMC) facility which monitors and controls the aeronautical terminal to comply with defined exclusion zones and ensure no interference is caused, provided the radio astronomy site's latitude, longitude and observing frequencies are inputted.
[30] They noted that CEPT studied ITU fixed link parameters (ITU-R Recommendation F.758-6) and ITU compatibility methodologies (ITU-R Recommendation SF.1650), and thus developed a PFD mask to protect fixed links in ECC report 271.

Coexistence arrangements between satellites

4.29 While our proposals did not specifically consider coexistence issues between existing GSO satellite systems and new NGSO constellations, we received several comments on this issue. The GSOA agreed with our position that the obligation to coordinate under the ITU Radio Regulations should resolve coexistence challenges with FSS. However, the BBC highlighted the need to carefully consider the compatibility of GSO and NGSO systems, referring to Ofcom's assurances to protect ongoing GSO operations which remain vital to its operations, and to monitor the impact of NGSO systems. Similarly, the GVF wanted more information about our approach to update and establish technical conditions to ensure no harmful interference is caused by FSS stations operating with GSO and NGSO FSS satellite systems, and how it is captured under the ESN framework.

4.30 Additionally, Viasat argued for appropriate regulation of large NGSO systems to mitigate the risk of interference between GSO and NGSO systems, in light of how NGSO constellations are changing the interference environment. It requested us to adopt a similar approach to address coexistence between satellite systems as proposed in our consultation (between satellite and incumbent services). Viasat also suggested that we introduce further technical conditions and requirements in our NGSO licensing regime, submitting detailed information on how this could be achieved, including requiring NGSO operators to demonstrate that EPFD[31] limits are not exceeded. For example, that we consider uplink EPFD limits from separate filings in aggregate (which it argues might not be taken account of in the ITU's process for evaluating satellite filings).

Our response

General views on the protection requirements – for radio astronomy, fixed links and Crown use

4.31 We note the general support for protecting incumbent users of the band – radio astronomy, fixed links and Crown users.

4.32 On the issue of developing operator specific protection requirements, we have adopted a pragmatic approach in our coexistence methodology which aims to produce a simple, accurate and proportionate outcome. While we understand that taking account of individual operators' deployment information might reduce the size of our protection zones in some cases (i.e. for some NGSO operators), we chose to adopt a simplified approach that works for all operators, under a wide range of deployment scenarios. It also contains a level of futureproofing against changes to terminals and the arrival of new operators.

4.33 In addition, we consider the effort to implement operator specific zones would be disproportionate given the complexity required to coordinate them, including for future satellite operators, and the additional burden this would place on incumbent operators (and/or Ofcom). This is particularly the case for the small number of fixed links remaining in the band for only a short period of time.

[31] Equivalent power flux density

4.34 We are therefore content that the baseline protection zones we proposed provide certainty that protections are sufficient for incumbents, minimise burdens on spectrum users, comply with ETSI standards[32], and set out the necessary parameters for satellite operators to take account of before future deployment.

Specific views on the radio astronomy protection requirements

4.35 We note the RAS' reference to radio astronomers' plans to extend their observations to five additional sites in the 14.47-14.5 GHz band, all operating as single dishes. These plans differed from our earlier understanding of measurements moving to the e-MERLIN array (which would have enabled protection zones to be reduced in size). We have now discussed these plans with the Jodrell Bank Observatory, which manages radio astronomy observation sites in the UK, and confirmed that the two proposed protection zones around Jodrell Bank and Cambridge are sufficient to protect all five sites, if/when observations move to additional sites (due to less stringent e-MERLIN protection criteria being required at new sites). Therefore, we do not envisage any change to our protection requirements arising from these future plans.

4.36 With regard to protecting radio astronomy observations from interference from satellite constellations, we note the 14.25-14.5 GHz band is used for satellite uplinks only. However, we consider broader questions of how we can protect radio astronomy facilities from interference caused by satellite downlinks in our Space spectrum strategy (see from paragraph 4.39).

4.37 We have considered stakeholders' views on the primary and secondary allocation status of various services under the ITU Radio Regulations, which set international rules for the allocation of spectrum. However, it remains up to national administrations to determine how they interpret those rules within their own jurisdictions. In the UK we have previously permitted radio astronomy measurements in the top 30 MHz of the 14.25-14.5 GHz band and therefore have decided to protect its continued operation, while still opening up the rest of the band for new satellite services. In any case, in the Ku band there is no ITU-R resolution on the use of ESIMs, unlike Ka band. Our current understanding is that:

- aeronautical ESIMs (operating under a secondary MSS allocation) must protect older secondary allocations like radio astronomy; and
- maritime ESIMs operate on a no protection, no interference basis under Resolution 902, Article 4.4 and must protect other services in this band.

4.38 We do not consider it proportionate to develop bespoke operator specific protections, as we explain at paragraph 4.32 above. We did look further into differences in the modelled protection areas from GSO and NGSO systems, given that radio astronomy sites require ongoing protection, but these were small (less than 20 km). Consequently, and in light of the additional ongoing work required to develop bespoke requirements for each satellite system, we do not consider that it would be proportionate to implement different protections zones for GSO and NGSO systems. We also determine it is not practical to

[32] For example, ETSI EN 303 980

coordinate all terminals on an ongoing basis, and would be too burdensome on radio astronomy users to coordinate directly with satellite operators.

4.39 Concerning our proposal to exclude aeronautical use between 14.47-14.5 GHz, rather than simply muting aeronautical terminals in exclusion areas around the radio astronomy sites, our position was drawn from the internationally agreed reports we reviewed. Our analysis found that exclusion zones as suggested in paragraph 4.26, are not sufficient to protect radio astronomy from aeronautical terminals in the UK. ECC report 271 notes that when an aircraft enters in visibility of a radio astronomy station performing observations in the 14.47-14.5 GHz band, compliance with the PFD mask can only be achieved by avoiding transmissions within that band. Our interpretation is that aeronautical terminals cannot be used within 'line of sight' of radio astronomy sites, and in practice, this means not within UK airspace. Furthermore, we understand that other national administrations also exclude aeronautical ESIMs to protect radio astronomy, for example Germany. Lastly, our review of ECC report 271 shows that the 340 km zones apply to land VSATs, not aeronautical terminals as suggested. We are therefore not persuaded to alter our approach for restricting aeronautical use above 14.47 GHz in this band.

Specific views on the fixed links protection requirements

4.40 With regard to adopting the PFD limit from ECC report 271 for aeronautical terminals, based on our analysis, that PFD mask is not sufficient to protect UK fixed links. With the majority of Ku band aeronautical terminals currently supported by GSO systems, ITU Recommendation M.1643 continues to be appropriate given the PFD mask in ECC Report 271 only relates to NGSO satellite systems and does not by itself provide sufficient protection for incumbent services. In any case, internationally, GSO operators are still obliged to abide by ITU Recommendation M.1643. We are therefore not persuaded to refine the PFD limit for aeronautical terminals, while fixed links remain in the 14.25-14.5 GHz band.

4.41 However, as explained above, given fixed links are expected to vacate the band by the end of 2023 (except for one pair of receivers on the Isle of Skye, remaining until end 2024), these restrictions are short term and so the requirement to protect them will end in the near future. We therefore consider that a solution that is simple and speedy to implement and that applies to all satellite operators is a proportionate approach and supports the fastest access to new services for citizens and consumers.

4.42 With regard to our plan for managing fixed links remaining in the band, we agree that to facilitate new satellite use it is important to provide certainty for satellite operators on which fixed links will temporarily remain and for what duration. We also stated our intention to 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. The details for the nine paired fixed links remaining in the band for a limited period are summarised in table 2 below, and set out in the Notice (which forms part of the updated ESN licence) at annex 3.

Coexistence between satellites

4.43 Satellite services coexist through a process of coordination as laid out in the ITU Radio Regulations. Article 22 requires NGSO operators to meet relevant EPFD limits to protect GSO operators in this band. In addition, a condition of our ESN licence is that NGSO operators comply with Article 22. This means that we expect licensees to operate their UK terminals in such a way that their uplink transmissions do not cause harmful interference to GSO satellite receivers, irrespective of the number of satellite filings they may be operating under.

4.44 We recognise the importance of ensuring the ITU process operates as it should, and we intend to play an active role in ITU discussions of this matter, for example in ITU Working Party 4A. In addition, the ITU is discussing potential changes to international regulations to provide further guidance to administrations operating NGSO systems and may encourage yearly meetings between them to ensure the overall EPFD limits are met.

4.45 In addition, we have set out comments in the Space spectrum strategy to further support sharing of spectrum between GSO and NGSO satellite systems (see from paragraph 4.30).

Our decisions

4.46 Given the broad support from stakeholders for protecting incumbent users of the band, we have decided to implement protection requirements for radio astronomy, fixed links (for a limited duration) and Crown users. Our decisions are set out for each service in turn below.

4.47 We were not persuaded by stakeholders' arguments to modify the protection zones we proposed in our consultation, so have not made any adjustments to them. We have however, carried out additional analysis to confirm bespoke exclusion zones for the nine fixed links pairs remaining in the band that will need to be protected temporarily, adopting the same methodology as set out in annex 6 of the consultation.

Protection requirements for radio astronomy

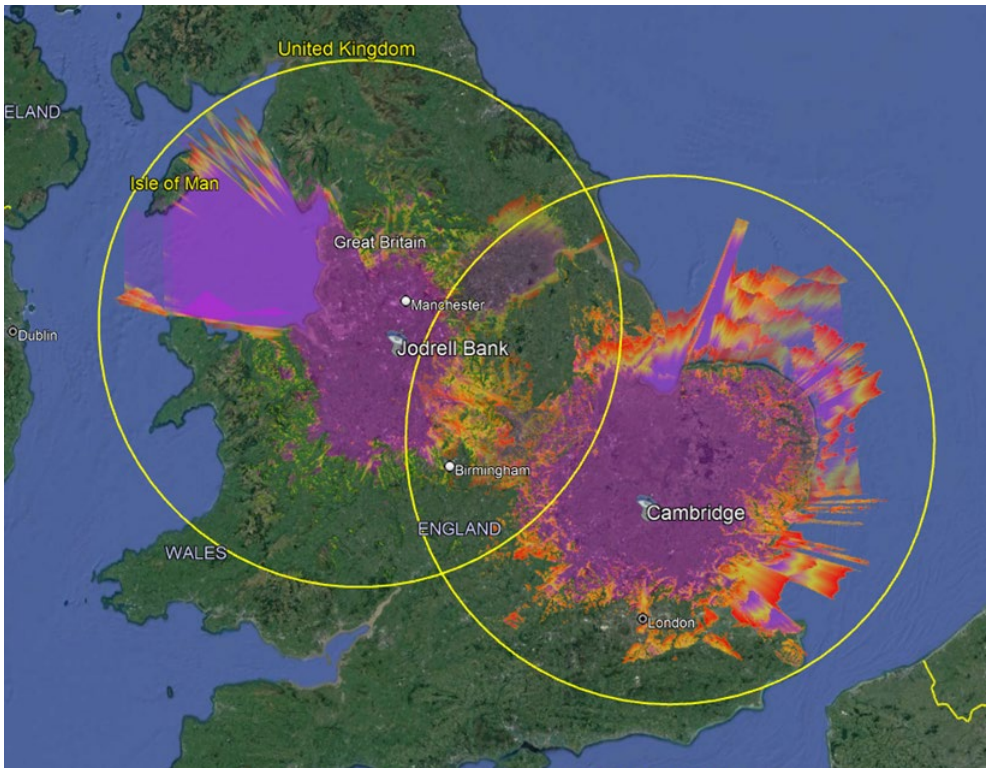
4.48 We have decided to proceed with our protection requirements for radio astronomy sites at Jodrell Bank and Cambridge, which apply to land, maritime and aeronautical terminals operating to GSO and NGSO satellite systems.

4.49 We will protect radio astronomy sites from **FSS land ES and FSS/mss land and maritime ESIM terminals** with the following exclusion zones applying to 14.47-14.5 GHz, as illustrated in figure 4:

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

4.50 We will also restrict the use of **FSS/mss aeronautical ESIM terminals** from transmitting between 14.47-14.5 GHz when in UK airspace.

Figure 4: Radio astronomy exclusion zones for Jodrell Bank and Cambridge from GSO and NGSO land and maritime terminals



Protection requirements for fixed links

4.51 We have decided to proceed with our protection requirements for fixed links, which apply to land, maritime and aeronautical terminals operating to GSO and NGSO satellite systems. These protections are time limited as discussed in paragraph 4.54 below, with expected maximum durations listed in table 2.

4.52 We will protect fixed link receivers from land and maritime terminals with a bespoke exclusion zone for each remaining receiver:

- **FSS land ES and FSS/mss land and maritime ESIM terminals** must not transmit between the specified frequencies within the bespoke exclusion zone for respective fixed link receivers. The exclusion zone is defined by the area formed within the NGR points for respective fixed link receivers, as listed in the Notice in annex 3 and summarised in pairs in table 2 below. (Exclusion zones for each of the remaining nine paired links are illustrated in annex 4.)

4.53 We will protect fixed link receivers from aeronautical terminals by limiting the PFD throughout the 14.25-14.5 GHz band:

- **FSS/mss aeronautical ESIM terminals** must not exceed the following PFD limit when transmitting between 14.25-14.5 GHz:

$-132 + 0.5 \bullet \theta$	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)

4.54 As fixed links are remaining in the band for a short period, we confirm that these protection requirements will only apply while the fixed links continue to operate. Specifically, each bespoke exclusion zone only applies at the location and relevant receiving frequency specified for that fixed link receiver, as set out in the Notice at annex 3. Therefore, the relevant protection requirements for land and maritime terminals will fall away as fixed links vacate the band (and the Notice is updated). For aeronautical terminals, the PFD limit will continue throughout the whole 14.25-14.5 GHz band until all nine remaining paired fixed links are removed (and the Notice is updated).

Table 2: Summary of protection requirements for fixed link receivers from land and maritime GSO and NGSO terminals

Receiver location (NGR)	Protection requirements for FSS land ES and FSS/mss land and maritime ESIM terminals	Timing
Dundry East (ST5620066100)	Must not transmit between **14.305-14.333 GHz** within the area formed by the following four NGRs: ST5703754171, ST5492568522, ST7798087946, ST8558956348	Until end 2022
Bathampton (ST7690065500)	Must not transmit between **14.445-14.473 GHz** within the area formed by the following four NGRs: ST4104373334, ST4359855690, ST7982354280, ST7996272371	
Southwick (SU6265406975)	Must not transmit between **14.305-14.333 GHz** within the area formed by the following four NGRs: SZ6894870801, SU3801231163, SU6837335489, TV0174085578	Until end 2022
Toothill (SU3840018100)	Must not transmit between **14.445-14.473 GHz** within the area formed by the following four NGRs: SZ5436190903, ST4365359764, SU1849344426, SU7625213952	
Wrekin Hill (SJ6280008200)	Must not transmit between **14.256-14.263 GHz** within the area formed by the following five NGRs: SO5851991283, SJ6009921550, SK2228258872, SK9580658937, TF0386519487	Until 31 March 2023
Pye Green (SJ9870014300)	Must not transmit between **14.396-14.403 GHz** within the area formed by the following five NGRs: SN7054383762, SH7066800477, SK0194348343, SK0291900695, SO5061384164	
Crockerton (ST8770042800)	Must not transmit between **14.277-14.305 GHz** within the area formed by the following four NGRs: ST7574531685, ST6571058551, SO7635106700, ST9700648310	Until 31 March 2023
Colerne (ST7940069200)	Must not transmit between **14.417-14.445 GHz** within the area formed by the following four NGRs: ST8861815577, ST6841366586, ST9103776083, ST9958720963	
Pendle Forest (SD8250038400)	Must not transmit between **14.277-14.305 GHz** within the area formed by the following four NGRs: SD6434910547,	Until 31 March

Receiver location (NGR)	Protection requirements for FSS land ES and FSS/mss land and maritime ESIM terminals	Timing
	SD5793030394, SD8400244179, SD8862323380	2023
Winter Hill (SD6600014400)	Must not transmit between **14.417-14.445 GHz** within the area formed by the following four NGRs: SD5429121376, SD9495479920, SE1962159524, SD8696102846	
Houghton on the Hill (SK6760004200)	Must not transmit between **14.305-14.333 GHz** within the area formed by the following four NGRs: SP4126499252, SK4006128742, SK7009315026, SP6918096284	Until 31 March 2023
Copt Oak (SK4840012700)	Must not transmit between **14.445-14.473 GHz** within the area formed by the following four NGRs: SP5070698843, SK4605516533, SK8467632276, SP8811685639	
Liverpool (SJ3480090400)	Must not transmit between **14.305-14.333 GHz** within area formed by the following four NGRs: SJ3491183878, SD3092605548, SE0550144087, SE0594707251	Until end 2023
Billinge/St Helens (SD5230001600)	Must not transmit between **14.445-14.473 GHz** within the area formed by the following four NGRs: SH6577440229, SH6088751257, SD5483515985, SJ5755291226	
Shilbottle ((NU1910008100)	Must not transmit between **14.277-14.305 GHz** within the area formed by the following four NGRs: NZ2369619026, NU0748409016, NU3198010457, NZ3551422190	Until end 2023
Morpeth (NZ2180086400)	Must not transmit between **14.417-14.445 GHz** within the area formed by the following four NGRs: NZ0218598105, NU2400928824, NZ3554394758, NZ2190186394	
Gairloch (NG7560090000)	Must not transmit between **14.305-14.333 GHz** within the area formed by the following four NGRs: NF8143745693, NF7860350086, NB7228407904, NG7936474883	Until end 2024
Isle of Skye (NG4160073890)	Must not transmit between **14.445-14.473 GHz** within the area formed by the following four NGRs: NG4435766759, NG3676382388, NC3070732585, NC3528011256	

Protection requirements for Crown use

4.55 We confirm that existing protections for the two Crown sites as set out in Schedule 3 of the ESN licence (where restrictions apply up to 7 km around each site, depending on EIRP levels) will be extended across the whole 14-14.5 GHz band.

Licence variations are necessary to give full effect to our proposals

Our proposals

4.56 We noted that extending access to the 14.25-14.5 GHz band for satellite connectivity would need to be reflected in relevant licences. While primarily affecting ESN licensees as the providers of satellite services, other licensees may also deliver satellite connectivity in conjunction with ESN licensees: e.g. inflight connectivity on aircraft, connectivity on ships, or for drones carrying out monitoring or surveillance. In summary:

- For **ESN licences**, we proposed to amend frequencies, where relevant, from 14-14.25 GHz to 14-14.5 GHz. We also proposed to add protection requirements to protect radio astronomy and fixed links from land, maritime and aeronautical terminals (as discussed above), and extend existing protections for Crown users.
- For **Aircraft radio licences (with WAS/Wi-Fi enabled equipment)** no changes proposed.
- For the new draft **Unmanned aircraft system (UAS) operator radio licence**, we proposed to amend frequencies from 14-14.25 GHz to 14-14.5 GHz, and require that use is only permitted when in conjunction with an authorised ESN licence.
- For **Ship radio licences (with ESV[33] enabled equipment)**, we proposed a new condition 9 (in place of existing authorisation for 14-14.25 GHz under condition 8) setting out a range of requirements for ES equipment used across the whole 14-14.5 GHz band, including that use is only permitted when in conjunction with an authorised ESN licence.

4.57 We proposed that new licence applicants would receive the new conditions as standard, and existing licensees could request to vary their licences to obtain the new conditions to access the additional spectrum. Once their licence(s) was issued/varied, they would be able to access the additional spectrum immediately.

4.58 We asked:

> 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, UAS).

Stakeholder views

4.59 Of the ten stakeholders providing views on our authorisation approach and draft licence conditions, seven respondents[34] simply agreed. A further two respondents (GSOA and SES) agreed in principle with our approach, but requested adjustments be made to reflect their comments on protection requirements. SES also sought to revise conditions to reflect the primary allocation of fixed and maritime operations relative to radio astronomy.

[33] ESV refers to earth station on a vessel

[34] BT, GVF, OneWeb, SKAO, SpaceX, UK Chamber of Shipping and a confidential respondent.

4.60 Viasat provided a detailed response on improvements it suggests should be made to our NGSO licence application process, to require additional information to protect GSO systems from interference.

Our response

4.61 As we explained in the previous subsection, we have not accepted that any changes are needed to our protection requirements and therefore do not consider it appropriate to make any adjustments to our authorisation approach. We also explained at paragraph 4.37 our position on how the ITU's primary and secondary services apply to this band.

4.62 We have identified an omission in our proposed variation to the Ship radio licence, as the note corresponding to condition 8(c)(a) at condition 8(c)(d) will also need to be removed to reflect the removal of the 14.25-14.5 GHz band from condition 8. For consistency across conditions, we have also amended the numbering format of condition 9 (from the version in the consultation).

4.63 Viasat's request to make changes to our NGSO licensing regime are addressed by comments our Space spectrum strategy.

Our decision

4.64 Given the widespread support for our authorisation approach, we have decided to proceed with our licensing changes. The specific changes for each licence are summarised below.

4.65 To gain access to the additional 250 MHz between 14.25-14.5 GHz, existing licensees will need to request a licence variation. All new licences will receive the revised licence conditions (for relevant licences) as standard.

Satellite earth station network licence

4.66 To give effect to our decisions in this statement, we will amend ESN licences as shown in annex 2 (changes highlighted in yellow). Specifically, we will amend frequencies from 14-14.25 GHz to 14-14.5 GHz in Condition 2 of Schedule 1, extend the existing protection for Crown use, and add new protection requirements as described below.

4.67 For radio astronomy, to protect sites at Jodrell Bank and Cambridge, we have decided to:

- restrict aeronautical terminals from transmitting between 14.47-14.5 GHz. This is 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(l));

4.68 For fixed links, since the restrictions are temporary and bespoke for each fixed link remaining in the band, we are not including the protection criteria in the ESN licence itself. Instead, we decided to require ESN licensees to protect fixed links in accordance with a separate Notice (see condition 2.5(m) and annex 3). 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 receiver) within the bespoke area formed by the specified NGR points. These bespoke areas for each receiver are defined in table 2 and annex 3, and illustrated in annex 4.

4.69 The Notice will apply to all ESN licensees authorised to use the 14.25-14.5 GHz band. We will update the Notice as necessary as fixed links vacate this band, and notify relevant ESN licensees accordingly. The Notice will no longer apply once all fixed links have vacated the band and their respective licences have been cancelled.

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

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

UAS operator radio licence

4.71 We published a consultation proposing to introduce a new UAS operator radio licence in June[35]. The proposed UAS radio licence is under consultation, and remains in draft form.

4.72 Nonetheless, if the UAS operator radio licence proceeds, we have determined that it should include frequencies permitting access across the whole band available for aeronautical use (i.e. between 14-14.47 GHz), and this should be reflected, where relevant, in proposed Schedule 2. If agreed, satellite connectivity in the 14-14.47 GHz band under a UAS operator radio licence is only possible when used in conjunction with an authorised ESN licence.

Ship radio licence (with ESV enabled equipment)

4.73 We have also decided to extend the frequencies available in the Ship radio licence[36]. Specifically, we will remove the conditions at 8(c)(a), 8(c)(d) 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). Condition 9 (as set out in annex 5) will require that the ES 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;

[35] Spectrum for Unmanned Aircraft Systems: Approach to authorising the use of radio equipment on UAS
[36] Conditions to the Ship radio licence are set out in the "Ship radio licence and Ship Portable Radio Licence: Terms, conditions and limitations" document, available on our website.

- must clearly identify all transmissions;
- must conform to Interface Requirement IR 2077.

4.74 Maritime connectivity in the 14.25-14.5 GHz band will only be possible once both the Ship radio and ESN licences are varied, as a Ship radio licence can only be used in conjunction with an authorised ESN licence.

Other comments

4.75 We also asked whether stakeholders had any additional comments on our proposals:

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

Stakeholder views

4.76 A number of respondents provided additional comments under question 5, and most of these have already been addressed in sections above. The remaining three issues are discussed below.

4.77 The GVF and SpaceX highlighted other ECC decisions they considered relevant to our proposals – ECC decisions 18(04)[37], 17(04)[38], and 18(05)[39] – which consider the application of licence exemption for FSS Ku band terminals. SpaceX contended that where specified standards are met by satellite operators, CEPT has decided licence exemption is appropriate when authorising the 14-14.5 GHz band.

4.78 Viasat raised concerns about large NGSO constellations threatening the safe and sustainable use of NGSO orbits(e.g. through increased risk of collisions and orbital debris), which could impact space science and spaceflight missions.

4.79 Viasat also pointed to studies that have identified an environmental cost from NGSO constellations, which have found changes to the chemistry of Earth's upper atmosphere from discharging alumina into the atmosphere when deorbiting satellites. It suggested we manage these risks through the introduction of new NGSO licence conditions.

Our response and decisions

4.80 With regard to licence exemption in the 14-14.5 GHz band, we do not exempt any terminals in this band. In the UK, following the CEPT's work, we have determined that a "light" licensing approach is appropriate, and as a result we authorise this band under an ESN licence. Therefore, we concluded that these ECC decisions were not applicable.

[37] ECC 18(04) - Harmonised use, exemption from individual licensing and free circulation and use of land based ESIM operating with GSO FSS satellite systems in the frequency bands 10.7-12.75 GHz and 14.0-14.5 GHz.
[38] ECC 17(04) - Harmonised use and exemption from individual licensing of fixed earth stations operating with NGSO FSS satellite systems in the frequency bands 10.7-12.75 GHz and 14.0-14.5 GHz.
[39] ECC 18(05) - Harmonised use, exemption from individual licensing and free circulation and use of ESIM operating with NGSO FSS satellite systems in the frequency bands 10.7-12.75 GHz and 14.0-14.5 GHz.

4.81 On the matter of safe and sustainable NGSO orbits, as we noted in our Space spectrum strategy from paragraph 5.17, Ofcom does not have a direct role in managing the safe and sustainable use of space.[40] However, we recognise the role spectrum can play, for example, to support radars to track the movements of objects in space or enabling in orbit servicing. We will continue to work with the relevant responsible bodies to support their work on these matters.

4.82 Concerning environmental matters, as we set out in our plan of work for 2022/23[41], we are engaging with our industry stakeholders to understand their approach to running their businesses sustainably, including how they affect the environment, and are affected by both environmental change and wider societal efforts to become more sustainable. We continue to consider how the sectors we regulate might contribute to the momentum towards the UK's net-zero carbon target.

4.83 However, we have no duties relating to the safe use of space or the environment, so it is not appropriate to include such matters in these licence conditions.

[40] Responsibilities lie with the UK Space Agency, the Civil Aviation Authority and BEIS.
[41] See page 53 of annex 2- Project Work for 2022/23 in Ofcom's Plan of Work 2022/23.

5. Summary of our decisions and next steps

Our decisions

Extending access for satellite connectivity

5.1 We have concluded that satellite connectivity is the best use of the 14.25-14.5 GHz band, to provide more spectrum to improve broadband, air, sea, energy and transport satellite services. To give effect to this decision, we have therefore decided to extend access to the frequencies available in the ESN licence to include the 14.25-14.5 GHz band.

Protecting incumbent users of the 14.25-14.5 GHz band

5.2 We confirm that existing services in the 14.25-14.5 GHz band (i.e. radio astronomy operating at 14.47-14.5 GHz, the nine remaining paired fixed links operating from various locations and on specified frequencies throughout the band, and Crown users) need to be protected from satellite services authorised under an ESN licence. However, as all fixed links are vacating the band by the end of 2024, the protection requirements will be temporary, with bespoke exclusion zones for each receiver, defined by the area within the NGR points listed (and also showing the longest length and width for each zone for scale).

5.3 We summarise the various protection requirements for radio astronomy and fixed links (grouped in their respective pairs) from GSO and NGSO land, maritime and aeronautical terminals in table 3 below. For the two Crown sites, existing restrictions (of up to 7 km depending on EIRP levels) will be extended across the whole 14-14.5 GHz band.

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

Site locations (NGR)	Protection requirements	
Radio astronomy	**FSS/mss aeronautical ESIM terminals:**	
UK wide	Must not transmit between **14.47-14.5 GHz**.	
Radio astronomy	**FSS land ES and FSS/mss land and maritime ESIM terminals:**	
Jodrell Bank and Cambridge	Must not transmit between **14.47-14.5 GHz** within a **175 km radius**[42] from focus points (NGRs): SJ5739392556, TL5439992385.	
Fixed link receivers	**FSS/mss aeronautical ESIM terminals:**	**Timing**
UK wide	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 θ[43] ≤ 40°	Until end 2024

[42] For Jodrell Bank, this includes the Isle of Man and surrounding waters within this area.
[43] where θ is the angle of arrival of the radiofrequency wave (degrees above the horizontal)

Site locations (NGR)	Protection requirements	
	-112 dB(W/(m^2 · MHz)) for 40 < θ ≤ 90°	
Fixed link receivers	**FSS land ES and FSS/mss land and maritime ESIM terminals:**	**Timing**
Dundry East (ST5620066100)	Must not transmit between **14.305-14.333 GHz** within the **37 x 33 km trapezoid** and area formed by the following four NGRs: ST5703754171, ST5492568522, ST7798087946, ST8558956348	Until end 2022
Bathampton (ST7690065500)	Must not transmit between **14.445-14.473 GHz** within the **39 x 20 km trapezium** and area formed by the following four NGRs: ST4104373334, ST4359855690, ST7982354280, ST7996272371	
Southwick (SU6265406975)	Must not transmit between **14.305-14.333 GHz** within the **61 x 40 km trapezium** and area formed by the following four NGRs: SZ6894870801, SU3801231163, SU6837335489, TV0174085578	Until end 2022
Toothill (SU3840018100)	Must not transmit between **14.445-14.473 GHz** within the **121 x 33 km trapezoid** and area formed by the following four NGRs: SZ5436190903, ST4365359764, SU1849344426, SU7625213952	
Wrekin Hill (SJ6280008200)	Must not transmit between **14.256-14.263 GHz** within the **147 x 54 km pentagon** and area formed by the following five NGRs: SO5851991283, SJ6009921550, SK2228258872, SK9580658937, TF0386519487	Until 31 March 2023
Pye Green (SJ9870014300)	Must not transmit between **14.396-14.403 GHz** within the **143 x 51 km pentagon** and area formed by the following five NGRs: SN7054383762, SH7066800477, SK0194348343, SK0291900695, SO5061384164	
Crockerton (ST8770042800)	Must not transmit between **14.277-14.305 GHz** within the **71 x 30 km trapezoid** and area formed by the following four NGRs: ST7574531685, ST6571058551, SO7635106700, ST9700648310	Until 31 March 2023
Colerne (ST7940069200)	Must not transmit between **14.417-14.445 GHz** within the **55 x 24 km trapezoid** and area formed by the following four NGRs: ST8861815577, ST6841366586, ST9103776083, ST9958720963	
Pendle Forest (SD8250038400)	Must not transmit between **14.277-14.305 GHz** within the **31 x 23 km trapezium** and area formed by the following four NGRs: SD6434910547, SD5793030394, SD8400244179, SD8862323380	Until 31 March 2023
Winter Hill (SD6600014400)	Must not transmit between **14.417-14.445 GHz** within the **72 x 33 km rectangle** and area formed by the following four NGRs: SD5429121376, SD9495479920, SE1962159524, SD8696102846	

Site locations (NGR)	Protection requirements	
Fixed link receivers	**FSS land ES and FSS/mss land and maritime ESIM terminals:**	**Timing**
Houghton on the Hill (SK6760004200)	Must not transmit between **14.305-14.333 GHz** within the **35 x 26 km trapezoid** and area formed by the following four NGRs: SP4126499252, SK4006128742, SK7009315026, SP6918096284	Until 31 March 2023
Copt Oak (SK4840012700)	Must not transmit between **14.445-14.473 GHz** within the **47 x 39 km trapezoid** and area formed by the following four NGRs: SP5070698843, SK4605516533, SK8467632276, SP8811685639	
Liverpool (SJ3480090400)	Must not transmit between **14.305-14.333 GHz** within the **81 x 30 km trapezoid** and area formed by the following four NGRs: SJ3491183878, SD3092605548, SE0550144087, SE0594707251	Until end 2023
Billinge/St Helens (SD5230001600)	Must not transmit between **14.445-14.473 GHz** within the **107 x 26 km trapezoid** and area formed by the following four NGRs: SH6577440229, SH6088751257, SD5483515985, SJ5755291226	
Shilbottle ((NU1910008100)	Must not transmit between **14.277-14.305 GHz** within the **90 x 24 km trapezium** and area formed by the following four NGRs: NZ2369619026, NU0748409016, NU3198010457, NZ3551422190	Until end 2023
Pegswood/**M**orpeth (NZ2180086400)	Must not transmit between **14.417-14.445 GHz** within the **43 x 34 km trapezoid** and area formed by the following four NGRs: NZ0218598105, NU2400928824, NZ3554394758, NZ2190186394	
Gairloch (NG7560090000)	Must not transmit between **14.305-14.333 GHz** within the **106 x 34 km trapezium** and area formed by the following four NGRs: NF8143745693, NF7860350086, NB7228407904, NG7936474883	Until end 2024
Isle of Skye (NG4160073890)	Must not transmit between **14.445-14.473 GHz** within the **104 x 20 km rectangle** and area formed by the following four NGRs: NG4435766759, NG3676382388, NC3070732585, NC3528011256	

Varying licences

5.4 To give effect to our decisions in this statement, we have decided to proceed with our licensing changes. To gain access to the additional 250 MHz between 14.25-14.5 GHz, existing licensees will need to request a licence variation. The licence conditions, for respective licences, will apply to all new licences as standard. The specific licensing changes are summarised below:

Satellite earth station network licence

5.5 We will amend ESN licences as shown in annex 2 (changes highlighted in yellow). Specifically, changing frequencies from 14-14.25 GHz to 14-14.5 GHz in Condition 2 of Schedule 1, extending existing protection for Crown use, and adding new protection requirements as set out below.

5.6 For radio astronomy, to protect sites at Jodrell Bank and Cambridge, we will:

- restrict aeronautical terminals from transmitting between 14.47-14.5 GHz. This is 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(l));

5.7 For fixed links, since the restrictions are temporary and bespoke for each receiver remaining in the band, we are not including the protection criteria in the ESN licence itself. Instead, we decided to require ESN licensees to protect fixed links in accordance with a separate Notice (see condition 2.5(m) and annex 3). 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 receiver) within the bespoke area formed by the specified NGR points. These bespoke areas for each fixed link receiver are defined in table 3 above.

5.8 The Notice applies to all ESN licensees authorised to use the 14.25-14.5 GHz band, and will no longer apply once all fixed links have vacated the band.

Other affected licences

5.9 **Aircraft radio licences (with WAS/Wi-Fi enabled equipment)** - use is already permitted between 14-14.5 GHz provided it is done in conjunction with an authorised ESN licence, so no change to the Aircraft radio licence is needed. However, inflight connectivity in the 14.25-14.47 GHz band will only be possible once the relevant ESN licence is varied. We also note the restrictions applying to aeronautical ESIMs between 14.47-14.5 GHz.

5.10 **UAS operator radio licence** – provided this proposed licence proceeds, it should reflect frequencies across the whole aeronautical band between 14-14.47 GHz in proposed Schedule 2. The UAS operator radio licence must also be used in conjunction with an authorised ESN licence.

5.11 **Ship radio licence (with ESV enabled equipment)** - we have also decided to extend the frequencies available in the Ship radio licence[44]. Specifically, we will remove the conditions at 8(c)(a), 8(c)(d) and 8(i) referencing the 14-14.25 GHz band, and replace it with a new

[44] As reflected in the Ship Radio licence and Ship Portable Radio Licence: Terms, conditions and limitations

provision for the whole 14-14.5 GHz band (condition 9). Condition 9, as set out in annex 5, will require that the ES 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.

Maritime connectivity in the 14.25-14.5 GHz band will only be possible once both the Ship radio and ESN licences are varied, as a Ship radio licence can only be used in conjunction with an authorised ESN licence.

Implementation and next steps

Availability of the 14.25-14.5 GHz band for satellite services

5.12 ESN licensees are able to request variations immediately, from the date of this Statement. These frequencies are also available in all new licences as standard.

5.13 Ship radio licensees wishing to seek a variation, or a new licence, to take advantage of maritime connectivity in this band, can apply online from 13 November 2022.

Transitional period for protecting the remaining fixed link pairs

5.14 Remaining fixed links licensees have plans to vacate the 14.25-14.5 GHz band. In the meantime, ESN licensees will need to be aware of the transitional period, requiring temporary protections for the nine paired fixed links remaining in the band for a limited period, as set out in table 3 above, and in the Notice at annex 3.

5.15 Most fixed links are expected to leave the band by the end of 2023 (with only one paired link remaining in 2024). Licensees' plans for removing the remaining fixed links falls into three categories:

- Six paired links are currently being migrated by Arqiva under a plan of works due to be completed by Spring 2023; two paired links are due to migrate by the end of 2022, the remaining four paired links by 31 March 2023;
- Two further paired links also being migrated by Arqiva are subject to further technical work, and are due to be migrated by end 2023. We aim to provide ESN licensees with further clarity on this timeframe in early 2023; and
- One paired link supporting the emergency services between Gairloch and the Isle of Skye. Vodafone has consented to this licence being revoked with effect from 31 December 2024.

5.16 The timeframes for respective fixed links vacating the band are shown in table 3 above. As links are migrated, we will update the Notice as necessary, and notify relevant ESN

licensees accordingly. The Notice will no longer apply once all fixed links have vacated the band and their respective licences have been cancelled. The Notice is published on our website.

Guidance documents

5.17 We have updated the following guidance documents to reflect the decisions in this document, which are available on our website:

- NGSO licensing guidance
- OfW241 - UK frequency allocations for satellite earth stations

Interface Requirement 2077 has completed notification

5.18 As we noted in the 14 GHz consultation, we are required to notify the European Commission of a change to the frequencies included in IR 2077 because Northern Ireland continues to be part of the EU single market. The European Commission has three months to comment on our proposals.

5.19 To reduce any delay to implementing our proposals, we started this process in July 2022, notifying our draft IR 2077 to reflect our extended frequencies. The three-month standstill period ended on 27 October, and we did not receive any comments from other EU Member States. This allows us to proceed with our implementation plans.

A1. Legal framework

A1.1 This annex explains our legal framework, derived from our duties and powers under both the Communications Act 2003 (the '2003 Act') and the Wireless Telegraphy Act 2006 (the '2006 Act'). It 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

A1.2 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.

A1.3 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

A1.4 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.

A1.5 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.

A1.6 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

A1.7 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.

A1.8 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.

A1.9 We have a broad discretion under paragraph 6 of Schedule 1 of the 2006 Act to vary licences, subject to certain limitations.

A1.10 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

A1.11 The 14 GHz consultation document as a whole, including its annexes, comprised an impact assessment as defined in Section 7 of the Communications Act 2003. We do not consider that our proposals had any equality implications under the Equality Act 2010 or the Northern Ireland Act 1998.

A2. Satellite (Earth Station Network) Licence

A2.1 The ESN licence will be varied as follows, with changes highlighted in yellow.

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

l) 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.

m) 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 – 14.5 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 i) and j) 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

Aerodrome name	Address	Postcode	Telephone	UK/CI/NI	Easting	Northing	Aerodrome POC
Edinburgh	Edinburgh Airport	EH12 9DN	0131 317 7638	UK	314389	673842	Duty Air Traffic Engineer
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

Aerodrome name	Address	Postcode	Telephone	UK/CI/NI	Easting	Northing	Aerodrome POC
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
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

A3. Notice for ESN licences - Requirement to protect fixed links

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.[45]

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 receiver location (NGR)	Exclusion zone (the area within the following NGR points):	Corresponding frequencies (GHz)
Wrekin Hill: SJ6280008200	SO5851991283, SJ6009921550, SK2228258872, SK9580658937, TF0386519487	14.256-14.263
Crockerton: ST8770042800	ST7574531685, ST6571058551, SO7635106700, ST9700648310	14.277-14.305
Pendle Forest: SD8250038400	SD6434910547, SD5793030394, SD8400244179, SD8862323380	14.277-14.305
Shilbottle: NU1910008100	NZ2369619026, NU0748409016, NU3198010457, NZ3551422190	14.277-14.305
Dundry East: ST5620066100	ST5703754171, ST5492568522, ST7798087946, ST8558956348	14.305-14.333
Gairloch: NG7560090000	NF8143745693, NF7860350086, NB7228407904, NG7936474883	14.305-14.333
Houghton on the Hill: SK6760004200	SP4126499252, SK4006128742, SK7009315026, SP6918096284	14.305-14.333
Liverpool: SJ3480090400	SJ3491183878, SD3092605548, SE0550144087, SE0594707251	14.305-14.333
Southwick: SU6265406975	SZ6894870801, SU3801231163, SU6837335489, TV0174085578	14.305-14.333

[45] See our website for the current version.

Fixed link receiver location (NGR)	Exclusion zone (the area within the following NGR points):	Corresponding frequencies (GHz)
Pye Green: SJ9870014300	SN7054383762, SH7066800477, SK0194348343, SK0291900695, SO5061384164	14.396-14.403
Colerne: ST7940069200	ST8861815577, ST6841366586, ST9103776083, ST9958720963	14.417-14.445
Pegswood/Morpeth: NZ2180086400	NZ0218598105, NU2400928824, NZ3554394758, NZ2190186394	14.417-14.445
Winter Hill: SD6600014400	SD5429121376, SD9495479920, SE1962159524, SD8696102846	14.417-14.445
Bathampton: ST7690065500	ST4104373334, ST4359855690, ST7982354280, ST7996272371	14.445-14.473
Billinge/St Helens: SD5230001600	SH6577440229, SH6088751257, SD5483515985, SJ5755291226	14.445-14.473
Copt Oak: SK4840012700	SP5070698843, SK4605516533, SK8467632276, SP8811685639	14.445-14.473
Isle of Skye: NG4160073890	NG4435766759, NG3676382388, NC3070732585, NC3528011256	14.445-14.473
Toothill: SU3840018100	SZ5436190903, ST4365359764, SU1849344426, SU7625213952	14.445-14.473

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.

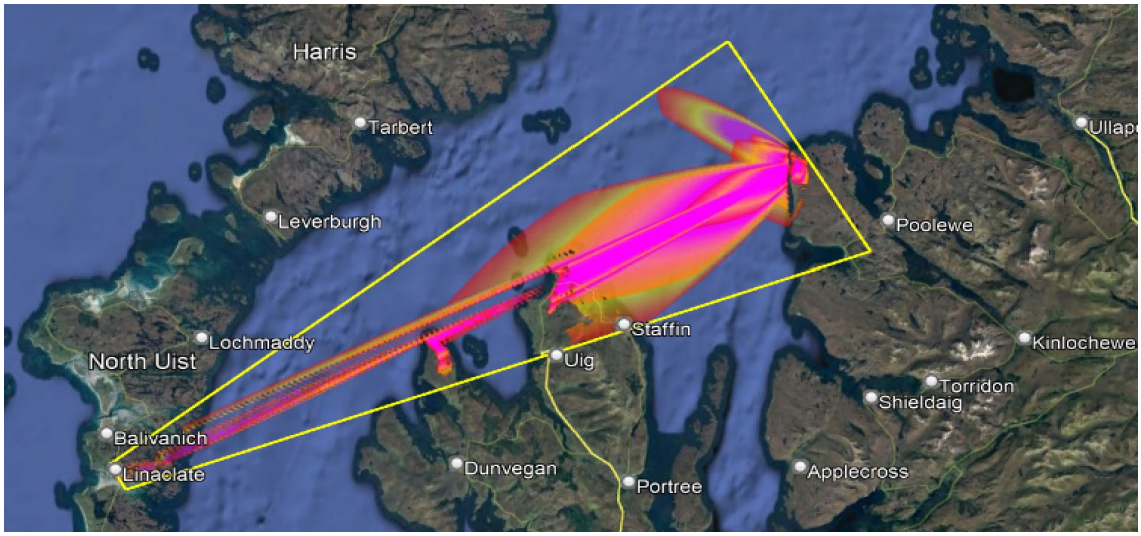
A4. Temporary fixed link exclusion zones

A4.1 The exclusion zones to protect fixed link receivers defined under the Notice set out in annex 3, which ESN licensees must take account of, are illustrated below. Note that in order to provide scale, the distances shown are for the longest length and width for each zone respectively, in kilometres.

West Scotland link

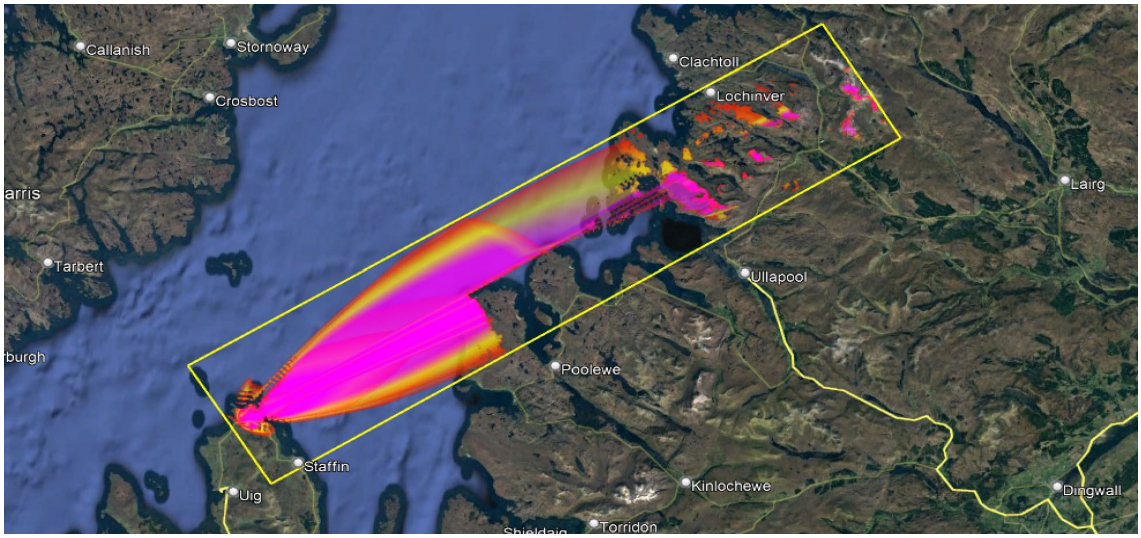
Gairloch

Figure 5: Combined interference area and exclusion zone to protect Gairloch fixed link receiver from GSO and NGSO land and maritime terminals (106 x 34 km)



Isle of Skye

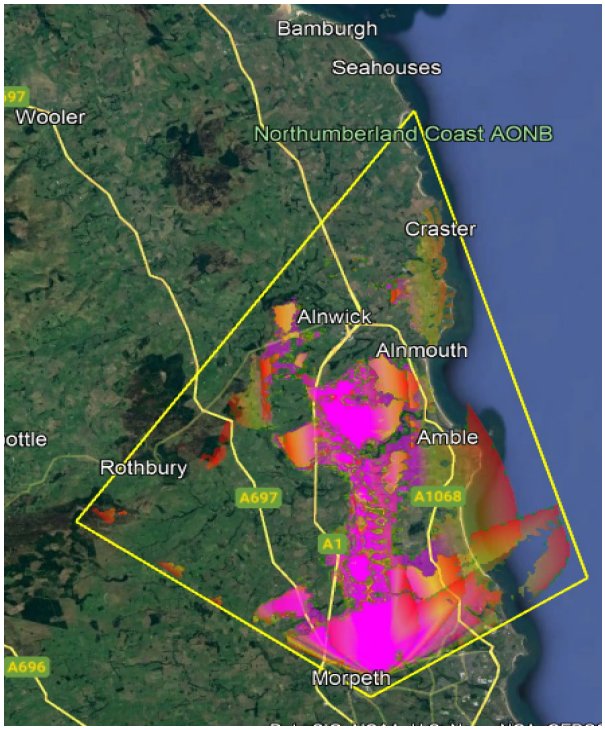
Figure 6: Combined interference area and exclusion zone to protect Isle of Skye fixed link receiver from GSO and NGSO land and maritime terminals (104 x 20 km)



Northumberland link

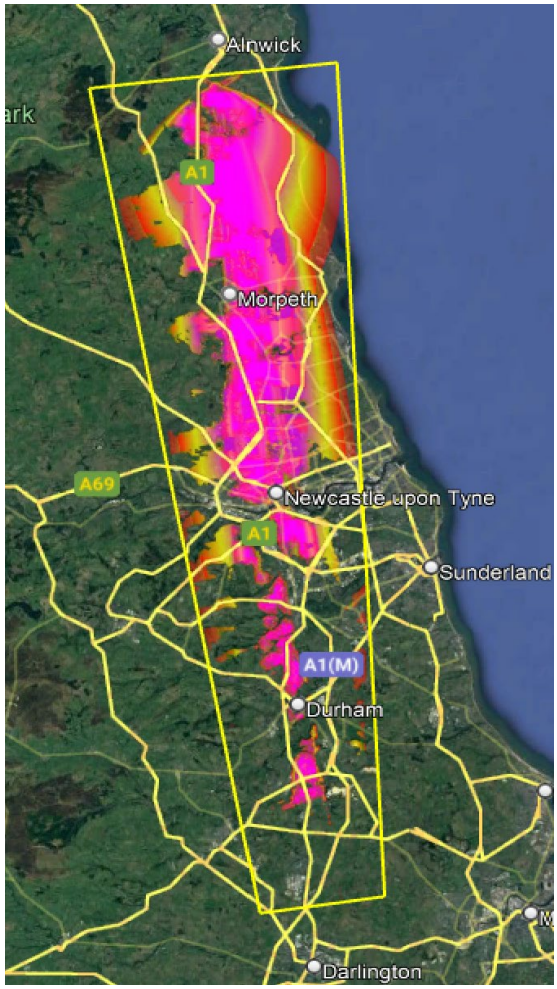
Pegswood/Morpeth

Figure 7: Combined interference area and exclusion zone to protect Pegswood/ Morpeth fixed link receiver from GSO and NGSO land and maritime terminals (43 x 34 km)



Shilbottle

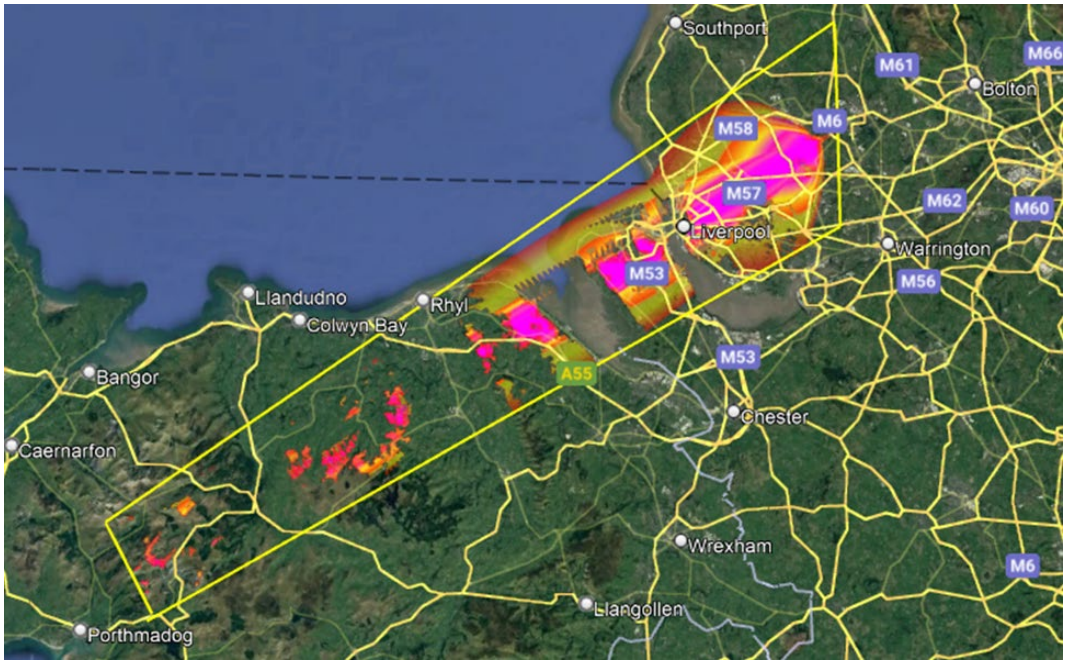
Figure 8: Combined interference area and exclusion zone to protect Shilbottle fixed link receiver from GSO and NGSO land and maritime terminals (90 x 24 km)



Liverpool link

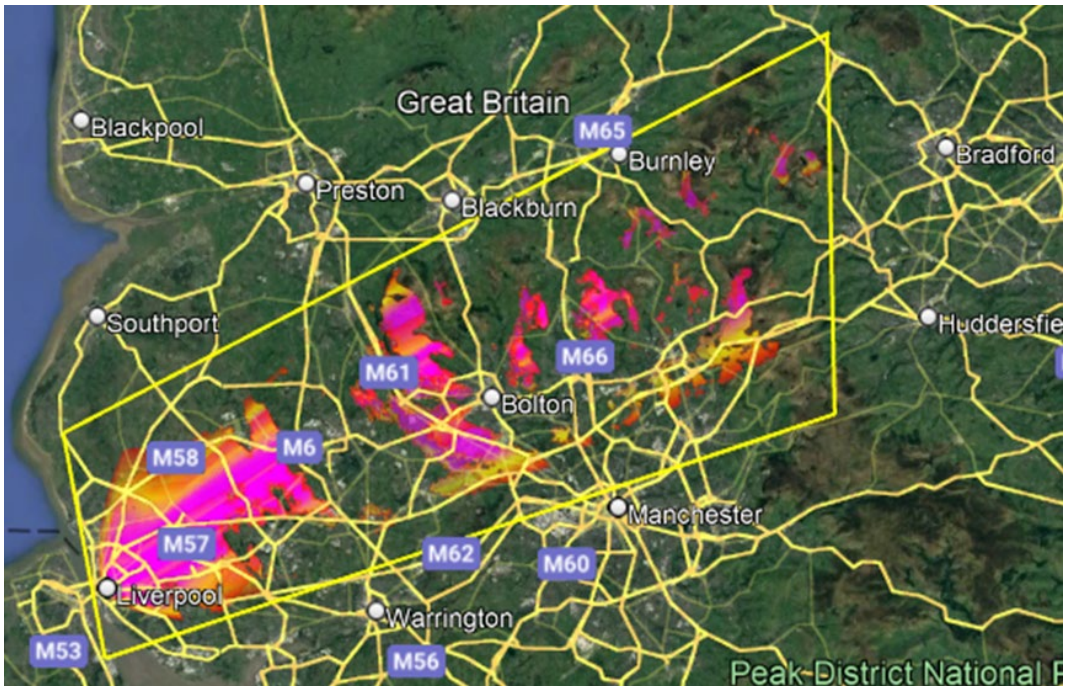
Billinge/St Helens

Figure 9: Combined interference area and exclusion zone to protect Billinge/St Helens fixed link receiver from GSO and NGSO land and maritime terminals (107 x 26 km)



Liverpool

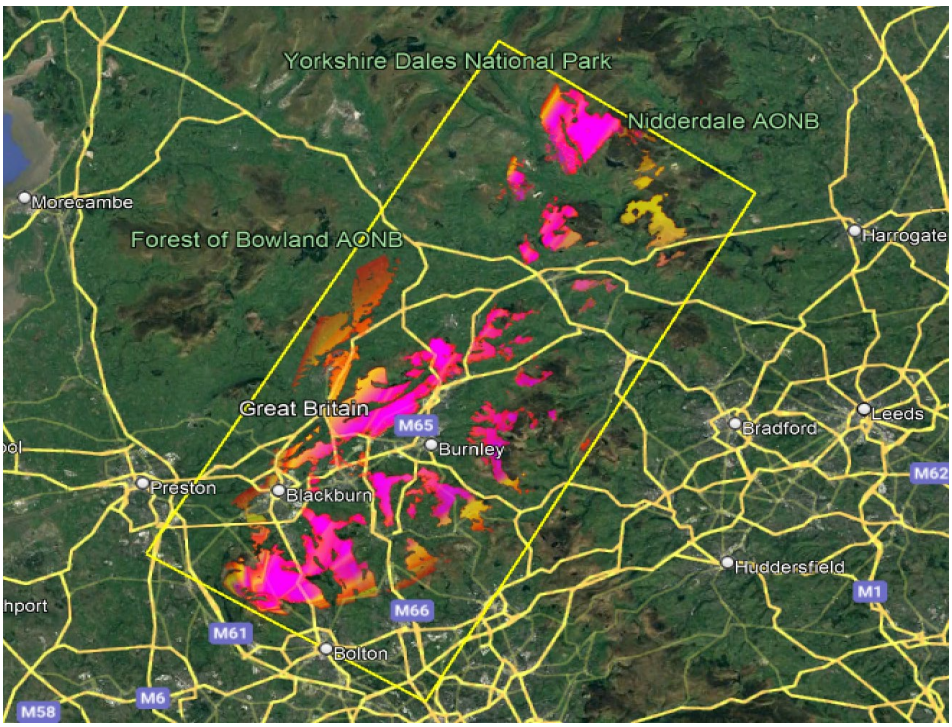
Figure 10: Combined interference area and exclusion zone to protect Liverpool fixed link receiver from GSO and NGSO land and maritime terminals (81 x 30 km)



Lancashire link

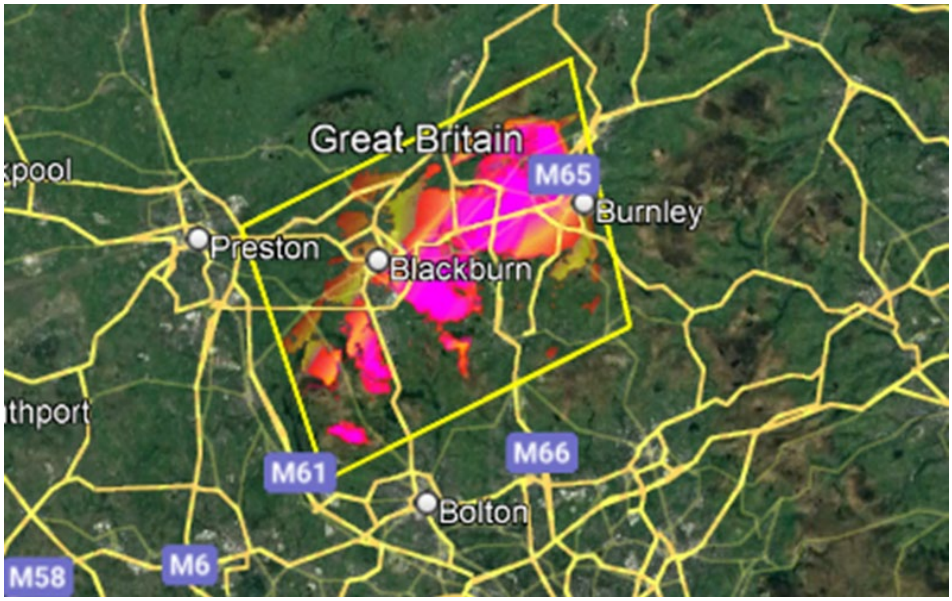
Winter Hill

Figure 11: Combined interference area and exclusion zone to protect Winter Hill fixed link receiver from GSO and NGSO land and maritime terminals (72 x 33 km)



Pendle Forest

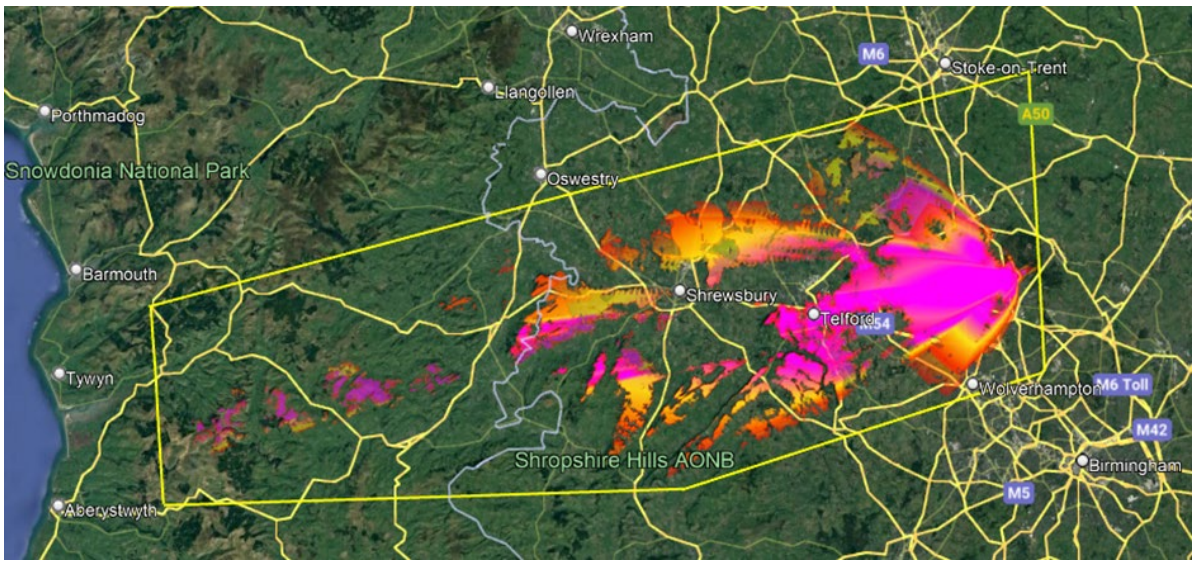
Figure 12: Combined interference area and exclusion zone to protect Pendle Forest fixed link receiver from GSO and NGSO land and maritime terminals (31 x 23 km)



Staffordshire link

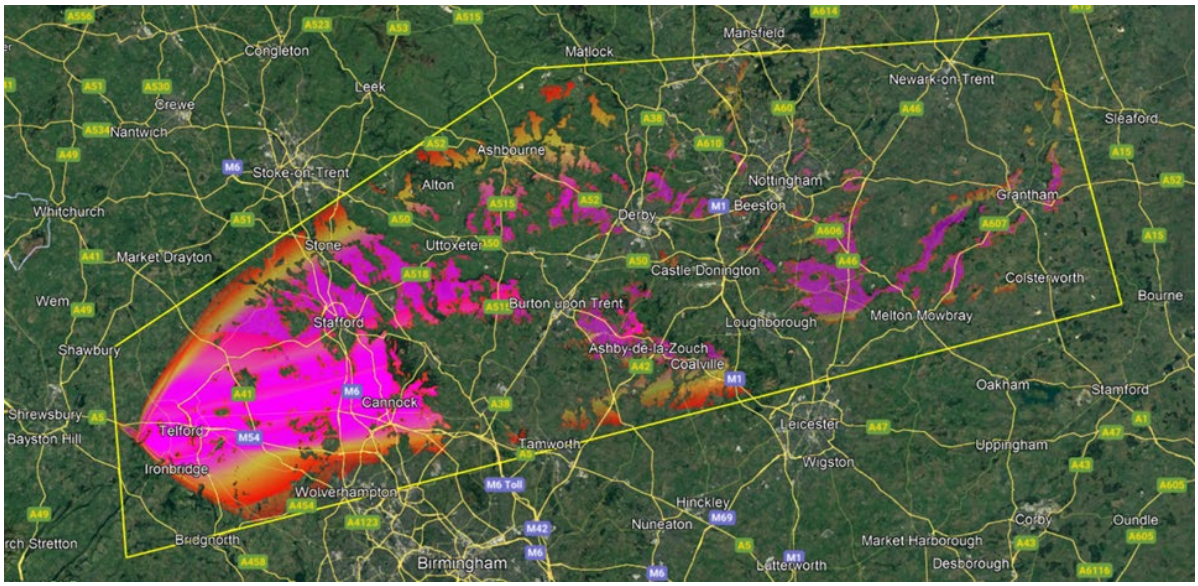
Pye Green

Figure 13: Combined interference area and exclusion zone to protect Pye Green fixed link receiver from GSO and NGSO land and maritime terminals (143 x 51 km)



Wrekin Hill

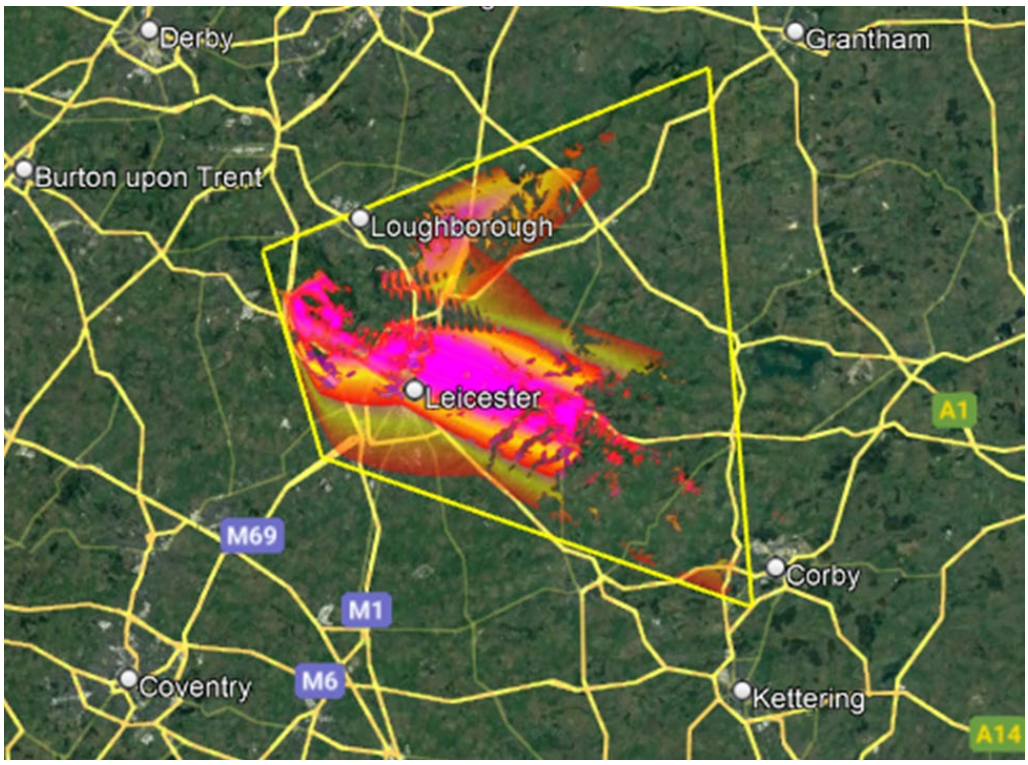
Figure 14: Combined interference area and exclusion zone to protect Wrekin Hill fixed link receiver from GSO and NGSO land and maritime terminals (147 x 54 km)



Leicestershire link

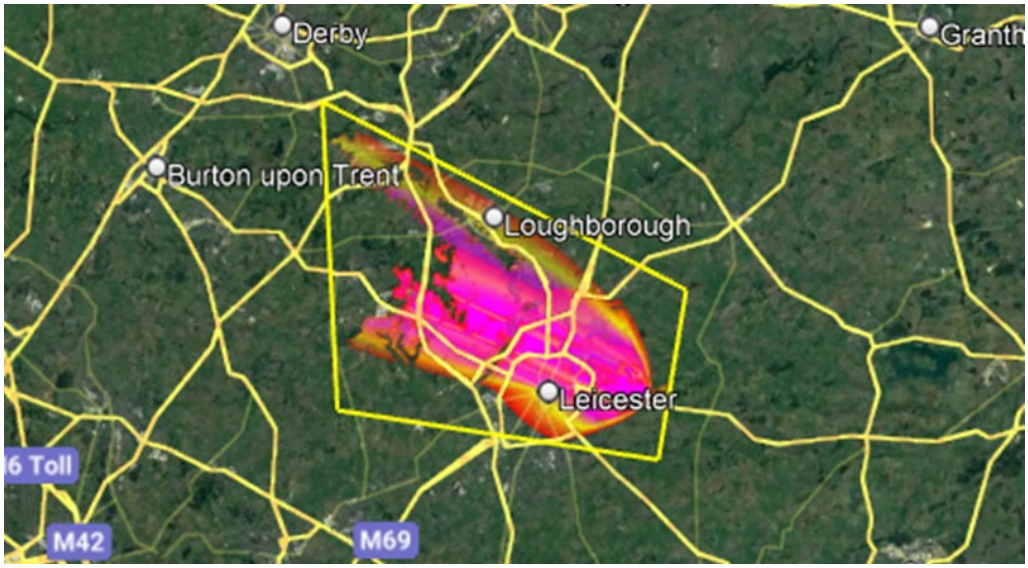
Copt Oak

Figure 15: Combined interference area and exclusion zone to protect Copt Oak fixed link receiver from GSO and NGSO land and maritime terminals (47 x 39 km)



Houghton on the Hill

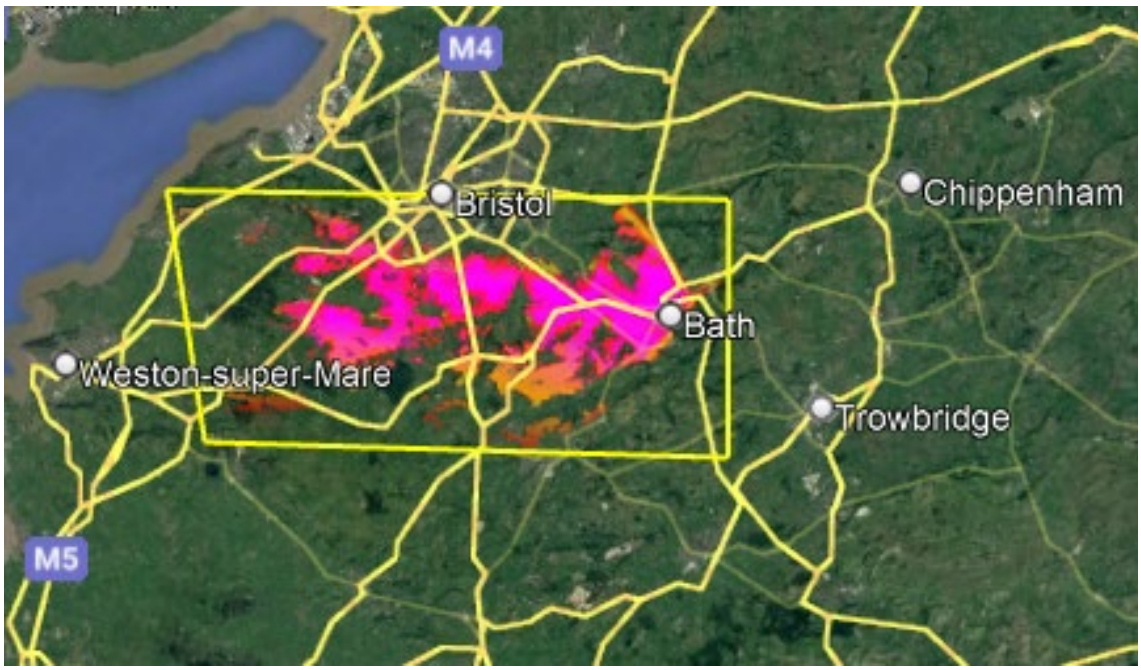
Figure 16: Combined interference area and exclusion zone to protect Houghton on the Hill fixed link receiver from GSO and NGSO land and maritime terminals (35 x 26 km)



Bath link

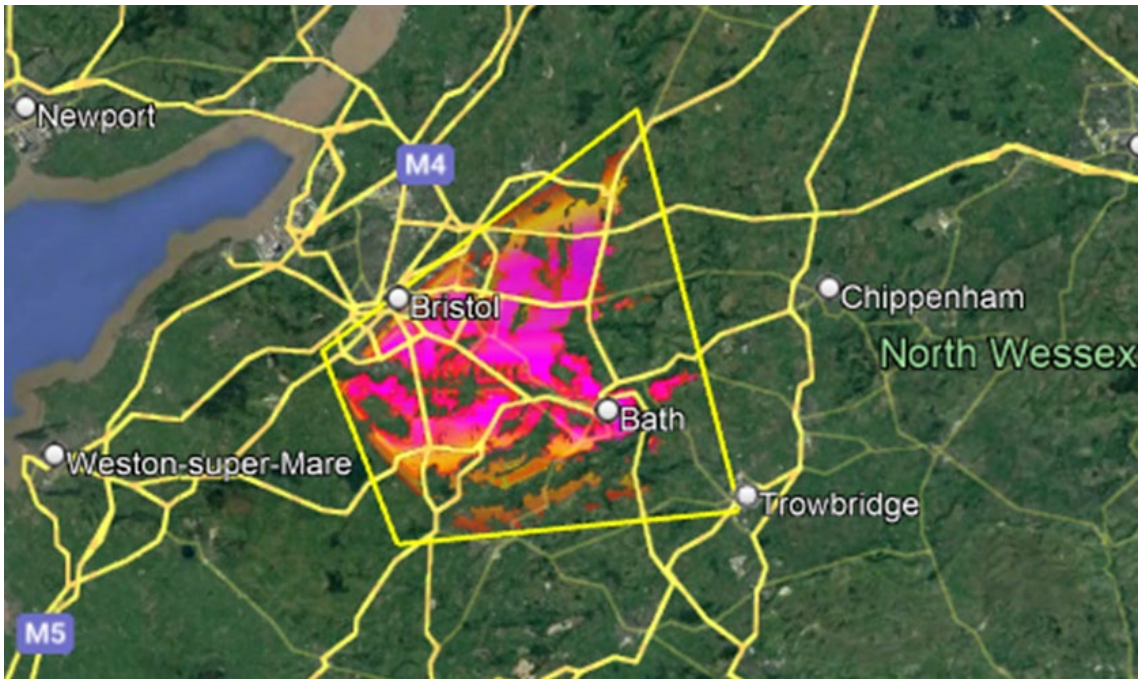
Bathampton

Figure 17: Combined interference area and exclusion zone to protect Bathampton fixed link receiver from GSO and NGSO land and maritime terminals (39 x 20 km)



Dundry East

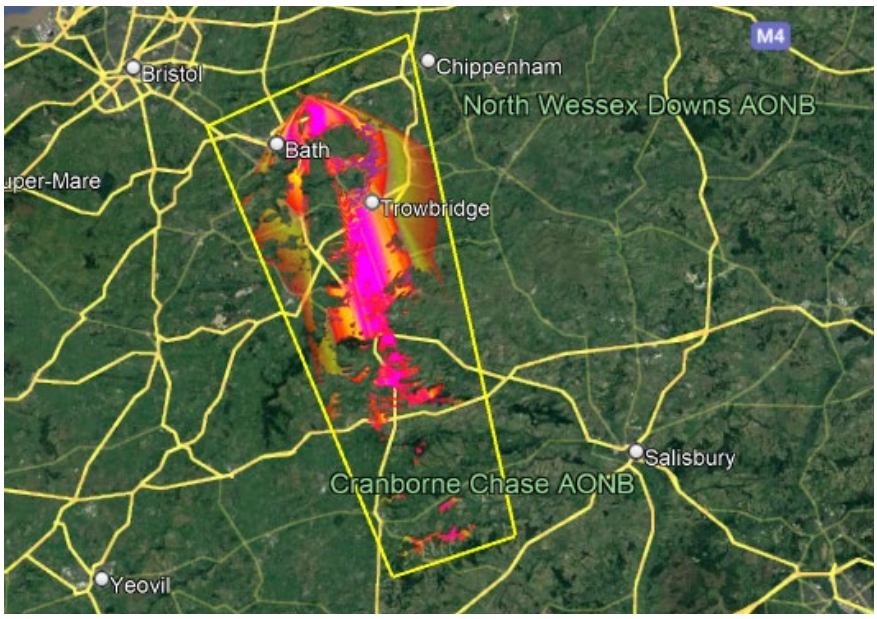
Figure 18: Combined interference area and exclusion zone to protect Dundry East fixed link receiver from GSO and NGSO land and maritime terminals (37 x 33 km)



Wiltshire link

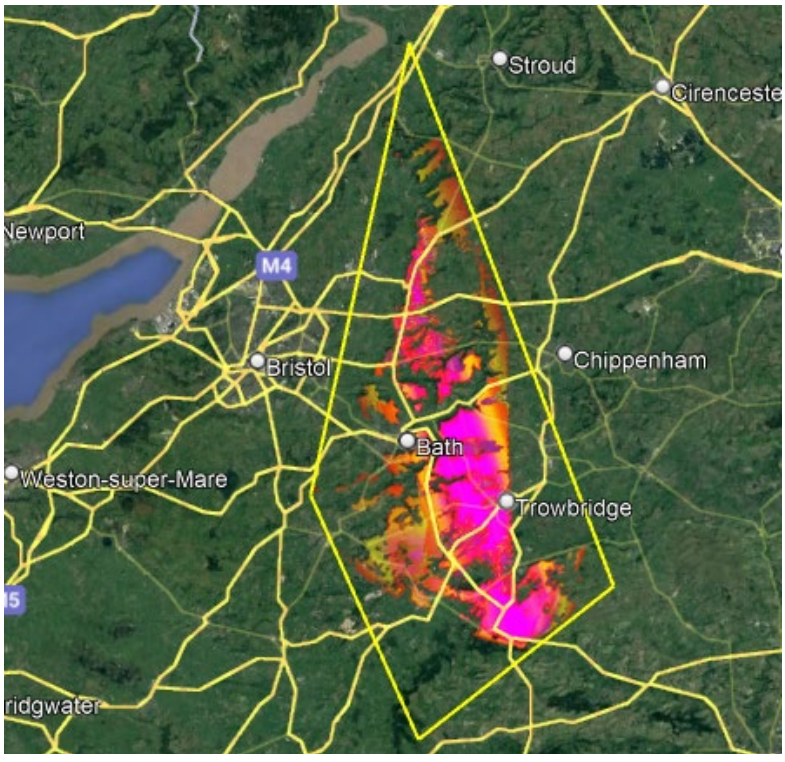
Colerne

Figure 19: Combined interference area and exclusion zone to protect Colerne fixed link receiver from GSO and NGSO land and maritime terminals (55 x 24 km)



Crockerton

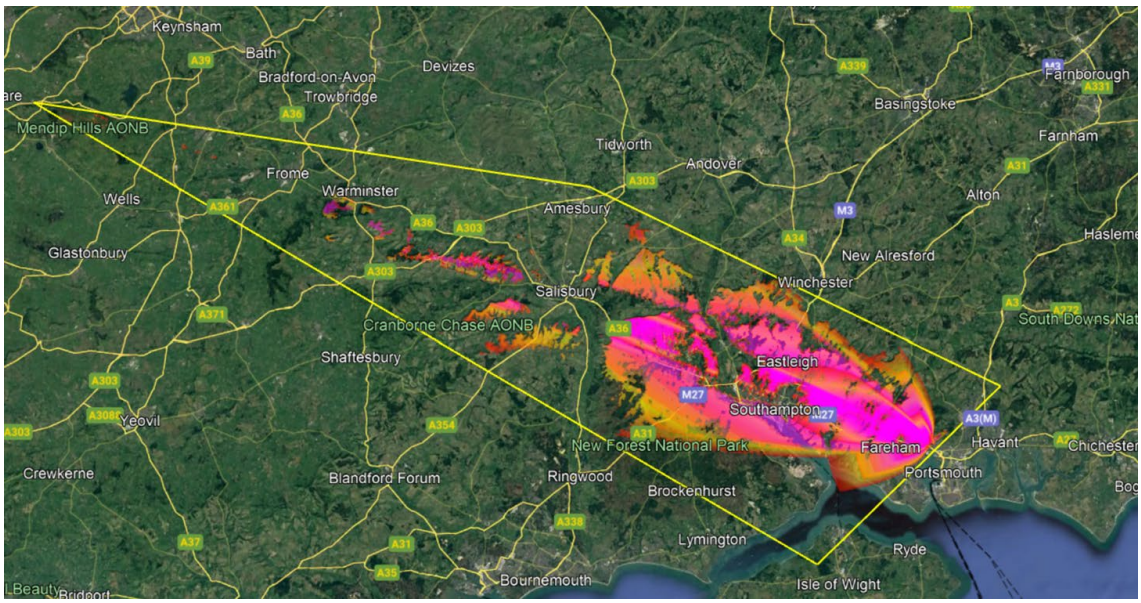
Figure 20: Combined interference area and exclusion zone to protect Crockerton fixed link receiver from GSO and NGSO land and maritime terminals (71 x 30 km)



Hampshire link

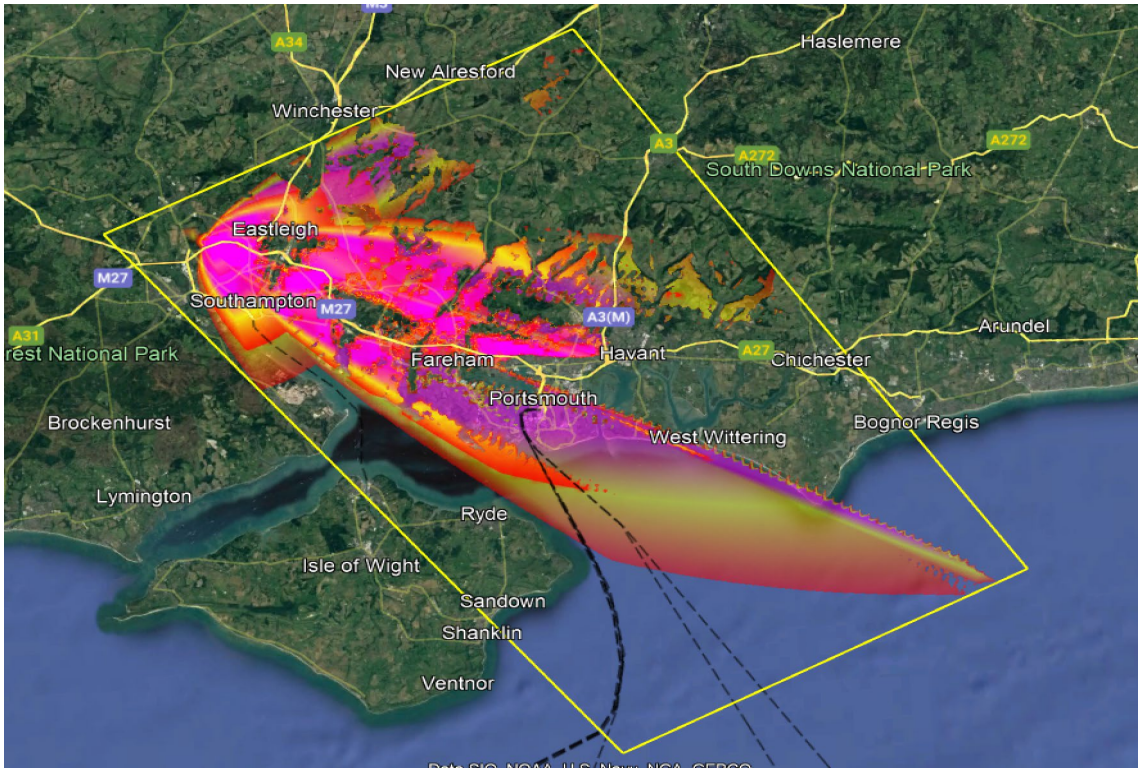
Toothill

Figure 21: Combined interference area and exclusion zone to protect Toothill fixed link receiver from GSO and NGSO land and maritime terminals (121 x 33 km)



Southwick

Figure 22: Combined interference area and exclusion zone to protect Southwick fixed link receiver from GSO and NGSO land and maritime terminals (61 x 40 km)



A5. New 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 at paragraph 4.73, we will make the following variation (by consent) to the Ship radio licence terms and conditions[46].

A5.2 Remove conditions 8(c)a, 8(c)d 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 authorising use of ES equipment in the 14-14.5 GHz band, as follows:

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

9 In relation to the use of 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;

(i) 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.

[46] Ship radio licence and ship portable licence: Terms, conditions and limitations

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

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

(ii) "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;

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

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